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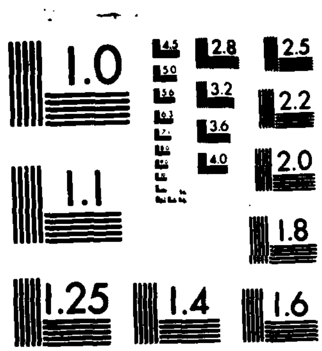

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ELECTRICAL RESISTIVITY OF CHROMIUM, COBALT, IRON, AND NICKEL

By

T. K. Chu and C. Y. Ho

CINDAS Report 60

June 1982

Prepared for

OFFICE OF STANDARD REFERENCE DATA
National Bureau of Standards
U. S. Department of Commerce
Washington, D.C. 20234

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This work compiles, reviews, and discusses the available data and information on the electrical resistivity of chromium, cobalt, iron, and nickel and presents the recommended values resulting from critical evaluation, correlation, analysis, and synthesis of the available data and information. The recommended values presented are uncorrected and also corrected for the thermal expansion of the material and cover the temperature range from 1 K to above the melting point into the molten state. The estimated uncertainties in most of the recommended values are about ±5%.

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PREFACE

This technical report was prepared by the Center for Information and Numerical Data Analysis and Synthesis (CINDAS), Purdue University, West Lafayette, Indiana, under the auspices of the Office of Standard Reference Data of the National Bureau of Standards (NBS), Department of Commerce, Washington, D.C.

This report represents the most exhaustive compilation and critical evaluation of the recorded world knowledge on the electrical resistivity of chromium, cobalt, iron, and nickel, and is one of a series of technical reports on the electrical resistivity of selected elements. The literature search and data compilation have been done in a most extensive and detailed manner, making it possible for all users of the subject to have access to the original data without having to duplicate the laborious and costly process of literature search and data extraction. Also, for the active researchers in the field, a detailed discussion is presented for each material, reviewing the available data and information, giving details of data analysis and synthesis, and discussing the considerations involved in arriving at the final recommended values.

It is hoped that this work will prove useful not only to the engineers and scientists in the field but also to other engineering research and development programs and for industrial applications, as it provides a wealth of knowledge heretofore unknown or inaccessible to many. In particular, it is thought that the critical evaluation, analysis and synthesis, and reference data generation constitute a unique aspect of this work.

Although this report is primarily the result of financial support and interest of the NBS Office of Standard Reference Data, the extensive documentary activity essential to this work was supported by the Defense Logistics Agency of the Department of Defense. Thanks are due Dr. H. J. White, Jr., of the NBS Office of Standard Reference Data for his guidance, cooperation, and sympathetic understanding during the course of this work.

ABSTRACT

This work compiles, reviews, and discusses the available data and information on the electrical resistivity of chromium, cobalt, iron, and nickel and presents the recommended values resulting from critical evaluation, correlation, analysis, and synthesis of the available data and information. The recommended values presented are uncorrected and also corrected for the thermal expansion of the material and cover the temperature range from 1 K to above the melting point into the molten state. The estimated uncertainties in most of the recommended values are about ±5%.

Key words: Chromium; cobalt; conductivity; critical evaluation; data analysis; data compilation; data synthesis; electrical conductivity; electrical resistivity; elements; iron; metals; nickel; recommended values; resistivity.

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NOMENCLATURE

A	Constant in eqs (3b) and (8)
c	Impurity concentration
C	Constant in eq (3a)
e	Base of natural logarithm
$\hbar$	Planck constant divided by 2π
k	Boltzmann constant
L	Length of specimen at T
L_0	Length of specimen at T_0
ΔL	$\Delta L = L - L_0$
M	Atomic weight
T	Temperature
T_0	Reference temperature
x	$x = \hbar\omega/kT$
α	Constant in eqs (7) and (8)
Δ	Deviation from the Matthiessen's rule
θ_D	Debye temperature
θ_R	Characteristic temperature for intrinsic electrical resistivity
ρ	Electrical resistivity
ρ_0	Residual electrical resistivity
ρ_e	Electrical resistivity due to electron-electron scattering
ρ_i	Intrinsic electrical resistivity
ω	Phonon angular frequency

1. INTRODUCTION

The principal objective of this project was to exhaustively compile, critically evaluate, analyze, and synthesize all the available data and information on the electrical resistivity of a large number of selected elements and to generate recommended values over a full range of temperature from 1 K to the melting point and beyond. The results on the electrical resistivity of chromium, cobalt, iron, and nickel are presented in this work, which is one in a series of similar works on the electrical resistivity of selected elements, some published [1-3][1]. The comprehensive study of the electrical resistivity of the elements at the Center for Information and Numerical Data Analysis and Synthesis (CINDAS) has been a continuation of a similar extensive work on the thermal conductivity of the elements [4].

The general background information on this work is given in Section 2, which includes a brief introduction to the theory of the electrical resistivity of metals and a detailed explanation of the specifics and conventions used in the presentation of the data and information.

The experimental data and information and the recommended values for the electrical resistivity of the four elements are presented in Section 3. In the discussion of the electrical resistivity of each element, individual pieces of available data and information are reviewed, details of data analysis and synthesis are given, the considerations involved in arriving at the final assessment and recommendation are discussed, the recommended values and the experimental data are compared, and the uncertainties in the recommended values are stated. Recommended values uncorrected and corrected for the thermal expansion of the material are both presented in this section. The values cover the temperature range from 1 K to above the melting point.

The last three sections are for acknowledgments, appendices, and references. There are two appendices given. The first appendix presents a logical organization of the methods for the measurement of electrical resistivity. The methods are are designated with respective code letters and the same code letters are used in the "Method Used" column of the Table of Measurement Information for indicating

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[1]Numbers in brackets indicate literature references listed in Section 6.

the experimental methods used by the various authors. The second appendix presents conversion factors for the units of electrical resistivity, which may be used to convert easily the electrical resistivity values in the SI units given in this work to values in any of the several other units listed.

2. GENERAL BACKGROUND

2.1. Theoretical Background

It was found experimentally by Matthiessen [5,6] that the increase in the electrical resistivity of a metal due to the presence of a small amount of another metal in solid solution is independent of the temperature. According to this Matthiessen's rule, the total electrical resitivity of an impure metal may therefore be separated into two additive contributions and written in the form

$$\rho(c,T) = \rho_0(c) + \rho_i(T), \tag{1}$$

where ρ_0 is the residual resistivity caused by the scattering of electrons by impurity atoms and lattice defects and is temperature-independent but dependent on the impurity concentration, c, and ρ_i is the temperature-dependent intrinsic resistivity arising from the scattering of electrons by lattice waves, or phonons.

In reality, however, deviations from Matthiessen's rule do occur. Thus, in general the electrical resistivity of an impure metal is given by

$$\rho(c,T) = \rho_0(c) + \rho_i(T) + \Delta(c,T), \tag{2}$$

where Δ is the deviation from the Matthiessen's rule.

The intrinsic electrical resistivity which is due to scattering of electrons by phonons may be approximated by the Bloch-Grüneisen formula [7,8]:

$$\rho_i = \frac{C}{M\theta_R}\left(\frac{T}{\theta_R}\right)^5 \int_0^{\theta_R/T} \frac{x^5 e^x \, dx}{(e^x - 1)^2} \tag{3a}$$

$$= A \left[\frac{T}{\theta_R}\right]^5 \int_0^{\theta_R/T} \frac{x^5 e^x \, dx}{(e^x - 1)^2}, \tag{3b}$$

where C is a constant characteristic of the metal and proportional to the square of the electron-phonon interaction constant, M is the atomic weight, θ_R is a characteristic temperature of the metal which characterizes its intrinsic electrical resistivity in the same way as the Debye temperature,

θ_D, characterizes its lattice specific heat, and $A \equiv C/M\theta_R$. The dimensionless variable of integration $x = \hbar\omega/kT$, where $\hbar$ is the Planck constant divided by 2π, ω is the phonon angular frequency, and k is the Boltzmann constant. The derivation of eq (3) is based on the simplifying assumptions that the Fermi surface is spherical, that the conduction electrons can be treated as free in the first approximation, that the spectrum of lattice vibrations is that of the Debye model, that the phonon distribution is essentially undisturbed by the scattering processes, and that electron-phonon Umklapp processes can be ignored. Consequently, it is perhaps most reasonable to expect the Bloch-Grüneisen formula to agree with experiment in the case of monovalent metals. Nevertheless, the intrinsic resistivity of many metals can be well represented by eq (3) over a wide temperature range by a suitable choice of θ_R and C, though no single values of θ_R can fits the data at all temperatures.

At low temperatures ($T \leq \theta_R/20$), eq (3a) reduced to

$$\rho_i = \frac{124.4C}{M\theta_R}\left(\frac{T}{\theta_R}\right)^5, \tag{4}$$

while at high temperatures ($T > \theta_R$), to a good approximation, it reduces to

$$\rho_i \approx \frac{C}{4M\theta_R}\left(\frac{T}{\theta_R}\right). \tag{5}$$

Thus it agrees with the experimental facts that at very low temperatures the intrinsic electrical resistivity (after subtracting ρ_0 from ρ) of most metallic elements is proportional to T^5, and at high temperatures the resistivity of most metals increases approximately linearly with temperature.

In separating the electrical resistivity into its components, the temperature dependent part sometimes includes the electrical resistivity due to electron-electron scattering, ρ_e; indeed, this is thought to be the dominant temperature-dependent term in transition metals at low temperatures. That is,

$$\rho = \rho_0 + \rho_e + \rho_i(T) \tag{6}$$

As in the case of the scattering of electrons by phonons, electron-electron collisions are of two types: normal processes in which the total wave vector is conserved, and Umklapp processes in which the total wave vectors before and after the collision differ by a reciprocal lattice vector. On the other hand, unlike electron-phonon Umklapp processes which are frozen out at low temperatures if the Fermi surface is everywhere clear of the zone boundary, electron-electron Umklapp processes are not frozen out at low temperatures. Normal processes, involving the collision between two s-band conduction electrons, do not contribute directly to the electrical resistivity because they do not change the total momentum and thus have no effect on the current. Normal processes involving the scattering of an s-band conduction electron by a non-conducting d-band electron do contribute to the electrical resistivity, and are thought to be the dominant temperature-dependent resistive processes in transition elements and their alloys at very low temperatures, since their resistivities show the T^2 temperature dependence expected for electron-electron scattering rather than the T^5 temperature dependence expected for the intrinsic resistivity. This temperature dependence of the electrical resistivity due to electron-electron scattering:

$$\rho_e = \alpha T^2 \tag{7}$$

comes about through the double application of the exclusion principle in the scattering processes; it applies to both the initial states and final states. In eq (7), α is a constant.

Umklapp processes between two conduction electrons do contribute to the electrical resistivity. Because these processes involve a reciprocal lattice vector, the wave functions of the electrons involved cannot be regarded as simple plane waves, but must be treated as true Bloch functions having the periodicity of the lattice. The results of this are to introduce into the expression for the resistivity the square of an interference factor. Apparently this factor is quite small, as the low temperature electrical resistivity of most ordinary metals does not show the T^2 temperature dependence expected for such a resistive mechanism.

Substituting eqs (7) and (3b) into eq (6) yields

$$\rho = \rho_0 + \alpha T^2 + A\left(\frac{T}{\theta_R}\right)^5 \int_0^{\theta_R/T} \frac{x^5 e^x dx}{(e^x-1)^2} \; . \tag{8}$$

Equation (8) has been used frequently in analyzing the experimental data and in generating the recommended values for the electrical resistivity of cobalt, iron, and nickel at low temperatures.

2.2. Presentation of Data and Information

In each of the subsections in Section 3, electrical resistivity data and information for each element are presented in the following order:

(1) A discussion text,

(2) A table of recommended values,

(3) A figure presenting recommended values and experimental data as a function of temperature in log-log scale,

(4) A figure presenting recommended values and experimental data as a function of temperature in linear scale,

(5) A table giving measurement information on the experimental data presented in the figures, and

(6) A comparable table tabulating experimental data of all the data sets presented in the figures and/or listed in the tables.

In the discussion text on the electrical resistivity of each alloy system, individual pieces of available data and information are reviewed, details of data analysis and synthesis are given, the considerations involved in arriving at the final assessment and recommendation are discussed, the recommended values and the experimental data are compared, and the uncertainties of the recommended values are stated.

The recommended values are for well-annealed high-purity specimens of the respective elements; however, those values for low temperatures are applicable only to the particular specimens having residual electrical resistivities as given at 1 K in the tables.

Recommended values uncorrected and corrected for the thermal expansion of the element are both given in the table. The uncorrected and corrected values are related by the following equation:

$$\rho_{corrected}(T) = \left[1 + \frac{\Delta L(T)}{L_0}\right] \rho_{uncorrected}(T), \qquad (9)$$

where $\Delta L = L - L_0$, and L and L_0 are the lengths of the specimen at any temperature T and at a reference temperature T_0, respectively. The thermal expansion correction amounts roughly to about -0.2% to -0.7% at very low temperatures, zero at room temperature, about 0.3% to 0.7% at 500 K, and about 2% near the melting point of the element.

The recommended values in some cases are given with more significant figures than warranted, which is merely for tabular smoothness or for the convenience of internal comparison. Hence, the number of significant figures given in the table has no bearing on the degree of accuracy or uncertainty in the values; the uncertainty in the values is always explicitly stated.

In the figures, a data set consisting of a single data point is denoted by a number enclosed by a square, and a curve that connects a set of two or more data points is denoted by a ringed number. These data set numbers correspond to those listed in the accompanying tables providing measurement information and tabulating numerical data for each of the data sets. When several sets of data are too close together to be distinguishable, some of the data sets, though listed and tabulated in the tables, are omitted from the figure for the sake of clarity. The data set numbers of those data sets omitted from the figure are asterisked in both tables providing the measurement information and tabulating the experimental data. If only part of the data points of a data set are omitted from the figure, only those data points omitted are asterisked in the table tabulating the experimental data.

The tables providing the measurement information contain for each set of experimental data the following information: data set number, reference number, author(s), year of publication, experimental method used for the measurement, temperature range covered by the data, name and specimen designation, specimen composition, specification and characterization, and information on measurement conditions, which are contained in the original paper. The experimental methods used for the measurement of the electrical resistivity are indicated in the column heated "Method Used" in the table by the following code letters:

A Direct-current potentiometer method
B Direct-current bridge method
C Alternating-current potentiometer method
D Alternating-current brige method
G Galvanometer amplifier method
R Rotating magnetic field method
V Voltmeter and ammeter direct reading method

→ This symbol means either that the method described by the author is not sufficient for assigning a specific code letter or that the use of a code letter would not convey enough of the information reported in the research document, and therefore the method used is described briefly in the last column of the table.

Details of these and other methods for the measurement of electrical resistivity may be found in the literature references given in Appendix 5.1, which presents a complete scheme for the classification and organization of the methods.

In the tables tabulating the experimental data, all the original data reported in different units have been converted to have the same units: the SI units $10^{-8}\ \Omega$ m. The recommended values generated are also given in the same units. Conversion factors for the units of electrical resistivity, which may be used to convert the electrical resistivity values in the SI units given in this work to values in other units, are given in Appendix 5.2.

3. ELECTRICAL RESISTIVITY DATA AND INFORMATION

3.1. Chromium

There are 163 sets of experimental data available for the electrical resistivity of chromium. The information on specimen characterization and measurement condition for each of the data sets is given in table 2. The data are tabulated in table 3 and shown partially in figures 1 and 2.

Chromium undergoes an antiferromagnetic-paramagnetic transition at about 312 K; it is not surprising that more than one third of the data sets deal with the behavior of the electrical resistivity at temperatures in the vicinity of the transition. In general, the purities of the chromium specimens studied are not as high as those of other more common elements, such as iron and nickel. Judging from the impurity analyses reported, a purity of 99.99% appears to be the highest available at the present time. It is therefore not unexpected that the reported residual resistivity ratios are not very high. Indeed, the highest for a polycrystalline specimen is 380 given by Laubitz and Matsumura [9] (data sets 53-61). Their specimen was the same as that of Moore et al. [10] (data sets 50-52), who reported a residual resistance ratio of 280. This specimen was prepared by compacting (apparently small) crystals, and by hot extending. The former authors, in addition, carried out extended annealing periods: four days at 1100 K and one day at 1200 K. The reported purity of this specimen was not particularly high; $99.98^{+}\%$ with major impurities of 0.0070% C and 0.0030% Fe. For comparison, the cast specimen of Meaden et al. [11-13] (data sets 69-75), had a reported purity of 99.999% with major impurities of 0.0010% C and 0.0080% O. However, the residual resistance ratio of this specimen is only 178. After annealing at >1273 K for 75 hours (of which 50 hours is at 1473 K), the residual resistance ratio increases to 295 (data sets 76, 77). It is apparent that, in order to obtain a true indication of the residual resistivity of a chromium specimen, prolonged annealing at temperatures in excess of 1000 K is quite essential. The present recommendation for the electrical resistivity of chromium at low temperatures is only for chromium having a particular residual resistivity, which is based on the residual resistance ratio reported by Laubitz and Matsumura [9] for data set 53.

There are only a few data sets which give the electrical resistivity of chromium from liquid-helium temperature to room temperature in reasonably small temperature intervals: Harper et al. [14] (data set 17), Goff [15,16] (data sets 79,80), and Arajs et al. [17-20] (data sets 94-102). The data of Harper et al. had been analyzed by White and Woods [21] who found the temperature dependent part of the resistivity proportional to $T^{3.2}$ for temperatures below 100 K. A similar analysis on the data sets 7, 79-80, and 99-100 substantiated the finding of White and Woods; the exponent was found to be 3.23, with an uncertainty of ±0.20. In addition, selected data points from those reported by Chiu et al. [22] (data set 46), and by Moore et al. [10] (data sets 47-50) in the temperature range 80-100 K are also in agreement with this finding. With a coefficient of $5.756 \times 10^{-15}\,\Omega\,m\,K^{-3.23}$, the experimental data of $\rho-\rho_0$ predominantly stay within $0.1 \times 10^{-8}\,\Omega\,m$ of the calculated values at the higher end of this temperature range, and within $0.002 \times 10^{-8}\,\Omega\,m$ at lower temperatures (<20 K). (It is interesting to note that the specimen of Arajs et al. [17,18] (data sets 94-99) is for a single crystal specimen with residual resistivity of $1.06 \times 10^{-8}\,\Omega\,m$.) The electrical resistivity values below 100 K were therefore obtained by the relation

$$\rho(10^{-8}\,\Omega\,m) = \rho_0 + 5.756 \times 10^{-7} T^{3.23} \qquad (10)$$

At temperatures above 100 K, the rate of increase of the temperature dependent part of the resistivity becomes slower with increasing temperature. The discrepancies between the data sets also become larger with increasing temperature, indicating that the deviation from Mattheissen's Rule becomes important. From studies of the electrical resistivities of chromium alloys (see, e.g., Arajs et al. [20], deVries [23], Cox and Lucke [24], Taylor [25], and Muheim and Müller [26]), it was found that impurities not only affect the values of the resistivity, but also the Néel temperature. Since the electrical resistivities of chromium and dilute chromium alloys generally show a local maximum at temperatures slightly below the Néel temperature, it is not unexpected that the data sets show greater discrepancies as the Néel temperature is approached. Furthermore, depending on the type of impurity, the electrical resistivity of a chromium alloy can be lower than that of the pure chromium at temperatures immediately below the Néel temperature of pure chromium (see, e.g., Taylor [25], Susuki [27] and deVries [23]). The recommended values in the temperature range from 100 K to the Néel temperature are based on the data of Moore et al. [10] (data set 50), and in the vicinity of the Néel temperature they are based on the above data and that of Laubitz and Matsumura [9] (data set 53). As it is mentioned previously, the same specimen was used in both of these two measurements: the latter authors annealed the specimen at a higher temperature for long periods of time. The difference between the resistivity values of these data sets at ∿300 K is ∿0.4% or ∿0.05 x 10^{-8} Ω m. This difference is higher than the difference of ∿0.01 x 10^{-8} Ω m in their residual resistivities (calculated from the reported residual resistance ratios); but is still within the limits given by the reported measurement inaccuracies. The data of Meaden et al. [13, 28] (data sets 76-78) for a specimen with a residual resistance ratio of 295 show slightly weaker temperature dependence: the values being ∿10% above and ∿2% below those of data set 50 at ∿100 K and ∿300 K, respectively.

The behavior of the electrical resistivity of chromium in the vicinity of the Néel temperature has been studied quite extensively: it goes through a broad maximum at approximately 4 K below the Néel temperature and decreases rapidly as the Néel temperature is approached. The temperature derivative of the electrical resistivity then goes through a spike-like minimum. The ensuing minimum in electrical resistivity value occurs at a few tenth of a degree above the Néel temperature. The position of the minimum in the temperature derivative has been associated with the Néel temperature. However it has been proposed recently, from theoretical calculations, that the temperature derivative of the electrical resistivity should follow a power law relation: $(T_N-T)T_N^{-1}$ (see, e.g., Suezaki and Mori [29], Alexander et al. [30]). The recent publication by Rapp et al. [31] showed that the power law was only applicable in the temperature range from T_N - 8.5 K to T_N - 0.5 K, and the temperature derivative of the measured resistance was at a minimum at about 0.18 degree below T_N determined by a fit to the power law relation. The simulataneous measurements of electrical resistivity and sublattice magnetization by neutron diffraction method on a single crystalline iodide chromium specimen by Ishikawa et al. [32] (data set 158), showed that the minimum in the electrical resistivity occurred at about 0.5 degree above the Néel temperature. They also found that there was some residual ordering above the transition. This residual ordering persisted till ∿315 K, and was attributed by the authors to the strain introduced in spot welding the specimen. However, this interpretation appears to be in conflict with the observation of Stebler [33] (data sets 112-115), who reported considerable hysteresis across the Néel transition. Stebler attributed the hysteresis to (thermal) strain, but failed to observe appreciable residual ordering (again with neutron diffraction method) in his specimen. It is apparent that the critical phenomenon of antiferromagnetic-paramagnetic transition in chromium is a complex one and is still subject to further investigations. Experimentally, the accurate determination of the electrical resistivity in the close vicinity of the Néel temperature poses considerable difficulties. This is due to the rapid change in the temperature derivative of the electrical resistivity over a narrow temperature range, while the value of the electrical resistivity itself changes only slightly. Thus, even for the same specimen, Laubitz and Matsumura [9] (data set 53) found that the position of the resistivity minimum was at 311.7 K, but from the data of Moore et al. [34] (data set 63), it appeared that the minimum occurred at around 312.3 K. For comparison, Matsumoto and Mitsui [35] stated that the minimum was at 312.0 K for a specimen with residual resistivity ratio comparable to that of the above (350 instead of 380). For these reasons, it is concluded that a recommendation for the detailed variation of the electrical resistivity of chromium at the close vicinity ($\sim\pm 0.5$ degree K) is beyond the scope of the present study. The position of the resistivity minimum is tentative taken at 311.7 K following Laubitz and Matsumura [9], as these authors apparently made their measurements at very small temperature intervals. This temperature is within ±0.2 degree of those determined from the data of Anderson et al. [36] (data set 87), Stebler [33] (data sets 114, 115) and Trego and Mackintosh [37] (data set 116). The Néel temperature of chromium is tentatively taken as 311.5 K, as determined by specific heat measurements.

Even though hysteresis across the Néel transition is not generally mentioned by most authors, it has been reported by some: Mitsui and Tomizuka [38] (data sets 33, 34), and Stebler [33] (data sets 112, 113). If the hysteresis is caused by strain, as suggested by Stebler [33], it should disappear in specimens that have been annealed for a sufficiently long period of time at high temperatures and are heated up and/or cooled down through the transition at a sufficiently slow rate during the measurements.

For chromium, there is another transition occurring at about 120 K: the spin-flip transition. At this temperature, the polarizations of the spin-density waves, which give rise to the antiferromagnetism in chromium, changes from longitudinal (at lower temperatures) to transverse (at higher temperatures). Arajs [39], upon reanalyzing the earlier data of Arajs and Dunmyre [19] (data set 100), concluded that there is a change in the temperature coefficient of the resistivity, which was first reported by Matsumoto et al. [35]. Meaden et al. [12,13] (data sets 71-77) reported a step-type anomaly, in addition to a change of slope.

However, the slope changes reported are quite different: from $T^{2.8}$ to $T^{2.0}$ according to Arajs [39] and from $T^{2.45}$ to $T^{2.25}$ according to Meaden et al. [12,13]. In addition, the step-type anomaly, also reported by Kostina et al. [40] (data sets 134, 138) for single crystalline specimen, is in the opposite direction (a decrease instead of an increase in value) to that reported by Meaden et al. [12,13]. Most other authors did not report any unusual behavior of the electrical resistivity at this temperature, and Moore et al. [10] stated that the spin-flip transition did not have a noticeable effect on the electrical resistivity. Muir and Ström-Olsen [41] also did not detect any change of the temperature coefficient of the measured resistance of their single domain specimen at the spin-flip temperature. In generating the present recommended values, it is assumed that the electrical resistivity is not affected by this transition, and the values and their temperature derivative are continuous through the transition.

At temperatures above the Néel transition, the electrical resistivity of chromium varies smoothly with temperature. Among the available data sets, there are three from independent sources that agree well with one another: Moore et al. [34] (data set 64), Arajs et al. [20] (data set 102), and Cox and Lucke [24] (data set 103). The agreement between data sets 64 and 102 is within 1% from 400 to 1000 K, and between data sets 64 and 103 is within 2.5% from 400 to 1300 K. The recommended values from the Néel temperature to 1300 K are based on these three data sets, with more weight given to that of Moore et al. [34] (data set 64) since the specimen of this data set is the same as that of data sets 50 and 53 upon which the recommended values at lower temperatures are based. It should be noted here that the resistivity values reported by Moore et al. [34] had been corrected for thermal expansion. However, these authors did not report the method by which the correction was applied. Therefore, the comparison mentioned above was carried out after account had been taken of the effect of thermal expansion, using the recommended thermal expansion values of Touloukian et al. [42, p. 61].

There are a number of data sets for temperatures above 1300 K. The agreement between them is not good: the spread among them is about $20 \times 10^{-8}\ \Omega m$ at 1500 K and $30 \times 10^{-8}\ \Omega m$ at 1900 K. Even though there are five data sets (26, 27, 29, 82, 83) from essentially two groups of workers that show agreement within $\pm 4 \times 10^{-8}\ \Omega m$ at 1700 K, these data are considered not reliable. Those by Anderson et al. [43] (data sets 82, 83) give values that are much too low at lower temperatures, and those by Baum et al. [44,45] (data sets 26, 27), and by Levin et al. [46] (data set 29) show slopes that are considered too low. In addition, the room temperature value given by data set 26 is much too high (by ∿4.5 x 10^{-8} Ω m than the recommended value). The recommended values from 1300 to 1700 K were derived by extrapolation of the recommended values for lower temperatures with a temperature dependence that was based roughly on the data by Powell and Tye [47] (data set 106) and by Anderson et al. [43] (data set 84). In this temperature range, both of these data sets show a slight curvature toward the temperature axis, and are more or less parallel to each other, even though data set 106 is for a 99.985% pure electrodeposited specimen and data set 84 is apparently for a single crystalline specimen. The slight curvature also appears to be evident in data sets 26, 27, and 29. The recommended values for temperatures from 1700 K to the melting point are based on numerical extrapolation of the values for 1300 to 1700 K. At 1700 K the recommended value is higher by ∿11% (or ∿9 x 10^{-8} Ω m) than the data of Baum et al. [44,45] (data set 26, 27), and at 2100 K it is higher by ∿12% (or ∿12 x 10^{-8} Ω m). Anderson et al. [43] (data sets 82, 83) reported sudden increase in electrical resistivity values at ∿1900 K, which they attributed to the evaporation of sample material. There was no evidence of such behavior from the data of Baum et al. [44,45] (data sets 26, 27) and those of Levin et al. [46] (data set 29). Neither was evident from the data of Grube and Knabe [48] (data sets 6-8) which were apparently for specimens that were either porous and/or less pure.

There are only three data sets on the electrical resistivity of chromium in the molten state: by Baum et al. [44,45] (data sets 26, 27) and by Levin et al. [46] (data set 29). As it is mentioned in the last paragraph, the electrical resistivity values of these data for lower temperatures appeared to be questionable. The recommended value for the electrical resistivity of molten chromium at the melting point was obtained by multiplying the recommended value for solid chromium at the melting point by the ratio of the electrical resistivity values (101.5 and 108.1 x 10^{-8} Ω m, respectively, for the solid and the molten states) reported explicitly in the text by Baum et al. [45] (data set 27). For temperatures above the melting point, the recommended values were calculated according to a linear dependence based on data sets 26 and 29.

The recommended values both uncorrected and corrected for thermal expansion of the material are presented in table 1, while only the uncorrected values are shown in figures 1 and 2 along with the experimental data. The values are applicable to chromium of purity 99.98% or higher; however, those values for temperatures below 100 K are applicable only to chromium having a residual resistivity of $0.0306 \times 10^{-8}\ \Omega m$. The estimated uncertainty in the recommended values is about ±5% up to 1300 K. The uncertainty increases with temperature at higher temperatures and is estimated to be ±10% immediately below the melting point, and ±15% for the molten state.

From the available data, it appears that the low-temperature resistivity of chromium of lower purity can be obtained by the use of the Mattheissen's rule if the residual resistivity of a specimen does not exceed $\sim 0.2 \times 10^{-8}\ \Omega m$. Thus, using the recommended values and the Mattheissen's rule, the data for the specimen CrB of Moore et al. [10] (data set 47) would be reproduced to within ∿±5%. For the data of Chiu et al. [22] (data set 46), it was ∿±10%. Generally, this method underestimates the resistivity values. And even though the derivation from Mattheissen's rule can be negative for some dilute chromium alloys, it is not likely to occur for chromium of reasonable purity.

The recommended values uncorrected for thermal expansion given in table 1 can be represented approximately by the following expressions to within ±0.5%.

1-90 K:

$$\rho = 0.0306 + 5.756 \times 10^{-7}T^{3.23} \qquad (11)$$

90-293 K:

$$\rho = 0.398 - 2.950 \times 10^{-2}T + 5.112 \times 10^{-4}T^2 - 9.218 \times 10^{-7}T^3 \qquad (12)$$

293-305 K:

$$\rho = 250.125 - 2.65115\ T + 9.68307 \times 10^{-3}T^2 - 1.16108 \times 10^{-5}T^3 \qquad (13)$$

305-311 K:

$$\rho = 1.4614467 \times 10^4 - 1.4360559 \times 10^2T + 4.7073008 \times 10^{-1}T^2 - 5.142874 \times 10^{-4}T^3 \qquad (14)$$

312-400 K:

$$\rho = 27.036 - 1.5301 \times 10^{-1}T + 4.5057 \times 10^{-4}T^2 - 3.4505 \times 10^{-7}T^3 \qquad (15)$$

400-1300 K:

$$\rho = 4.457 + 1.3084 \times 10^{-2}T + 4.9046 \times 10^{-5}T^2 - 3.0031 \times 10^{-8}T^3 + 8.653 \times 10^{-12}T^4 \qquad (16)$$

1300-2133 K:

$$\rho = -49.515 + 1.11856 \times 10^{-1}T - 2.3954 \times 10^{-5}T^2 + 3.4937 \times 10^{-9}T^3 \quad (17)$$

2133-2300 K:

$$\rho = 14.54 + 0.050\ T \quad (18)$$

It should be emphasized that these expressions do not necessarily suggest any theoretical justification, and should be treated, most appropriately, as numerical aids only. It should also be understood that giving these expressions does not imply a recommendation for the temperature derivative of the electrical resistivity.

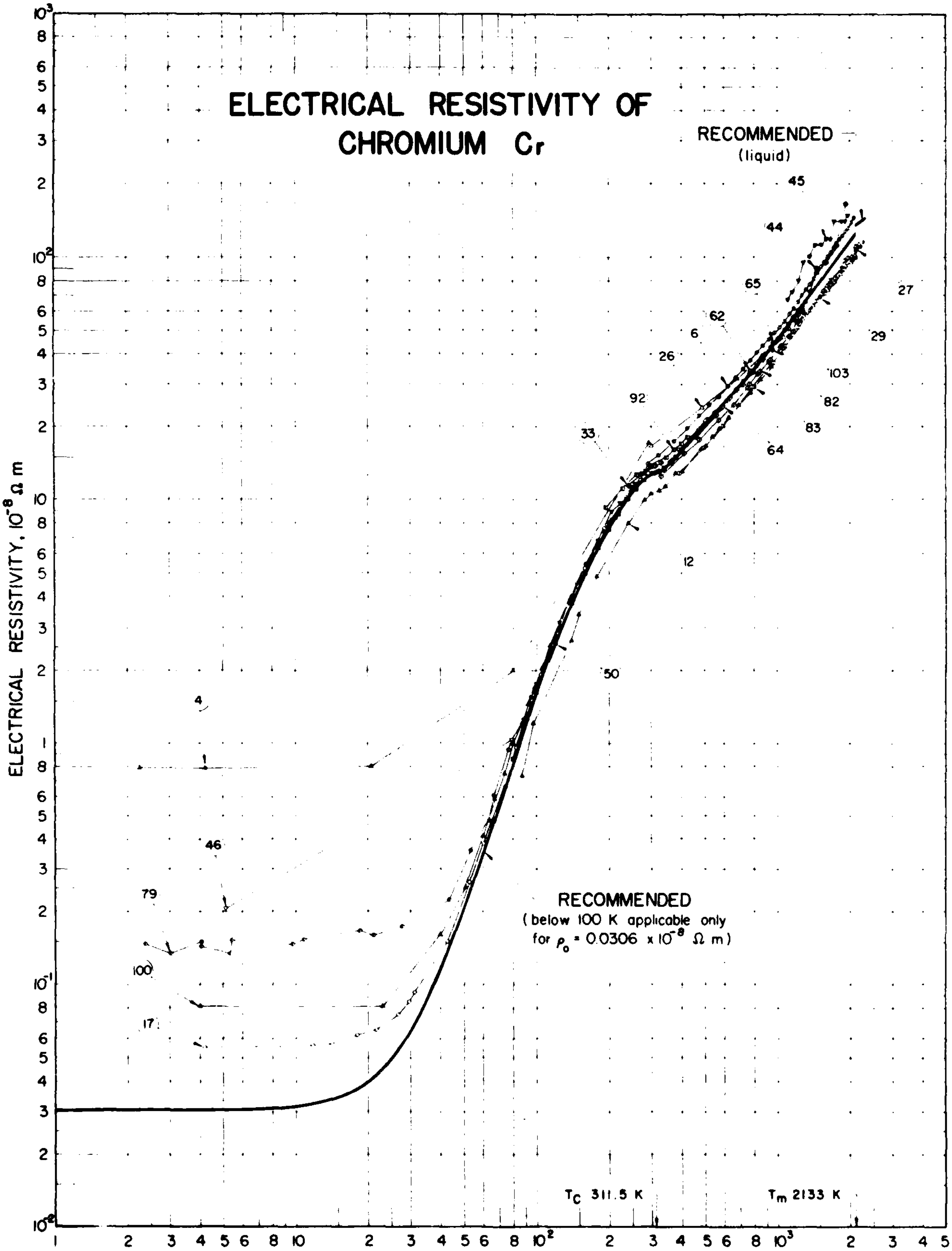
TABLE 1. RECOMMENDED VALUES FOR THE ELECTRICAL RESISTIVITY OF CHROMIUM[a]

[Temperature, T, K; Electrical Resistivity, ρ, 10^{-8} Ω m]

T	ρ		T	ρ	
	uncorrected	corrected		uncorrected	corrected
1	0.0306	0.0306	316	12.785	12.786
4	0.0307	0.0307	320	12.905	12.907
7	0.0309	0.0309	350	13.888	13.891
10	0.0316	0.0316	400	15.84	15.86
15	0.0342	0.0342	500	20.05	20.08
20	0.0398	0.0398	600	24.60	24.66
25	0.0495	0.0495	700	29.43	29.53
30	0.0646	0.0645	800	34.48	34.64
35	0.0865	0.0864	900	39.75	39.98
40	0.117	0.117	1000	45.21	45.52
50	0.207	0.207	1100	50.89	51.30
60	0.349	0.349	1200	56.84	57.37
70	0.555	0.554	1300	63.09	63.78
80	0.838	0.837	1400	69.72[b]	70.56[b]
90	1.212	1.21	1500	76.16[b]	7[illegible].18[b]
100	1.64	1.64	1600	82.44[b]	83.68[b]
150	4.36	4.36	1700	88.58[b]	90.05[b]
200	7.57	7.57	1800	94.59[b]	96.33[b]
250	10.57	10.57	1900	100.5[b]	102.5[b]
273	11.69	11.69	2000	106.3[b]	108.7[b]
293	12.45	12.45	2100	112.1[b]	114.8[b]
300	12.650	12.650	2133	114.0[b] (s)	116.8[b] (s)
306	12.760	12.761	2133	121.4[b] (ℓ)	124.4[b] (ℓ)
308	12.779	12.780	2200	124.8[b]	127.8[b]
309	12.779	12.780	2300	129.8[b]	132.8[b]
310	12.769	12.770			
311	12.739	12.740			
311.7	12.670	12.671			
312	12.673	12.674			
314	12.728	12.729			

[a] The values are for chromium of purity 99.98% or higher, but those below 100 K are applicable only to chromium having a residual resistivity of 0.0306 x 10^{-8} Ω m. The columns headed uncorrected and corrected refer to values uncorrected and corrected for thermal expansion, respectively. Solid line separating tabular values indicates solid to liquid state transformation.

[b] Provisional value.



CINDAS

FIGURE 1

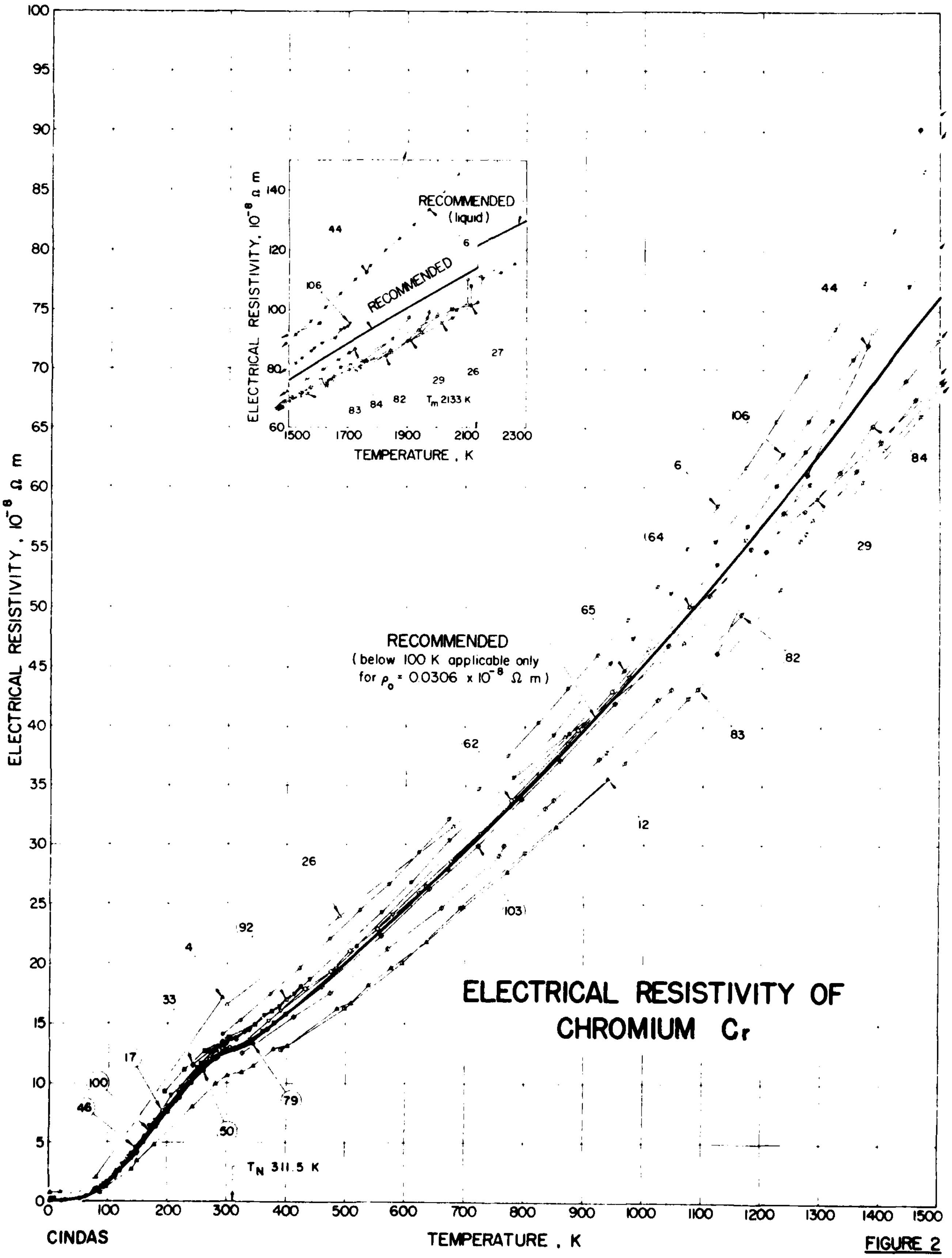

ELECTRICAL RESISTIVITY OF CHROMIUM Cr
RECOMMENDED (below 100 K applicable only for ρ_0 = 0.0306 x 10^{-8} Ω m)
RECOMMENDED
RECOMMENDED (liquid)
T_m 2133 K
T_N 311.5 K
ELECTRICAL RESISTIVITY, 10^{-8} Ω m
TEMPERATURE, K
CINDAS

FIGURE 2

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
1*	49	McLennan, J.C. and Niven, C.D.	1927	B	2.4-290	Unaged-I	Trace of Cu; strip sample obtained from General Electric Co. of England; electrolytically deposited sheet ground down to 3.81 cm (1.5 in.) long and 0.475 cm (0.187 in.) thick; unannealed; data uncorrected for thermal expansion.
2*	49	McLennan, J.C. and Niven, C.D.	1927	B	2.2-290	Unaged-II	Trace of Cu; strip sample; material obtained from General Electric Co. of England; electrolytically deposited sheet dissolved in acid with aid of electrical potential; unannealed; data uncorrected for thermal expansion.
3*	49	McLennan, J.C. and Niven, C.D.	1927	B	20.6-292	Aged-I	Similar to the above specimen; annealed for 1 h at comparatively low temperature, cooled to room temperature, annealed for 2 h at much higher temperature; data uncorrected for thermal expansion.
4	50	McLennan, J.C., Niven, C.D., and Wilhelm, J.O.	1928	B	2.3-293		The above specimen with measurements extended to lower temperatures (there is an apparent discrepancy between values at 80 K between data set and the above).
5*	48	Grube, G. and Knabe, R.	1936	A	373-1673		"Pure Cr."
6	48	Grube, G. and Knabe, R.	1936	A	293-2073		Electrolytic Cr, sintered in H_2 atmosphere at 1673 K; density 6.95 x 10^3 kg cm^{-3}.
7*	48	Grube, G. and Knabe, R.	1936	A	1643-1973	B	Electrolytic Cr, remelted and measured in an Ar atmosphere.
8*	48	Grube, G. and Knabe, R.	1936	A	1643-1933	B	The above specimen measured with decreasing temperature.
9*	48	Grube, G. and Knabe, R.	1936	A	1553-1973	C	Electrolytical Cr, remelted and measured in an Ar atmosphere.
10*	48	Grube, G. and Knabe, R.	1936	A	1563-1953	C	The above specimen measured with decreasing temperature.
11*	51	Potter, H.H.	1941	V	87-1064		"99.99" pure; 1 cm long; annealed at 873 K.
12	51	Potter, H.H.	1941	V	87-941		Similar to the above; outgassed just below the melting point by electron bombardment.
13*	14	Harper, A.F.A., Kemp, W.R.G., Klemens, P.G., Tainsh, R.J., and White, G.K.	1957	G	4.2	Sample 1	99.998 pure; supplied by Dr. H.L. Wain of the Aeronautical Res. Lab., Commonwealth Dept. of Supply; 3 mm in diam and 8 cm long; cold worked; temperature 4.2 K assumed.
14*	14	Harper, A.F.A., et al.	1957	G	4.2	Sample 2	The above specimen annealed in vacuum at 1323 K for 4 h.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
15*	14	Harper, A.F.A., Kemp, W.R.G., Klemens, P.G., Tainsh, R.J., and White, G.K.	1957	G	4.2	Sample 3	Similar to the above; partially recrystallized after cold worked.
16*	14	Harper, A.F.A., et al.	1957	G	4.2	Sample 4	The above specimen; annealed.
17	14	Harper, A.F.A., et al.	1957	G	4.2-320	Sample 5	Similar to the above; cold worked and fully recrystallized.
18*	52	De Morton, M.E.	1958		200-344		0.013 O_2, 0.0015 C, 0.0005 Al, Fe, N_2 and Si each, 0.00027 H_2 (3Nl/100 gm), 0.0002 Cu, Mg, and Pb each, and 0.00001 Ag; metallic impurities spectrographically determined; 0.073 cm diam and 20.7 cm long; arc-melted electrolytic Cr ingot 1.5 in. diam; extruded to 0.5 in. diam; swaged to 0.2 in. diam; drawn at 573 K to 0.027 in. diam; given a 3% reduction at 423 K; total reduction 98%.
19*	52	De Morton, M.E.	1958		200-346		The above specimen annealed at 973 K for 15 min. under a vacuum of 2×10^{-6} mmHg; "completely recrystallized".
20*	53	Newmann, M.M. and Stevens, K.W.H.	1959	A	94-390		Spectrographically standardized chromium supplied by Johnson and Matthey Co.; contains dissolved oxygen; 2 cm long; machined; sealed in evacuated quartz tube and annealed at 1200 K for 1 month.
21*	54	Sabine, T.M. and Svenson, A.C.	1968	D	301-328		0.024 O_2 and 0.015 N_2; supplied by Aeronautic Res. Lab., Melbourne; hot extruded (1373 K); 0.5 in. in diam and 3 in. long; measured with an AC bridge at 50 Hz; error of measurement 1%.
22*	54	Sabine, T.M. and Svenson, A.C.	1968	D	291-328		Similar to the above, annealed at 1373 K.
23*	54	Sabine, T.M. and Svenson, A.C.	1968	D	289-328		Similar to the above, annealed at 1673 K; fine grained.
24*	54	Sabine, T.M. and Svenson, A.C.	1968	D	289-328		Similar to the above, annealed at 1673 K; course grained; grain diam 0.25 in. approximately.
25*	55	Hamaguchi, Y. and Kunitomi, N.	1964		295-810		99.9 pure; cut by diamond saw; measured in vacuum.
26	44	Baum, B.A., Gel'd, P.V., and Sachil'nikov, S.I.	1964	R	300-2194		99.98 pure.
27	45	Baum, B.A., Gel'd, P.V., and Sachil'nikov, S.I.	1963	R	1673-2113		>99.98 pure (specimen appears to be the same as the above); resistivity values at melting point (reported at 2113 K approximately) from text.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
28*	56	Pavars, I.A., Baum, B.A., and Gel'd, P.V.	1969	R	2013		99.98 pure, doubly refined electrolytic chromium; melted in a fusion induction furnace in an argon atmosphere of 500 mmHg.
29	46	Levin, E.S., Gel'd, P.V., and Ayushina, G.D.	1973	R	1084-2261		99.98 pure, doubly refined electrolytic.
30*	57	Levin, E.S.	1971	R	1973		99.98 pure, doubly refined.
31*	58	Fine, M.E., Greiner, E.S., and Ellis, W.C.	1951	A	78-401		99.8 pure; prepared by cold pressing sintered electrolytic powder compact; annealed at 1673 K in purified helium.
32*	58	Fine, M.E., et al.	1951	A	275-377		99.998 pure, from electrochemical analysis by E.K. Jaycox, no Fe or Ni detected; electroformed from an aqueous solution by R.A. Ehrhardt and G. Brittrich, using the method of Brennar, Burhead and Jennings, NBS J. of Res., 40, 31, (1948); vacuum annealed at 1273 K with specimen packed in chromium powder.
33	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-331		0.08 N and 0.03 O, others not detectable spectrographically; supplied by Prof. R. Street of Monash Univ., Melbourne; 0.5 mm wide, 0.5 mm thick and 58 mm long approximately; manufactured from ARL chromium ingot; ground and formed; annealed and recrystallized at 1523 K for 2 h; resistivity values calculated from reported $\rho(T)/\rho(273\ K)$ and reported $\rho(273\ K) = 12.7 \times 10^{-8}\ \Omega m$.
34*	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-322		The above measured with decreasing temperature.
35*	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-330		The above measured under a pressure of 0.98 kbar.
36*	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-326		The above with decreasing temperature.
37*	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-331		The above measured under a pressure of 1.96 kbar.
38*	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-329		The above with decreasing temperature.
39*	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-331		The above measured under a pressure of 2.94 kbar.
40*	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-326		The above measured under a pressure of 5.30 kbar.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
41*	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-326		The above with decreasing temperature.
42*	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-325		The above measured under a pressure of 7.16 kbar.
43*	38	Mitsui, T. and Tomizuka, C.T.	1965	A	243-326		The above measured under a pressure of 7.85 kbar.
44	59	Barykin, B.M., Gordon, V.G., Levinov, B.M. Rekov, A.I., and Spiridonov, E.G.	1974	V	1124-1938		99.9^{+} pure chromium powder; average particle size 5-10 μm; pressed and sintered at 1973 K; density 7.0 g cm^{-3}; porosity 1.5%.
45*	59	Barykin, B.M., et al.		V	1120-1976		Similar to the above.
46	22	Chiu, C.H., Jericho, N.M., and March, R.H.	1971	V	5.1-313		0.0012 O_2 and Fe each, 0.0010 Si, 0.00009 N_2, 0.00003 Al, Ca and Ni each, 0.00002 H_2 and 0.00001 Cu, Mg, and Mn each (at.%); "10^{-2} cm^2 diameter," and 5 cm long; spark machined; measurement error 2%.
47*	10	Moore, J.P., William, R.K., and McElroy, D.L.	1968	A	80-400	CrB	99.98^{+} pure; 0.0060 C, 0.0028 N, <0.0020 Ga, 0.0009 H, 0.0008 Mo, 0.0006 O, 0.0005 Cu, S, and Si each, 0.0004 K, 0.0003 Co, Fe, and U each, <0.0003 Pt, <0.0002 Sr and Zn each, 0.0001 B, <0.0001 Hg, Pd, Rn, Ru, Sb, Te, Tl, U, W, and Zr each, <0.00008 Cu and Pb each, 0.00006 Ca, <0.00005 Ag and Ba each, <0.00004 Bi, 0.00003 Mn, 0.00002 Nb, <0.00002 Ge, In, Mg and Na each, 0.00001 Ti and <0.00001 Ag, Li, and P each (at.%); content of C by combustion analysis, H, N, and O by vacuum fusion analysis, and of others by semi-quantitative spectrographic analysis; material supplied by Glrowalloy Corp.; consolidated into a disc-shaped ingot and drop-cast into a rod of 1.6 cm diam and 15 cm long; machined to 0.96 cm in diam and 7.7 cm in length; density 7.15 g cm^{-3}; grain diam 440 to 840 μm; $\rho(273\ K)/\rho(4.2\ K) = 58$; measurement error ±0.38%; smoothed values from table.
48*	10	Moore, J.P., et al.	1968	A	310-315	CrB	The above in the vicinity of the Néel temperature.
49*	10	Moore, J.P., et al.	1968	A	307-320	CrB	The above measured with a temperature gradient of 0.014 k m^{-1}.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
50*	10	Moore, J.P. William, R.K., and McElroy, D.L.	1968	A	80-400	CrA	99.98^{+} pure; 0.0070 C, 0.0030 Fe, <0.0020 Au and Mg each, 0.0015 S, 0.0014 O, 0.0010 Mn, <0.0010 Pt, 0.0006 Ca, 0.0005 H and Si each, 0.0003 B, N and U each, 0.0002 Ba, Cu, and Pb each, <0.0002 Ta, 0.0001 Ag and As each, <0.0001 Hg, P, Pd, Ru, Sb, Sn, Te, Tl, U, W, and Zr each, <0.00008 Cd, 0.00005 Ti, <0.00005 Mo, Ni, and Sr each, 0.00004 K and Nb each, <0.00004 Bi, <0.00003 Co, <0.00002 Ge, In, and Na each, and <0.00001 Li and Rn each (at.%); same methods of analysis as above; crystals supplied by Chromalloy Corp.; sealed in vacuum jacket after cleaned and compacted; hot extruded to a rod of 1.6 cm diam and 60 cm long (by BMI); machined to a rod of 0.96 cm diam and 7.7 cm long; density 7.19 g cm^{-3}; average grain diam 63 μm; ρ(273 K)/ρ(4.2 K) = 280; measurement error ±0.38%; smoothed values from table.
51*	10	Moore, J.P., et al.	1968	A	308-320	CrA	The above in the vicinity of the Néel temperature.
52*	10	Moore, J.P., et al.	1968	A	307-320	CrA	The above measured with a temperature gradient of 0.014 K m^{-1}.
53*	9	Laubitz, M.J. and Matsumura, T.	1970	D	300-319		The above specimen on loan from Oak Ridge National Lab.; annealed at 1100 K for 4 days and 1200 K for 1 day; ρ(273 K)/ρ(4.2 K) = 380; specimen immersed in oil bath maintained to with 1 x 10^{-3} K of desired temperature; measured with an ac (7 Hz) bridge with an absolute accuracy of 0.2%, and a precision of 0.03%; smoothed values from curve, which is reported to be based on 68 data points and to deviate from the measured values by amounts less than the precision of the measurements.
54*	9	Laubitz, M.J. and Matsumura, T.	1970	D	301-318		The above measured in a thermal conductivity apparatus, with temperature difference along specimen less than 0.01 K.
55*	9	Laubitz, M.J. and Matsumura, T.	1970	D	301		The above after being cooled from 320 K.
56*	9	Laubitz, M.J. and Matsumura, T.	1970	D	301-318		The above specimen measured during a thermal conductivity experiment with temperature difference along specimen less than 0.25 K.
57*	9	Laubitz, M.J. and Matsumura, T.	1970	D	301		The above after being cooled from 320 K.
58*	9	Laubitz, M.J. and Matsumura, T.	1970	D	301-315		The above specimen measured during a thermal conductivity experiment with temperature difference along specimen less than 0.5 K.
59*	9	Laubitz, M.J. and Matsumura, T.	1970	D	318		The above after being cooled from 320 K.
60*	9	Laubitz, M.J. and Matsumura, T.	1970	D	302-319		The above specimen measured during a thermal conductivity experiment with temperature difference along specimen less than 1.0 K.
61*	9	Laubitz, M.J. and Matsumura, T.	1970	D	302		The above after being cooled from 320 K.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
62	34	Moore, J.P., Williams, R.K., and Graves, R.S.	1977	A	293-1008	CrA'	Same sample material as the above; average grain diam 60 μm; ρ(273 K)/ρ(4.2 K) = 280 - 380, depending on thermal cycling; measurement error ±0.38%; corrected for thermal expansion.
63*	34	Moore, J.P., et al.	1977	A	300-320	CrA'	The above in the vicinity of the Néel temperature; corrected for thermal expansion.
64	34	Moore, J.P., et al.	1977	A	371-1172	CrA	From the same stock as the above; thermally cycled during brazing of specimen to heater and nickel heat sink; ρ(273 K)/ρ(4.2 K) = 380; corrected for thermal expansion.
65	34	Moore, J.P., et al.	1977	A	518-1319	CrB	Same specimen material as for Data Set 47; density 7.19 g cm^{-3}; grain size 400 to 800 μm; arc-cast, ρ(273 K)/ρ(4.2 K) = 58; specimen found to have a hairline casting void along its axis, causing approximately 1% change in the measured values; corrected for thermal expansion.
66*	60	Söchtig, H.	1940		79-319	CrI	From Dr. Kroll of Luxenburg; cut from a rolled plate; approximate dimensions: 0.12 cm thick, 0.21 cm wide and 1.37 cm long; resistivity values calculated from reported resistances and reported ρ(273 K) = 19.7 x 10^{-8} Ω m.
67*	60	Söchtig, H.	1940		20.8-373	CrII	Electrolytic chromium; approximate dimensions: 0.21 cm wide, 0.23 cm thick, and 0.58 cm long; resistivity values calculated from reported resistances and reported ρ(273 K) = 21.1 x 10^{-8} Ω m.
68*	61	Meaden, G.T., Rao, K.V., and Loo, H.Y.	1969		278-323		99.999 pure; 0.0010 C, 0.0009 O_2, 0.0003 Ca, 0.0002 Fe, 0.0001 Al, Cu, and Mg each, and 0.0008 H_2; residual resistance ratio 178.
69*	11	Meaden, G.T. and Sze, N.H.	1969		301-317		99.999 pure; 0.0010 C, 0.0008 O, 0.0003 Ca and N_2 each, 0.0002 Fe, 0.0001 Al, Cu, and Mg each, and 0.00008 H_2; cast iodide chromium machined to 3.8 mm in diam and 65 mm in length; unannealed; ρ(295 K)/ρ(4.2 K) = 178; measured with increasing temperature (specimen is apparently the same as the above).
70*	11	Meaden, G.T. and Sze, N.H.	1969		300-318		The above specimen measured with decreasing temperature.
71*	12	Meaden, G.T., Rao, K.V., and Loo, H.Y.	1969		100-145		99.999 pure; 0.0010 C, 0.0008 O_2, 0.0003 Ca, 0.0002 Fe, 0.0001 Al, Cu, and Mg each; residual resistivity ratio 178 (specimen is apparently the same as the above).
72*	13	Meaden, G.T. and Sze, N.H.	1969		101-140	Cr-0	99.999 pure; unannealed; grain diam 0.25 mm; residual resistivity ratio 178 (specimen is apparently the same as the above).
73*	13	Meaden, G.T. and Sze, N.H.	1969		116-124	Cr-0	The above in the vicinity of the spin-flip transition.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
74*	13	Meaden, G.T. and Sze, N.H.	1969		101-140	Cr-1	Similar to the above except annealed at 1473 K for 1 h.
75*	13	Meaden, G.T. and Sze, N.H.	1969		116-125	Cr-1	The above in the vicinity of the spin-flip transition.
76*	13	Meaden, G.T. and Sze, N.H.	1969		101-140	Cr-50	Similar to the above except annealed for 75 h at temperatures above 1273 K, 50 h of which is at 1473 K; grain diam 2 to 4 mm; grain orientation is random as determined by x-ray Laue photography; residual resistivity ratio 295.
77*	13	Meaden, G.T. and Sze, N.H.	1969		117-125	Cr-50	The above in the vicinity of the spin-flip transition (discrepancies between these two data sets are due to graph-reading errors).
78*	28	Meaden, G.T., Rao, K.V., and Tee, K.T.	1970		202-329		Pure chromium sample; annealed in vacuum (10^{-6} Torr) for 75 h above 1273 K of which 50 h is at 1473 K; grain diam 2 to 4 mm; residual resistivity ratio 295 (specimen is apparently the same as the above).
79	15	Goff, J.F.	1970	A	2.4-343	CrII	99.92 pure; 0.005 Fe, 0.004 Mn, 0.003 Cu, 0.002 Mg, and balance mostly S, P, Ni and Mn; electrolytic; melted with argon arc, cast in oxygen-free copper boat; annealed twice at 1173 K for 24 h; ground to approximate dimensions of 4 mm wide, 4 mm thick and 50 mm long; polycrystalline; $\rho(297\ K)/\rho(4\ K) = 88$; average residual resistivity 0.145 x $10^{-8}\ \Omega m$; measurement error 1%.
80*	15, 16	Goff, J.F. Goff, J.F.	1970 1968	A	1.2-286	CrI	Similar to the above except $\rho(297\ K)/\rho(4\ K) = 72$ and average residual resistivity (1.2 K to 12.9 K) = 0.1834 x $10^{-8}\ \Omega m$.
81*	62	Moore, J.P., Williams, R.K., and McElroy, D.L.	1969	A	90-360		The above specimen; $\rho(296\ K)/\rho(4.2\ K) = 70.5$; smoothed values from table.
82	43	Anderson, J.M., Stewart, A.D., and Ramsay, I.	1970	A	330-1973		Single crystal produced by the iodide process; supplied by Material Research Corp.; 0.0025 interstitial impurities and 0.0015 substitutional impurities, quoted by manufacturers; 1 mm thick, 1 mm wide and 5 mm long; cut by a combination of diamond saw, spark planning and electropolishing techniques; measurement done in a high purity hydrogen atmosphere; reported errors in resistivity value 0.002%, and in temperature 0.2%; values corrected for thermal expansion using expansion data of B.N. Vasyutinskii, G.N. Katurazov and G.N. Finkel, Soviet Phys.-Phys. Met. Metallog., 12, 141 (1961); rapid increase of resistivity above 1750 K was reported to be due to evaporation of material.
83	43	Anderson, J.M., et al.	1970	A	391-1905		Similar to the above, except supplied by Koch-Light Lab. and containing 0.0021 interstitial and 0.0005 substitutional impurities.
84	43	Anderson, J.M., et al.	1970	A	1272-1724		"Crystal 3"; no specimen detail reported; measured with decreasing temperature.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
85*	43	Anderson, J.M., Stewart, A.D., and Ramsay, I.	1970	A	1482-1740		The above specimen; measured with increasing temperature.
86*	43	Anderson, J.M., et al.	1970	A	1469-1693		The above specimen; measured with decreasing temperature again.
87	36	Anderson, J.M., Stewart, A.D., and Ramsay, I.	1972	A	285-324		0.0012 O_2 and Fe each, 0.0010 Si, 0.00009 N_2, 0.00002 H_2, <0.000001 C and 0.0002 others (at.%); single crystal prepared from Koch-Light crystalline, cut with diamond saw, spark planned and electropolished; 1 mm thick, 1 mm wide and 7 mm long; specimen axis parallel to the [100] direction; annealed at 1970 K for 3 h in hydrogen; T_N 311.5 K.
88*	36	Anderson, J.M., et al.	1972	A	282-324		The above specimen deformed at a strain rate of $5 \times 10^{-5}\ s^{-1}$; T_N 309 K.
89*	36	Anderson, J.M., et al.	1972	A	77		0.03 O_2, 0.02 H_2, 0.0030 C and 0.0010 N_2 (at.%); polycrystal from vacuum melted ingot; average grain size 1 mm.
90*	63	Marcinkowski, M.J. and Lipsitt, H.A.	1961		199-414		Pure; plastically deformed: 96% reduction in area at 623 K.
91*	63	Marcinkowski, M.J. and Lipsitt, H.A.	1961		283-323		The above specimen in the vicinity of the Néel temperature.
92	63	Marcinkowski, M.J. and Lipsitt, H.A.	1961		196-425		The above specimen recrystallized by annealing at 1323 K for 1/2 h.
93*	63	Marcinkowski, M.J. and Lipsitt, H.A.	1961		284-323		The above specimen in the vicinity of the Néel temperature.
94*	17 18	Arajs, , Colvin, R.V., and Marcinkowski, M.J. Calvin, R.V. and Arajs, S.	1962 1962	A	298-315		0.055 O_2 and <0.001 N_2; single crystal; 0.235 cm thick, 0.254 cm wide and 0.900 cm long; long axis of specimen aligned to within 1 degree of the [100] direction; measured at temperatures in the order: 297.4, 305.3, 306.1, 307.2, 313.5, 314.5, 312.4, 311.4, 310.3, 308.8, 309.5, and 309.6 K.
95*	17, 18	Arajs, S., et al.	1962	A	310-328		The above specimen measured after being left overnight at 309.6 K; measurements between 309.6 K and 312.7 K were done over a period of 8 h, changing temperature slowly; the rest of the data points were obtained the following day.
96*	17, 18	Arajs, S., et al.	1962	A	312		The above specimen, cooled; "leaving the crystal at this temperature overnight did not change the value of the resistivity".
97*	17, 18	Arajs, S., et al.	1962	A	78		The above specimen; heated to 373 K and cooled rapidly to 78 K, and kept at 78 K for two days.
98*	17, 18	Arajs, S., et al.	1962	A	78-140		The above specimen.
99*	17, 18	Arajs, S., et al.	1962	A	4.2-330		The above specimen, cooled to 78 K, left overnight and cooled to 4.2 K; measurements in the temperature ranges, 4 to 115 K, 130 to 155 K, 155 to 215 K, and 215 to 295 K were done in successive days.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
100	19	Arajs, S. and Dunmyre, G.R.	1965	A	4-297		0.0013 O, 0.0010 C and Si each, 0.0001 Ca, Mg, N, and Ni each, and 0.00005 H, others not detected; contents of O, H, and N determined by vacuum fusion, of C by combustion, and the rest by spectroscopic methods; arc-melted polycrystalline ingest 0.7 x 1.6 x 8.0 cm supplied by Chromalloy Corp.; cut by surface grinding machine to 0.478 ± 0.001 cm thick, 0.476 ± 0.001 cm wide and ∿5 cm long; $\rho(273\ K)/\rho(4.2\ K) = 160$; T_N 313.0 ± 0.2 K; duration of measurement 8 h; specimen was left at 290.5 K for 15 h without detectable change in resistivity (due to small size of graph, data points below 80 K are selected values; hence this curve does not represent all the measurements reported by the authors).
101*	19	Arajs, S. and Dunmyre, G.R.	1965	A	300-318		The above specimen in the vicinity of the Néel temperature; duration of measurement 8 h.
102*	20	Arajs, S., DeYoung, T.F., and Anderson, E.E.	1970	A	9-1035		From the same stock as the above.
103	24	Cox, J.E. and Lucke, W.H.	1967	→	299-1281		99.999 iodide chromium; melted 15 to 18 times in 2/3 atmosphere of ionization grade; 99.999 pure argon; spark eroded to cylindrical form; centerless-ground to 1/8 in. diam and 2 1/2 in. long; wrapped in molybdenum foil and annealed at 1523 K in 1/2 atmosphere of ionization grade helium; water quenched and etched; measured by a method by Dauphinee, T.M. and Mooser, E., Rev. Sci. Instr., 26, 660, 1955.
104*	25	Taylor, M.A.	1962		77-359		99.99 pure; 0.01 O, ∿0.0001 N, C, S and Sn each, and <0.0001 others; electrolytic; supplied by the Aeronautical Res. Lab., Melbourne; smoothed values from curve.
105*	64	Taylor, M.A. and Smith, C.H.L.	1962	A	20-273		99.99 pure; supplied by the Aeronautical Res. Lab., Melbourne; 1 mm wide, 1 mm thick, and 10 mm long; cut with carborundum slitting wheel; annealed at 1073 K for 50 h in vacuum; measurement error 1%.
106*	47	Powell, R.W. and Tye, R.P.	1956	A	94-1707		99.985 pure; <0.01 N and <0.005 O (as Cr_2O_3); electrodeposited chromium 1.28 cm O.D., 0.63 cm I.D. and 18.05 cm long; prepared from chromium flakes supplied by Johnson Matthey Co.; enclosed in alumina tube and heat-treated at 443, 486, 678, 818, 1133, 1327, and 1683 K, with the five last treatments done in vacuum; reductions of 0.010 cm in O.D. and I.D. are observed after final treatment; initial density 6.975×10^3 kg m^{-3}, after final treatment 7.15×10^3 kg m^{-3}.
107*	47	Powell, R.W. and Tye, R.P.	1956	A	273-333		The above in the vicinity of the Néel temperature.
108*	26	Muheim, J. and Müller, J.	1964	→	100-339		Cylindrical specimen 1 mm in diam and 50 cm long; measured by a compensation method.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
109*	23	DeVries, G.	1959		165-356		Prepared by Prof. Fast, Eindhoven.
110*	65	Zinov'ev, V.E., Krentsis, R.P., and Gel'd, P.V.	1969		300-1800		0.05 total impurity; residual resistance ratio = 65; values calculated from reported equations: $\rho = 4.8 \times 10^{-2} T$, $T < 800$ K and $\rho = 4.8 \times 10^{-2} T + 3.1 \times 10^{-6} (T-800)^2$, $T > 800$ K.
111*	66	Maystrenko, L.G. and Polovov, V.M.	1977	A	89-400		Polycrystalline; appropriate dimensions 1 mm thick, 1 mm wide, and 10-15 cm long; annealed at 1273 K for 24 h in helium; furnace cooled; measurement error ±5%.
112	33	Stebler, B.	1970	A	296-344		99.996 pure, 0.0002 N_2; single crystal; 7 mm thick, 8 mm wide and 25 mm long; specimen axis ~8 degrees of arc from the [100] direction; measured with increasing temperature; resistivity values calculated from reported $\Delta\rho/\rho_0$, where ρ_0 is the resistivity at 273.2 K, taken to be 11.687×10^{-8} Ω m.
113	33	Stebler, B.	1970	A	287-350		The above specimen measured with decreasing temperature.
114	33	Stebler, B.	1970	A	305-316		The above specimen in the vicinity of the Néel temperature; measured with increasing temperature.
115	33	Stebler, B.	1970	A	305-316		The above specimen in the vicinity of the Néel temperature; measured with decreasing temperature.
116	37	Trego, A.L. and Mackintosh, A.R.	1968		277-320		0.0072 C, 0.0030 N, 0.0016 O and 0.0001 H (at.%); Iodide Cr supplied by Chromalloy Corp.; arc melted and arc zone melted; single crystal 2 mm square cross section and 1.5 cm long, cut by spark erosion technique from 0.5 in. diam and 6 in. long ingot; electropolished in orthophosphoric acid; annealed in vacuum at 1273 K for 50 h; sample length parallel to crystal [001] axis; resistivity values calculated from reported resistance R(T) and R(320 K), with ρ(320 K) taken to be 12.906×10^{-8} Ω m.
117	37	Trego, A.L. and Mackintosh, A.R.	1968		272-310		The above specimen measured after cooled through the Néel temperature in a longitudinal magnetic field of 55 kG.
118	37	Trego, A.L. and Mackintosh, A.R.	1968		275-311		The above specimen but measured after cooled through the Néel temperature in a transverse magnetic field (either in [010] or [100] direction) of 55 kG.
119	37	Trego, A.L. and Mackintosh, A.R.	1968		270-310		The above specimen, but measured after cooled through the Néel temperature in a longitudinal magnetic field of 40.5 kG; resistivity value calculated from reported $\Delta\rho/\rho(T_N)$, with $\rho(T_N)$ taken to be 12.70×10^{-8} Ω m.
120	37	Trego, A.L. and Mackintosh, A.R.	1968		270-313		The above specimen except strength of magnetic field is 28 kG.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
121	37	Trego, A.L. and Mackintosh, A.R.	1968		275-307		The above specimen except strength of magnetic field is 15.6 kG.
122	37	Trego, A.L. and Mackintosh, A.R	1968		285-310		The above specimen but cooled through the Néel temperature in a transverse magnetic field of 47 kG.
123	37	Trego, A.L. and Mackintosh, A.R.	1968		274-308		The above specimen except strength of magnetic field is 40.5 kG.
1_4	37	Trego, A.L. and Mackintosh, A.R.	1968		274-310		The above specimen except strength of magnetic field is 28 kG.
125	37	Trego, A.L. and Mackintosh, A.R.	1968		275-307		The above specimen except strength of magnetic field is 15.6 kG.
126	67	Akiba, C. and Mitsui, T.	1972	A	294-320		99.997 pure; iodide chromium supplied by A.D. Mackay Inc.; 0.77 mm thick, 0.7 mm wide and 10 mm long; single crystal, spark cut and chemically polished; specimen axis within ±3 degrees from the crystalline <100> direction; R(293 K)/R(4.2 K) = 630 without magnetic field cooling; specimen in single magnetic domain state (single Q) prepared by heating to 329 K, applying a longitudinal magnetic field of 74 kG, then cooled to 273 K, and magnetic field reduced to zero; resistivity values calculated from reported resistance, and with ρ(320 K) taken to be 12.906 x 10^{-8} Ωm.
127	67	Akiba, C. and Mitsui, T.	1972	A	301-320		The above specimen except magnetically cooled with a transverse field of 74 kG.
128	73	Semenenko, E.E. and Tutov, V.I.	1969		1.5-6.8		Monocrystalline whisker specimen, 0.10-0.12 mm in diam and ~8 mm long; R(4.2 K)/R(300 K) = 8 x 10^{-3}; resistivity values calculated from reported resistance and ρ(300 K), taken to be 12.650 x 10^{-8} Ωm.
129	68	Semenenko, E.E. and Tutov, V.I.	1972		4.7-329		Primary impurity is iron; only resistance as a function of temperature reported; resistivity calculated by assuming ρ(328.6 K) = 13.177 x 10^{-8} Ωm.
130	68	Semenenko, E.E. and Tutov, V.I.	1972		280-330		The above specimen in the vicinity of the Néel temperature.
131	68, 74	Semenenko, E.E. and Tutov, V.I.; Semenenko, E.E.	1972; 1966		4.4-16.1		Similar to the above; R(1.5 K)/R(300 K) = 8 x 10^{-3}; resistivity values calculated from reported R/R(300 K) with ρ(300 K) taken to be 12.650 x 10^{-8} Ωm.
132	68	Semenenko, E.E. and Tutov, V.I.	1972		1.7-14.8		Similar to the above; R(1.5 K)/R(300 K) = 7.6 x 10^{-3}.
133	68	Semenenko, E.E. and Tutov, V.I.	1972		2.0-7.1		Similar to the above; R(1.5 K)/R(300 K) = 6.8 x 10^{-3}.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
134	40	Kostina, T.I., Ekonomova, L.N., and Kondorskii, E.I.	1970		103-130		Single crystal cut by electric spark method; 0.1 mm thick, 0.15 mm wide and 4 mm long; R(293 K)/R(4.2 K) = 500; T_N 311 ± 2 K; longitudinal axis of sample parallel to the [110] direction; resistivity values calculated from reported R/R(77 K), with ρ(77 K) taken to be 0.737 x 10^{-8} Ω m.
135	40	Kostina, T.I., et al.	1970		285-326		The above specimen.
136	40	Kostina, T.I., et al.	1970		106-131		The above specimen after magnetically annealed by an external field in the [100] direction of magnitude 34 kOe.
137	40	Kostina, T.I., et al.	1970		103-119		Similar to the above except external field is in the [110] direction.
138	40	Kostina, T.I., et al.	1970		121-153		Similar to the specimen of data set 134, except longitudinal axis of sample is parallel to the [100] direction.
139	40	Kostina, T.I., et al.	1970		287-329		The above specimen.
140	40	Kostina, T.I., et al.	1970		101-125		The above specimen after magnetically annealed by an external field in the [100] direction of magnitude 34 kOe.
141	40	Kostina, T.I., et al.	1970		111-133		Similar to the above except magnetic field is in the [110] direction.
142	41	Muir, W.B. and Ström-Olsen, J.O.	1971		76-326		Single crystal, 1 mm thick, 1 mm wide and 7 mm long; cut by spark erosion technique from vapor transport grown polycrystal ingot containing many large single crystals, supplied by Battelle Memorial Institute; annealed at 1470 K in argon for 50 h; strain free (found by x-ray technique; specimen axis parallel to the <100> direction; R(300 K)/R(4.2 K) = 350; in single magnetic domain state by cooling from 343 to 273 K in a longitudinal magnetic field of 60 kOe; measuring current parallel to the spin density wave vector Q; resistivity values calculated from reported R/R(320 K) with ρ(320 K) taken to 12.906 x 10^{-8} Ω m.
143	41	Muir, W.B. and Ström-Olsen, J.O.	1971		76-328		The above specimen in the multidomain state.
144	41	Muir, W.B. and Ström-Olsen, J.O.	1971		296-320		The above specimen, single domain state, in the vicinity of the Néel temperature; measuring current parallel to Q.
145	41	Muir, W.B. and Ström-Olsen, J.O.	1971		298-318		The above specimen, in the multidomain state after the above measurement.
146	41	Muir, W.B. and Ström-Olsen, J.O.	1971		300-319		The above specimen, magnetically cooled to the single domain state again after the above measurement; measuring current again parallel to Q.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
147	41	Muir, W.B. and Ström-Olsen, J.O.	1971		295-312		The above specimen, in the multidomain state after the above measurement.
148	41	Muir, W.B. and Ström-Olsen, J.O.	1971		299-320		The above specimen, in single domain state after cooling from 343 to 273 K in a transverse magnetic field of 60 kOe; measuring current perpendicular to Q.
149	41	Muir, W.B. and Ström-Olsen, J.O.	1971		299-310		The above in the multidomain state.
150	69	Borovik, E.S. and Volotskaya, V.G.	1959		2.4-78		Vacuum distilled chromium; needle shaped; "0.35 mm across" and 8 mm long; "appear to be single crystal;" resistivity value calculated from reported R/R(273 K), with ρ(273 K) taken to be 11.687 x 10^{-8} Ω m.
151	70	McWhan, D.B. and Rice, T.M.	1967		4.3-232	Sample 2	Battelle Iochrome; single crystal; R(298 K)/R(4.2 K) = 140; measured under a pressure of 26.5 kbar; AgCl used as pressure transmitting medium; resistivity values calculated from reported R/R(1 atm, 298 K), with ρ(1 atm., 298 K) taken to be 12.319 x 10^{-8} Ω m.
152	70	McWhan, D.B. and Rice, T.M.	1967		60-223	Sample 2	The above measured under a pressure of 45.7 kbar.
153	70	McWhan, D.B. and Rice, T.M.	1967		32.5-223	Sample 2	The above measured under a pressure of 64.9 kbar; data points below 30 K cannot be resolved from graph, and are not reported here.
154	70	McWhan, D.B. and Rice, T.M.	1967		188-276	Sample 2	From the same ingot as the above specimen; R(298 K)/R(4.2 K) = 275 and 165 before and after pressure experiment respectively; measured under a pressure of 26.3 kbar; AgCl used as pressure transmitting medium; resistivity values calculated by the same method as for the above specimen.
155	70	McWhan, D.B. and Rice, T.M.	1967		59-262	Sample 2	The above measured under a pressure of 45.9 kbar.
156	70	McWhan, D.B. and Rice, T.M.	1967		70-262	Sample 2	The above measured under a pressure of 65.9 kbar.
157	27	Suzuki, T.	1966		216-331		99.99 pure; electrolytic, supplied by Johnson and Matthey Co.; 0.5 mm thick, 0.5 mm wide and 20 mm long; degassed at 773 K; electropolished in a solution of 90% acetic acid and 10% perchloric acid; resistivity values calculated from reported [ρ(T) - ρ(300 K)]/ρ(300 K), with ρ(300 K) taken to be 12.650 x 10^{-8} Ω m.
158	32	Ishikawa, Y., Ikeda, S., and Akiba, C.	1975		299-320		99.997 pure; iodide chromium from A.D. Mackay Inc.; single crystal, 0.7 mm thick, 0.7 mm wide and 10 mm long; specimen axis along [100] direction; resistivity value calculated from reported resistance values and ρ(370 K), taken to be 12.906 x 10^{-8} Ω m.

* Not shown in figure.

TABLE 2. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
159	71	Bridgman, P.W.	1933		193-347		Swaged rod supplied by P.H. Brace, Westinghouse Electric and Manufacturing Co., spectroscopic examination by Martin Graban show only a "doubtful trace of magnesium"; resistivity values calculated from reported R(T)/R(273 K) with ρ(273 K) taken to be 11.687 x 10^{-8} Ω m.
160	31	Rapp, Ö., Benediktsson, G., Aström, H.U., Arajs, S., and Rao, K.V.	1978	A	300.2-315.0	Cr(1)	Specimen material same as for Data Set 100; approximate dimensions 0.1 mm thick, 1 mm wide and 20 mm long; spark cut from arc-melted ingot, etched in HCl, placed in silica tube, flushed with helium, evacuated to about 0.1 Torr and encapsulated; annealed at 1250 K for 100 h, and water quenched; etched again in HCl to the suitable dimensions; data reported as ratio of ρ to the ρ at the Néel temperature, value at Néel temperature not reported; measured with increasing temperature at ~1 K hr^{-1}; resistivity values calculated from reported resistance ratios and an assumed ρ(300.23 K) = 12.655 x 10^{-8} Ω m; because of graph reading difficulties, not all data points are included.
161	31	Rapp, Ö., et al.	1978	A	300.1-313.5	Cr(2)	Similar to the above except approximate dimensions 1 mm thick, 1 mm wide and 20 mm long, and annealed at 1250 K for 24 h and furnace-cooled in 12 h; T_N determined from a power law fit to ρ^{-1} x dρ/dT 310.79 K; resistivity value calculated from reported resistance ratio and an assumed ρ(300.07 K) = 12.651 x 10^{-8} Ω m.
162	31	Rapp, Ö., et al.	1978	A	304.2-313.4	Cr(3)	Similar to the above except approximate dimensions 1 mm thick, 1 mm wide and 15 mm long, and annealed at 1250 K for 100 h and furnace-cooled in 24 h; "thermally cycled before measurement;" T_N determined by same method as above 310.77 K; resistivity values calculated from reported resistance ratio and an assumed ρ(304.15 K) = 12.733 x 10^{-8} Ω m.
163*	72	Clinard, F.W. and Kempter, C.P.	1968	A	4-300		0.3 O, <0.002 N and H each by chemical analysis; <0.03 Zn and <0.01 K by spectrographic analysis; polycrystalline specimen; 0.25 in. in diam and 1 in. long; annealed; resistivity values calculated from reported equations: $\rho = 0.1 + 1.58 \times 10^{-6} T^{3.62}$ for T < 109.5 K, and $\rho = -1.08 + \left(\frac{C}{M\theta}\right) \times \left(\frac{T}{\theta}\right)^5 \int_0^{\theta/T} \frac{x^5\,dx}{(e^x-1)(1-e^{-x})}$, with θ = 357 K and $C = 1.43 \times 10^{-6}$ (M = atomic weight).

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr

[Temperature, T, K; Electrical Resistivity, ρ, 10^{-8} Ω m]

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 1*		DATA SET 6		DATA SET 6(cont.)		DATA SET 7(cont.)*		DATA SET 8(cont.)*		DATA SET 9(cont.)*	
2.35	25.9	293	14.1	1753	112.8	1723	116.9	1793	120.7	1813	117.5
4.2	26.2	323	15.3	1763	113.8	1733	117.3	1803	121.1	1823	117.9
20.6	26.7	373	17.5	1773	114.7	1743	117.8	1813	121.6	1833	118.5
83	29.2	423	19.7	1783	115.8	1753	118.8	1823	122.0	1843	119.0
290	43.8	473	22.1	1793	117.0	1763	118.8	1833	122.5	1853	119.5
		523	24.5	1803	118.2	1773	119.3	1843	122.8	1863	120.1
DATA SET 2*		573	26.7	1813	119.3	1783	119.8	1853	123.3	1873	120.7
		623	29.4	1823	119.9	1793	120.3	1863	123.8	1883	121.3
2.20	26.5	673	32.0	1833	120.5	1803	120.7	1873	124.2	1893	122.0
3.01	26.6	723	34.8	1843	121.1	1813	121.2	1883	124.7	1903	122.7
4.2	26.7	773	37.6	1853	121.8	1823	121.7	1893	125.1	1913	123.5
20.6	27.0	823	40.4	1863	122.8	1833	122.1	1903	125.6	1923	124.3
83	28.8	873	43.3	1873	123.8	1843	122.6	1913	126.1	1933	125.2
290	43.8	923	46.1	1883	124.7	1853	123.0	1923	126.5	1943	126.0
		973	49.0	1893	125.6	1863	123.4	1933	126.8	1953	126.8
DATA SET 3*		1023	51.8	1903	126.6	1873	123.8			1963	127.6
		1073	54.9	1913	127.5	1883	124.3	DATA SET 9*		1973	128.5
20.6	0.90	1123	58.5	1923	128.5	1893	124.7				
80	2.01	1173	61.8	1933	129.5	1903	125.2	1553	100.4	DATA SET 10*	
292	17.2	1223	65.6	1943	130.5	1913	125.6	1563	101.4		
		1273	69.5	1953	131.5	1923	126.2	1573	102.4	1563	105.1
DATA SET 4		1323	73.6	1963	132.5	1933	126.8	1583	103.3	1573	106.5
		1373	77.4	1973	133.5	1943	127.5	1593	104.3	1583	107.5
2.25	0.79	1423	81.8	1983	134.5	1953	128.2	1603	105.2	1593	108.5
4.2	0.79	1473	86.7	1993	135.7	1963	129.0	1613	106.2	1603	109.4
20.6	0.80	1523	91.4	2003	136.9	1973	129.9	1623	107.3	1613	110.4
80	2.01	1573	96.0	2013	138.2			1633	107.9	1623	111.2
293	17.2	1583	96.9	2023	139.5	DATA SET 8*		1643	108.5	1633	112.2
		1593	97.8	2033	140.9			1653	109.1	1643	112.6
DATA SET 5*		1603	98.7	2043	141.3	1643	109.0	1663	109.7	1653	113.1
		1613	99.6	2053	142.7	1654	110.3	1673	110.3	1663	113.6
373	17.501	1623	100.7	2063	144.1	1663	111.7	1683	110.9	1673	114.1
473	22.002	1633	101.6	2073	145.5	1673	112.9	1693	111.4	1683	114.9
573	26.702	1643	102.6			1683	114.2	1703	112.0	1693	115.4
673	32.000	1653	103.6	DATA SET 7*		1693	115.6	1713	112.6	1703	115.9
873	43.290	1663	104.5			1703	116.5	1723	113.1	1713	116.4
973	48.996	1673	105.4	1643	108.3	1713	117.0	1733	113.6	1723	116.8
1073	55.006	1683	106.3	1653	109.5	1723	117.5	1743	114.1	1733	117.3
1173	61.805	1693	107.2	1663	110.7	1733	118.0	1753	114.6	1743	117.7
1273	69.493	1703	108.2	1673	111.8	1743	118.4	1763	115.1	1753	118.2
1373	77.519	1713	109.4	1683	112.9	1753	118.9	1773	115.6	1763	118.6
1473	86.730	1723	110.0	1693	113.9	1763	119.3	1783	116.0	1773	119.0
1573	95.969	1733	110.0	1703	114.9	1773	119.8	1793	116.5	1783	119.4
1673	105.374	1743	111.9	1713	115.9	1783	120.2	1803	116.9	1793	119.9

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ
DATA SET 10(cont.)*	
1803	120.3
1813	120.8
1823	121.2
1833	121.6
1843	122.0
1853	122.5
1863	122.9
1873	123.3
1883	123.8
1893	124.2
1903	124.7
1913	125.2
1923	125.6
1933	126.0
1943	126.5
1953	126.9
DATA SET 11*	
87.3	0.56
145.9	3.26
165.4	4.25
277.7	9.66
292.4	9.91
316.8	10.41
326.6	10.41
380.4	12.38
487.9	15.83
561.2	18.54
654.0	22.24
732.1	25.44
810.2	28.89
868.9	30.61
961.6	35.53
1000.7	37.26
1049.4	40.21
1064.1	40.95
DATA SET 12	
87.3	0.73
97.1	1.22
140.7	2.68
150.4	3.40
179.5	4.86
242.6	8.02

T	ρ
DATA SET 12(cont.)	
281.3	9.96
300.7	10.69
325.0	10.93
344.4	11.42
378.4	12.87
402.6	13.12
485.1	16.27
509.4	16.76
538.5	18.22
577.3	19.67
630.6	21.86
698.5	24.77
771.3	27.69
853.7	31.57
941.0	35.70
DATA SET 13*	
4.2	0.255
DATA SET 14*	
4.2	0.181
DATA SET 15*	
4.2	0.125
DATA SET 16*	
4.2	0.090
DATA SET 17	
4.2	0.055
11.8	0.056
14.2	0.057
18.0	0.062
21.6	0.065
26.7	0.075
29.7	0.085
31.3	0.093
42.9	0.151
52.9	0.264
60.3	0.384
74.4	0.665

T	ρ
DATA SET 17(cont.)	
82.7	0.967
91.8	1.27
105	1.93
123	2.86
133	3.72
160	5.26
192	7.63
214	8.49
237	10.25
271	12.05
293	12.65
298	12.83
305	12.97
308	12.96*
313	12.93*
314	12.95
317	13.00*
320	13.07
DATA SET 18*	
200	8.05
204	8.33
209	8.61
215	8.91
219	9.16
224	9.47
230	9.84
239	10.28
242	10.51
251	10.93
256	11.23
259	11.37
267	11.79
272	12.02
278	12.26
283	12.47
290	12.72
310	13.23
316	13.37
321	13.54
324	13.88
336	14.05
339	14.16
344	14.35

T	ρ
DATA SET 19*	
200	8.16
204	8.51
210	8.86
219	9.37
226	9.74
233	10.21
238	10.44
243	10.72
251	11.09
262	11.65
268	11.98
279	12.44
287	12.72
294	12.93
303	13.12
314	13.14
321	13.30
326	13.47
331	13.65
340	13.93
346	14.14
DATA SET 20*	
93.5	2.6
133.2	5.1
166.4	7.8
196.7	9.8
222.2	11.0
252.5	13.0
291.2	14.3
322.4	14.9
347.0	16.0
367.8	16.9
377.2	17.1
389.5	17.6
DATA SET 21*	
300.8	13.014
301.9	13.033
304.1	13.057
305.5	13.069
307.2	13.069
308.5	13.062
309.9	13.037

T	ρ
DATA SET 21(cont.)*	
310.7	13.015
311.4	12.964
312.0	12.950
312.5	12.950
313.7	12.983
319.5	13.167
324.4	13.339
328.2	13.465
DATA SET 22*	
291.5	12.721
295.2	12.825
299.1	12.922
301.3	12.966
304.5	13.003
305.5	13.024
308.1	13.026
309.5	13.023
310.5	13.015
310.7	13.003
311.6	12.909
311.8	12.909
314.6	12.984
320.0	13.163
325.8	13.362
328.2	13.439
DATA SET 23*	
288.6	12.515
292.5	12.655
296.0	12.761
298.6	12.824
301.6	12.891
303.1	12.918
304.9	12.939
305.5	12.945
306.7	12.945
308.0	12.937
309.8	12.937
310.4	12.924
310.6	12.907
311.0	12.827
320.5	13.124
328.2	13.367

T	ρ
DATA SET 24*	
288.7	12.478
292.9	12.624
296.4	12.725
299.8	12.812
302.7	12.871
304.6	12.900
305.8	12.912
306.9	12.912
308.1	12.903
309.4	12.903
310.1	12.897
310.5	12.885
310.7	12.864
310.9	12.800
316.3	12.958
323.7	13.199
328.2	13.334
DATA SET 25*	
295	14.5
308	15.6
325	16.1
357	16.9
382	18.6
477	23.2
668	33.2
745	37.3
810	40.6
DATA SET 26	
300	16.6
489	24.0
680	31.6
868	39.2
1069	47.1
1285	57.4
1468	63.3
1527	70.8
1607	76.9
1628	73.9
1708	81.9
1727	79.1
1847	85.4
1928	92.4

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ
DATA SET 26(cont.)	
2002	98.5
2015	95.4
2049	101.0
2065	99.9
2103	102.3
2103	110.2
2146	111.4
2194	113.6
DATA SET 27	
1673	80.3
2053	100.0
2113	101.5
2113	108.1
DATA SET 28*	
2013	132
DATA SET 29	
1084	50.0
1292	59.1
1501	68.9
1702	79.6
1911	89.5
2051	97.1
2136	102.5
2152	108.7
2214	112.5
2261	115.6
DATA SET 30*	
1973	120.8
DATA SET 31*	
78	1.7
105	2.0
108	3.2
114	3.6
121	4.1
127	4.3
133	4.6

T	ρ
DATA SET 31(cont.)*	
143	5.1
146	5.4
148	5.5
154	5.8
160	6.2
183	7.5
186	7.7
189	7.9
192	8.3
208	9.4
216	9.9
219	9.9
219	10.1
226	10.4
242	11.4
253	12.2
259	12.3
261	12.5
277	13.0
281	13.2
285	13.4
288	13.5
293	13.6
294	13.6
297	13.7
302	13.9
307	13.9
310	13.9
315	13.8
325	14.0
334	14.2
337	14.5
357	15.1
379	16.0
401	17.0
DATA SET 32*	
275	11.6
282	11.8
285	12.1
291	12.3
293	12.3
298	12.3
301	12.5
306	12.6

T	ρ
DATA SET 32(cont.)*	
312	12.6
318	12.5
325	12.7
341	13.2
347	13.5
357	13.8
369	14.2
377	14.5
DATA SET 33	
242.9	11.49
247.4	11.63*
249.1	11.72*
250.8	11.81*
251.9	11.84*
254.8	11.95*
258.4	12.10*
260.8	12.20*
264.4	12.36*
266.7	12.45*
268.8	12.52*
272.5	12.66
272.1	12.74*
276.3	13.83*
278.8	12.95*
279.7	12.97*
281.4	13.03*
283.1	13.11*
285.8	13.22*
289.0	13.34*
290.9	13.40*
291.8	13.44*
292.6	13.46
296.2	13.60*
299.6	13.72*
301.3	13.77*
302.4	13.79*
303.8	13.82*
305.3	13.83*
306.2	13.83*
307.0	13.80*
308.3	13.78*
309.6	13.75*
310.0	13.68*
310.6	13.63*

T	ρ
DATA SET 33(cont.)	
310.8	13.58*
311.3	13.58*
312.6	13.61*
314.0	13.67*
315.1	13.69
316.1	13.75*
318.3	13.83*
320.2	13.88*
322.9	14.00*
326.3	14.15*
328.7	14.22*
330.8	14.35
DATA SET 34*	
243.0	11.48
247.2	11.65
249.1	11.72
250.8	11.81
251.9	11.84
254.6	11.95
258.2	12.12
260.8	12.20
264.4	12.36
266.5	12.45
268.8	12.52
272.5	12.66
273.9	12.74
276.3	12.83
278.8	12.94
279.7	12.97
281.1	13.04
283.0	13.11
285.8	13.22
288.8	13.32
290.5	13.40
291.8	13.44
292.6	13.46
296.2	13.61
299.2	13.73
300.9	13.78
302.1	13.82
303.6	13.86
304.9	13.86
306.2	13.88
307.2	13.86

T	ρ
DATA SET 34(cont.)*	
307.9	13.86
309.1	13.83
310.0	13.79
310.6	13.75
311.3	13.68
312.1	13.68
313.2	13.70
317.2	13.86
320.2	13.97
322.3	14.06
DATA SET 35*	
243.0	11.34
247.0	11.52
250.2	11.63
253.4	11.79
258.0	11.96
262.3	12.13
265.2	12.24
269.3	12.42
273.9	12.55
278.6	12.71
280.9	12.80
284.3	12.92
286.7	12.99
289.0	13.07
292.0	13.16
293.9	13.21
295.4	13.25
296.9	13.26
298.1	13.28
299.2	13.30
300.3	13.28
301.3	13.28
301.9	13.26
303.0	13.23
303.4	13.20
303.9	13.14
304.3	13.09
304.7	13.07
305.1	13.03
306.0	13.04
307.0	13.06
308.5	13.12
310.2	13.18

T	ρ
DATA SET 35(cont.)*	
311.5	13.23
313.2	13.28
314.9	13.35
316.8	13.42
320.0	13.55
323.0	13.67
326.3	13.79
327.6	13.84
329.5	13.93
DATA SET 36*	
243.0	11.34
247.0	11.51
250.4	11.63
253.4	11.76
258.2	11.95
262.0	12.13
265.2	12.24
269.0	12.41
274.2	12.53
278.6	12.70
281.2	12.79
284.5	12.89
286.7	12.98
289.2	13.11
292.0	13.20
294.1	13.26
296.2	13.31
297.9	13.32
299.0	13.34
300.2	13.35
301.1	13.32
302.2	13.32
303.0	13.30
303.9	13.27
304.7	13.22
304.7	13.18
305.1	13.12
306.0	13.11
306.8	13.12
308.5	13.21
310.2	13.28
313.0	13.37
317.2	13.54
321.0	13.68
326.3	13.87

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 37*		DATA SET 37(cont.)*		DATA SET 38(cont.)*		DATA SET 39(cont.)*		DATA SET 40(cont.)*		DATA SET 42*	
242.8	11.24	320.8	13.25	317.2	13.18	311.7	12.74	310.0	12.38	243.0	10.40
247.0	11.39	322.7	13.30	321.0	13.31	314.3	12.85	312.1	12.48	249.1	10.60
251.0	11.56	324.2	13.37	325.1	13.49	316.0	12.90	316.2	12.66	252.1	10.68
252.3	11.61	327.2	13.50	329.1	13.63	318.3	13.00	318.9	12.78	255.3	10.77
255.1	11.70	329.3	13.59			321.1	13.12	321.1	12.89	259.1	10.85
256.1	11.75	331.4	13.68	DATA SET 39*		323.8	13.23	323.6	13.00	264.0	10.95
259.3	11.86					325.9	13.31	325.3	13.08	266.1	10.99
262.1	11.98	DATA SET 38*		243.0	11.02	327.4	13.39	326.4	13.14	267.0	10.99
263.8	12.04			246.4	11.16	330.0	13.49			268.0	10.99
264.6	12.08	242.8	11.24	251.3	11.32	331.2	13.56	DATA SET 41*		269.1	10.99
267.4	12.18	247.0	11.39	254.2	11.44					270.2	10.97
269.1	12.23	251.0	11.56	258.3	11.61	DATA SET 40*		243.0	10.78	271.0	10.96
271.6	12.31	252.3	11.60	260.2	11.68			244.3	10.82	272.1	10.93
273.5	12.37	254.9	11.71	262.1	11.75	243.0	10.80	246.6	10.92	272.7	10.91
275.4	12.43	255.9	11.73	264.2	11.84	244.3	10.82	248.3	10.99	273.1	10.88
278.0	12.51	259.1	11.87	266.1	11.90	246.8	10.91	250.0	11.05	273.6	10.86
280.5	12.57	262.1	11.98	269.9	12.03	248.3	10.99	253.0	11.16	273.8	10.80
283.1	12.65	263.6	12.04	273.1	12.14	250.0	11.05	253.6	11.20	273.8	10.76
284.1	12.67	264.6	12.09	275.0	12.20	252.7	11.15	256.6	11.32	274.4	10.74
287.1	12.75	267.4	12.17	277.1	12.26	253.6	11.20	260.0	11.43	275.0	10.74
289.2	12.78	268.9	12.22	278.0	12.28	256.6	11.32	264.2	11.57	275.9	10.77
290.9	12.80	271.6	12.31	279.0	12.31	260.2	11.43	268.0	11.66	278.0	10.82
292.2	12.81	273.3	12.38	281.2	12.37	264.2	11.56	271.4	11.71	280.1	10.91
293.3	12.83	275.4	12.43	282.9	12.41	268.0	11.66	273.1	11.77	282.3	10.96
294.1	12.84	278.0	12.51	284.1	12.43	271.2	11.71	275.0	11.77	285.0	11.06
294.9	12.84	280.5	12.66	285.6	12.43	273.1	11.72	275.9	11.79	287.1	11.14
296.0	12.81	283.1	12.66	288.6	12.46	274.1	11.72	277.1	11.79	290.1	11.25
296.9	12.81	284.1	12.67	290.1	12.46	275.0	11.72	279.7	11.77	293.5	11.37
297.7	12.81	286.9	12.78	291.1	12.46	275.9	11.75	281.4	11.75	295.8	11.47
298.8	12.79	288.8	12.80	291.6	12.46	277.1	11.75	282.4	11.68	298.8	11.58
299.0	12.76	290.1	12.83	292.4	12.46	278.0	11.73	283.1	11.61	300.9	11.66
299.4	12.74	291.8	12.84	293.3	12.43	279.1	11.73	283.7	11.54	304.1	11.77
299.8	12.69	293.0	12.87	294.1	12.38	280.3	11.70	284.6	11.52	309.0	11.95
300.3	12.66	294.1	12.87	294.3	12.32	281.0	11.68	285.0	11.54	314.1	12.17
300.5	12.61	294.9	12.89	294.5	12.27	281.6	11.63	286.5	11.60	320.6	12.46
300.7	12.56	296.0	12.89	294.7	12.23	282.9	11.58	287.8	11.65	323.0	12.59
301.3	12.55	297.1	12.89	295.2	12.20	283.3	11.53	289.9	11.73	325.1	12.66
302.2	12.56	298.6	12.84	296.4	12.20	283.3	11.48	293.1	11.83		
303.2	12.59	299.8	12.75	296.9	12.23	283.9	11.46	296.7	12.00	DATA SET 43*	
304.1	12.61	300.5	12.70	297.1	12.26	285.2	11.48	300.9	12.15		
305.1	12.64	300.9	12.65	298.1	12.26	286.5	11.53	306.0	12.33	243.0	10.30
307.7	12.71	301.3	12.60	300.1	12.34	289.0	11.60	312.1	12.60	247.5	10.44
309.0	12.78	302.2	12.62	303.7	12.45	293.1	11.73	316.0	12.76	251.5	10.55
313.8	12.94	303.9	12.69	305.1	12.50	295.0	11.82	321.1	12.98	255.7	10.60
315.5	13.02	305.1	12.74	307.1	12.57	297.9	11.93	326.4	13.14	257.4	10.69
317.7	13.08	308.1	12.84	309.2	12.65	303.7	12.13			259.5	10.73
319.6	13.17	312.4	12.99	310.9	12.70	307.1	12.28			262.1	10.76

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ
DATA SET 43(cont.)*	
264.0	10.76
264.9	10.76
265.9	10.74
267.0	10.74
268.0	10.72
269.3	10.69
270.2	10.64
270.4	10.60
270.8	10.54
271.0	10.49
271.9	10.50
272.5	10.53
274.0	10.58
275.0	10.62
277.6	10.69
280.1	10.80
282.7	10.88
286.3	11.01
291.4	11.20
293.5	11.30
298.2	11.46
301.3	11.57
303.3	11.63
308.3	11.85
312.2	12.03
316.2	12.18
321.5	12.42
325.9	12.64
DATA SET 44	
1124	46.2
1206	54.7
1276	61.1
1379	72.1
1466	90.2
1605	95.3
1761	112.5
1938	166.3
DATA SET 45*	
1120	68.6
1160	72.4
1239	80.9
1284	95.7

T	ρ
DATA SET 45(cont.)*	
1372	101.2
1447	113.0
1531	112.7
1605	119.1
1669	119.1
1724	140.9
1869	140.6
1919	140.6
1976	148.6
DATA SET 46	
5.1	0.20
79.6	1.03
89.0	1.26
94.1	1.47
100.9	1.76
107.8	2.08*
112.0	2.32*
116.3	2.58*
125.7	3.17
132.5	3 [illegible]7*
147.8	4.55
157.2	5.28*
167.4	6.01*
180.2	6.80
190.4	7.54*
198.1	8.65*
199.0	8.09*
206.6	8.97
211.8	8.94*
210.0	9.18*
218.6	9.62*
223.7	9.65
233.9	10.35*
245.9	11.03*
257.8	11.67
268.0	12.26*
278.3	12.76*
286.8	13.11
291.9	13.28*
297.1	13.37*
297.9	13.37*
300.5	13.34
303.1	13.31*
304.8	13.28*

T	ρ
DATA SET 46(cont.)	
307.4	13.20*
308.2	13.31*
309.9	13.40*
313.4	13.52*
DATA SET 47*	
80	1.060
90	1.445
100	1.860
120	2.860
140	4.050
160	5.295
180	6.575
200	7.830
220	9.100
240	10.300
260	11.385
280	12.270
300	12.880
304	12.946
306	12.961
308	12.958
310	12.931
312	12.900
314	12.898
316	12.940
320	13.080
340	13.765
360	14.470
380	15.200
400	15.935
DATA SET 48*	
310.4	12.937
311.8	12.880
312.6	12.853
313.1	12.847
313.8	12.871
314.6	12.896
DATA SET 49*	
306.6	12.961
309.5	12.937

T	ρ
DATA SET 49(cont.)*	
311.9	12.901
313.6	12.895
315.0	12.911
316.5	12.953
320.4	13.078
DATA SET 50	
80	0.860
90	1.225
100	1.630
120	2.605
140	3.760
160	5.000
180	6.315
200	7.545
220	8.790
240	10.015
260	11.095
280	12.030
300	12.710*
304	12.792*
306	12.813
308	12.816*
310	12 791
312	12.772*
314	12.780*
316	12.808*
320	12.925*
340	13.605
360	14.340
380	15.085
400	15.845
DATA SET 51*	
307.9	12.788
310.3	12.795
311.2	12.762
311.8	12.722
312.9	12.716
314.6	12.759
316.9	12.805
317.9	12.851
320.5	12.945

T	ρ
DATA SET 52*	
306.9	12.812
307.1	12.800
307.9	12.807
310.1	12.786
311.4	12.777
312.9	12.774
313.6	12.774
314.8	12.790
316.4	12.811
320.3	12.945
DATA SET 53*	
300.00	12.619
300.71	12.637
301.54	12.655
302.37	12.671
303.02	12.683
303.73	12.698
304.91	12.719
305.50	12.728
305.97	12.733
306.45	12.738
307.04	12.743
307.51	12.747
308.10	12.751
308.45	12.751
308.69	12.752
308.98	12.753
309.10	12.753
309.34	12.753
309.57	12.752
309.69	12.751
309.93	12.749
310.05	12.748
310.16	12.746
310.40	12.743
310.52	12.740
310.63	12.735
310.87	12.725
311.16	12.696
311.45	12.662
311.57	12.648
311.57	12.645
311.68	12.644
311.74	12.643

T	ρ
DATA SET 53(cont.)*	
311.86	12.642
311.98	12.643
312.10	12.645
312.21	12.646
312.33	12.651
312.92	12.665
313.70	12.689
314.41	12.710
315.29	12.736
316.01	12.759
317.07	12.793
317.78	12.814
318.38	12.835
318.91	12.850
319.15	12.859
DATA SET 54*	
300.95	12.698
304.74	12.762
308.52	12.794
310.99	12.762
312.22	12.672
314.05	12.720
317.79	12.835
DATA SET 55*	
301.04	12.692
DATA SET 56*	
301.28	12.703
301.16	12.704
304.91	12.766
308.79	12.795
311.27	12.740
312.63	12.678
314.27	12.728
317.96	12.844
DATA SET 57*	
301.28	12.699

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ
DATA SET 58*	
301.43	12.710
301.54	12.712
301.60	12.709
305.21	12.769
309.11	12.794
311.51	12.704
312.81	12.685
314.59	12.736
DATA SET 59*	
318.32	12.853
DATA SET 60*	
301.98	12.718
302.10	12.719
302.21	12.720
305.91	12.776
309.62	12.792
311.99	12.675
313.39	12.699
315.09	12.752
318.72	12.867
DATA SET 61*	
302.10	12.714
DATA SET 62	
293	12.88
325	13.19
432	17.92
475	19.40
507	21.17
553	22.94
625	25.90
636	26.49
671	27.97
677	28.56
775	33.28
777	33.87
890	39.77
947	43.02
1008	46.56

T	ρ
DATA SET 63*	
299.7	12.630
299.4	12.680
304.8	12.799
305.3	12.847
305.8	12.841
306.4	12.835
308.1	12.844
308.7	12.877
309.1	12.862
309.5	12.838
311.0	12.773
311.3	12.776
311.6	12.788
311.6	12.773
311.9	12.731
312.0	12.770
312.3	12.719
312.5	12.743
313.8	12.746
314.5	12.808
315.1	12.803
315.5	12.809
317.7	12.865
318.5	12.913
319.1	12.925
320.0	12.942
320.3	12.910
DATA SET 64	
371	15.25
391	16.14
484	19.69
579	24.13
726	30.92
824	35.94
873	38.60
976	44.20
1077	50.10
1172	55.71
DATA SET 65	
518	21.47
875	39.48
968	44.79

T	ρ
DATA SET 65(cont.)	
1123	53.64
1175	56.88
1224	60.41
1273	63.07
1319	65.72
DATA SET 66*	
78.9	2.51
273.2	19.70
279.1	20.11
283.6	20.40
294.5	20.76
301.1	21.12
309.6	21.10
311.8	21.02
313.9	21.02
315.1	21.07
316.5	21.13
317.5	21.17
319.1	21.26
DATA SET 67*	
20.8	0.36
77.7	1.83
90.1	2.57
192.3	14.78
273.2	21.10
278.3	21.51
285.4	21.93
291.5	22.23
295.2	22.41
300.4	22.51
305.7	22.57
310.2	22.43
312.5	22.37
316.8	22.52
319.6	22.64
325.0	23.11
327.8	23.21
373.2	29.58
DATA SET 68	
278.4	12.07

T	ρ
DATA SET 68(cont.)	
283.6	12.30
287.3	12.44
294.6	12.70
297.1	12.75
299.3	12.80
301.0	12.81
302.4	12.85
305.6	12.86
307.1	12.86
309.6	12.83
311.5	12.80
311.2	12.78
312.3	12.75
312.8	12.75
313.9	12.78
317.6	12.90
323.0	13.08
DATA SET 69*	
300.6	12.899
301.2	12.913
302.2	12.932
303.1	12.945
303.6	12.949
304.7	12.953
305.0	12.961
305.6	12.958
306.0	12.964
306.5	12.972
307.0	12.971
307.4	12.968
308.3	12.961
308.6	12.967
309.5	12.968
309.9	12.974
310.3	12.984
310.5	12.997
310.8	13.000
311.3	12.971
311.7	12.920
312.0	12.918
312.3	12.910
312.5	12.899
312.8	12.879
313.0	12.859

T	ρ
DATA SET 69(cont.)*	
313.4	12.859
313.6	12.868
313.7	12.875
314.4	12.892
314.6	12.892
315.1	12.909
315.6	12.900
316.6	12.937
317.3	12.960
DATA SET 70*	
300.3	12.888
301.2	12.900
302.1	12.922
302.8	12.940
303.4	12.946
303.9	12.957
304.5	12.960
304.9	12.963
305.5	12.975
306.0	21.977
306.4	12.979
307.0	12.985
307.3	12.986
307.8	12.984
308.0	12.986
308.4	12.979
308.8	12.981
309.0	12.978
309.2	12.986
309.5	12.989
309.8	12.988
309.9	12.978
310.3	12.970
310.3	12.961
310.5	12.965
310.8	12.964
310.9	12.982
311.2	12.982
311.4	12.979
311.4	12.966
311.5	12.960
311.5	12.941
311.6	12.932
311.6	12.925

T	ρ
DATA SET 70(cont.)*	
311.8	12.920
311.9	12.909
312.0	12.906
312.0	12.902
312.1	12.898
312.3	12.892
312.3	12.889
312.5	12.884
312.6	12.878
312.7	12.873
312.9	12.867
313.0	12.860
313.3	12.857
313.3	12.854
313.6	12.854
313.8	12.856
314.0	12.867
314.3	12.874
314.7	12.885
315.1	12.882
315.4	12.911
315.6	12.920
315.9	12.932
316.4	12.939
316.6	12.931
317.0	12.939
317.3	12.960
317.5	12.966
317.8	12.875
DATA SET 71*	
100.0	1.78
102.6	1.89
104.9	1.99
107.6	2.10
109.2	2.18
110.2	2.23
111.3	2.28
112.2	2.32
113.0	2.36
113.9	2.41
114.5	2.45
115.9	2.51
116.5	2.55
117.2	2.59

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 71(cont.)*		DATA SET 72(cont.)*		DATA SET 74(cont.)*		DATA SET 75(cont.)*		DATA SET 76(cont.)*		DATA SET 77(cont.)*	
118.6	2.66	122.3	3.012	108.7	2.186	120.7	2.766	126.1	3.020	123.6	2.888
119.3	2.70	122.8	3.025	110.8	2.270	121.3	2.783	126.7	3.074	123.8	2.897
120.2	2.75	123.8	3.058	112.7	2.362	121.3	2.802	128.3	3.172	124.2	2.918
121.3	2.80	124.3	3.098	113.8	2.409	121.5	2.813	131.6	3.340	124.9	2.950
121.6	2.84	125.3	3.160	114.7	2.452	121.8	2.831	135.3	3.590		
122.0	2.86	126.2	3.208	116.2	2.535	122.4	2.860	136.4	3.655	DATA SET 78*	
122.6	2.87	129.0	3.387	117.3	2.587	123.3	2.901	137.6	3.742		
123.1	2.89	129.6	3.417	119.1	2.668	124.0	2.940	140.4	3.919	281.7	11.93
123.6	2.90	130.8	3.500	120.2	2.741	124.6	2.969			292.3	12.27
123.9	2.92	131.6	3.546	120.5	2.765	124.9	2.987	DATA SET 77*		298.7	12.45
124.4	2.95	132.5	3.616	121.3	2.784					302.0	12.52
125.2	3.00	133.5	3.672	121.7	2.834	DATA SET 76*		117.4	2.557	305.4	12.59
125.9	3.03	135.3	3.787	122.6	2.834			117.6	2.563	307.1	12.60
126.8	3.08	135.9	3.873	123.2	2.904	100.8	1.812	117.7	2.558	308.2	12.61
127.8	3.15	136.9	3.914	124.1	2.956	101.7	1.848	117.7	2.572	308.4	12.57
129.4	3.25	138.0	4.000	125.0	2.983	102.7	1.889	118.1	2.587	309.4	12.57
130.1	3.29	139.1	4.080	125.8	3.036	104.1	1.944	118.2	2.593	311.0	12.57
131.8	3.40	140.3	4.171	126.5	3.084	105.1	1.987	118.4	2.607	311.4	12.51
132.8	3.46			127.4	3.133	105.9	2.014	118.6	2.613	311.6	12.47
133.7	3.52	DATA SET 73*		128.5	3.197	106.6	2.050	118.7	2.621	311.7	12.44
135.1	3.60			129.8	3.298	107.4	2.077	119.1	2.642	312.5	12.42
135.8	3.66	116.3	2.669	131.4	3.403	108.0	2.110	119.2	2.650	313.3	12.44
136.9	3.74	116.8	2.699	133.3	3.504	108.7	2.138	119.5	2.662	314.2	12.47
138.3	3.82	117.3	2.722	135.4	3.665	109.3	2.162	119.6	2.673	315.5	12.52
138.8	3.87	118.2	2.770	137.7	3.825	110.3	2.200	119.8	2.678	318.0	12.59
140.1	3.95	118.9	2.810	139.5	3.965	111.1	2.240	119.9	2.684	319.9	12.65
141.7	4.07	119.3	2.834	140.4	4.028	112.0	2.280	120.0	2.692	328.7	12.93
144.5	4.25	119.9	2.876			112.5	2.305	120.1	2.699		
		120.3	2.909	DATA SET 75*		113.1	2.336	120.3	2.705	DATA SET 79	
DATA SET 72*		120.8	2.928			113.5	2.357	120.5	2.717		
		121.3	2.943	116.2	2.531	114.2	2.383	120.6	2.724	2.39	0.147
100.8	1.976	121.7	2.961	117.0	2.576	114.6	2.410	120.7	2.770	3.03	0.135
102.4	2.043	122.3	2.980	117.4	2.590	115.4	2.453	120.9	2.773	4.08	0.150
105.0	2.153	122.6	3.004	117.9	2.615	116.5	2.503	121.1	2.778	4.08	0.144
108.0	2.280	122.7	3.020	118.2	2.634	117.8	2.565	121.3	2.785	5.38	0.135
111.5	2.440	123.4	3.050	118.5	2.652	118.6	2.611	121.4	2.791	5.49	0.153
113.2	2.520	123.9	3.083	118.9	2.673	119.6	2.670	121.6	2.803	9.74	0.147
114.2	2.558			119.4	2.695	120.6	2.724	121.7	2.815	10.8	0.153
115.3	2.608	DATA SET 74*		119.6	2.708	121.2	2.742	121.8	2.820	18.7	0.166
116.2	2.670			119.8	2.722	121.7	2.780	121.9	2.820	21.1	0.159
117.1	2.716	100.8	1.775	119.9	2.741	122.4	2.812	122.1	2.822	27.8	0.173
118.5	2.769	101.8	1.891	120.0	2.741	122.4	2.855	122.1	2.825	43.8	0.224
119.7	2.854	102.6	1.924	120.2	2.742	123.1	2.868	122.5	2.836	53.4	0.357
121.0	2.910	104.0	1.976	120.3	2.743	123.8	2.900	122.9	2.858	63.8	0.474
121.4	2.948	105.7	2.046	120.4	2.745	124.8	2.946	123.1	2.868	66.4	0.604
121.8	2.993	107.2	2.110	120.5	2.747	125.4	2.986	123.4	2.877	76.3	0.941

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 79(cont.)		DATA SET 81(cont.)*		DATA SET 82(cont.)		DATA SET 86*		DATA SET 90(cont.)*		DATA SET 91(cont.)*	
94.9	1.56	180	6.830	1764	82.6	1469	70.7	239.7	11.54	311.0	13.98
118	2.64*	190	7.480	1829	84.4	1520	74.0	244.3	11.78	313.9	14.05
140	4.03	200	8.130	1844	86.1	1545	75.5	249.9	12.09	318.7	14.15
162	5.46	210	8.805	1900	89.2	1570	77.4	254.6	12.31	323.0	14.33
201	8.01	220	9.460	1939	93.1	1603	79.2	259.3	12.48		
250	11.3	230	10.125	1967	97.1	1633	81.3	265.9	12.80	DATA SET 92	
282	12.2	240	10.755	1973	99.3	1693	85.1	269.6	12.99		
343	13.3	250	11.325					274.3	13.14	195.7	9.29
		260	11.895	DATA SET 83		DATA SET 87*		279.0	13.33	203.2	9.72*
DATA SET 80*		270	12.385					284.6	13.48	207.9	9.96*
		280	12.840	391	12.8	285.4	14.16	290.3	13.62	215.3	10.33*
1.15	0.183	290	13.230	498	16.3	289.1	14.27	295.0	13.67	224.7	10.93*
2.40	0.186	300	13.480	595	20.1	292.9	14.38	300.7	13.74	228.4	11.13
2.70	0.178	310	13.560	692	24.7	298.3	14.47	305.4	13.84	232.1	11.34*
3.16	0.187	320	13.745	800	29.3	303.4	14.52	308.2	13.87	239.6	11.68*
3.63	0.178	330	14.110	967	36.9	308.6	14.47	310.1	13.89	243.4	11.88*
4.26	0.187	340	14.460	1075	42.4	311.6	14.40	312.0	13.94	248.0	12.14*
4.70	0.182	350	14.830	1092	43.2	313.5	14.40	315.8	13.99	255.5	12.43*
7.0	0.183	360	15.190	1231	51.6	318.7	14.56	319.6	14.13	259.3	12.60*
12.4	0.186			1371	60.6	323.6	14.77	325.2	14.33	262.1	12.72
19.6	0.197	DATA SET 82		1469	66.1			330.8	14.47	265.9	12.87*
21.3	0.198			1564	71.6	DATA SET 88*		334.6	14.67	273.3	13.23*
25.9	0.205	330	12.5	1628	75.0			340.2	14.86	275.2	13.31*
32.9	0.227	412	15.6	1750	82.5	281.9	16.40	346.8	15.06	280.9	13.43*
48.0	0.313	474	17.6	1850	90.0	288.2	16.56	350.5	15.27	286.5	13.57*
62.1	0.530	571	21.3	1905	97.3	293.1	16.70	358.1	15.47	289.3	13.67*
77.3	1.01	661	24.7			298.3	16.79	363.7	15.76	295.0	13.79*
82.0	1.14	757	29.1	DATA SET 84		303.5	16.74	369.3	15.93	299.7	13.84*
90.6	1.55	765	29.9			308.6	16.53	375.9	16.19	304.5	13.84
115	2.05	835	33.1	1272	58.1	313.5	16.63	381.5	16.39	307.3	13.79*
168	6.27	849	33.8	1325	61.4	318.7	16.83	388.1	16.70	310.2	13.70*
221	9.60	926	37.3	1387	65.3	323.6	17.06	393.7	16.83	312.1	13.75*
235	11.10	939	37.9	1443	69.1			397.5	17.07	313.0	13.79*
286	13.00	1025	42.6	1498	72.5	DATA SET 89*		405.9	17.33	315.8	13.84*
		1047	43.2	1560	76.5			411.5	17.60	320.5	13.99*
DATA SET 81*		1165	49.5	1614	79.8	77	0.8	414.4	17.70	325.2	14.13*
		1264	55.6	1664	83.0					335.6	14.47*
90	1.495	1275	56.2	1704	85.5	DATA SET 90*		DATA SET 91*		337.5	14.50*
100	1.935	1360	61.5	1724	86.7					337.5	14.52*
110	2.415	1402	63.9			198.5	9.48	283.0	13.51	338.4	14.62*
120	2.935	1460	67.5	DATA SET 85*		207.9	9.89	287.9	13.63	341.2	14.72*
130	3.515	1510	70.3			214.4	10.21	292.3	13.71	343.1	14.77*
140	4.190	1542	71.9	1482	71.4	218.1	10.50	298.0	13.79	348.7	14.96
150	4.870	1574	73.7	1511	73.5	224.7	10.69	303.7	13.87	358.1	15.37*
160	5.515	1652	77.4	1651	82.4	230.3	11.00	305.7	13.91	375.9	16.07
170	6.170	1740	80.8	1682	84.3	234.0	11.30	308.6	13.93	383.4	16.29*
				1740	87.9						

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 92(cont.)		DATA SET 95(cont.)*		DATA SET 99(cont.)*		DATA SET 99(cont.)*		DATA SET 100(cont.)		DATA SET 102(cont.)*	
400.3	17.04	310.1	12.40	56.0	1.26	300.1	12.86	204	8.20	123.6	3.22
405.0	17.24*	310.4	12.38	59.4	1.32	301.4	12.88	216	9.02*	132.1	3.65
408.7	17.46*	310.8	12.38	65.4	1.49	302.7	12.90	226	9.69*	149.1	4.50
414.3	17.72*	311.2	12.38	72.7	1.63	303.9	12.90	237	10.39*	157.6	4.93
424.7	18.13	311.7	12.39	78.7	1.85	305.2	12.91	248	11.01	174.6	5.79
		312.3	12.40	79.8	1.90	306.0	12.92	260	11.69*	183.1	6.64
DATA SET 93*		312.7	12.41	89.2	2.26	306.9	12.92	271	12.26*	191.6	7.50
		313.0	12.41	101	2.76	308.2	12.92	282	12.77	204.4	8.14
283.8	13.57	313.6	12.44	110	3.23	309.0	12.91	291	13.05*	217.2	9.00
288.1	13.68	314.8	12.47	114	3.40	209.5	12.88	297	13.24*	225.7	9.64
293.3	13.79	316.1	12.50	133	4.47	209.8	12.85			238.4	10.28
296.3	13.84	318.5	12.58	136	4.64	309.9	12.80	DATA SET 101		251.2	10.93
297.7	13.86	321.8	12.68	143	5.08	310.1	12.76			264.0	11.57
305.0	13.82	323.8	12.77	149	5.33	310.4	12.74	300.3	13.29	272.5	12.21
305.9	13.78	327.5	12.94	151	5.49	311.1	12.74	301.4	13.31	289.5	12.85
306.4	13.75			152	5.60	311.7	12.76	302.5	13.33	298.0	13.07
307.4	13.70	DATA SET 96*		156	5.84	311.9	12.67	304.3	13.36	302.3	13.28
308.8	13.80			163	6.23	314.1	12.73	305.3	13.37	306.3	13.07
309.8	13.73	312.22	12.45	168	6.57	316.1	12.80	306.3	13.38	319.4	13.07
310.7	13.79			173	6.84	319.7	12.93	307.7	13.38	327.9	13.50
313.6	13.89	DATA SET 97*		179	7.17	325.0	13.13	308.6	13.38	336.4	13.93
318.0	13.98			184	7.45	330.1	13.30	309.6	13.37	349.2	14.14
323.2	14.15	78	1.635	189	7.78			310.2	13.36	349.2	14.36
				195	8.11	DATA SET 100		311.0	13.34	362.0	14.79
DATA SET 94*		DATA SET 98*		200	8.41			311.3	13.31	374.8	15.22
				205	8.69	4	0.0811	311.9	13.29	387.5	15.64
297.4	12.64	77.6	1.77	211	9.02	23	0.0811	312.2	13.27	400.3	16.07
305.3	12.78	85.9	2.10	217	9.35	40	0.16	313.0	13.27	417.4	16.72
306.1	12.75	95.3	2.51	222	9.62	51	0.25	313.4	13.28	434.4	17.36
307.2	12.72	106.3	3.01	227	9.90	60	0.41	314.2	13.30	451.5	17.79
308.8	12.66	116.8	3.56	233	10.23	67	0.59	315.9	13.35	460.0	18.65
309.5	12.60	119.5	3.73	239	10.51	74	0.75	317.4	13.40	481.2	19.50
309.6	12.58	123.4	3.89	244	10.75	80	1.00	317.8	13.41	498.3	20.36
310.3	12.49	127.2	4.06	249	11.00	88	1.22			511.1	20.79
311.4	12.54	130.5	4.28	254	11.25	93	1.47	DATA SET 102*		540.9	22.08
312.4	12.57	140.4	4.83	259	11.47	99	1.72			562.2	22.93
313.5	12.57			265	11.72	106	2.04	8.5	0.21	592.0	24.43
314.5	12.62	DATA SET 99*		271	11.94	114	2.54	21.3	0.21	604.7	25.29
				276	12.19	126	3.18*	34.1	0.21	630.3	26.36
DATA SET 95*		4.19	1.04	282	12.39	134	3.67*	46.9	0.22	664.3	27.86
		10.3	1.04	290	12.61	139	3.97	64.0	0.43	685.6	28.93
309.6	12.57	17.0	1.02	293	12.69	148	4.52*	68.2	0.65	719.7	30.43
309.8	12.52	24.2	1.03	295	12.72	159	5.21*	85.3	1.08	749.5	31.93
309.8	12.49	33.2	1.08	296.5	12.82	171	5.98	93.8	1.50	787.8	33.86
309.8	12.47	41.0	1.10	298.2	12.84	182	6.69	106.6	1.93	813.3	35.57
310.1	12.45	47.1	1.15	299.2	12.86	192	7.47	115.1	2.36	847.4	37.29

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

DATA SET 102(cont.)

T	ρ
885.7	38.57
915.5	40.71
949.6	42.00
979.4	43.71
1004.9	45.00
1034.7	46.71

DATA SET 103

T	ρ
298.6	13.00*
368.6	14.52
460.7	18.15
560.0	22.38
641.0	26.31
722.0	29.93
795.5	33.85
861.8	37.17
953.7	42.00
1042.0	46.82
1111.9	51.04
1181.8	54.96
1236.9	57.97
1281.1	60.39

DATA SET 104*

T	ρ
76.9	1.04
83.6	1.13
90.4	1.32
100.1	1.70
113.7	2.46
131.2	3.59
146.7	4.63
166.1	5.96
182.6	7.09
200.1	8.23
224.3	9.93
242.8	10.98
257.3	11.83
266.0	12.20
272.8	12.68
281.6	12.96
287.4	13.24
293.2	13.53
297.1	13.62
300.9	13.71

DATA SET 104(cont.)*

T	ρ
303.8	13.81
307.7	13.71
310.6	13.71
313.5	13.52
318.4	13.71
335.8	14.37
359.1	15.12

DATA SET 105*

T	ρ
20	0.10
77	0.83
273	12.49

DATA SET 106

T	ρ
93.5	1.29*
112.5	2.05
125.1	2.81*
150.3	4.07
162.9	5.09*
169.1	6.35
194.3	7.36
213.2	8.38*
219.5	9.14
225.8	9.90*
244.8	10.66
251.0	11.16*
269.9	12.18*
276.2	12.68*
295.2	13.19
301.4	13.70*
307.7	14.20*
307.8	13.70
326.8	14.21*
339.4	14.46
345.7	14.97*
364.6	15.73
389.9	16.49
396.2	17.00*
415.2	17.51
440.4	18.77
560.3	24.35
610.8	26.88
673.8	30.43
781.0	35.75

DATA SET 106(cont.)

T	ρ
850.4	39.30
944.8	45.38
982.7	47.41
1046	51.21
1121	55.51
1235	62.86
1279	65.64
1354	70.96
1449	77.04
1524	81.85
1543	83.62
1575	85.90
1587	86.91
1612	88.68
1637	90.46
1675	93.24
1688	94.00
1700	94.51
1707	95.52

DATA SET 107*

T	ρ
273.2	12.77
288.0	13.41
291.2	13.54
292.5	13.67
294.4	13.60
294.4	13.73
296.4	13.73
298.3	13.80
300.2	13.80
301.5	13.86
302.8	13.86
304.1	13.86
304.7	13.93
306.0	13.86
307.3	13.86
308.0	13.93
309.2	13.86
311.2	13.86
312.5	13.86
312.5	13.74
313.1	13.74
313.8	13.74
315.1	13.80
316.4	13.86

DATA SET 107(cont.)*

T	ρ
318.3	13.86
319.6	13.86
320.2	13.99
327.3	14.25
332.5	14.44

DATA SET 108*

T	ρ
100.0	2.01
105.2	2.28
122.8	2.98
135.0	3.50
145.6	4.47
182.4	6.93
208.7	8.59
238.5	10.43
254.3	11.49
278.9	12.80
285.9	13.07
294.7	13.24
301.7	13.51
308.7	13.50
319.2	13.50
324.5	13.68
329.8	13.94
338.5	14.29

DATA SET 109*

T	ρ
164.8	5.44
168.6	5.82
181.3	6.58
194.1	7.33
204.3	8.09
214.5	8.60
224.7	9.23
237.4	9.87
248.9	10.62
260.4	11.13
270.6	11.51
280.8	12.15
287.2	12.27
292.3	12.40
296.1	12.65
301.2	12.66
307.6	12.91

DATA SET 109(cont.)*

T	ρ
311.5	12.91
315.3	12.91
320.4	12.79
328.1	12.92
330.6	13.17
335.7	13.30
339.5	13.42
347.2	13.68
351.0	13.81
356.1	14.06

DATA SET 110*

T	ρ
300	14.4
400	19.2
500	24.0
600	28.8
700	33.6
800	38.4
900	43.231
1000	48.124
1100	53.079
1200	58.096
1300	63.175
1400	68.316
1500	73.519
1600	78.784
1700	84.111
1800	89.500

DATA SET 111*

T	ρ
89.4	1.38
110.0	2.42
134.5	3.81
172.2	6.25
204.0	8.69
240.0	10.96
266.3	12.35
290.7	13.39
316.9	13.36
337.6	14.22
367.6	15.61
399.5	16.99

DATA SET 112

T	ρ
295.9	12.366
299.9	12.430
304.7	12.506
306.2	12.518
307.7	12.531
308.8	12.531
309.9	12.506
311.0	12.381
312.5	12.381
312.9	12.406
314.0	12.431
315.1	12.482
315.8	12.482
317.0	12.507
318.1	12.558
322.5	12.709
327.7	12.860
332.8	13.037
338.0	13.239
343.5	13.403
344.3	13.491

DATA SET 113

T	ρ
287.0	12.152
289.2	12.215
291.8	12.290
295.1	12.391
299.2	12.480
304.3	12.581
305.5	12.606
306.9	12.619
307.7	12.619
308.8	12.607
309.2	12.594
309.9	12.582
310.6	12.557
310.7	12.481
311.4	12.481
312.1	12.481
312.5	12.507
312.9	12.532
314.0	12.544
314.7	12.582
315.8	12.608
316.9	12.633

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 113(cont.)		DATA SET 116		DATA SET 119(cont.)		DATA SET 122(cont.)		DATA SET 126(cont.)		DATA SET 126(cont.)	
317.7	12.658	277.1	12.109	284.8	12.954	302.3	12.594	294.6	12.764	306.1	12.891
322.5	12.809	282.4	12.307	289.8	12.916	305.1	12.611	294.8	12.768	306.4	12.889
327.6	12.948	286.4	12.460	292.1	12.901	307.2	12.634	295.0	12.774	306.8	12.888
332.4	13.087	292.4	12.610	294.9	12.883	309.9	12.659	295.3	12.776	307.1	12.886
338.0	13.276	294.0	12.669	297.4	12.863			295.5	12.780	307.4	12.882
350.2	13.667	300.5	12.789	299.9	12.857	DATA SET 123		295.8	12.786	307.6	12.879
		305.4	12.837	302.4	12.833			296.0	12.789	307.8	12.877
DATA SET 114		307.8	12.829	304.9	12.810	274.4	12.471	296.3	12.795	308.1	12.875
		310.4	12.789	307.2	12.786	279.7	12.502	296.5	12.800	308.3	12.873
304.5	12.633	311.8	12.632	310.0	12.751	284.6	12.522	296.8	12.804	308.6	12.867
305.4	12.648	312.0	12.646			289.7	12.551	297.0	12.808	308.9	12.862
307.1	12.665	312.8	12.661	DATA SET 120		292.2	12.562	297.2	12.813	309.2	12.855
308.1	12.662	317.5	12.818			295.0	12.574	297.5	12.816	309.3	12.851
309.0	12.662	320.1	12.906	269.9	12.879	297.3	12.591	297.7	12.818	309.5	12.847
309.7	12.625			274.9	12.855	299.8	12.605	297.9	12.822	309.6	12.842
310.1	12.620	DATA SET 117		284.8	12.816	307.6	12.654	298.2	12.826	309.7	12.837
310.8	12.600			289.8	12.793			298.4	12.830	309.9	12.835
311.1	12.497	271.5	12.274	292.3	12.790	DATA SET 124		298.7	12.834	310.0	12.830
311.7	12.497	277.4	12.453	294.8	12.796			299.0	12.838	310.0	12.826
312.1	12.514	282.4	12.610	297.4	12.795	274.4	12.528	299.2	12.843	310.2	12.819
312.6	12.520	290.0	12.804	299.9	12.781	279.7	12.571	299.4	12.845	310.2	12.815
312.6	12.523	294.5	12.888	302.4	12.781	284.6	12.577	299.6	12.850	310.3	12.810
313.0	12.540	300.5	12.954	304.9	12.775	290.1	12.599	299.9	12.852	310.3	12.807
314.1	12.577	305.4	12.947	307.7	12.751	292.2	12.605	300.1	12.854	310.5	12.803
315.1	12.620	308.0	12.917	310.0	12.727	294.5	12.611	300.4	12.859	310.5	12.796
316.1	12.646	310.4	12.837	312.5	12.701	297.3	12.619	300.9	12.863	310.6	12.792
						302.3	12.648	301.2	12.866	310.6	12.790
DATA SET 115		DATA SET 118		DATA SET 121		307.4	12.674	301.7	12.870	310.7	12.787
						309.9	12.696	301.9	12.873	310.7	12.785
305.0	12.519	275.2	11.769	274.9	12.808			302.1	12.876	310.7	12.784
306.0	12.539	277.6	11.871	279.9	12.790	DATA SET 125		302.4	12.877	310.7	12.780
306.8	12.554	280.7	12.010	284.7	12.778			302.7	12.881	310.7	12.776
308.0	12.551	287.3	12.270	289.8	12.764	274.7	12.665	302.9	12.882	310.7	12.775
309.0	12.542	293.1	12.464	294.8	12.749	279.5	12.671	303.0	12.884	310.7	12.772
309.1	12.534	297.3	12.592	299.6	12.743	284.6	12.671	303.4	12.884	310.8	12.766
309.9	12.517	302.1	12.705	304.7	12.736	289.7	12.668	303.6	12.886	310.8	12.762
310.5	12.500	306.8	12.756	307.2	12.728	294.5	12.668	303.8	12.887	310.9	12.756
311.0	12.383	308.0	12.753			299.6	12.677	304.1	12.888	310.9	12.752
311.4	12.372	310.4	12.738	DATA SET 122		304.6	12.688	304.4	12.889	310.9	12.742
311.7	12.377	310.9	12.716			307.4	12.696	304.6	12.889	310.9	12.739
312.1	12.380			284.8	12.477			304.8	12.890	310.9	12.732
312.7	12.395	DATA SET 119		289.7	12.511	DATA SET 126		305.0	12.891	311.0	12.724
313.0	12.403			292.2	12.522			305.3	12.892	311.0	12.722
314.2	12.437	269.7	13.098	295.0	12.534	293.8	12.749	305.5	12.890	311.0	12.721
315.3	12.475	275.0	13.040	297.5	12.557	294.1	12.753	305.6	12.889	311.0	12.716
316.1	12.503	279.8	12.004	300.0	12.574	294.3	12.759	305.8	12.892	311.0	12.711

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

DATA SET 126 (cont.)

T	ρ
311.1	12.707
311.0	12.700
311.1	12.698
311.1	12.696
311.1	12.693
311.2	12.687
311.3	12.685
311.3	12.681
311.4	12.676
311.3	12.675
311.5	12.671
311.6	12.670
311.7	12.670
311.9	12.671
312.0	12.672
312.0	12.673
312.1	12.674
312.4	12.677
312.5	12.680
312.6	12.683
312.7	12.685
312.8	12.689
312.9	12.691
314.0	12.726
314.8	12.741
314.8	12.748
316.7	12.799
317.0	12.806
317.5	12.822
317.7	12.829
318.0	12.837
320.1	12.906

DATA SET 127

T	ρ
301.4	12.672
301.6	12.679
301.9	12.685
302.1	12.689
302.4	12.694
302.6	12.699
303.1	12.706
303.3	12.706
303.6	12.711
303.8	12.715
304.7	12.730

DATA SET 127 (cont.)

T	ρ
305.0	12.732
305.2	12.737
305.5	12.739
305.8	12.744
306.3	12.748
306.4	12.753
306.7	12.753
306.9	12.756
307.1	12.758
307.4	12.759
307.7	12.760
307.9	12.762
308.1	12.762
308.4	12.765
308.6	12.765
308.9	12.763
309.1	12.763
309.3	12.763
309.5	12.762
309.6	12.761
309.9	12.761
309.9	12.756
310.0	12.754
310.1	12.753
310.1	12.751
310.3	12.749
310.3	12.747
310.3	12.745
310.4	12.741
310.6	12.739
310.6	12.735
310.6	12.732
310.6	12.731
310.6	12.728
310.7	12.723
310.8	12.720
310.8	12.716
310.9	12.709
311.0	12.703
311.0	12.694
311.0	12.692
311.0	12.686
311.0	12.681
311.1	12.677
311.1	12.674
311.2	12.673

DATA SET 127 (cont.)

T	ρ
311.2	12.671
311.3	12.666
311.5	12.666
311.7	12.669
312.0	12.671
312.2	12.674
312.5	12.679
312.7	12.684
312.8	12.689
313.0	12.692
313.1	12.698
313.4	12.703
313.7	12.709
313.8	12.716
314.2	12.726
314.4	12.732
314.6	12.737
315.1	12.752
315.4	12.757
315.6	12.765
315.8	12.772
316.1	12.780
316.3	12.788
316.6	12.794
316.8	12.800
317.0	12.808
317.3	12.815
318.3	12.844
318.5	12.852
318.7	12.861
318.9	12.869
319.3	12.875
319.4	12.882
319.7	12.891

DATA SET 128

T	ρ
1.51	0.10106
1.77	0.10105
2.05	0.10105
2.33	0.10104
2.47	0.10103
2.78	0.10102
3.01	0.10102
3.24	0.10101
3.40	0.10101

DATA SET 128 (cont.)

T	ρ
3.86	0.10101
4.22	0.10100
4.79	0.10100
5.52	0.10102
6.25	0.10105
6.83	0.10110

DATA SET 129

T	ρ
4.68	0.861
11.6	0.956
20.8	0.859
20.8	0.955
27.8	0.859
30.1	0.954
39.3	0.953
48.5	1.047
57.8	1.046
69.3	1.333
74.0	1.523
78.6	1.714
90.1	2.001
99.4	2.382
106.3	2.573
111.0	2.764
115.6	3.147
120.2	3.338
129.5	3.719
134.1	4.102
138.8	4.293
148.0	4.867
159.6	5.536
166.6	6.110
178.1	6.683
182.8	6.873
187.4	7.362
201.3	7.925
203.7	8.308
208.3	8.498
217.6	9.072
229.1	9.645
238.4	10.315
247.7	10.888
257.0	11.079
266.2	11.556
270.8	11.748

DATA SET 129 (cont.)

T	ρ
277.8	11.938
282.4	12.225
287.0	12.225
289.3	12.416
291.6	12.416
298.6	12.606
300.9	12.606
305.5	12.510
310.1	12.605
314.7	12.700
319.4	12.795
321.7	12.891
328.6	13.177

DATA SET 130

T	ρ
279.7	12.154
282.1	12.229
288.0	12.342
289.2	12.530
293.9	12.568
299.8	12.681
305.6	12.737
310.3	12.699
315.1	12.737
315.1	12.775
319.8	12.906
324.5	13.094
330.4	13.208

DATA SET 131

T	ρ
4.39	0.96321
4.40	0.96353
5.13	0.96304
5.43	0.96298
5.74	0.96317
6.02	0.96284
6.76	0.96260
7.21	0.96250
7.50	0.96239
7.95	0.96237
8.10	0.96222
8.39	0.96197
8.99	0.96201
9.58	0.96170

DATA SET 131 (cont.)

T	ρ
9.58	0.96180
10.17	0.96180
10.32	0.96184
10.92	0.96170
11.37	0.96167
11.82	0.96180
12.42	0.96180
13.17	0.96202
13.77	0.96210
14.68	0.96237
15.75	0.96290
16.06	0.96343

DATA SET 132

T	ρ
1.65	0.86027
2.09	0.86024
2.54	0.86021
2.83	0.86022
3.28	0.86022
3.57	0.86018
3.87	0.86012
5.35	0.86007
5.94	0.85997
6.53	0.85990
6.83	0.85984
7.42	0.85980
7.57	0.85984
8.01	0.85971
9.05	0.85977
9.49	0.85969
10.09	0.85977
11.27	0.85973
11.86	0.85980
12.61	0.85992
13.50	0.85810
13.80	0.86012
14.39	0.86021
14.84	0.86036

DATA SET 133

T	ρ
1.97	0.79508
2.56	0.67552
2.56	0.60725
2.86	0.46648
3.30	0.37245

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

DATA SET 133(cont.)

T	ρ
3.30	0.37245
4.20	0.34839
4.79	0.18398
5.70	0.39417
6.45	0.79188
7.07	1.26000

DATA SET 134

T	ρ
102.6	1.731
105.3	1.801
106.6	1.895
108.6	1.941
111.8	1.968
113.8	2.034
116.4	2.151
119.1	2.291
120.4	2.409
124.3	2.572
130.2	2.852

DATA SET 135

T	ρ
285.0	9.153
288.8	9.226
291.3	9.367
295.1	9.438
300.1	9.533
303.8	9.580
308.8	9.580
308.8	9.532
312.6	9.461
315.1	9.532
317.6	9.627
322.6	9.722
326.3	9.793

DATA SET 136

T	ρ
105.5	0.975
107.3	0.975
109.8	0.999
111.6	0.999
114.7	1.046
116.5	1.094
119.6	1.117

DATA SET 136(cont.)

T	ρ
121.4	1.141
123.9	1.307
126.3	1.426
128.8	1.736
130.0	1.973
130.6	2.140

DATA SET 137

T	ρ
103.2	1.825
105.1	1.966
107.7	2.106
109.6	2.224
111.6	2.317
113.5	2.411
116.7	2.598
119.3	2.785

DATA SET 138

T	ρ
121.3	1.667
122.0	1.739
124.0	1.788
126.6	1.836
128.6	1.932
129.9	1.957
131.8	2.005
133.8	2.005
135.8	2.101
139.1	2.078
140.4	2.294
141.7	2.391
145.0	2.511
148.3	2.559
150.2	2.632
152.9	2.704

DATA SET 139

T	ρ
287.3	6.609
290.9	6.655
295.8	6.701
299.4	6.746
303.1	6.793
307.9	6.792
312.7	6.723

DATA SET 139(cont.)

T	ρ
313.9	6.676
317.6	6.722
320.0	6.814
322.5	6.929
328.6	7.067

DATA SET 140

T	ρ
101.3	2.378
103.8	2.473
105.0	2.544
106.3	2.639
108.8	2.758
111.3	2.972
115.0	3.091
116.9	3.115
118.8	3.138
122.5	3.281
122.5	3.376
123.8	3.447
125.0	3.566

DATA SET 141

T	ρ
110.6	2.651
111.3	2.740
113.9	2.793
115.2	2.865
117.1	3.007
118.4	3.102
119.7	3.197
122.3	3.269
123.6	3.411
126.2	3.625
130.0	3.791
130.7	3.886
132.6	4.028

DATA SET 142

T	ρ
76.1	0.929
99.0	1.988
124.7	3.536
175.0	6.814
225.4	10.041
275.6	12.390

DATA SET 142(cont.)

T	ρ
311.3	12.816
313.0	12.622
320.8	12.958
326.4	13.151

DATA SET 143

T	ρ
76.1	0.929
90.1	1.407
99.0	1.794
123.6	3.239
175.6	6.376
225.3	9.512
275.0	12.003
311.3	12.764
312.4	12.570
320.8	12.958
327.5	13.151

DATA SET 144

T	ρ
296.1	12.880
297.5	12.906
299.9	12.930
302.4	12.958
303.1	12.971
304.2	12.971
304.9	12.971
305.5	12.971
306.5	12.958
307.4	12.958
308.3	12.945
309.2	12.919
311.3	12.880
312.3	12.622
314.1	12.687
314.9	12.725
315.9	12.751
316.6	12.790
317.7	12.829
319.6	12.893

DATA SET 145

T	ρ
297.8	12.687
298.6	12.712

DATA SET 145(cont.)

T	ρ
299.4	12.725
299.9	12.739
301.0	12.777
301.7	12.777
302.4	12.790
303.2	12.816
304.0	12.816
305.4	12.841
307.9	12.841
309.0	12.829
310.0	12.816
310.6	12.803
311.2	12.790
311.4	12.700
311.5	12.738
311.7	12.661
312.7	12.635
313.4	12.661
313.8	12.674
314.2	12.700
314.6	12.712
315.2	12.725
315.5	12.738
316.1	12.764
316.5	12.777
316.9	12.803
317.4	12.816
318.0	12.841

DATA SET 146

T	ρ
300.0	12.919
301.9	12.932
302.9	12.945
303.8	12.958
304.8	12.958
306.5	12.971
307.7	12.958
309.0	12.932
310.3	12.893
310.9	12.854
311.1	12.829
311.5	12.790
311.5	12.764
311.6	12.751
311.7	12.725

DATA SET 146(cont.)

T	ρ
311.8	12.687
311.9	12.661
311.9	12.648
312.9	12.661
316.7	12.790
318.5	12.854

DATA SET 147

T	ρ
295.2	12.609
297.1	12.674
299.0	12.725
300.1	12.751
303.0	12.803
305.2	12.829
307.5	12.841
309.6	12.816
311.8	12.700

DATA SET 148

T	ρ
299.4	12.545
300.8	12.583
302.1	12.622
303.4	12.661
304.7	12.700
306.1	12.725
307.2	12.738
308.6	12.751
309.9	12.751
310.6	12.751
311.1	12.738
311.3	12.725
311.4	12.712
311.8	12.648
311.9	12.635
312.3	12.635
313.1	12.648
313.5	12.674
314.7	12.712
317.1	12.816
318.7	12.854
320.0	12.906

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ
DATA SET 149	
299.1	12.725
301.8	12.790
304.4	12.829
307.0	12.854
309.6	12.829
DATA SET 150	
2.4	0.0149
4.2	0.0149
20.4	0.0157
78	0.0939
DATA SET 151	
4.31	0.0616
9.73	0.0616
15.1	0.0616
20.6	0.0616
24.9	0.0616
29.2	0.0616
34.6	0.0862
40.0	0.123
45.4	0.148
48.7	0.172
55.1	0.259
59.4	0.370
63.7	0.456
70.2	0.616
73.4	0.727
77.6	0.899
84.0	1.121
89.4	1.281
93.7	1.528
100.0	1.749
104.3	1.971
108.5	2.242
113.8	2.550
120.2	2.821
124.4	3.043
128.6	3.351
134.0	3.622
139.3	3.868
144.6	4.139
148.8	4.447
156.2	4.780
159.4	5.002

T	ρ
DATA SET 151(cont.)	
163.6	5.273
168.9	5.494
174.3	5.716
178.5	5.852
183.9	6.049
193.5	6.209
198.9	6.344
202.6	6.270
207.6	6.209
213.0	6.320
218.3	6.517
221.5	6.677
221.0	6.936
232.2	7.096
DATA SET 152	
59.5	0.283
64.8	0.394
70.2	0.505
74.5	0.616
75.5	0.702
78.8	0.788
82.0	0.702
107.5	1.946
113.9	2.193
118.2	2.415
123.5	2.599
129.9	2.883
133.1	3.129
138.4	3.289
144.8	3.462
149.1	3.622
153.4	3.683
158.8	3.622
164.2	3.794
173.8	4.152
180.2	4.349
184.5	4.570
198.3	5.174
202.6	5.359
207.9	5.581
212.1	5.778
216.4	5.975
222.8	6.184

T	ρ
DATA SET 153	
32.5	0.0370
40.0	0.062
44.4	0.062
49.8	0.123
55.2	0.172
59.5	0.259
63.8	0.370
69.1	0.480
74.5	0.591
83.1	0.788
84.1	0.899
88.4	1.12
93.7	1.26
98.0	1.39
102.3	1.56
113.0	1.84
118.4	1.86
122.7	1.92
129.1	2.12
133.4	2.30
144.1	2.66
149.4	2.83
154.7	3.06
159.0	3.24
164.3	3.41
168.6	3.63
177.1	4.04
183.5	4.26
187.7	4.48
194.2	4.68
198.4	4.89
202.7	5.06
209.1	5.31
217.6	5.73
222.9	5.94
DATA SET 154	
188.2	6.07
192.5	6.18
197.9	6.23
202.2	6.21
208.8	6.07
213.1	6.18
217.3	6.38
222.7	6.58
226.9	6.79

T	ρ
DATA SET 154(cont.)	
233.2	6.96
237.6	7.18
242.9	7.43
247.1	7.61
251.4	7.83
256.7	8.06
262.0	8.28
266.3	8.50
271.6	8.75
275.8	9.02
DATA SET 155	
59.4	0.320
63.7	0.394
69.1	0.505
76.1	0.727
83.0	0.949
89.4	1.17
92.6	1.39
99.0	1.53
99.0	1.61
103.2	1.84
108.6	2.08
113.9	2.33
118.1	2.55
123.5	2.71
128.8	2.86
134.1	3.10
138.4	3.29
143.7	3.46
149.1	3.51
153.5	3.46
158.9	3.57
163.1	3.73
173.8	4.15
179.1	4.35
183.4	4.56
187.6	4.82
194.0	4.98
198.3	5.09
203.7	5.31
207.9	5.58
212.2	5.75
218.6	5.97
221.7	6.16
227.1	6.38

T	ρ
DATA SET 155(cont.)	
232.4	6.58
236.6	6.82
240.9	7.07
247.3	7.23
252.6	7.48
256.9	7.70
262.2	7.92
DATA SET 156	
70.2	0.505
76.6	0.727
83.0	0.949
89.4	1.17
93.7	1.37
103.3	1.61
113.0	1.72
118.4	1.79
128.1	2.08
133.4	2.30
138.7	2.48
144.1	2.66
149.4	2.83
152.6	3.02
157.9	3.19
163.3	3.41
168.6	3.63
173.9	3.83
179.2	4.07
184.6	4.26
188.8	4.48
194.2	4.64
198.4	4.84
203.8	5.06
208.0	5.28
212.3	5.47
217.6	5.69
222.9	5.89
227.2	6.11
232.5	6.27
236.8	6.47
241.0	6.71
247.4	6.94
251.7	7.13
257.0	7.32
262.3	7.54

T	ρ
DATA SET 157	
216.1	6.79
228.4	7.87
240.0	8.83
252.3	9.83
263.9	10.65
274.0	11.40
280.5	11.87
286.3	12.13
289.2	12.31
292.1	12.43
295.7	12.52
297.8	12.56
300.0	12.65
306.5	12.60
308.6	12.60
310.8	12.51
320.9	12.99
331.0	13.47
DATA SET 158	
298.5	12.712
299.6	12.720
300.6	12.742
301.7	12.765
302.8	12.789
304.0	12.809
305.0	12.827
306.0	12.843
307.4	12.845
307.8	12.853
308.4	12.853
308.8	12.853
309.3	12.849
309.7	12.845
309.9	12.845
310.5	12.837
311.0	12.831
311.2	12.823
311.5	12.805
311.9	12.791
312.0	12.787
312.2	12.763
312.3	12.723
312.6	12.719
312.9	12.719

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 158(cont.)		DATA SET 160(cont.)		DATA SET 160(cont.)		DATA SET 161(cont.)		DATA SET 161(cont.)		DATA SET 162(cont.)	
313.0	12.727	302.65	12.689	311.25	12.680	304.65	12.716	311.10	12.599	308.77	12.737
313.3	12.735	302.80	12.692	311.33	12.679	304.76	12.718	311.22	12.596	308.89	12.735
313.7	12.751	302.99	12.694	311.40	12.676	304.91	12.719	311.40	12.595	308.93	12.734
314.3	12.763	303.26	12.696	311.48	12.675	305.10	12.721	311.56	12.596	309.08	12.699
314.8	12.771	303.37	12.698	311.55	12.673	305.33	12.722	311.63	12.598	309.23	12.734
315.4	12.799	303.75	12.702	311.74	12.668	305.48	12.722	311.78	12.600	309.34	12.726
317.0	12.838	303.94	12.704	311.97	12.664	305.67	12.724	311.90	12.602	309.38	12.724
318.2	12.854	304.20	12.706	312.16	12.662	305.86	12.725	312.08	12.607	309.50	12.722
318.9	12.878	304.43	12.707	312.27	12.660	306.09	12.726	312.20	12.610	309.57	12.719
319.4	12.888	304.66	12.710	312.39	12.659	306.39	12.727	312.31	12.612	309.65	12.717
319.8	12.906	304.84	12.712	312.50	12.659	306.62	12.727	312.46	12.616	309.72	12.714
		305.00	12.713	312.62	12.659	306.92	12.728	312.54	12.620	309.72	12.712
DATA SET 159		305.22	12.714	312.77	12.658	307.34	12.728	312.69	12.623	309.80	12.709
		305.45	12.715	313.07	12.658	307.71	12.726	312.84	12.629	309.88	12.706
193.0	10.331	305.68	12.717	313.26	12.659	307.87	12.726	312.95	12.632	309.95	12.702
193.8	10.331	305.83	12.718	313.60	12.663	308.09	12.724	313.18	12.638	309.99	12.697
212.6	10.834	305.94	12.718	313.90	12.666	308.24	12.724	313.37	12.643	310.03	12.694
232.3	11.278	306.17	12.719	313.98	12.668	308.40	12.722	313.52	12.648	310.11	12.690
232.8	11.231	306.36	12.720	314.09	12.669	308.62	12.720			310.18	12.687
252.8	11.558	306.51	12.721	314.28	12.672	308.81	12.717	DATA SET 162		310.22	12.682
252.8	11.582	306.66	12.721	314.36	12.673	309.00	12.715			310.26	12.678
272.9	11.699	306.85	12.721	314.47	12.675	309.12	12.713	304.15	12.733	310.30	12.674
278.0	11.664	307.00	12.721	314.51	12.677	309.23	12.710	304.19	12.734	310.34	12.670
283.1	11.629	307.23	12.722	314.66	12.678	309.34	12.707	304.53	12.737	310.37	12.667
292.1	11.710	307.46	12.721	314.73	12.680	309.42	12.704	304.68	12.738	310.37	12.663
302.3	11.921	307.76	12.721	314.85	12.682	309.50	12.702	305.06	12.740	310.45	12.655
302.8	11.909	308.06	12.720	314.96	12.685	309.61	12.700	305.21	12.742	310.45	12.652
302.8	11.944	308.33	12.719			309.69	12.697	305.33	12.742	310.53	12.649
346.3	12.786	308.56	12.719	DATA SET 161		309.73	12.695	305.44	12.743	310.60	12.643
347.2	12.821	308.71	12.717			309.81	12.692	305.67	12.744	310.60	12.640
		308.90	12.716	300.07	12.651	309.84	12.689	306.05	12.745	310.68	12.636
DATA SET 160		309.16	12.714	300.49	12.658	309.92	12.687	306.27	12.745	310.68	12.632
		309.31	12.713	300.75	12.663	310.00	12.682	306.35	12.746	310.76	12.628
300.23	12.655	309.54	12.710	301.02	12.668	310.11	12.677	306.50	12.746	310.83	12.624
300.42	12.658	309.66	12.709	301.24	12.671	310.15	12.672	306.73	12.746	310.91	12.623
300.57	12.660	309.81	12.708	301.47	12.676	310.26	12.668	307.03	12.746	310.99	12.616
300.72	12.662	309.88	12.705	301.74	12.679	310.26	12.663	307.11	12.746	311.06	12.612
300.91	12.665	310.00	12.704	302.15	12.685	310.34	12.658	307.33	12.746	311.10	12.609
301.06	12.668	310.26	12.701	302.30	12.688	310.41	12.651	307.56	12.745	311.21	12.608
301.25	12.671	310.34	12.699	302.53	12.692	310.49	12.646	307.67	12.745	311.33	12.606
301.40	12.674	310.41	12.698	302.83	12.695	310.57	12.641	307.75	12.744	311.56	12.606
301.55	12.675	310.53	12.696	303.10	12.699	310.64	12.631	307.83	12.744	311.63	12.609
301.74	12.678	310.76	12.690	303.29	12.701	310.68	12.626	307.90	12.743	311.74	12.611
301.93	12.681	310.87	12.688	303.51	12.704	310.76	12.619	308.05	12.743	311.82	12.613
302.12	12.683	310.95	12.687	303.66	12.706	310.83	12.613	308.36	12.741	311.97	12.617
302.35	12.685	311.02	12.684	304.27	12.702	310.91	12.608	308.47	12.740	312.08	12.620
302.50	12.688	311.14	12.683	304.38	12.714	310.99	12.603	308.55	12.739	312.16	12.621

* Not shown in figure.

TABLE 3. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CHROMIUM Cr (continued)

T	ρ
DATA SET 162 (cont.)	
312.20	12.624
312.31	12.626
312.42	12.628
312.58	12.634
312.69	12.638
312.80	12.642
312.95	12.644
313.07	12.650
313.22	12.653
313.37	12.658
313.44	12.662
DATA SET 163*	
4.2	0.100
7	0.101
10	0.102
15	0.107
20	0.113
25	0.126
30	0.146
40	0.209
50	0.314
60	0.470
70	0.690
80	0.983
90	1.36
109.5	2.37
125	3.35
150	4.92
175	6.48
200	8.01
225	9.51
250	10.99
273	12.33
300	13.90

* Not shown in figure.

3.2. Cobalt

There are 55 sets of experimental data available for the electrical resistivity of cobalt with purity higher than 99.9%. The information on specimen characterization and measurement condition for each of the data sets is given in table 5. The data sets are tabulated in table 6 and shown partially in figures 3 and 4.

Since cobalt is a transition element and is ferromagnetic, its electrical resistivity is expected to resemble those of nickel and iron. As it can be surmised from the size of the available data, the electrical resistivity of cobalt is not investigated as extensively as either that of iron or of nickel. Nonetheless, some features of the behavior of the electrical resistivity of iron and nickel have also been reported for cobalt, such as the T^2 variation in the temperature dependence of the electrical resistivity at low temperatures. The coefficient of this T^2 term becomes larger when measured in an applied magnetic field than when measured in the absence of an applied field [75].

Judging from the impurity analyses reported by some of the authors, cobalt specimens of purity higher than 99.999% are available commercially: Laubitz and Matsumura [76] (data set 43), White and Woods [77,21] (data sets 27, 28, 39), Kierspe et al. [78] (data set 16). However, there are wide disagreement between the reported residual resistivity ratios, even for specimens from the same manufacturer and having nearly the same impurities, as illustrated by the specimens of data sets 27 and 39. Since cobalt is nearly as strongly magnetic as iron (the spontaneous magnetization of 20.8 kG vs. 22 kG for iron), effects due to magnetic structure of specimens and due to the measuring current densities, etc. are expected to be significant. Unfortunately, there is very scarce information on these effects for cobalt specimens. In addition, the morphology of cobalt may have significant influence also. Even though the temperature of the α-β phase transformation of cobalt is greater than 700 K, this cph-fcc transformation is very sluggish, and the high-temperature fcc phase has been reported to persist at lower temperatures [79]. It is not unlikely for a specimen to contain a mixture of these two phases, depending on its thermal and mechanical history [76].

Amongst the available data for high-purity polycrystalline cobalt specimens, Laubitz and Matsumura [76] (data set 43) reported the highest residual resistance ratio ($\rho_{273\,K}/\rho_{4\,K}$) of 140 ± 10. The impurity analysis reported also indicated that their specimen was one of the purest. For comparison, the residual resistance ratio of a whisker specimen by Marker et al. [75] (data set 19) was reported to be 388. There are available only a few data sets giving the electrical resistivity of high-purity cobalt over a temperature range extending from ∿4 to 300 K: White and Woods [77] (data sets 27, 28), and Price and Williams [80] (data set 26). Aside from these data sets, White and Woods [21] (data set 39) reported data from 126 to 273 K, Semenenko et al. [81] (data set 3), Olsën-Bar [82] (data sets 4, 5), and Radhakrishna and Nielsen [83] (data set 9) reported data for low temperatures (<20 K) only. In addition, Loegel and Gautier [84] (data sets 47, 48) reported the temperature dependent part of the resistivity of specimens of unspecified purity for temperatures below 80 K. Most of these authors reported a T^2 dependence for the temperature dependent part of the resistivity for temperatures below 10 K. The coefficient of this T^2 component was reported to be $1.6 \times 10^{-11}\ \Omega\,m\ K^{-2}$ by White and Woods [77] and $\lesssim 1.0 \times 10^{-11}\ \Omega\,m\ K^{-2}$ by Radhakrishna and Nielsen [83]. Loegel and Gautier [84] reported, together with a T^5 component, a coefficient of $1.06 \times 10^{-11}\ \Omega\,m\ K^{-2}$ for temperatures up to 30 K. Semenenko et al. [81] reported an additional T component for temperatures 1.4-4.2 K; however, Radhakrishna and Nielsen [83] concluded from their data that the T component, if present at all, was not significant. Marker et al. [75] also reported the T^2 dependence for their whisker specimen with a coefficient of $1.5 \times 10^{-11}\ \Omega\,m\ K^{-2}$ in the temperature range 1.1-4.2 K.

The present analysis of the electrical resistivity of cobalt at low temperatures follows the same method as employed in the analysis of that of iron and nickel, i.e., by fitting the resistivity data to the expression

$$\rho = \rho_0 + \alpha T^2 + A\left(\frac{T}{\theta_R}\right)^5 \int_0^{\theta_R/T} \frac{x^5 e^x}{(e^x - 1)^2}\,dx \qquad (8)$$

However, because of the small number of available data sets and because of the apparent large deviation of the electrical resistivity of cobalt from the Mattheissen's rule, the coefficients α and A cannot be determined simultaneously with small uncertainties. Therefore, the value of α is taken to be $1.00 \times 10^{-11}\ \Omega\,m\ K^{-2}$, a value close to the mean of the coefficients reported by Radhakrishna and Nielsen [83] and by Loegel and Gautier [84]. Using a Debye temperature of 445 K approximately as the value for θ_R, the value of A was determined from eq (8) with the data of White and Woods [77] (data sets 27, 28). A value of 70 x $10^{-8}\,\Omega\,m\,K^{-2}$ was obtained. With these values of α and A, the resistivity values calculated from eq (8) agree to within 2% with the experimental data for temperatures below ∿25 K. For higher temperatures, the calculated values do not agree well with the experimental data, and therefore in the temperature range ∿35 to 90 K, the recommended values were obtained by interpolating the low-temperature values calculated from eq (8) and the data of Laubitz and Matsumura [76] (data set 43).

Two data sets are available covering a very wide temperature range (∿80-1700 K): by Laubitz and Matsumura [76] (data set 43) and by Kierspe et al. [78] (data set 16). Except for temperatures below ∿200 K, where the latter data set appears to be in error, the agreement between these two data sets is within ∿±3%. The recommended values from 90 to 1700 K are therefore based on these, with more weight given to that of Laubitz and Matsumura, especially for temperatures below 250 K. In this temperature range, cobalt undergoes two transitions: one polymorphic at ∿715 K, from cph(α) to fcc(β), and one ferromagnetic-paramagnetic at ∿1395 K. The polymorphic transformation is martensitic and is very sluggish, due to the small associated free energy change. Thus the temperature range in which this transformation occurs has been reported to vary from about 660 K [85] (data set 14) to about 740 K [86] (data set 1), and thermal hysteresis is generally reported. The careful study of Laubitz and Matsumura [76] on a specimen which had been x-ray analyzed to contain no detectable fcc phase at room temperature showed that the range of transformation was about 703-710 K upon heating and about 686-693 K upon cooling (data sets 44, 45). The resistivity of the β phase is generally reported to be lower than that of the α phase. Kierspe et al. [78] did not report details of the transformation, even though their data appeared to have a strange behavior at the transformation, which occurred at ∿720 ± 5.0 K. These authors reported a temperature coefficient that shows a decrease (∿30%) at the transition, instead of the usual positive-negative-positive change in the temperature coefficient indicated by a number of the other works (see, e.g., Laubitz and Matsumura [76] (data sets 44, 45), Powell [85] (data sets 11-14), and Fraser et al. [86] (data sets 1, 2)). A possible reason for the behavior of the data of Kierspe et al. was that their specimen might have been heated or cooled at too fast a rate.

The α-β phase transition temperature of 715 K indicated in figures 3 and 4 is based actually on specific heat measurements. At temperatures above the α-β transition, the temperature coefficient reported by Kierspe et al. [78] showed a gradual rise to a flat maximum at ∿1150 K, and decreased gradually again. It became almost constant at temperatures above ∿1500 K. There was no sharp δ-function like maximum as in the cases of nickel and iron at the Curie temperature. This behavior of their data is consistent with the data of Laubitz and Matsumura [76] (data set 43), which appeared to have a change of slope at ∿1250 K. At temperatures above the Curie temperature, the data of Seydel and Fucke [87] (data set 42) are in good agreement with those of Laubitz and Matsumura [76] and of Kierspe [78] and are also taken into account.

There are eight data sets for the electrical resistivity of molten cobalt [87-94] (data sets 7, 18, 40-42, 50-52). Of these, the data of Güntherodt et al. [92] (data set 41) and of Seydel and Fucke [87] (data set 42) agree to within ±1%. In addition, their data for the solid phase at the melting point agree to within ±1.5% of the recommended value. The recommended values for the molten state are therefore based on their data. The linear temperature dependence of the electrical resistivity of molten cobalt was reported also by Ono and Yagi [89] (data set 18), and by Kita et al. [93] (data sets 50,51).

The recommended values both uncorrected and corrected for thermal expansion of the material are presented in table 4, while only the uncorrected values (except those for the liquid state) are shown in figures 3 and 4 along with the experimental data. The values are for polycrystalline cobalt of purity 99.99% or higher; however, those values for temperatures below 200 K are applicable only to cobalt having a residual resistivity of 0.0370 x 10^{-8} Ωm. The estimated uncertainty in the recommended values is about ±5% for the solid state and ±7% for the molten state.

As mentioned earlier, the electrical resistivity of cobalt appears to deviate from the Matthiessen's rule fairly large. For specimens with somewhat higher residual resistivities, the application of Matthiessen's rule is likely to underestimate the electrical resistivity by up to a few percent. For example, for the specimens of White and Woods [77] (data sets 27,28) which have residual resistivities of about 0.09 x 10^{-8} Ωm, Matthiessen's rule appears to be applicable for temperatures below ∿15 K with resulting error less than -1%, but the error increases with temperature to -2% at ∿20 K, -5% at ∿35%, and -6% at 200 K and higher. For the specimen of Price and Williams [80] (data set 26) which has a residual resistivity of $\sim 0.13 \times 10^{-8}\ \Omega$m, the errors are approximately +2% at $\sim$20 K, -6% from $\sim$35 to 60 K, -5% at 100 K, and -4% from 200 to 300 K. Unfortunately, there are no available data sets for specimens of higher residual resistivity covering more or less continuously from low to room temperatures, so that a more extensive comparison could be made. The earlier measurement by McLennon et al. [50] (data set 30) on a specimen of residual resistivity 0.45 x $10^{-8}\ \Omega$m indicates that the use of Mattheissen's rule yields an error of only -1% at 20.6 K, but the error jumps to -20% at 83 K and reduces to $\sim$-10% at 293 K. The more recent measurement by Wilkes [95] (data set 46), whose specimen has a residual resistivity of $\sim 0.17 \times 10^{-8}\ \Omega$m, shows that the errors are -1% at $\sim$77 K, +1% at $\sim$200 K, and +1% at $\sim$300 K. It is interesting to note that the total impurity content of this specimen, $\sim$0.08%, is more than ten times higher than that of the specimen of White and Woods [77] (data sets 27, 28). However, it has been determined by Laubitz and Matsumura [76] that the specimen of Wilkes contains approximately 33% of the fcc phase at room temperature. It is evident that the phase constitution of a specimen has significant influence on the resistivity of cobalt, especially below the α-β transition. The presence of the fcc phase below 700 K is likely to lower the resistivity. On the other hand, the low-temperature cph phase is not likely to be stable at temperatures much higher than 700 K so that the higher temperature resistivity of cobalt of reasonable purity should not deviate by more than two or three percent from the recommended values.

The recommended values uncorrected for thermal expansion given in table 4 can be represented approximately by the following expressions to within ±0.5%.

1-35 K:

$$\rho = 0.0370 + 1.00 \times 10^{-5}T^2 + 70\left(\frac{T}{445}\right)^5 \int_0^{445/T} \frac{x^5 e^x}{(e^x - 1)^2}\,dx \qquad (19)$$

35-90 K:

$$\rho = 8.20 \times 10^{-2} - 5.261 \times 10^{-3}T + 1.477 \times 10^{-4}T^2 - 8.559 \times 10^{-8}T^3 \qquad (20)$$

90-700 K:

$$\rho = -9.98 \times 10^{-1} + 1.865 \times 10^{-2}T + 4.237 \times 10^{-6}T^2 + 3.777 \times 10^{-8}T^3 \qquad (21)$$

715-1250 K:

$$\rho = 31.71 - 1.0987 \times 10^{-1}T + 1.7872 \times 10^{-4}T^2 - 5.098 \times 10^{-8}T^3 \qquad (22)$$

1250–1400 K:

$$\rho = -117.61 + 1.8101 \times 10^{-1}T + 2.042 \times 10^{-8}T^2 - 1.773 \times 10^{-8}T^3 \qquad (23)$$

1400–1767 K:

$$\rho = -342.15 + 7.2544 \times 10^{-1}T - 4.1393 \times 10^{-4}T^2 + 8.201 \times 10^{-8}T^3 \qquad (24)$$

1767–3000 K:

$$\rho = 94.80 + 1.128 \times 10^{-2}T \qquad (25)$$

It should be stressed that these expressions do not necessarily suggest any theoretical justification, and should be treated, most appropriately, as numerical aids only. It should also be understood that giving these expressions does not imply a recommendation for the temperature derivative of the electrical resistivity.

TABLE 4. RECOMMENDED VALUES FOR THE ELECTRICAL RESISTIVITY OF COBALT[a]

[Temperature, T, K; Electrical Resistivity, ρ, 10^{-8} Ω m]

T	ρ uncorrected	ρ corrected	T	ρ uncorrected	ρ corrected
1	0.0370	0.0370	1100	59.26	60.05
4	0.0372	0.0372	1200	69.14	70.18
7	0.0375	0.0374	1300	78.79	80.11
10	0.0381	0.0380	1400	87.20	88.83
15	0.0396	0.0395	1500	91.46	93.34
20	0.0426	0.0425	1600	94.81	96.94
25	0.0481	0.0480	1700	97.76	100.15
30	0.0581	0.0580	1767	99.75(β)	102.32(β)
40	0.102	0.102	1767		114.7[b](ℓ)
50	0.178	0.178	1800		115.1[b]
60	0.280	0.279	1900		116.2[b]
70	0.408	0.407	2000		117.4[b]
80	0.563	0.562	2100		118.5[b]
90	0.742	0.740	2200		119.6[b]
100	0.947	0.945	2300		120.7[b]
150	2.02	2.02	2400		121.9[b]
200	3.20	3.20	2500		123.0[b]
250	4.52	4.52	2600		124.1[b]
273	5.18	5.18	2700		125.2[b]
293	5.78	5.78	2800		126.4[b]
300	6.00	6.00	2900		127.5[b]
350	7.67	7.67	3000		128.6[b]
400	9.56	9.57			
500	14.11	14.15			
600	19.88	19.97			
700	27.09(α)	27.25(α)			
715	25.89(β)	26.07(β)			
800	32.09	32.36			
900	40.43	40.83			
1000	49.58	50.15			

[a] The values are for polycrystalline cobalt of purity 99.99% or higher, but those below 200 K are applicable only to cobalt having a residual resistivity of 0.0370 x 10^{-8} Ω m. The columns headed uncorrected and corrected refer to values uncorrected and corrected for thermal expansion, respectively. Solid line separating tabular values indicates solid to liquid state transformation, while dotted line indicates solid phase transition.
α: cph; β: fcc.

[b] Provisional value.

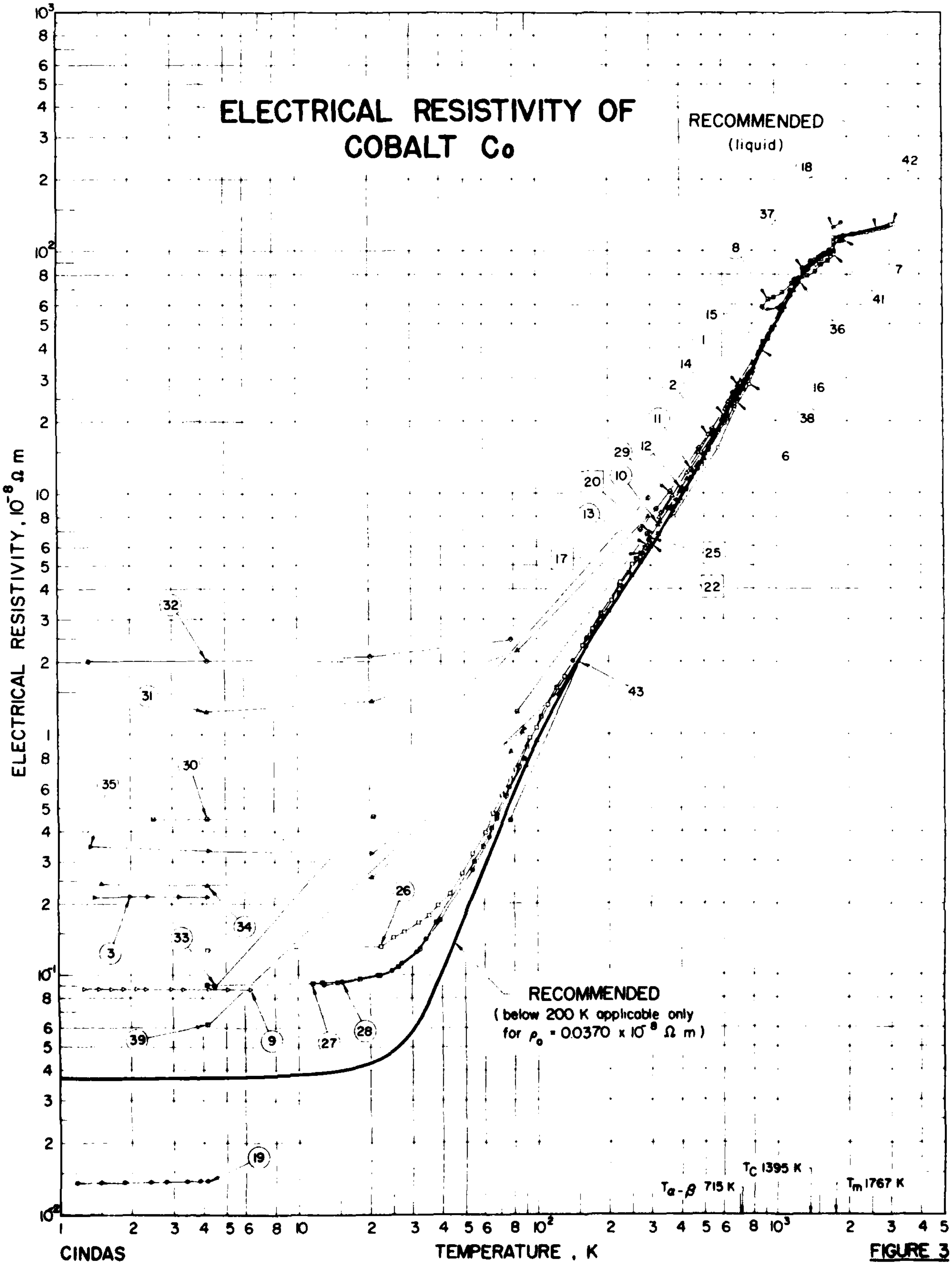

ELECTRICAL RESISTIVITY OF COBALT Co
RECOMMENDED (liquid)
RECOMMENDED (below 200 K applicable only for ρ_0 = 0.0370 x 10^{-8} Ω m)
ELECTRICAL RESISTIVITY, 10^{-8} Ω m
TEMPERATURE , K
$T_{\alpha-\beta}$ 715 K
T_C 1395 K
T_m 1767 K
CINDAS

FIGURE 3

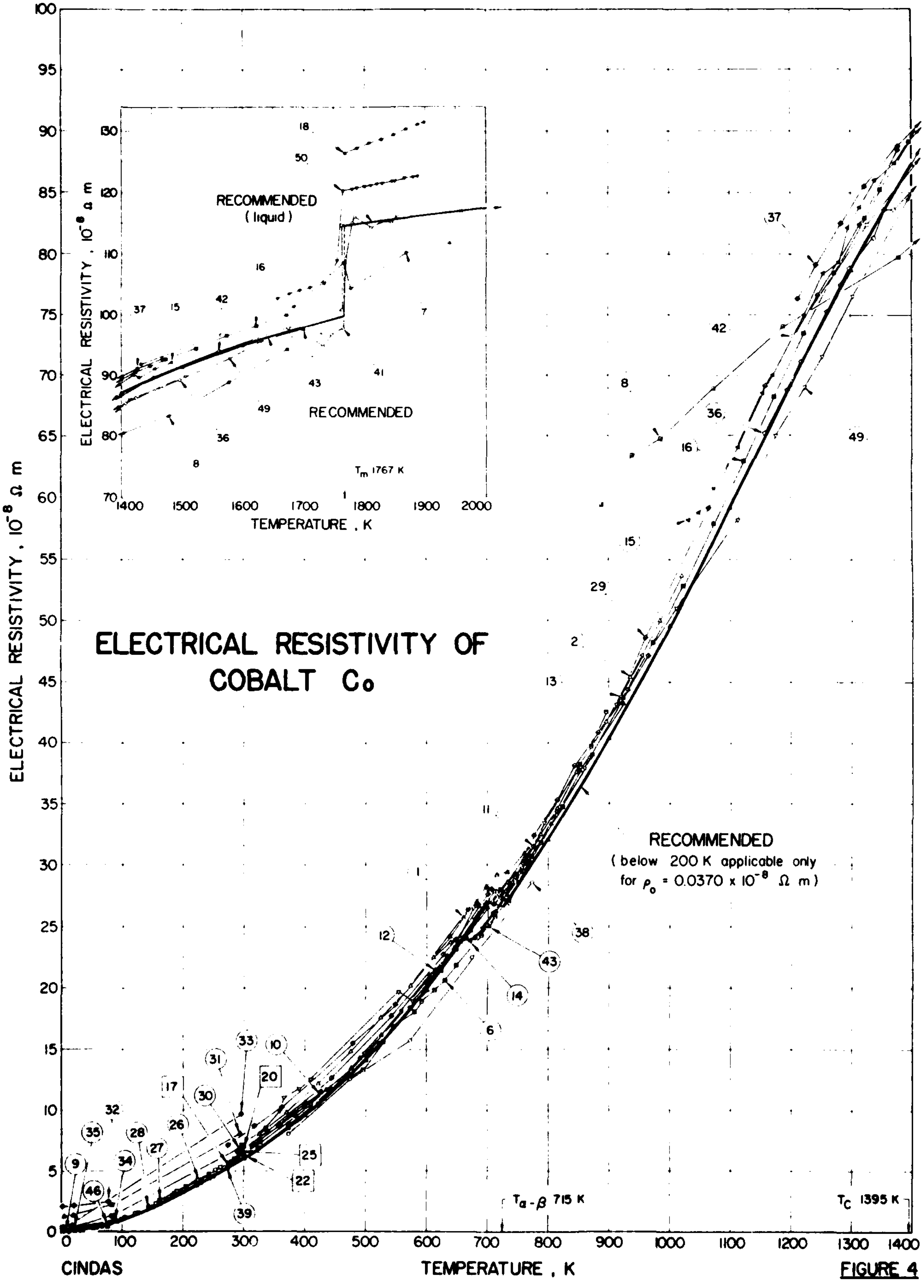

ELECTRICAL RESISTIVITY OF COBALT Co
ELECTRICAL RESISTIVITY, 10^{-8} Ω m
TEMPERATURE, K
RECOMMENDED
(below 200 K applicable only for ρ_0 = 0.0370 x 10^{-8} Ω m)
RECOMMENDED (liquid)
T_m 1767 K
$T_{\alpha-\beta}$ 715 K
T_C 1395 K
CINDAS

FIGURE 4

TABLE 5. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF COBALT Co

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
1	86	Fraser, R.W., Evans, D.J.I., and Mackiw, V.N.	1964		293-1020		99.9 pure; 99.5 Co + Ni, 0.07 Ni, 0.005 Fe, 0.001 Cu, 0.005 S, and 0.008 C by chemical analysis; <0.001 Ag, Al, B, Be, Ca, Cr, Hg, Mg, Mn, Mo, Pb, Sb, and Zn each by spectrographical analysis; 8.99×10^{-4} O_2, $<2.4 \times 10^{-6}$ N_2, and 1.9×10^{-6} H_2 for specimen hot rolled to 0.127 cm (0.050 in.); 1.47×10^{-3} O_2, 1.19×10^{-5} N_2, and 4.3×10^{-6} H_2 for specimen hot rolled to 0.127 cm (0.050 in.) and cold rolled to 0.0762 cm (0.030 in.); 1.31×10^{-3} O_2, 4.8×10^{-6} N_2, and 3.9×10^{-6} H_2 for specimen annealed at 1273 K after hot and cold rolling; gas impurities determined by gas analysis; strip specimens from Sherrit Gordon Mines; prepared from powder; rolled and compacted, sintered in hydrogen, hot rolled and cold rolled to desired thickness, and annealed at 1203 K for 1 h; density 8.85×10^3 kg m^{-3}; Rockwell hardness 45T 50-70; $\alpha \rightarrow \beta$ transformation temperature 778 K upon heating and 668 K upon cooling; T_C 1394 K; data extracted from heating curve.
2	86	Fraser, et al.	1964		325-1020		The above specimen; data extracted from cooling curve.
3	81	Semenenko, E.E., Sudovtsov, A.I., and Volkenshtein, N.V.	1964	A	1.4-4.2		99.9984 pure; specimens prepared by electric-spark cutting from rod 5 mm in diam; cross section of $\sim$0.30 x 0.25 mm^2 and $\sim$35 mm long; residual resistivity ratio, R(273 K)/R(0 K) 26.19; values calculated from reported R(T)/R(273 K) with ρ(273 K) = 5.57×10^{-8} Ω m, taken from Bridgman, P.W., Proc. Am. Acad. Arts Sci., 79, 149, 1940; measured with terrestial magnetic field compensated by means of Helmhdtz coilds.
4*	82	Olsën-Bär, M.	1956	G	4.2-20.2		Spectroscopically pure wire; obtained from Johnson Matthey Co.; 0.1 mm in diam and 3 to 5 cm long; annealed for several hours in high vacuum at approximately two thirds of the melting temperature by passing a current through it; Debye temperature = 385 K; values calculated from reported $\rho(T)/\rho(90\ K)$, with ρ(90 K) = 0.744×10^{-8} Ω m, taken from Data Set 43.
5*	82	Olsën-Bär, M.	1956	G	4.2-20.4		Same as above.
6	96	Chevemushkina, A.V. and Vasil'eva, R.P.	1965		374-895		Cobalt samples consist of an orthogonal parallelepipe with dimensions 3 x 6 x 120 mm; magnetized along the long axis of a solenoid producing magnetic fields up to 3000 Oe; data extracted from figure.
7	88	Eliutin, V.P., Turov, V.D., and Maurakh, M.A.	1965	R	1433-1940		98.5-99.0% pure; electrolytic cobalt; data extracted from figure.
8	97	Kovenskiy, I.I. and Samsonov, G.V.	1963	→	888-1673		99.82 Co, 0.12 C, 0.008 Ni, 0.004 Fe, 0.002 Cu, and 0.001 Mn and S each; measured by a direct-heating method.
9	83	Radhakrishna, P. and Nielsen, M.	1965	D	1.3-6.4		Pure; polycrystalline wire from Johnson Matthey Co.; 1 mm in diam and $\sim$6.6 cm long; annealed at 1313 K for 3 h at a pressure less than 4×10^{-5} PA; samples were demagnetized and the earth's field were compensated; data extracted from figure.

* Not shown in figure.

TABLE 5. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF COBALT Co (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
10	85	Powell, R.W.	1964	A,→	293-427		99.97% pure; 0.951 cm in diam and 4.346 cm long; supplied by Metallurgy Division of the National Physical Laboratory; data obtained from figure; resistivity measured by passing a measured current both forward and reverse through the sample; and using thermocouples as potential leads.
11	85	Powell, R.W.	1964	A,→	290-965		Similar to the above specimen except heated to 973 K.
12	85	Powell, R.W.	1964	A,→	290-923		Similar to the above specimen except cooled from 973 to 293 K.
13	85	Powell, R.W.	1964	A,→	290-955		The above specimen heated up to 973 K again.
14	85	Powell, R.W.	1964	A,→	384-756		The above specimen except cooled from 973 to 293 K.
15	98	Schröder, K. and Giannuzzi, A.J.	1969		1032-1483		99.7 pure; samples in wire form; annealed in an inert gas atmosphere consists of 92% He and 8% H for 2 h at ~150 K above the Curie temperature; values calculated from reported resistivity ratio, $\rho(T)/\rho(T_C) = 87.45 \times 10^{-8}$ Ω m taken from Data Set 16.
16	78	Kierspe, W., Kohlhass, R., and Gonska, H.	1967	→	77-1673		99.999^+ pure, <0.0001 Ag, Al, Ca and Cu each, 0.0003 Fe and Si each, 0.0002 Mn and 0.0001 Mg; supplied by Koch-Light Laboratories Ltd., England; a non-compensated Thomson bridge is used; values from table.
17	99	Bennett, M.R. and Wright, J.G.	1972	V,→	273	Bulk Co	99.998^+ pure with major impurities of 0.002 C, 0.0001 to 0.02 O_2, 0.004 N_2, and 0.0001 H_2; amorphous specimen with a cross section of ~5 x 10 mm^2; supplied by Koch Light Laboratories Ltd.; resistance measured by a standard four-terminal technique using thick silver lands evaporated on to the substrated prior to mounting in the ultra-high vacuum system; a 0.03% Fe in gold-chromel thermocouple from Johnson Matthey Co. was damped to the surface of the substrate for temperature measurement from 4 to 500 K.
18	89, 90	Ono, Y. and Yagi, T. Ono, Y.	1972 1977	R	1768-1898		99.9^+ pure; in molten state in a vacuum induction furnace; values calculated from the reported equation $\rho(\mu\Omega\text{-cm}) = \alpha T(°C) + \beta$ with $\alpha = 0.0384$ and $\beta = 69.07$.
19	75	Marker, D.L., Reichardt, J.W., and Coleman, R.V.	1971		1.1-4.2	Co DLM 20	Cobalt whisker grown by the hydrogen reduction of $CoBr_2$ at 673-773 K in a reducing atmosphere of argon; residual resistance ratio R(295 K)/R(4.2 K) = 388; data extracted from figure of R(T)/R(295 K) as function of square of temperature; reference value of ρ(295 K) = 5.8 μΩ cm, taken from White and Woods, Phil. Trans. Roy. Soc., London, A251, 273, 1959; used to calculate resistivity.
20	100	Plewes, J.T. and Bachmann, K.J.	1973	D	299	Specimen No. 13	99.999 pure Co; 0.0250 N, 0.0190 O, <0.0010 C, <0.0003 Si, Mg and Fe each; determined by emission spectrograph and vacuum fusion analysis; samples consist of 0.025 cm thick strips cold rolled to 0.011 cm, cut to ~20 cm in length by 0.25 cm in width; supplied by Johnson Matthey Co.; the center of the hysteresis gap found at 690 K; resistivity was monitored by superimposing an ac voltage on the ramp and measuring differentially the ac voltage drop across the specimen against an 0.010 Ω standard using a phase sensitive detection; reproducibility of measurement 0.1%.

TABLE 5. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF COBALT Co (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
21*	100	Plewes, J.T. and Bachmann, K.J.	1973	D	299	Specimen No. 13	Similar to the above specimen except heated to 573 K for 46 h after cold rolled, representing a fully recovered structure.
22	100	Plewes, J.T. and Bachmann, K.J.	1973	D	299	Specimen No. 13	The above specimen after 100 heat cycles carried out in a diffusion-pumped vacuum system which could be evacuated to 1.33×10^{-8} PA.
23*	100	Plewes, J.T. and Bachmann, K.J.	1973	D	299	Specimen No. 11	Similar to the above specimen except only cold rolled.
24*	100	Plewes, J.T. and Bachmann, K.J.	1973	D	299	Specimen No. 11	The above specimen heated to 1073 K for 10 minutes representing a fully recrystallized structure.
25	100	Plewes, J.T. and Bachmann, K.J.	1973	D	299	Specimen No. 11	The above specimen after 100 heat cycles carried out in a diffusion-pumped vacuum system which could be evacuated to 1.33×10^{-8} PA.
26	80	Price, D.C. and Williams, G.	1973	V	4.2-292		99.9985% pure; dimensions of 10 cm x 0.2 cm x 0.15 cm; supplied by Johnson Matthey Co.; annealed in vacuo for 2 h at 1173 K and then quenched; ideal resistivity ρ_i were reported from 22 to 292 K; data from table, uncorrected for thermal expansion; total resistivity calculated from data of ideal resistivity by the relation $\rho(T) = \rho_i(T) + \rho(4.2\ K)$; temperatures stabilized and measured to better than 0.5%; area to length ratio determined to within 0.5%.
27	77	White, G.K. and Woods, S.B.	1957	G	4.2-286	Col. a	Pure; 0.0002 Si, <0.0005 Fe, ∿0.0001 Al, and <0.0001 Mg and Cu each; by spectrographic analysis; rod specimen 5 to 8 cm long and 2 mm in diam; supplied by Johnson Matthey Co.; annealed in vacuum for ∿2 h at 973 K; residual resistance ratio $\rho(295\ K)/\rho(4.2\ K) = 65.36$; total resistivity calculated using $\rho = \rho_i + \rho_o$; ideal resistivity ρ_i extracted from figure; measurement error ∿±1%.
28	77	White, G.K. and Woods, S.B.	1957	G	4.2-279	Col. b	The above specimen remounted in a second cryostat and resistivity and thermal conductivity determined together; residual resistance ratio $\rho(295\ K)/\rho(4.2\ K) = 64.52$.
29	101	Tsoukalas, I.A.	1974		273-1378		99.99 (nominal) pure; polycrystalline; dimension 1 x 5 x 0.1 cm^3; martensitic transformation at 660 K form hcp to fcc; values extracted from figure.
30	50	McLennan, J.C., Niven, C.D., and Wilhelm, J.O.	1928		2.5-293	Cobalt(aged)	Pure; supplied by Belga American Trading Corp., New York; cut into strip and annealed in vacuum for 4 h at a dull red heat; values extracted from table.
31	50	McLennan, J.C., et al.	1928		4.2-293	Cobalt(unaged)	Similar to the above specimen, unannealed.
32	102	Meissner, W.	1928		1.4-273	CoI(27)	Specimen annealed for 2.5 h at 600 K; 50 mm in length and 2.5 x 0.5 mm cross section; resistance ratio reported; reference value of $\rho(273) = 5.57\ \mu\Omega\ cm$, taken from Bridgman, P.W., Proc. Am. Acad. Arts Sci., 79, 149, 1940, used to calculate resistivity from resistance ratio.

* Not shown in figure.

TABLE 5. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF COBALT Co (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
33	103	Horak, J.A. and Blewitt, T.H.	1972	A	4.5,295		Polycrystalline; ∿5 cm long, 0.025 cm diam; annealed, values extracted from table.
34	104	Meissner, W. and Voigt, B.	1930	→	1.5-273	Co 2	Sample in sintered polycrystalline form; 0.5 mm in diam and 57.6 mm in length; specimen obtained from Heraeus, von A.E.G.; sample annealed at 773 K in vacuum for 2.5 h; measured by compensation method; relative resistance data reported; reference value of $\rho(273) = 5.57\ \mu\Omega$ cm, taken from Bridgman (Proc. Am. Acad. Arts Sci., 79, 149, 1940), used to calculate resistivity.
35	104	Meissner, W. and Voigt, B.	1930	→	1.3-273	Co 3	Pure; 0.05 Cr, 0.01 Mn and <0.05 Fe; dimension 12.5 mm in length and 2.5 mm thick; obtained from Kahlb; sample melted in vacuum; measured by compensation method; reference value of $\rho(273) = 5.57\ \mu\Omega$ cm, taken from Bridgman (Proc. Am. Acad. Arts Sci., 79, 149, 1940), used to calculate resistivity.
36	105	Jain, S.C., Narayan, V., and Goel, T.C.	1969	B,→	1158-1496	Specimen 1	99.998 pure; specimen in rod form 15 cm long and 0.5 cm in diam; supplied by Koch Light Laboratories, United Kingdom; sample heated by electric current; the potential drop across the length of the uniform-temperature region was measured with a Tinsley *ac/dc* coordinate potentiometer type 4580; current through the sample determined by measuring the potential difference across a non-inductive standard resistor type 660 of 0.001 Ω in series with the specimen; values extracted from graph.
37	105	Jain, S.C., et al.	1969	B	1213-1468	Specimen 2	Similar to the above specimen except contains a total impurity concentration of about 0.001% of Si, Ni, Cu, Fe, Mg and Ag; sample supplied by Johnson Matthey Co.
38	106	Kirichenko, P.I.	1969		373-773		99.7 pure; 3 mm in diam and 30 cm long; annealed in vacuum for 24 h at 1273, oven-cooled; measured in a vacuum of 4×10^{-4} mmHg; measurement error: 1-1.5% in resistivity and 0.1 K in temperature; minima of resistivity versus temperature reported to occur at 655 K upon heating and 655 K upon cooling; values extracted from figure.
39	21	White, G.K. and Woods, S.B.	1959	G	4.2-273	Co 2	99.999 pure; 0.0002 Si, 0.0005 Fe, ∿0.0001 Al, and <0.0001 Mg and Cu; wire specimen 0.05 mm in diam and about 6 to 8 cm long, from Johnson Matthey Co. (JM9484); annealed in vacuum at 973 K; Debye temperature reported to be 380 K; residual resistance ratio R(295 K)/R(0 K) = 90.9; values calculated from reported ideal resistivity, extracted from graph, and reported $\rho_0 = 0.062 \times 10^{-8}\ \Omega$m from Table 1.
40*	91	Levin, E.S., Ayushina, G.D., and Gel'd, P.V.	1972	R	1923		99.98 pure; electrolytic.

* Not shown in figure.

TABLE 5. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF COBALT Co (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
41	92	Güntherodt, H.J., Hauser, E., Künzi, H.U., and Müller, R.	1975	A	1720-1854		99.999 pure from Johnson Matthey Co.; measured by a four probe method in which the sample material was enclosed in an alumina tube with four protrusion serving as current and potential contacts.
	110	Mueller, R.	1976				
42	87	Seydel, U. and Fucke, W.	1977	→	1205-3108		99.99 pure, 0.0007 Fe, 0.0005 Si, 0.0003 Cu, 0.0002 Ag and Ni, 0.0001 Al, Ca, Mg, and Sn each, <0.0001 Bi, Cr, and Mn each; measured by an exploding wire technique; measurement error 4%; smoothed values from curve; values corrected for thermal expansion.
43	76	Laubitz, M.J. and Matsumura, T.	1973	A	90-1700		99.999 pure, 0.00070 C, 0.00060 Ni, 0.00050 O_2, 0.00016 Fe, 0.00010 K, 0.00008 N_2, 0.00007 Na, 0.00004 Mo, 0.00003 Al, 0.00002 Ga and S each, 0.00001 P, 0.000007 Cl, 0.000006 Ca, Cr, and Cu each, 0.000002 Mg, and 0.000008 Ag and Pd each (at.%), by semiquantitative mass spectrographic analysis; from Metals Research Ltd., England; material originally rod shape ~2 cm in diam and 20 cm long; polycrystalline; annealed at 1500 K for 4 h in a vacuum of 5×10^{-6} Torr; cooled at 100 K hr^{-1}, except in the range 710 to 670 K, where it is cooled at 0.5 K hr^{-1}; residual resistance ratio 140 ± 10; density 8.831×10^3 kg m^{-3} at 293 K; grain size ~0.1 cm; specimen trimmed to a nominal diam of 2 cm and length of 20 cm with no machining of the region on which measurements were made; one specimen then measured from 300 to 1250 K; residual resistivity ratio after measurement 120; a second specimen, 1 cm in diam and 10 cm long were cut from the first and measured from 90 to 370 K; no change in residual resistivity ratio, and in ice point resistivity were detected; the second specimen measured again from 1000 to 1750 K; grain size increases to 0.5-1.0 cm after high temperature measurement; residual resistivity ratio unchanged; but specimen geometry is changed; smoothed values from table, these values are reported to be averages in the temperature range where the two measurements overlap; values uncorrected for thermal expansion; values above 1300 K had been adjusted by +0.8% by the authors to avoid discontinuity in resistivity values between the large and the small specimens; measurement error reported 0.5%; smoothed values from table.
44*	76	Laubitz, M.J. and Matsumura, T.	1973	A	680-710		The smaller of the above specimens, measured after the high temperature measurements; measured while heating.
45*	76	Laubitz, M.J. and Matsumura, T.	1973	A	685-715		The above measured while cooling.
46	95	Wilkes, K.E.	1968	A	78-300		99.92 pure, 0.040 Fe, 0.012 Ni, 0.004 C, 0.001 Ca, Cu and Si each, 0.0008 S, 0.0003 Al and Mn each, 0.0002 Mg, and 0.0001 Pb; rod specimen 1.000 cm in diam and 10.05 cm long; supplied by Centre D'Information on Cobalt, Brussels, Belgium; density 8.805×10^3 kg m^{-3} at 296 K; values from table; residual resistivity ratio measured by M.J. Laubitz and T. Matsumura, Can. J. Phys., 51(2), 1247, 1973, to be 31, and reported to change to 48 after being "carefully reannealed".

* Not shown in figure.

TABLE 5. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF COBALT Co (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
47*	84	Loegel, B. and Gautier, F.	1973		6.8-79		"Pure cobalt," no other details reported; only temperature dependent part of resistivity reported.
48*	84	Loegel, B. and Gautier, F.	1973		5.6-33		Similar to the above.
49	107	Zinov'yev, V.F., Krentsis, R.P., Perova, I.N., and Gel'd, P.V.	1968	A,R	296-1730		99.95 pure; 0.2 mm thick, 8 mm wide and 8 mm long; ground from rolled stock; annealed at 1200 K for 7 h under a pressure of 1 x 10^{-5} mmHg; ρ(288 K)/ρ(4.2 K) = 86; α-β transition reported at 703 K; measured by potentiometric method below 1330 K, and by rotating field method above 1400 K; hysteresis at α-β transition reported but resistivity values given for heating only; uncertainty in temperature measurement 10-15 degrees.
50	93	Kita, Y., Ohguchi, S., and Morita, Z.	1978	→	1658-1888		0.137 Fe, 0.09 Ni, 0.017 Si, 0.012 Mn, 0.011 S, and 0.008 C; measured in a vacuum of 10^{-4} Torr, with a four probe method in which the electrodes are of the same material as the specimen; data points are taken at temperatures in the following sequence: 1788, 1811, 1829, 1850, 1870, 1888, 1881, 1867, 1846, 1820, 1801, 1781, 1765, 1755, 1735, 1711, 1694, 1678 and 1658 K; values from table supplied by authors.
51*	93	Kita, Y., et al.	1978	→	1764-1895		Same as the above, a second melt; temperature sequence: 1795, 1809, 1823, 1843, 1863, 1878, 1895, 1883, 1869, 1854, 1836, 1819, 1801, 1782, and 1764 K.
52*	94	Samarin, A.M.	1962	R	1767-2000		Measured by the rotating field method; apparatus calibrated with iron; using resistivity value reported by R.W. Powell, Philos. Mag., 44, 772, 1953; resistivity value calculated from reported conductivity (1.12-0.228 x 10^{-3} T(C)) x 10^{4} $\Omega^{-1}cm^{-1}$; upper temperature limit issued to be 2000 K.
53*	108	Shimank, H.	1914	A	20.2-273		Wire specimen 1-2 m long; resistivity values calculated from reported R(T)/R(273 K) ratio, with ρ(273 K) taken to be 5.178 x 10^{-8} Ωm.
54	109	Thomas, J.G. and Mendoza, E.	1952		1.2,4.2		99.95 pure, from New Metals and Chemical Ltd., 0.13 mm in diam; drawn; x-ray show hcp structure; resistivity value calculated from reported R(T)/R(273 K) with ρ(273 K) taken to be 5.178 x 10^{-8} Ωm.
55	109	Thomas, J.G. and Mendoza, E.	1952		0.06-4.2		Similar to the above except annealed for 3 h in vacuo at 1273 K; contains a small amount of fcc structure.

* Not shown in figure.

TABLE 6. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF COBALT Co

[Temperature, T, K; Electrical Resistivity, ρ, $10^{-8}\ \Omega m$]

T	ρ
DATA SET 1	
293	6.3
325.15	8.0
370	9.8
422	12.2
476	14.8
525	17.6
573	20.2
611	22.5
638	24.2
660	25.7
682	27.0
698	28.2
715	29.2
733	29.4
761	30.9
788	32.5*
814	34.6*
847	37.6*
895	41.7*
935	45.4*
983	50.0*
1020	53.7*
DATA SET 2	
325.15	8.0
370	9.8
422	12.2
476	14.8
525	17.6
573	20.2
611	22.5
638	23.7
664	24.4
683	25.7
700	26.7
716	27.7
733	28.6
761	30.5
788	32.5
814	34.6
847	37.6
895	41.7
935	45.4
DATA SET 2 (cont.)	
983	50.0
1020	53.7
DATA SET 3	
1.41	0.212755
1.61	0.212750*
1.78	0.212765*
1.99	0.212773
2.22	0.212817*
2.36	0.212815
2.60	0.212812*
2.80	0.212831*
3.19	0.212855
3.38	0.212868*
3.57	0.212893*
3.77	0.212912*
4.00	0.212944*
4.18	0.212948
DATA SET 4*	
4.17	0.1578
4.96	0.1578
5.24	0.1576
5.86	0.1579
6.52	0.1581
6.99	0.1581
7.41	0.1581
7.78	0.1581
8.21	0.1581
8.61	0.1565
9.08	0.1566
10.50	0.1585
11.29	0.1589
11.66	0.1584
12.26	0.1595
12.40	0.1584
13.35	0.1585
14.11	0.1589
14.88	0.1594
16.08	0.1600
16.75	0.1604
18.85	0.1612
20.22	0.1622
DATA SET 5	
4.16	0.1499
4.80	0.1500
5.22	0.1501
5.75	0.1501
6.10	0.1502
6.62	0.1504
7.24	0.1504
7.92	0.1505
8.54	0.1506
9.08	0.1507
9.54	0.1507
10.15	0.1508
10.83	0.1511
11.56	0.1512
12.43	0.1519
20.38	0.1547
DATA SET 6	
374	8.8
391	9.3
443	11.7
496	13.3
529	15.6
546	16.8
580	18.0
592	18.9
612	19.8
630	20.6
649	21.8
690	24.3
712	25.8
733	27.1
752	28.6
764	30.3
789	31.8
815	34.6*
851	38.2
870	39.7
895	42.5
DATA SET 7	
1433	91.8
1685	101.4
DATA SET 7 (cont.)	
1765	108.6
1773	104.3
1868	110.3
1940	111.8
DATA SET 8	
888	59.4
939	63.4
986	64.7
1073	68.9
1188	74.0
1379	79.7
1478	83.3
1576	88.9
1673	92.2
DATA SET 9	
1.28	0.087146
1.49	0.087151
1.67	0.087151
1.87	0.087162
2.12	0.087168
2.31	0.087176
2.49	0.087187*
2.74	0.087200*
2.96	0.087212
3.16	0.087223*
3.34	0.087238
3.56	0.087248*
3.75	0.087263*
3.96	0.087281*
4.22	0.087302
4.61	0.087337*
4.82	0.087355*
5.11	0.087381
5.28	0.087400*
5.49	0.087423*
5.69	0.087445*
5.88	0.087468*
6.16	0.087497*
6.36	0.087521
DATA SET 10	
293	6.46
294	6.27*
324	7.43
327	7.63
356	8.64
359	8.88
399	10.28
424	11.41
427	11.56
DATA SET 11	
290	6.45
339	8.19
444	12.66
542	17.71
627	22.75
648	23.93
701	27.64
701	28.00
704	28.00*
707	28.00
722	27.38
738	28.43
747	28.93
749	29.00*
760	30.05
776	31.43
814	34.33
869	38.74
931	44.36
965	47.16
DATA SET 12	
290	5.9
401	10.6
435	11.62
476	13.47
490	14.24
505	14.66
526	16.13
596	20.47
613	21.42
633	22.53
DATA SET 12 (cont.)	
644	23.18
650	23.58*
655	23.80*
661	24.02*
666	24.13*
677	24.03
686	24.53*
694	25.03
705	25.73*
713	26.29
724	27.01*
732	27.56
742	28.39*
767	30.08
805	33.35
852	37.74
923	43.24
DATA SET 13	
290	6.06
327	7.35
410	10.51
498	14.71
626	22.07
644	23.39*
679	25.67
695	26.76
701	27.14
705	27.75*
711	27.83
714	27.88*
718	28.00
718	28.05*
721	27.51
721	27.73
725	27.59*
730	27.88
735	28.13
742	28.60
749	29.10*
757	29.77
768	30.51
860	37.95
919	43.80
955	47.15

* Not shown in figure.

TABLE 6. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF COBALT Co (continued)

DATA SET 14

T	ρ
384	9.44
458	12.39
559	18.15
605	21.05
626	22.14*
645	23.24*
652	23.66
659	23.94*
665	24.02
667	24.00*
669	23.92*
671	23.89
673	23.85*
674	23.87*
676	23.91*
677	24.02*
680	24.22
684	24.63*
692	24.97
709	26.16
725	27.29
734	28.00
756	29.45

DATA SET 15

T	ρ
1032	58.24
1049	58.85
1074	60.87
1114	64.10
1133	68.56
1154	68.56
1171	70.05
1223	74.94
1231	76.69
1255	78.44
1280	79.32
1283	80.63*
1295	82.12
1316	83.86
1321	83.86*
1340	86.05
1370	87.45
1373	87.45
1407	88.85
1420	90.07
1424	89.72*

DATA SET 15(cont.)

T	ρ
1428	89.72
1455	91.04
1458	91.21*
1461	91.82*
1483	92.17

DATA SET 16

T	ρ
77	0.44
173	2.65
223	3.84
273	5.25
323	6.81
373	8.52
423	10.50
473	12.80
523	15.45
573	18.38
623	21.48
673	24.72
698	26.55
723	28.00
748	29.25
773	30.65
823	34.72
873	39.05
923	43.66
973	48.20
1023	52.85
1073	57.92
1123	62.95
1173	68.20
1223	73.48
1273	78.45
1323	82.97
1348	85.27
1373	87.45*
1398	89.17
1423	90.60
1448	91.62
1473	92.65
1523	94.35
1573	96.52
1623	98.17
1673	99.95

DATA SET 17

T	ρ
273	5.6

DATA SET 18

T	ρ
1768	126.478
1788	127.246
1808	128.014
1828	128.782
1848	129.550
1868	130.318
1888	131.086
1898	131.470

DATA SET 19

T	ρ
1.18	0.013658
1.31	0.013668
1.39	0.013668
1.49	0.013675
1.60	0.013680
1.69	0.013684
1.78	0.013688
1.88	0.013693
1.97	0.013698
2.08	0.013705
2.19	0.013711
2.28	0.013715
2.40	0.013732
2.50	0.013728
2.59	0.013740
2.69	0.013746
2.80	0.013758
2.89	0.013765
3.00	0.013772
3.09	0.013780
3.19	0.013790
3.29	0.013797
3.40	0.013810
3.50	0.013822
3.59	0.013834
3.69	0.013843
3.79	0.013859
3.89	0.013867
3.99	0.013875
4.09	0.013888
4.18	0.013898

DATA SET 20

T	ρ
299	6.90

DATA SET 21*

T	ρ
299	6.25

DATA SET 22

T	ρ
299	6.24

DATA SET 23*

T	ρ
299	6.91

DATA SET 24*

T	ρ
299	6.48

DATA SET 25

T	ρ
299	6.58

DATA SET 26

T	ρ
4.2	0.1275
22.1	0.1328
25.2	0.1441
27.9	0.1516
31.8	0.1660
35.3	0.1788
38.7	0.1965
43.1	0.2208
48.5	0.2662
53.5	0.3203
60.7	0.3954
65.3	0.4726
71.6	0.5660
73.3	0.5974*
77.4	0.6547
81.3	0.7177
84.7	0.7791*
89.7	0.8671*
93.8	0.9612*
100.0	1.0694
105.2	1.1966*
113.2	1.3298
122.2	1.5207

DATA SET 26(cont.)

T	ρ
131.8	1.7419
141.9	1.9810*
156.3	2.3355
171.8	2.7038
182.0	2.9524*
191.4	3.2178
206.5	3.5710
225.9	4.2580
253.5	5.0140
261.2	5.2917
271.0	5.4120
292.4	6.1254*

DATA SET 27

T	ρ
4.2	0.0902
11.56	0.0914
12.74	0.0921
12.88	0.0919*
14.59	0.0926
15.49	0.0933*
16.07	0.0943*
16.83	0.0942*
18.20	0.0958
20.28	0.0974
22.03	0.0998
26.24	0.1088
28.91	0.1172*
32.06	0.1295
34.91	0.1495*
37.84	0.1664
54.83	0.2972
59.70	0.3461
64.27	0.4145
67.45	0.4508
74.30	0.5655
84.33	0.7359
91.62	0.8827
105.9	1.184
122.2	1.563
162.6	2.506
187.5	3.159
205.6	3.646
224.4	4.136
243.2	4.640
264.9	5.314
285.8	5.992

DATA SET 28

T	ρ
4.2	0.0907*
12.91	0.0922
15.31	0.0933
18.07	0.0958*
21.53	0.0991
24.83	0.1048
27.42	0.1122
31.05	0.1250
34.36	0.1418
39.81	0.1707
53.95	0.2786
63.10	0.3804
68.55	0.4726
76.38	0.6047
88.31	0.7970
143.5	2.032
279.3	5.688

DATA SET 29

T	ρ
273	7.1
317	8.7
362	10.2
479	15.5
549	18.7
668	26.4
684	26.8
698	26.8
711	26.8
745	28.7
777	32.4
815	35.3
843	38.1
882	40.8
916	43.2
960	48.6
1065	59.2
1159	69.1
1246	76.6
1315	82.4
1378	88.5

DATA SET 30

T	ρ
2.5	0.45
4.2	0.45
20.6	0.46

* Not shown in figure.

TABLE 6. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF COBALT Co (continued)

DATA SET 30 (cont.)

T	ρ
83	1.24
293	6.85

DATA SET 31

T	ρ
4.2	1.24
20.6	1.37
83	2.22
293	8.07

DATA SET 32

T	ρ
1.35	2.0230
4.22	2.0498
20.44	2.1004
78.24	2.4653
273.2	5.57

DATA SET 33

T	ρ
4.5	0.0896
295	9.677

DATA SET 34

T	ρ
1.51	0.2401
4.20	0.2373
20.42	0.2578
77.78	0.8444
86.92	1.0188
273.2	5.57

DATA SET 35

T	ρ
1.36	0.3476
4.22	0.3387
20.41	0.3258
20.45	0.3264*
78.30	0.8845*
88.16	1.0589

DATA SET 36

T	ρ
1158	65.2
1195	68.8
1218	71.1

DATA SET 36 (cont.)

T	ρ
1261	75.2
1284	77.4
1298	78.8
1338	81.3
1356	83.6
1372	83.6
1407	85.4
1423	86.3
1434	86.5*
1470	88.1
1488	89.6*
1496	89.2

DATA SET 37

T	ρ
1213	76.3
1242	79.1
1284	82.5
1323	85.5
1379	88.8
1427	91.1
1468	92.7

DATA SET 38

T	ρ
373	8.00
473	12.60
573	15.70
673	22.50
773	28.50

DATA SET 39

T	ρ
4.2	0.062
126	1.512
163	2.312
183	2.862
190	3.052
230	4.062
244	4.402
250	4.582*
273	5.182

DATA SET 40*

T	ρ
1923	109

DATA SET 41

T	ρ
1720	95.8
1732	94.8
1746	96.8
1765	97.8
1769	109.3
1780	115.1
1784	116.1
1811	114.3
1828	115.3
1844	115.3
1854	116.3

DATA SET 42

T	ρ
1205	73.2
1327	82.4
1452	89.7
1561	93.9
1675	97.8
1763	100.8
1763	114.7
1959	117.0
2131	118.7
2295	120.7
2442	122.2
2584	123.9
2718	125.6
2869	127.2
2982	128.4
3057	129.3
3108	129.8

DATA SET 43

T	ρ
90	0.744
100	0.939
125	1.461
150	2.018
200	3.214
250	4.527
300	5.995
400	9.542
500	14.118
600	19.872
700	26.590
701	25.015

DATA SET 43 (cont.)

T	ρ
800	32.056
900	40.377
1000	49.562
1100	59.259
1200	69.116
1250	73.995
1300	78.78
1400	87.17
1500	91.37
1600	94.86
1700	97.62

DATA SET 44*

T	ρ
679.8	25.212
684.8	25.595
688.2	25.846
696.7	26.493
697.9	26.599
699.1	26.652
700.3	26.744
701.1	26.823
701.7	26.876
702.3	26.929
703.1	26.955
703.5	26.942
703.9	26.862
704.5	26.478
705.3	26.107
706.0	25.763
706.4	25.630
707.2	25.550
708.0	25.510
708.8	25.497
710.0	25.497

DATA SET 45*

T	ρ
684.6	25.516
685.4	25.515
686.4	25.542
687.6	25.515
688.4	25.462
689.4	25.382
689.8	25.289
690.2	25.051

DATA SET 45 (cont.)*

T	ρ
690.8	24.786
691.0	24.561
691.4	24.481
692.0	24.348
693.0	24.308
694.0	24.348
694.8	24.467
696.0	24.493
698.0	24.625
700.2	24.757
702.0	24.903
705.0	25.114
707.0	25.246
715.4	25.866

DATA SET 46

T	ρ
77.84	0.655
194.4	3.158
273.2	5.23*
273.2	5.23*
273.2	5.26*
299.0	6.02*
299.7	6.04*

DATA SET 47*

T	$\rho - \rho_0$
6.75	0.000357
7.41	0.000357
7.94	0.000521
9.56	0.000983
10.0	0.000984
10.7	0.00108
11.0	0.00113
12.6	0.00161
14.2	0.00186
15.5	0.00335
21.5	0.00783
23.6	0.0117
27.1	0.0155
29.7	0.0243
34.2	0.0389
36.6	0.0469
38.3	0.0567

DATA SET 47 (cont.)*

T	$\rho - \rho_0$
41.1	0.0701
44.1	0.0807
46.1	0.0998
50.6	0.118
50.6	0.132
78.6	0.507

DATA SET 48*

T	$\rho - \rho_0$
5.61	0.000189
6.44	0.000545
7.40	0.000659
7.57	0.000834
8.13	0.000628
8.51	0.000795
9.56	0.000916
11.5	0.00127
18.3	0.00368
21.0	0.00512
22.0	0.00604
23.1	0.00801
24.7	0.00923
28.4	0.0196
30.4	0.0273
32.6	0.0314

DATA SET 49

T	ρ
296	7.1
336	8.5
355	9.9
366	11.0
391	11.7
410	12.5
556	19.7
578	18.9
648	23.3
677	26.5
736	26.9
795	33.4
912	43.1
1011	51.0
1114	58.2
1176	65.0

* Not shown in figure.

TABLE 6. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF COBALT Co (continued)

T	ρ	T	ρ
DATA SET 49(cont.)		**DATA SET 51(cont.)***	
1224	69.0	1883	122.8
1253	71.5	1895	123.05
1304	76.5		
1414	86.0	**DATA SET 52***	
1506	89.9		
1579	92.7	1767	128.3
1627	95.6	1800	129.6
1730	98.5	1900	133.5
		2000	137.7
DATA SET 50			
		DATA SET 53*	
1658	102.9		
1678	103.5	20.2	2.02
1694	104.0	81.8	2.38
1711	104.5	198.4	3.89
1735	105.25	273.09	5.18
1755	109.0		
1765	120.4	**DATA SET 54***	
1781	120.75		
1788	120.85	1.20	0.828
1801	121.1	4.2	0.839
1811	121.25		
1820	121.5	**DATA SET 55***	
1829	121.6		
1846	121.95	0.06	0.157
1850	122.0	1.20	0.157
1867	122.35	1.36	0.156
1870	122.4*	4.2	0.156
1881	122.6		
1888	122.75		
DATA SET 51*			
1764	120.5		
1782	120.8		
1795	121.15		
1801	121.2		
1809	121.4		
1819	121.55		
1823	121.65		
1836	121.9		
1843	122.05		
1854	122.25		
1863	122.4		
1869	122.5		
1878	122.7		

* Not shown in figure.

3.3. Iron

The electrical resistivity of iron has been studied extensively. There are 223 sets of experimental data available for iron specimens of purity 99.8% or higher. The information on specimen characterization and measurement condition for each of the data sets is given in table 8. The data are tabulated in table 9 and shown partially in figures 5 and 6.

Because of magnetic effects, the residual resistivity of iron has been studied with intense interest. Berger and De Vroomen [111] suggested that the residual resistivity measured in the absence of an applied magnetic field is not an indication of the purity of an iron specimen. Fujii and Morimoto [112] suggested that the magnetic contribution to the residual resistivity is $\sim 0.02 \times 10^{-8}\ \Omega\,m$; a value also agreed upon by Volkenshteyn and Yakina [113]. Thus, even for zone-refined iron, the residual resistance ratio, RRR, has low values of $\lesssim 400$ as compared with values of a few thousand or even higher for other pure metals. The more recent results of Takaki and Igaki [114] seem to indicate that even for iron that has been highly purified by anion exchange separation, floating-zone melting and hydrogen treatment, the residual resistance ratio has a limiting value of about 500. It is worth noting, however, that the quantity RRR_H, the residual resistance ratio obtained as the minimum value from resistivity measurement as a function of an applied longitudinal magnetic field, of some of their specimens are greater than 2000. The same group of authors [115] later reported RRR_H values of over 10,000 on specimens that had been electrolytically polished to remove silicon contamination on the surface layer (of thickness $\sim 100\ \mu m$). The resistivity of iron is also dependent on the density of the measuring current [114]. The results of Takaki and Igaki [114] on specimens of various purity showed that the current density dependence is negligible for specimens having RRR (or RRR_H) values of $\lesssim 100$. For RRR values higher than 200, or RRR_H values of $\gtrsim 1000$, the resistivity may still be increasing with measuring current at current density values of $>6 \times 10^6\ A\ m^{-2}$. The limiting RRR value of 500 quoted above was for a measuring current density of $\sim 5 \times 10^5\ A\ m^{-2}$ [114]. This result appears to agree with that of Glaeser et al. [116], even though the magnetic field and current density dependences reported by these two works show some discrepancies. The recommended value for the electrical resistivity of iron at the temperature of 1 K is based on these references and subject to the condition that the measuring current is <1 x 10^6 A m^{-2} in the absence of an applied magnetic field. It should represent the value for the electrical resistivity of iron purified by modern electron-beam zone-refining techniques.

The electrical resistivity of iron is dependent on other factors. The most notable factors are the external magnetic field and the magnetic domain structure of the specimen itself. The effects of the former have been investigated mostly at 4 K [112,116-120], and those of the latter have been investigated chiefly for single crystal whisker specimens [121-125]. These effects, together with the effect of the measuring current, are inter-related and are not fully investigated. A resolution of these effects is clearly beyond the scope of this work. Hence, only the conditions "in the absence of an external applied magnetic field" and "with a measuring current of <1 x 10^6 A m^{-2}" are specified. The latter condition is chosen such that the (transverse) magneto-resistance due to the self-induction of the measuring current would not adversely affect the resistivity value.

The electrical resistivity of iron at low temperatures has been reported to contain a T^2 component; see, for example, White and Woods [21], Volkenshtein and Yakina [113], Semenenko and Sudovtsov [126], Fert and Campbell [127], Price and Williams [80], and Janos et al. [128]. However, Kondorskii et al. [129] reported $T^{1.5}$ and T^5 components. More recently, Isshiki and Igaki [115] reported that the temperature dependent part of the resistivity, when measured in a longitudinal magnetic field of 60 K A m^{-1}, can be fitted to a T^2 term and a Bloch-Grüneisen term with θ_R = 467 K for temperatures 1 to 250 K.

A similar analysis [115] on the data of Kemp et al. [130] (data set 31), Kemp et al. [131] (data set 11), White and Woods [21] (data set 86), Fert and Campbell [127] (data set 119), Schwerer et al. [132] (data set 107), Volkenshtein and Yakina [113] (data set 209), and of Hust and Giarratano [133] (data set 47) indicates that, even without an applied longitudinal magnetic field, the electrical resistivity of iron can be represented by eq (8) for temperatures up to about 100 K. The values of A and θ_R in the Bloch-Grüneisen term were taken to be 58.1 x 10^{-8} Ωm and 467 K [115], respectively. The coefficient of the quadratic term varies approximately from 1.1 to 3.4 x 10^{-13} Ωm K^{-2}. There seems to be some correlation between the values of the coefficient and the residual resistivities, i.e., a specimen with a low residual resistivity seems to have a low coefficient (data sets 11, 86, 209) and vice versa (data sets 31, 47). However, with only a few data sets available, a definite relationship between the residual resistivity and the coefficient in the quadratic term cannot be established. Furthermore, the reported T^2 dependence of the electrical resistivity extends probably to temperatures below 1 K [126], whereas most of the authors report data to 2 K or higher. One way of circumventing this problem is to assume that the resistivity can be fitted to a residual term plus a quadratic term below 20 K (the T^5 or the Bloch-Grüneisen term is negligible compared with the other two terms at these temperatures), and the residual term, taken to be the value at 1 K, is obtained by extrapolation. The recommended values for the electrical resistivity of iron below 100 K are obtained by this procedure. The values of the quantities A and θ are taken to be the same as those given by Isshiki and Igaki [115], i.e., 58.1 x $10^{-8}\,\Omega$m and 467 K, respectively. The value of the coefficient of the T^2 term is 1.3 x $10^{-13}\,\Omega$m K^{-2}. This was obtained both by a graphical method where the logarithm of the quantity

$$\left(\rho_{measured} - \rho_0 - A\left(\frac{T}{\theta_R}\right)^5 \int_0^{\theta_R/T} \frac{x^5 e^x}{(e^x-1)^5}\,dx\right)$$

is plotted against log T, and also by numerically fitting the same quantity to a quadratic function in temperature. This value is in agreement with that suggested by White and Woods [21], but is somewhat below the value of 2.2 x $10^{-13}\,\Omega$m K^{-2} given by Isshiki and Igaki [115] for their highly purified specimens measured in an applied magnetic field of 60 K A m^{-1}.

At temperatures above ∿100 K, there is a slight change in the temperature dependence of the electrical resistivity. A log-log plot of the quantity

$$\rho_{measured} - \rho_0 - A\left(\frac{T}{\theta_R}\right)^5 \int_0^{\theta_R/T} \frac{x^5 e^x}{(e^x-1)^2}\,dx$$

against T for the data of White and Woods [21] (data set 86), Richter and Kohlhaas [134] (data set 43), Moore et al. [135] (data set 17), Fulkerson et al. [136] (data set 16), Hust and Giarratano [133] (data set 47), Kohlhaas and Richter [137] (data set 34), and of Dewar and Fleming [138] (data set 53) shows a decrease from the T^2 line starting at ∿100 K. This departure from the T^2 line is at a maximum of about 0.05 x $10^{-8}\,\Omega$m at ∿140 K. At higher temperature, the temperature dependence becomes stronger, with a temperature dependence that approaches a T^3 function. It is interesting to note that the same plot on the data of Kemp et al. [130] (data set 31) shows a slight increase at ∿100 K. It is not obvious whether this behavior is purely a magnetic effect or an impurity effect. The specimens of Isshiki and Igaki [115] (data sets 219-223) are supposed to be purged of metallic impurities and to contain approximately 0.001 at.% C, 0.0007 at.% O, and <0.0001 at.% N, whereas the specimen of White and Woods [21] (data set 86) contains about 0.03% of mostly metallic impurities. The electrolytic iron specimen of Hust and Giarratano [133] (data set 47) contains about 0.1% also of mostly metallic impurities. The specimen of Moore et al. [139] (data set 15) contains ≲0.01% Ni, ≤0.01% Si, and lesser amounts of other impurities, and the specimen of Fulkerson et al. [136] (data set 16) contains ≲0.02% Si, 0.014% C, <0.01% Ni, and lesser amounts of other impurities. On the other hand, the magnetoresistance of iron is positive at room temperatures (see, for example, Kornetzki [140], Schindler and La Roy [118]), and negative at helium temperatures (see, for example, Fujii and Morimoto [112], Glaeser et al. [116], and Arajs et al. [119]). From the only available data by Shirakawa [141] and by Matuyama [142] on electrolytic iron at intermediate temperatures, the magnetoresistance of iron changes sign at ∿77 K. For the lack of definite conclusion, this behavior is ignored at the present, and the resistivity value is assumed to follow the relation

$$\rho = \rho_0 + \alpha T^2 + A \left(\frac{T}{\theta_R}\right)^5 \int_0^{\theta_R/T} \frac{x^5 e^x}{(e^x-1)^2}\, dx \tag{8}$$

up to 200 K. This assumption may result in a maximum probable error of only -1% or $-0.03 \times 10^{-8}\ \Omega\text{m}$ at ∿150 K.

At temperatures above 150 K, and up to the Curie temperature, there are a number of data sets that agree with each other to within ±2%: Moore et al. [139] (data set 15), Fulkerson et al. [136] (data set 16), Wallace et al. [143] (data set 21), Pallister [144] (data set 22), Jaeger et al. [145] (data set 24), Kohlhaas et al. [137] (data set 33), Kierspe et al. [78] (data set 39), Richter and Kohlhaas [134] (data set 43), Powell et al. [146] (data set 77), and Lauchbury and Saunders [147] (data set 217). Among these sources, Fulkerson et al. [136] (data set 16) reported also the resistivity at 4 K, and Moore et al. [135] (data set 17) reported the residual resistivity ratio. Greater weight is given to the data of Moore et al. Most of these data sets appear to have resistivity values slightly higher than 9 x 10^{-8} Ωm at 273 K, except for data sets 17 and 22. Judging from the ice point resistivity values and from the temperature variation of the solute resistivities of various elements in iron (see, for example, Schwerer and Cuddy [148]), it appears that the specimen of Moore et al. [135] (data set 17) is the purest among these groups, and its resistivity values at 90 K are within 2% of the recommended values based on the analysis of the available low temperature data described earlier. The recommended values within the range of ±100 K of the ice point are, therefore, based on data set 17, and in the higher temperature range up to 900 K they are based on the data sets mentioned above. Both graphical and numerical methods in curve fitting are employed. It is found that the electrical resistivity of iron can be represented by a cubic polynomial at temperatures from about 200 to 900 K.

For temperatures higher than 900 K and up to the Curie temperature, the electrical resistivity of iron increases more rapidly with temperature. Even though there are detailed accounts on the temperature derivative of the resistivity, the agreement between them is not good (see, for example, Lauchbury and Saunders [147] and Seehra et al. [149], the values of $d\rho/dT$ from these two accounts differ by ∿40% at 1030 K). The value of the Curie temperature has been reported to be 1040.3 ± 1 K (Seehra et al. [149]), 1038-1043 K (Fulkerson et al. [136]), 1051-1055 K (Morris [150]), 1044 ± 2 K (Arajs and Colvin [151]), 1037 K (Richter and Kohlhaas [134]), 1027 K (Kohlhaas and Richter [137]), 1042.7 K (Lauchbury and Saunders [147]), and 1036 K (Wallace et al. [143]). The last authors also reported a Curie temperature of 1042 K from their specific heat measurements. In view of the wide spread of the reported values, a Curie temperature of 1043 K is adopted from the AIP Handbook [152]. The recommended values below this temperature are based on the data of Lauchbury and Saunders [147] (data set 217), with slight adjustments so that they would merge smoothly with the recommended values at lower temperatures. The recommended value at the Curie temperature, 101.1 x 10^{-8} Ωm, is within 0.3% of the values given by Lauchbury and Saunders [147].

At temperatures above the Curie point, the differences between reported resistivity values from the above references become greater, even though they are generally still within 2% of each other. The recommended values from the Curie temperature to the α-γ transition are based mainly on the results of Fulkerson et al. [136] (data set 16), Wallace et al. [143] (data set 21), and also of Powell et al. [146] (data sets 75-77). There are other detailed accounts on the resistivity at temperatures close to the α-γ transition: Kohlhaas and Richter [137] (data sets 37-38), Arajs and Colvin [151] (data sets 57-58), and Bullock [153] (data sets 98-99). However, there are wide discrepancies among these data sets. The data of Bullock and of Kohlhaas and Richter are too high and too low, respectively. The specimen of Arajs and Colvin showed some unexplained behavior, its residual resistivity ratio changed by +13% after the high temperature measurement, and the resistivity value at room temperature appeared to be too high for a zone-refined specimen. The onset of the α-γ transition, Ac_3 point, has been reported at 1188-1189 K (Moore et al. [139]), 1189 K (Kohlhaas and Richter [137]), 1189.7 K (Richter and Kohlhaas [134]), and has been inferred from graphical illustrations at about 1182 K (Powell et al. [146] data set 75), 1183 K (Arajs and Colvin [151] data set 57), 1187 K (Kohlhaas and Richter [137] data set 37), and 1186 K (Bullock [153] data set 98). Because of the lack of general agreement, the transition temperature is taken to be 1185 K, a value deduced from thermal expansion data [42].

As mentioned earlier, there are detailed reports on the behavior of the electrical resistivity at the α-γ transition. Not surprisingly, all these reports show that the transition occurs over a finite temperature range: ∿4 K according to Powell et al. [146], Arajs and Colvin [151], and Bullock [153], and ∿5 K according to Kohlhaas and Richter [137]. All reported a hysteresis effect: in the transition region, the resistivity values measured at decreasing temperatures were lower than those measured at increasing temperatures. The temperature for the onset of the γ-α transition upon cooling, the Ar_3 point, is also reported to be somewhat lower than the Ac_3 point. The latter three groups of authors also reported that the resistivity of α-iron at temperatures about one degree below the Ar_3 point after being cooled from the γ phase is higher than that of the α-iron after being heated from lower temperatures. In view of these and of the lack of such evidence from the data of Powell et al. [24] (data sets 75-77), this behavior is ignored at the present time. It is probable that such behavior is dependent upon specimen purity and its thermal history and mechanical history as well. Even though recommended values are given at a single transition temperature (for both the α and the γ phases), the transition for a given specimen may be expected to occur over a small temperature range of approximately 1180-1190 K. Its resistivity below 1185 K may be somewhat ($\leq 0.5 \times 10^{-8}\ \Omega m$) lower than the recommended value and vice versa above 1185 K.

There are relatively fewer data sets available for temperatures above the α-γ transition. The data sets which are considered reliable and from which the recommended values are derived are generally for temperatures less than ∿1300 K. For higher temperatures, close to the γ-δ transition, the data of Cezairliyan and McClure [154] (data sets 62-63) appear to merge well with extrapolations of the data of Fulkerson et al. [136] (data set 16) and of Wallace et al. [143] (data set 21). The recommended values from the α-γ transition to the γ-δ transition are based on these data sets. At temperatures immediately above the α-γ transition, the data of Powell et al. [146] (data sets 75-76) are also taken into account.

There are only a few data sets for the electrical resistivity of δ-iron. The recommended values are based on the results of Cezairliyan and McClure [154] (data sets 62 and 64), Güntherodt et al. [92] (data set 206), and Powell [155] (data set 138). The slight upturn in the resistivity value at temperatures close to the melting point is based on the latter two data sets. This upturn seems to be substantiated by the data of Baum et al. [156] (data set 114) and of Kita et al. [93] (data sets 212-214). There exists only two reports on the change of resistivity value at the γ-δ transition, by Cezairliyan and McClure [154] (data sets 62-65), and by Kierspe et al. [78] (data set 41). Both indicate a slight increase in resistivity from the γ to the δ phase. No hysteresis has been reported.

There are in excess of 10 data sets available for the electrical resistivity of molten iron. Some of these: Güntherodt et al. [92] (data set 206), Kita et al. [93] (data sets 211-213), Baum et al. [156] (data set 114), Arsentiev et al. [157] (data sets 215-216), Ono and Yagi [89] (data set 115), and Eliutin et al. [88] (data set 92) cover the transition from the solid to the molten state. The last authors reported a decrease in resistivity upon melting for an impure specimen (∿99.0% purity), in agreement with an earlier measurement on Armco iron by Mokrovskii and Regel [158], whose result has been widely quoted. However, the more recent measurements on purer specimens reported in the references mentioned above all show an increase. The majority of the reported data show a linear dependence on temperature, and the data of Seydel and Fucke [87] (data set 205) which were obtained by a pulse-heated exploding wire technique show that the linear dependence is applicable up to 3000 K. The recommended values are based on the data of Güntherodt et al. [92] (data set 206) and Kita et al. [93] (data sets 212-214), both of which are obtained by steady state methods. Values above 1900 K are extrapolated according to a linear temperature dependence. The value at 3000 K is about 7% higher than that of Seydel and Fucke [87]. A few of the available data sets are obtained by the rotating field method: Ono and Yagi [89] (data set 115), Levin et al. [91] (data set 112), Baum et al. [156,159] (data sets 114,121), and Samarin [94] (data set 137). The reported data among this group show relatively large variations, but are still within 4% of the recommended values.

The recommended values both uncorrected and corrected for thermal expansion of the material are presented in table 7, while only the uncorrected values (except those for the liquid state) are shown in figures 5 and 6 along with the experimental data. These values at temperatures above 200 K are for iron of purity 99.99% or higher, while those below 200 K are applicable only to highly purified zone-refined iron having a residual resistivity of 0.0200 x 10^{-8} Ωm. The estimated uncertainty in the recommended values is ±5% below 100 K, ±3% from 100 to 200 K, and ±2% above 200 K up to the melting point. The uncertainty at temperatures immediately above the melting point is about ±5%, increasing to ±10% at the highest temperatures.

For slightly less pure iron having different residual resistivity, its electrical resistivity values can be calculated from the recommended values using the Matthiessen's rule, which will not introduce serious errors. For example, using Matthiessen's rule for the specimen of Moore et al. [135] (data set 17) gives discrepancies of +1.7% (compared with the measured data) at 90 K, -2% at 260 K, and <0.1% at 400 K. That for the specimen of White and Woods [21] (data set 86) gives discrepancies of -0.5% at 11 K, -1.3% at 22 K, +1.6% at 98 K, -1.8% at 178 K, and -1.4% at 273 K. And that for the specimen of Fulkerson et al. [136] (data set 16) gives -1% at 77.5 K, +0.6% at 194 K, and -1% at 273 K. Thus, it does appear that using the Matthiessen's rule and the recommended values will give resistivity values for a specimen with residual resistivity lower than 0.4 x 10^{-8} Ωm to within ±2%, subject to the uncertainties in the recommended values specified in the preceding paragraph. The applicability of Matthiessen's rule, to within the possible error of ±2%, also seems to be confirmed for a more commonly available material, the electrolytic iron. For example, using the rule and comparing with the data of Hust and Giarratano [133] (data set 47) for SRM Iron-1265 gives discrepancies of -1% at 100 K, -0.9% at 200 K, and -1.5% at 280 K. Since deviations from the Matthiessen's rule for dilute iron alloys are positive (see, for example, Bass [160]), its application in calculating the electrical resistivity of an iron specimen lower in purity is likely to result in an underestimate, especially around room temperature where the deviation from Matthiessen's rule approaches a maximum. At high temperatures, the relative error introduced by the application of Matthiessen's rule should diminish with increasing temperature.

The recommended values uncorrected for thermal expansion given in table 7 can be represented approximately by the following expressions to within ±0.1%.

1-200 K:

$$\rho = 0.02 + 58.1 \left(\frac{T}{467}\right)^5 \int_0^{467/T} \frac{e^x x^5}{(e^x-1)^5}\,dx + 1.3 \times 10^{-5} T^2 \tag{26}$$

200-900 K:

$$\rho = -1.120747752 + 2.261529506 \times 10^{-2} T + 3.913892564 \times 10^{-5} T^2 + 2.952608182 \times 10^{-8} T^3 \tag{27}$$

900-1020 K:

$$\rho = -513.9789758 + 1.70577020\ T - 1.804410343 \times 10^{-3} T^2 + 7.034546961 \times 10^{-7} T^3 \tag{28}$$

1020-1143 K in the vicinity of the Curie temperature, T_C:

$$\rho = 101.13 - 2.984305206 \times 10^{-1} (T_C - T) + 1.905714112 \times 10^{-3} (T_C - T)^2 - 1.3355493086 \times 10^{-5} (T_C - T)^3 \tag{29}$$

1043-1070 K:

$$\rho = 101.13 + 2.020277018 \times 10^{-1} (T - T_C) - 5.420505212 \times 10^{-3} (T - T_C)^2 + 1.294364953 \times 10^{-4} (T - T_C)^3 - 1.243596538 \times 10^{-6} (T - T_C)^4 \tag{30}$$

1070-1185 K:

$$\rho = -1309.064808 + 3.419572717\ T - 2.773870769 \times 10^{-3} T^2 + 7.595259559 \times 10^{-7} T^3 \tag{31}$$

1185-1667 K:

$$\rho = 55.0861977 + 5.289665269 \times 10^{-2}T + 9.77621850 \times 10^{-12}T^2 - 4.0798019 \times 10^{-9}T^3 \quad (32)$$

1667-1811 K:

$$\rho = -11976.94918 + 21.0981583\,T - 1.226701138 \times 10^{-2}T^2 + 2.378811917 \times 10^{-6}T^3 \quad (33)$$

1811-3000 K:

$$\rho = 135.2 + (T-1811) \times 1.545 \times 10^{-2} \quad (34)$$

It should be emphasized that these expressions do not necessarily suggest any theoretical justification, and should be treated, most appropriately, as numerical aids only. It should also be understood that giving these expressions does not imply a recommendation for the temperature derivative of the electrical resistivity.

TABLE 7. RECOMMENDED VALUES FOR THE ELECTRICAL RESISTIVITY OF IRON[a]

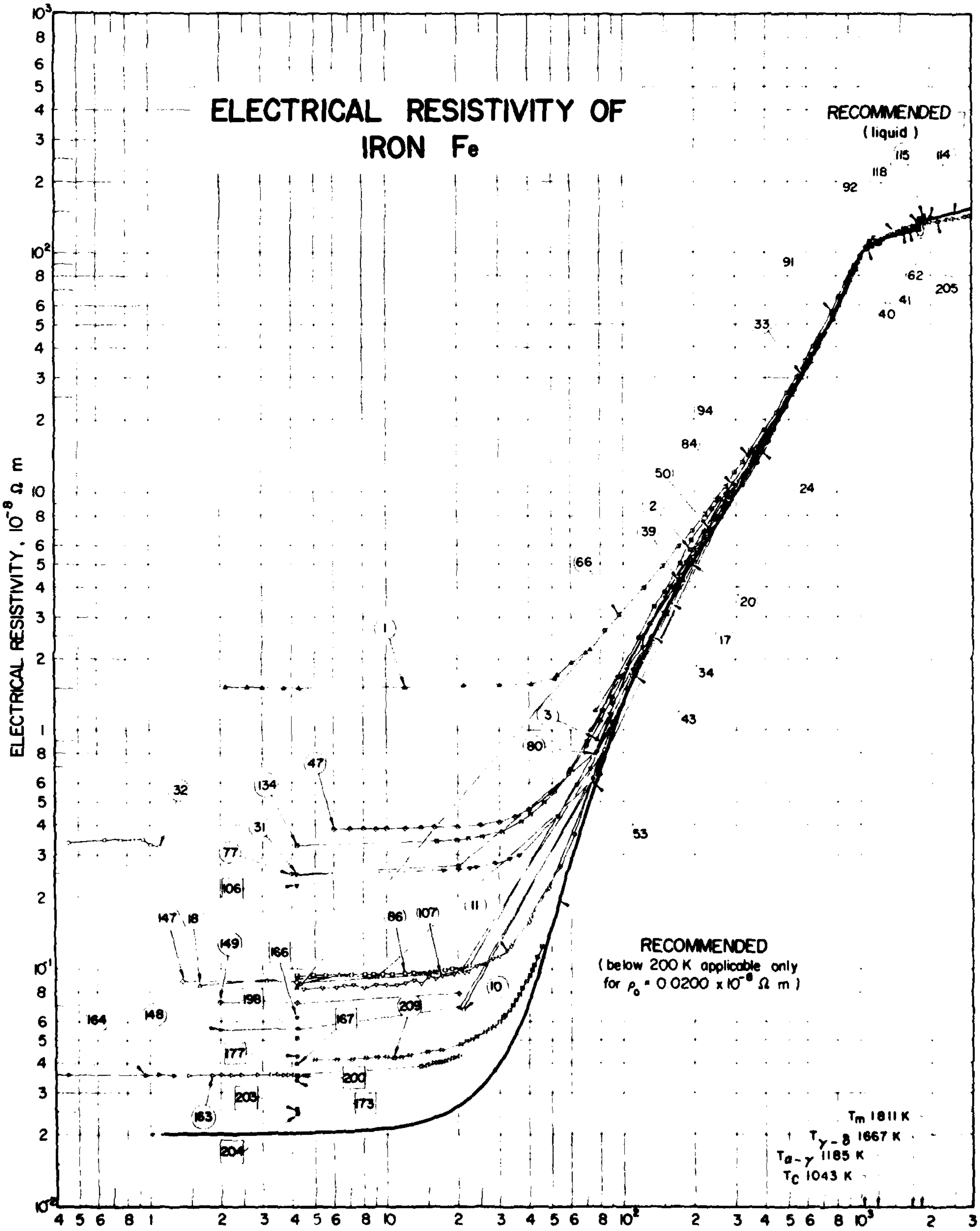
[Temperature, T, K; Electrical Resistivity, ρ, 10^{-8} Ω m]

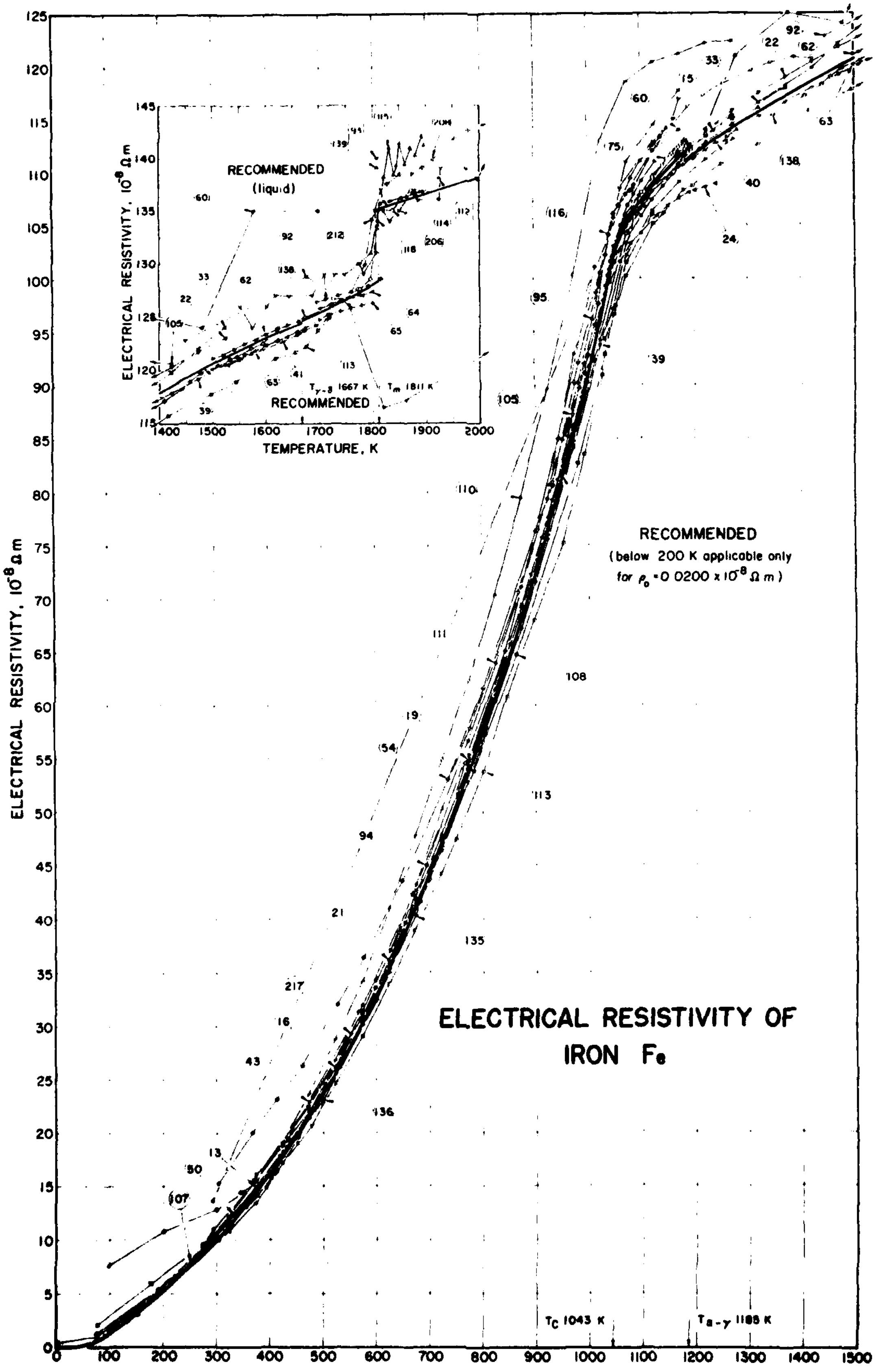
T	ρ uncorrected	ρ corrected	T	ρ uncorrected	ρ corrected
1	0.0200	0.0200	800	57.14	57.56
4	0.0202	0.0202	900	72.46	73.11
7	0.0206	0.0206	1000	90.80	91.76
10	0.0213	0.0212	1043	101.1[b]	102.2[b]
15	0.0232	0.0231	1100	107.0	108.3
20	0.0262	0.0261	1150	110.1	111.5
25	0.0313	0.0312	1185	111.9(α)	113.4(α)
30	0.0396	0.0395	1185	111.0(γ)	112.1(γ)
40	0.0733	0.732	1200	111.5	112.6
50	0.145	0.145	1300	114.9	116.4
60	0.268	0.267	1400	117.9	119.7
70	0.449	0.448	1500	120.7	122.8
80	0.690	0.689	1600	123.0	125.4
90	0.964	0.962	1667	124.4(γ)	127.0(γ)
100	1.28	1.28	1667	124.6(δ)	
150	3.16	3.16	1700	125.4	
200	5.20	5.19	1800	127.9	
250	7.44	7.44	1811	128.6(δ)	
273	8.57	8.57	1811		135.2[c](ℓ)
293	9.61	9.61	1900		136.6[c]
300	9.98	9.98	2000		138.2[c]
400	16.08	16.10	3000		153.6[c]
500	23.66	23.72			
600	32.92	33.06			
700	44.02	44.27			

[a] The values are for iron of purity 99.99% or higher, but those below 200 K are applicable only to iron having a residual resistivity of 0.0200 x 10^{-8} Ωm. Columns headed uncorrected and corrected refer to values uncorrected and corrected for thermal expansion, respectively. Dotted lines separating tabular values indicate solid phase transitions and solid line indicates solid to liquid state transformation.
α: bcc; γ: fcc; δ:bcc.

[b] Value at the Curie temperature.

[c] Provisional value.


ELECTRICAL RESISTIVITY OF
IRON Fe
RECOMMENDED
(liquid)
RECOMMENDED
(below 200 K applicable only
for ρ_0 = 0.0200 x 10^{-8} Ω m)
ELECTRICAL RESISTIVITY, 10^{-8} Ω m
TEMPERATURE, K
T_m 1811 K
$T_{\gamma-\delta}$ 1667 K
$T_{\alpha-\gamma}$ 1185 K
T_C 1043 K
CINDAS
FIGURE 5



CINDAS TEMPERATURE, K FIGURE 6

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
1	129	Kondorskii, E.I., Galkina, O.S., and Chernikova, L.A.	1958		2.1-73		"Chemically pure"; annealed in vacuum at 1173 K for 1 h; furnace cooled; residual resistivity 1.458 x 10^{-8} Ω m.
2	161	Broom, T.	1952	B	90-373		99.99^{+} Fe, 0.005 Ni, and 0.002 Cu (spectrographic analysis); wire specimen 0.056 cm (0.022 in.) in diam; drawn from 0.183 cm (0.072 in.) in diam; annealed at 873 K for 2 h; furnace cooled.
3	95	Wilkes, K.E.	1968	A	78-299	18 AF 3	99.96 Fe, 0.007 Cu, 0.0058 C, 0.004 Mn, 0.004 Si, 0.003 S, 0.0023 N, 0.002 Cr, 0.001 Al, 0.001 P, and 0.0008 O; 3.167 cm (1.247 in.) in diam and 10.44 cm long; prepared by National Physical Lab., England; density 7.872 g cm^{-3} at 297 K; resistivity values corrected for thermal expansion.
4*	162	Adrock, F. and Bristow, C.A.	1935	A	323-423	Batch 5	0.0045 C, 0.002 Mn, 0.0015 S, 0.001 P, 0.0001 H, 0.001 N, 0.0006 Ni, 0.0005 O, 0.0002 Si, traces of Al and Mg; prepared by chemical reduction of ferrous chloride; cold-rolled from 3 cm bar to 1 cm in diam; annealed at 1223 K for 2 h; density at 292 K, 7.871 ± 0.002 g cm^{-3}; smoothed values from table.
5*	163	Eucken, A. and Dittrich, K.	1927		80,273	Electrolytic Iron; 1	Coarse-grained
6*	163	Eucken, A. and Dittrich, K.	1927		80,273	Electrolytic Iron; 2	Fine-grained
7*	163	Eucken, A. and Dittrich, K.	1927		80,273	Electrolytic Iron; 3	Obtained from Firma Heraeus.
8*	164	Grüneisen, E. and Goens, E.	1927		21-273	Iron 2	Technically pure; polycrystalline; electrolytically precipitated; unannealed.
9*	164	Grüneisen, E. and Goens, E.	1927		21-273	Iron 3	Electrolytic; repeatedly hammered; annealed at 773 K for 1 h.
10	164	Grüneisen, E. and Goens, E.	1927		21-273	Iron 1	Twice electrolytically refined; hammered and annealed.
11	131	Kemp, W.R.G., Klemens, P.G., and Tainish, R.J.	1959	A	4.2-293		Doubly refined electrolytic iron; 2.4 x 1.7 x 30 mm; cut from a precipitated plate; annealed at 1223 K; compressed, and reannealed in vacuum at 1223 K; sample material believed to be the same as Data Set 10 above.
12*	165	Powell, R.W. and Tye, R.P.	1967	A	323-523	Pure iron Sample No. 1	0.025 Ni, 0.01 Cu, 0.01 Mo, 0.007 Cr, 0.005 C, 0.004 O, 0.004 S, 0.004 V, 0.003 P, 0.001 Mn, <0.001 Si, 0.0006 N, and 0.000048 H; type 1, 1.27 cm in diam and 15 cm long; supplied by Metals Research, submitted for test by Tube Investments Ltd.

* Not shown in figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
13	165	Powell, R.W. and Tye, R.P.	1967	A	323-1073	Pure iron Sample No. 2	0.0055 Ni, 0.0053 Si, 0.0038 Al, 0.0035 S, 0.002 Co, 0.0017 P, 0.0014 C, 0.001 Cr, <0.001 Mn, 0.0008 O, 0.0007 N, and 0.000016 H; short rod 1.27 cm diam prepared by Metallurgy Division of National Physical Lab.; machined from a disk.
14*	165	Powell, R.W. and Tye, R.P.	1967	A	323-523	Purefree iron Sample No. 6	0.08 Si, 0.03 C, 0.015 P, 0.01 Mn, and 0.01 S; 2.54 cm in diam and 20 cm long; supplied by Low Moor Best Yorkshire Iron Ltd.; 1) the above specimen measured at increasing temperatures; 2) the above specimen measured at decreasing temperatures.
15	139	Moore, J.P., Fulkerson, W., and McElroy, D.L.	1964	A	73-1273	High purity iron	0.001-0.01 Ni, 0.001-0.01 Si, 0.003 S, 0.003 C, 0.0025 O, 0.0011 P, 0.0001-0.001 Al, 0.0001-0.001 Ca, 0.0001-0.001 Cu, 0.0005 N, and 0.0001 H; atomic percent, data here rounded off; prepared by arc melting Armco iron stock in pure inert atm to produce pancake shaped billets, rolled into sheets and cut to make feed stock for electron beam melting, then cast into 10.16 cm (4 in.) in diam and 15.24 cm (6 in.) long billet; trimmed off outside edges; rod specimen 38.10 cm (0.15 in.) in diam and 7.62 cm (3 in.) long, cut from center portion of billet; measured in vacuum at 10^{-5} to 10^{-7} Torr; data corrected for thermal expansion except points at 73, 189, and 273 K.
16	136	Fulkerson, W., Moore, J.P., and McElroy, D.L.	1966	A	4.0-1273	High purity iron	99.95 Fe, 0.002-0.02 Si, 0.014 C, 0.00095-0.0095 Ni, 0.0088 O, <0.0056 H, 0.0052 S, 0.00021-0.0021 Al, 0.002 P, 0.002 N, 0.00014-0.0014 Ca, and 0.00009-0.0009 Cu, in atomic percent; obtained by electron beam melting of Armco iron; homogeneous to ±0.19; rod specimen 38.10 cm (0.15 in.) in diam and 7.62 cm (3 in.) long; free of voids; immersion density 7.881 g cm^{-3}; smoothed data extracted from table; data corrected for thermal linear expansion; resistivity measured with current densities of 6.8, 11 and 11 A cm^{-2} at 4, 77.5 and 194.1 K respectively.
17	135	Moore, J.P., McElroy, D.L., and Barisoni, M.	1966	A	90-40	Grade 1	Cylindrical specimen machined from electron beam zone-refined iron (3-pass); produced by Materials Research Corp.; density 7.824 g cm^{-3}; electrical resistivity ratio $\rho(273\,K)/\rho(4.2\,K)$ = 201; smoothed data from table.
18	166	McDonald, W.J., Jr.	1962	A	1.63-80.7		Cut from a zone-refined ingot; prepared at BMI; machined into a rectangular parallel piped 0.157 x 0.157 x 0.381 cm (0.062 x 0.062 x 1.5 in.).
19	167	Bungardt, K. and Spyra, W.	1965		293-1373		0.03 Ni, 0.015 C, 0.007 S, and traces Al, Mo, P, and Si; cylindrical specimen.
20	168	Bohm, R. and Wachtel, E.	1969		196-406		0.005 N, 0.004 C, and 0.003 O; cylindrical specimen 10 mm in diam.

* Not shown in figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
21	143	Wallace, D.G., Sidles, P.H., and Danielson, G.C.	1959	B	298-1323	High purity iron	0.03 C, 0.01 N and O each, <0.0005 Ni, 0.0001 Cu, <0.0001 each of Mg, Si, Ag, and Na; wire specimen 0.0254 to 0.0346 cm in diam and 4 to 7 cm long; from Johnson and Matthey Co.; drawn and annealed at 1273 K for 1 h, cooled at a rate of 40 Kh^{-1} while measurement was made; with some specimens, measurements here made upon reheating, and data "accurately reproduced"; smoothed values from table, representing data for two specimens; uncorrected for thermal expansion; values do not reflect a discontinuity of 0.6% upon cooling at 1173 K.
22	144	Pallister, P.R.	1949	A	273-1548		99.99^+ Fe; 1 cm in diam and 30 cm long; density 7.87 ± 0.005 g cm^{-3}; uncorrected for thermal expansion; data extracted from table.
23*	169	Bäcklund, N.G.	1961	A	90-290	Pure iron Data Set 1	Three types of specimens: 1) "very pure iron" wire; 2.5 mm in diam; from Phillips Research Lab., 2) spectroscopically standardized pure iron wire; 5 mm in diam; from Johnson and Matthey Co., 3) pure iron wires; 1.0 and 2.0 mm in diam; from Heraeus Inc.; all specimens annealed at 773.2 K for 10 h; data reported as average of all three types.
24	145	Jaeger, F.M., Rosenbohm, E., and Zuithoff, A.J.	1938		293-1243	Pure iron	Pure; 0.25 mm in diam and 925 mm long; data corrected for thermal expansion.
25*	170	Cleaves, H.E. and Hiegel, J.M.	1942		293	Ingot #2	0.002 S, <0.002 Cu, 0.001 C and Si each, <0.001 Be, and <0.0005 P; 2 mm in diam and about 1 meter long; ingots produced by recrystallization of ferric nitrate, conversion to ferric oxide, reduction to sponge iron, and melting under hydrogen and in a vacuum, forged, cold-rolled, swaged, and drawn; annealed in vacuum for 15 min at 1123 K.
26*	170	Cleaves, H.E. and Hiegel, J.M.	1942		293	Ingot #7	0.002 O and S each, <0.002 Cu, 0.001 Si, and <0.001 C; dimensions, fabrication method, and heat treatment same as the above specimen.
27*	170	Cleaves, H.E. and Hiegel, J.M.	1942		293	Ingot #14	0.002 O and Si each, 0.002 Cu, 0.001 C and S each; dimensions, fabrication method, and heat treatment same as the above specimen.
28*	170	Cleaves, H.E. and Hiegel, J.M.	1942		293	Ingot #11	0.004 O, <0.002 Cu, and 0.001 S; dimensions, fabrication method, and heat treatment same as the above specimen.
29*	170	Cleaves, H.E. and Hiegel, J.M.	1942		293	Ingot #19	0.004 O, 0.002 S, <0.002 Cu, and <0.001 C; dimensions, fabrication method, and heat treatment same as the above specimen.
30*	170	Cleaves, H.E. and Hiegel, J.M.	1942		293	Ingot #6	0.004 O, <0.002 Cu, 0.001 S and Si each, and <0.001 Be and C each; dimensions, fabrication method, and heat treatment same as the above specimen.
31	130	Kemp, W.R.G., Klemens, P.G., and White, G.K.	1956	A	4.2-293	JM 5092	99.99 Fe, 0.005 Ni, 0.0002 Cu, 0.0001 Ag, and traces Mg and Mn; 2 mm in diam rod; supplied by Johnson and Matthey Co.; annealed at 1023 K (750 C) for 4 h in vacuum; resistivity values calculated from reported ideal electrical resistivity and ρ_0 = 0.248 10^{-8} Ω m.

* Not shown in figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
32	171	Yoshida, I.	1965		0.5–1.1		No details given.
33	137	Kohlhaas, R. and Richter, F.	1962	B	293–1523	Fe_{μ}	0.064 O, 0.0027 C, 0.002 S, 0.001 Mn, N, and Si each; 0.5 cm in diam and 25 to 30 cm long; turned from square bar, transition temperatures: Ac_2 = 1027 K (754 C), Ac_3 = 1189 K (916 C) and Ar_3 = 1175 K (902 C); smoothed data from table.
34	137	Kohlhaas, R. and Richter, F.	1962	B	90–291	Fe_{μ}	The above specimen.
35*	137	Kohlhaas, R. and Richter, F.	1962	B	969–1080	Fe_{μ}	The above specimen at temperatures about the Curie point; measured while heating.
36*	137	Kohlhaas, R. and Richter, F.	1962	B	972–1079	Fe_{μ}	The above specimen at temperatures about the Curie point; measured while cooling.
37*	137	Kohlhaas, R. and Richter, F.	1962	B	1176–1198	Fe_{μ}	The above specimen at temperatures about the α-γ transition; measured while heating.
38*	137	Kohlhaas, R. and Richter, F.	1962	B	1164–1195	Fe_{μ}	The above specimen at temperatures about the α-γ transition; measured while cooling.
39	78	Kierspe, W., Kohlhaas, R., and Gonska, H.	1967	B	73–1715		0.0060 S, 0.0050 C, O, and Si each, 0.0016 M, 0.0010 N, and P each; wire specimen from Prof. W.A. Fischer, Max-Planck-Institute for Iron Research; smoothed values from figure.
40	78	Kierspe, W., et al.	1967	B	1103–1283		The above specimen at temperatures about the α-γ transition.
41	78	Kierspe, W., et al.	1967	B	1553–1713		The above specimen at temperatures about the γ-δ transition.
42*	208	Kohlhaas, R. and Kierspe, W.	1965		83–353		0.0027 C, 0.002 S, 0.001 Mn, N, and Si each, and trace of Cr.
43	134	Richter, F. and Kohlhaas, R.	1964		93–1273		0.012 O, 0.008 P, 0.007 C, and Al each, 0.004 S, and 0.002 N; disk specimen 63 mm outer diam; annealed for several hours at 1193 K (900 C); Curie point 1037 K (764 C); α-γ transition: Ac_3 = 1189.7 K (916.7 C), Ar_3 = 1186.3 K (913.3 C).
44*	172	Jaeger, W. and Diesselhorst, H.	1900		291–373	Eisen I	0.1 C, metallic impurities not determined; 1.3007 cm in diam and 27.0 cm long; density 7.84 g cm^{-3}.
45*	173	Lorenz, L.	1881		273–373		No details reported.
46*	174	Brown, H.M.	1928	A	312		0.0794 cm^2 x 10 cm.

* Not shown in figure.

AD-A129 078 ELECTRICAL RESISTIVITY OF CHROMIUM COBALT IRON AND NICKEL(U) THERMOPHYSICAL AND ELECTRONIC PROPERTIES INFORMATION ANALYSIS CENTER LAFAYETTE IN 2/2

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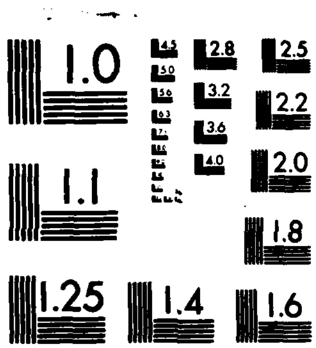

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TABLE 8. *MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON* Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
47	133	Hust, J.G. and Giarratano, P.J.	1975		4-280	NBS electrolytic iron	99.9$^+$ Fe, 0.041 Ni, 0.0080 Si, 0.0072 Cr, 0.007 Co, 0.0067 C, 0.0059 S, 0.0058 Cu, 0.0057 Mn, 0.005 Mo, 0.0025 P, 0.0007 Al, 0.0006 Ti and V each, 0.0002 As, 0.00013 B, 0.00002 Pb; chemical composition certified by NBS, SRM 1265; grain size 0.05 mm for annealed condition; rod specimen 3.6 mm in diam and 23 cm long, apparently annealed; density 7.867 ± 0.005 g cm^{-3}, for annealed condition; Rockwell hardness B24, for annealed condition; mean residual resistivity ratio ρ(273 K/ρ(4 K) is 23; residual resistivity 0.385 x 10^{-8} Ω m, average ρ_i(273 K) 8.71 x 10^{-8} Ω m; data uncorrected for thermal expansion; data smoothed with linear least squares methods to the expression $\rho = \Sigma b_i(\ell n\ T)^{i-1}$, where b_1 = 1.52995843 x 10^{-5}, b_2 = 6.57221842 x 10^{-5}, b_3 = 1.28083500 x 10^{-4}, b_4 = -1.50027718 x 10^{-4}, b_5 = 1.17942860 x 10^{-4}, b_6 = -6.57740194 x 10^{-5}, b_7 = 2.67952461 x 10^{-5}, b_8 = -8.08115141 x 10^{-6}, b_9 = 1.80581011 x 10^{-6}, b_{10} = -2.95519976 x 10^{-7}, b_{11} = 3.44469418 x 10^{-8}, b_{12} = -2.70952664 x 10^{-9}, b_{13} = 1.28939040 x 10^{-10} and b_{14} = -2.80388287 x 10^{-12}, the b's presented on p. 18 of Hust, J.G. and Sparks, L.L., "Thermal Conductivity Standard Reference Materials from 4 to 300 K: II OSRM Iron-1265," NBS Report 9771, 35 pp., 1970; data presented here are from table on p. 24 and 25, and are different from values calculated from the above polynomial.
48*	138	Dewar, J. and Fleming, J.A.	1893	B	76-471	Iron A	0.25 Mn, 0.01 S, very free from C, Si, and P; wire specimen 0.02657 cm mean diam and 100 cm long; from Armstrong's works, sent by Colonel Dyer of Elswick Ordnance Works; resistance 0.4223, 1.1909, 1.5086, 1.9104, 2.0737, 2.4167, 2.8368, 3.4091, and 4.1935 Ω at 76.1, 191.3, 229.3, 274.55, 291.65, 325.25, 363.7, 412.0, and 470.5 K, respectively; temperature below 273 K (0 C) measured by platinum resistance thermometer; data uncorrected for thermal expansion, length and mean diameter measured at 288 K; data extracted from table.
49*	138	Dewar, J. and Fleming, J.A.	1893	B	54,76	Iron A	Longer specimen cut from the same piece as Data Set 48; resistance 2.983 and 3.834 Ω at 53.8 and 76.1 K, respectively; data uncorrected for thermal expansion, length measured at 288 K; data extracted from text; temperatures measured by platinum resistance thermometer.
50	138	Dewar, J. and Fleming, J.A.	1893	B	76-469	Iron H.W.	High degree of purity; wire specimen 0.023078 cm mean diam and 100 cm long; from Messrs. Hopkins and Williams; very soft and well annealed, cold worked under the hammer and drawn without heating, into a very uniform wire; resistance 0.2918, 1.2713, 1.7137, 2.1791, 2.3940, 2.9546, 3.4976, 4.2536, and 5.1395 Ω at 76.1, 191.3, 234.0, 273.85, 291.40, 333.40, 371.25, 418.6 and 469.3 K, respectively; mean temperature coefficient between 273 and 373 K, 0.00625; data uncorrected for thermal expansion, length and mean diameter measured at 288 K; data extracted from table; temperature below 273 K (0 C) measured by platinum resistance thermometer.

* Not shown in figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
51*	138	Dewar, J. and Fleming, J.A.	1893	B	51-76	Iron H.W. Coil (a)	Longer coil cut from the same wire as the above specimen, 2600 cm long; resistance 3.839, 4.154, and 7.091 Ω at 51.0, 54.0 and 76.1 K, respectively; data uncorrected for thermal expansion, length measured at 288 K; data extracted from table; temperature measured by platinum resistance thermometer.
52*	138	Dewar, J. and Fleming, J.A.	1893	B	51-76	Iron H.W. Coil (b)	Still longer coil cut from the same wire as the above specimen; wire specimen 3700 cm long; resistance 5.222, 5.257, and 9.875 Ω at 50.5, 50.8, and 76.1 K, respectively; data uncorrected for thermal expansion, length measured at 288 K; data extracted from table; temperature measured by platinum resistance thermometer.
53	138	Dewar, J. and Fleming, J.A.	1892	B	76-370		Pure soft iron; wire specimen had probable dimensions of 0.0076 (0.003 in) in diam and 50 or 100 cm long; from Messrs. Griffin and Co.; annealed; mean diameter of wire measured to nearest 0.000254 cm (0.0001 in); measurement of resistance repeated several times; mean observed specific resistance reported; data uncorrected for thermal expansion; data extracted from table.
54	175	Honda, K. and Simidu, T.	1917	A	303-1174	Swedish iron	Cylindrical specimen, 0.5 cm in diam and 20 cm long.
55*	151	Arajs, S. and Colvin, R.V.	1964	A	300-1291		0.00300 O, 0.0015 Ni, 0.0012 Co, 0.0005 C and Ge each, 0.0004 Cr, 0.0003 N, 0.00015 Cu, 0.00008 Zn, 0.00004 Ga, 0.00003 Nb, 0.000025 Ti, 0.00002 V, 0.000009 As, <0.000004 Mn, and <0.000007 Others; zone refined; 0.1 x 0.3 x 2.0 cm; $\rho(4.2\ K)/\rho(298\ K) = 3.76 \times 10^{-3}$ before high temperature test and 4.30×10^{-3} after test; Curie temperature 1044 ± 2 K; measured with a current density of $\sim 12.9 \times 10^4\ A\ m^{-2}$; corrected for thermal expansion; data extracted from figure.
56*	151	Arajs, S. and Colvin, R.V.	1964	A	1018-1068		The above specimen in the neighborhood of Curie temperature; corrected for thermal expansion; data from figure.
57*	151	Arajs, S. and Colvin, R.V.	1964	A	1151-1197		The above specimen measured through α-γ transition; temperature increasing; uncorrected for thermal expansion; data from figure.
58*	151	Arajs, S. and Colvin, R.V.	1964	A	1150-1186		The above specimen measured while cooling through α-γ transition; temperature decreasing; uncorrected for thermal expansion; data from figure.
59*	176	Kondorskii, E.I. and Sedov, V.L.	1960	A	4.2		Technically pure; 0.59 cm in diam and 11.2 cm long; vacuum annealed at 1273 K for 8 h; oven cooled; measured under saturation magnetization 1751 g.
60	177	Ibragimov, Sh.Sh.	1962	A	293-1698	Iron	0.06 Si, 0.04 C, 0.02 Mn and Cr each; annealed at 1033 K.
61*	178	Butler, E.H., Jr. and Pugh, E.M.	1940		313-343		Electrolytical iron; annealed in hydrogen.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
62	154	Cezairliyan, A. and McClure, J.L.	1973		1500-1660	γ iron 1	Tubular specimen 6.3 mm O.D., 0.5 mm thick and 102 mm long; fabricated from rods by electro-erosion technique; γ-δ transition reported at 1682 K; melting point 1808 K; specimen heated to measuring temperature in one second by passing current through; uncorrected for thermal expansion; smoothed data from table.
63	154	Cezairliyan, A. and McClure, J.L.	1973		1500-1660	γ iron 2	Similar to the above specimen (one of this or the above specimen has an electrical resistivity value of 10.2×10^{-8} Ω m at 273 K).
64	154	Cezairliyan, A. and McClure, J.L.	1973		1700-1800	δ iron 1	The same specimen as for Data Set 62.
65	154	Cezairliyan, A. and McClure, J.L.	1973		1700-1800	δ iron 2	The same specimen as for Data Set 63.
66	179	Niccolai, G.	1908	B	84-673		0.5 mm in diam and 5 mm long; from Firma C.A.F. Kahlbaum.
67*	180	Wruck, D. and Wert, C.	1955	V	293		99.95 pure; 0.04 O, little metallic impurity.
68*	180	Wruck, D. and Wert, C.	1955	V	93		Same as above; foil polycrystal, 0.008 cm x 0.2 cm x 4 cm; Run II.
69*	180	Wruck, D. and Wert, C.	1955	V	93		Same as above; Run II.
70*	180	Wruck, D. and Wert, C.	1955	V	93		Same as above; Run IV.
71*	180	Wruck, D. and Wert, C.	1955	V	77		Same as above except wire specimen; 0.0762 cm in diam and 15 cm long; grain size ~0.6 cm; decarbonized.
72*	180	Wruck, D. and Wert, C.	1955	V	77		Same as above.
73*	180	Wruck, D. and Wert, C.	1955	V	77		Same as above.
74*	181	Rosenberg, H.M.	1955	A	1.8-77	JM 4975 (Run 2)	99.99 pure (excluding gases); from Johnson and Matthey Co.; polycrystalline; 0.202 cm in diam and 2.89 cm long; annealed in vacuum for several hours.
75	146	Powell, R.W., Tye, R.P., and Woodman, M.J.	1961	A	1088-1196	18 AF 3	0.007 Cu and Ni each, 0.0058 C, 0.004 Mn and Si each, 0.003 S, 0.0023 N, 0.002 Cr, <0.001 Al, <0.001 P, 0.0008 O, and <0.000005 H; measured during heating of the sample at a rate of 0.25 K min^{-1}, data uncorrected for thermal expansion.
76*	146	Powell, R.W., et al.	1961	A	1160-1191	18 AF 3	The above specimen measured during cooling.
77	146	Powell, R.W., et al.	1961	A	4-1073	18 AF 3	The above specimen measured at lower temperatures; smoothed values from table.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
78*	123	Taylor, G.R., Isin, A., and Coleman, R.V.	1963	A	77-191	Specimen #25	One of iron whisker specimens 100-300 μ in diam and about 2 cm long.
79*	123	Taylor, G.R., et al.	1963	A	77-300		Same as the above; resistivity values calculated from reported resistance ratios $R(T)/R(77\,K)$ and $\rho(77\,K)$ given in the above data set; average of seven specimens.
80	182	Soffer, S., Diessen, J.A., and Pugh, E.M.	1965	A	76-300		<0.0185 metallic impurities; zone-refined; 0.1 cm x 1 cm x 10 cm.
81*	183	Yoshikawa, A. and Okamoto, M.	1967	A	77,273		Zone refined iron (total impurity less than 0.001%); grain <70 μ in diam; decarburized at 973 K for 7 days in wet hydrogen stream; ultrasonically cleaned; chemically polished with HF + H_2O_2; heat treated at 773 K for 14 days in hydrogen purified by zirconium hydride; annealed at 773 K for 30 min; then cooled at 15 K hr^{-1}; room temperature value calculated from reported resistance ratio (ρ_{273K}/ρ_{77K}).
82*	184	Takamura, S., Maeta, H., and Okuta, S.	1968	A	4.2,293		99.996 pure, 0.0008 C, 0.007 N and O each, from Materials Research Corp.; wire specimen 0.12 mm in diam; as received condition: value at room temperature calculated from reported resistivity ratio and residual resistivity.
83*	184	Takamura, S., et al.	1968	A	4.2,293		Same as the above specimen except annealed at 773 K for 1 h in vacuum and then at 973 K for 1 h.
84	184	Takamura, S., et al.	1968	A	4.2,293		Similar to the above.
85*	184	Takamura, S., et al.	1968	A	4.2,293		Similar to the above.
86	21	White, G.K. and Woods, S.B.	1959	A	4.2-295	Fe 2	99.97 pure, ~0.004 Si, <0.004 Co, Cu, and Ni each, ~0.003 Mo and Mn each, <0.00015 N, and traces Pb and Zr; 0.05 mm x 1 mm x 6-8 cm; from Vacuum Metals Co.; zone-melted in wet hydrogen to obtain large crystals; electrically annealed at 873 K to remove hydrogen; resistivity calculated from reported $\rho_i(T)$, $\rho(4.2K)/\rho(295K) = 9.61 \times 10^{-3}$, and $\rho_i(295K) = 9.82 \times 10^{-8}\ \Omega\,m$.
87*	185	Smith, A.W., Gregory, J.H., and Lynn, J.T.	1946	B	293		"Chemically pure"; wire specimen 0.1019 cm in diam and 15.2 cm long.
88*	185	Smith, A.W., et al.	1946	B	293		"Chemically pure"; wire specimen 0.0823 cm in diam and 15.5 cm long.
89*	185	Smith, A.W., et al.	1946	B	293		"Chemically pure"; wire specimen 0.0406 cm in diam and 5.0 cm long.
90*	185	Smith, A.W., et al.	1946	B	293		"Chemically pure"; wire specimen 0.0201 cm in diam and 3.4 cm long.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
91	186	Zinov'ev, V.E., Abel'skii, Sh.Sh., Sandakova, M.I., Petrova, L.N., and Gel'd, P.V.	1973	A	288–1167		0.03 impurities; well annealed iron supplied by Johnson and Matthey Co.; average grain size 2 mm; measured in vacuum (~10^{-5} mmHg) under quasistatic condition with heating rate not more than 1 K/min.
92	88	[illegible], V.P., Turov, V.D., and [illegible], N.A.	1965	R	1448–2094		99.0 pure; by carbonyl method or electrolytically; liquid state obtained by melting in graphite crucible either in a helium atm or in vacuum.
93	187	Güntherodt, H.J. and Künzi, H.U.	1973	C	1808		99.998 pure, from Johnson and Matthey Co., in liquid state; temperature = 1808 K assumed.
94	188	[illegible], I.A.	1974	A	344–1015		99.99$^+$ pure; from Goodfellow Metals Ltd., England; 1.0 cm x 2.0 cm x 4.0 cm; annealed at 1473 K for 24 h under vacuum.
95	153	Bullock, G.	1956	V	928–1150		0.027 Mn, 0.02 C, 0.018 P, 0.017 S, 0.007 Si, 0.005 N and traces Ni; Armco iron manufactured by the basic O.H. technique; inclusions not detectable by microscope; 1.3 cm in diam and about 15 cm long; measured with a current of 20–30 A, and in vacuo; this curve represents coincident values during both heating and cooling (rate 1–1.5 K/min).
96*	153	Bullock, G.	1956	V	1004–1221		The above specimen while cooling.
97*	153	Bullock, G.	1956	V	1003–1220		The above specimen while heating.
98*	153	Bullock, G.	1956	V	1174–1198		The above specimen heating at a rate of 0.25 K min^{-1}.
99*	153	Bullock, G.	1956	V	1163–1186		The above specimen cooling at a rate of 0.25 K min^{-1}.
100*	189	Kaufmann, L., Clougherty, E.V., and Weiss, R.J.	1963		325–1425		Specimen same as used in Kaufmann, L., Leyenaar, A., and Harvey, J.S., Progress in Very High Pressure Research, p. 89, Wiley, New York, 1961; swaged; $\alpha \to \gamma$ transition 1183 K; resistivity calculated from reported magnetic resistivity: $\rho(magnetic) = \rho - 0.029T\ (1-0.002P)$; values from table.
101*	150	Morris, D.M.	1897	B	273–1036	Specimen A	Charcoal Iron; from Messr. Jos. Sankey and Sons; ring shape specimen of cross sectional area 0.131 cm^2 and mean ring diameter 2.35 cm; density 7.775 g cm^{-3}; measured during heating.
102*	150	Morris, D.M.	1897	B	273–1323	Specimen A	The above specimen; measured during cooling after heated to 1323 K; Curie temperature 1068 K.
103*	150	Morris, D.M.	1897	B	289–1158	Specimen A	The above specimen after reheating to 1193 K; measured during cooling.
104*	150	Morris, D.M.	1897	B	273–1099	Specimen B	0.075 impurities, including C, P and Si, and traces of Mn; Swedish transformer iron from Messr. Jos. Sankey and Sons; ring shape specimen with cross sectional area 0.143 cm^2 and mean ring diam 2.23 cm; density 7.461 g cm^{-3}; measured during cooling after annealing at 1113 K; Curie temperature 1055 K.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
105	150	Morris, D.M.	1897	B	273-1423	Specimen B	The above specimen measured during cooling after annealing at 1423 K Curie temperature 1051 K.
106	190	Arajs, S., Schwerer, F.C., and Fisher, R.M.	1969	A	4.2		99.9$^+$ pure; electrolytic; about 5 mm in diam and 50 mm long.
107	132	Schwerer, F.C., Conroy, J.W., and Arajs, S.	1969	A	4.5-300		0.002 C and 0.001 N, "high purity iron standard"; 0.508 cm in diam and 5 cm long; annealed at 1273 K for 1 week under vacuum; machined, re-annealed at 1123 for 2 h; data at $T \geq 50$ K calculated from reported residual resistivity ($0.08 \times 10^{-8}\ \Omega$ m) and smoothed ideal resistivity (from graph); measured with a current of 0.1 A.
108	141	Shirakawa, Y.	1939		78-1123		0.05 P and Si each, 0.04 C, 0.02 Co and Mn each, 0.01 Al and 0.003 S; electrolytic from Nippon-Deukai-Seitetsusho; 0.0617 cm in diam and 5.25 cm long; annealed at 1273 K for 1 h under vacuum with specimen axis in the east-west direction; slow-coded; lead wires of nickel soldered by pure silver; reannealed at 1123 K for 1 h under vacuum and slow-cooled; measurement done with sample axis in east-west direction.
109*	191	Meyer, A.R.	1911	V	273-1273		Chemically pure; ~0.015 SiO_2, 0.004 Cu and Ni each, <0.001 Mn and trace Si; from Kahlbaum; impurities analyzed by Physikalisch-Technischen Reichsanstalt; measured by AC voltage-current method; smoothed values from table; except for value at 293 K which is measured separately by a DC voltage-current method.
110	191	Meyer, A.R.	1911	V	273-1273		99.94 pure charcoal iron from Armco; other information same as above.
111	191	Meyer, A.R.	1911	V	273-1173		<0.008 S, 0.007 P and traces C, Cu, Mn, and Si; from Langbein-Pfunhauser-Werke; other information same as above.
112	91	Levin, E.S., Ayushina, G.D., and Gel'd, P.V.	1972	R	1923		99.988 pure, carbonyl iron class V-3; measurements carried out in aluminum or zirconium oxide crucibles covered with lapped lids in purified helium at a pressure of 760 mmHg; pure tungsten used as comparison standard.
113	192	Gumenyuk, V.S. and Lebedev, V.V.	1959		309-1718		High purity iron obtained by vacuum distillation; total impurity 0.02%, estimated from residual resistivity; specimen 3-6 mm in diam and 50-100 mm long; annealed at 1373 K for 4 h in high vacuum; measured in a vacuum of 10^{-5}-10^{-6} mmHg.
114	156	Baum, B.A., Gel'd, P.V., and Tyagunov, G.V.	1967	→	1551-2018		99.99 pure carbonyl iron; remelted in a hydrogen atm and degassed in vacuum in the molten state; measured by "refluence method" of Baum et al., Izv. Akad. Nauk SSSR, Neorg. Materialy, 1, 1289(1965) in pure helium at a pressure of 780 mmHg; tungsten used as comparison standard.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
115	89	Ono, Y. and Yagi, T. Ono, Y.	1972 1977	R R	1773-1898		99.9+ pure; liquid state; contained in a 10 mm I.D. recrystallized alumina crucible at a pressure of 0.05-0.1 mmHg; density data of Saito et al. (Bull. Res. Inst. Min. Dress. Metall., Tohoku Univ., 25, 67, 109, 1969) used for calculating specimen volume.
116	149	Seehra, M.S., Capan, V.L., and Silinsky, P.	1974	A	1000-1087		0.02 Mn, 0.01 Cr, and <0.01 Co; single crystal; 0.2 x 0.3 x 1.5 cm; polished and etched in HCl + 10% H_2O_2; Curie temperature 1040 ± 1 K; uncorrected for thermal expansion; data in table form supplied by the first author.
117	193	Dubini, E., Esin, O.A., and Vatolin, N.A.	1969		1873		"High purity"; measured in purified helium.
118	194	Lebedev, S.V., Savvatimskii, A.I., and Smirnov, Yu.B.	1974	+	1809		<0.2 C; in liquid state; measured by an exploding wire technique, wire heated by an almost rectangular shape pulse ($\sim 10^{-5}$ s); current density $\sim 4 \times 10^{10}$ A/m^2; voltage and current measured by pulse oscillogram.
119*	127	Fert, A. and Campbell, I.A.	1976	A	2.4-63		"Pure"; obtained by zone melting; residual resistivity ratio 25; only temperature dependent part of resistivity reported.
120*	127	Fert, A. and Campbell, I.A.	1976	A	2.4-78		Same as the above.
121*	159	Baum, B.A., Tyagunov, G.V., Gel'd, P.V., and Khasin, G.A.	1971	R	1573,1873		Specimen contained in either alumina or zirconia crucible, measured in an atm of helium.
122*	195	Tanaka, K. and Watanabe, T.	1972	A	77,298	JM	0.0166 N, 0.0048 C, 0.0036 O, 0.0003 Si, 0.0002 Cu and Mn each, and <0.0001 Al and P each; grain diam 50 ± 20 μm; 0.5 mm in diam and 170 mm long; from Johnson and Matthey; heated at 1246 K for 48 h in wet hydrogen; and 2 h in dry hydrogen; cold rolled from 5 mm to 2 mm in diam; annealed at 823 K for 1 h in dry hydrogen; drawn to wire; annealed at 923 K for 3 h in vacuum; carbon or nitrogen in solution <0.0002.
123*	195	Tanaka, K. and Watanabe, T.	1972	A	77,298	RE	0.0060 S, 0.0040 C, Mn and Si each; 0.0030 P and 0.0020 Cu; re-electrolytic iron supplied by Denko Co.; melted by induction heating and cast in vacuum; surface layer removed; hot-swaged into rod of 7 mm in diam; wire specimen prepared in similar manner as above.
124*	195	Tanaka, K. and Watanabe, T.	1972	A	77,298	TI	0.0400 Ti; "C, N, O and B atoms in solid solution extremely low"; prepared from re-electrolytic iron by alloying with Ti; specimen preparation same as the above except for no annealing in wet hydrogen.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
125*	196	Wagenblast, H., Schwerer, F.C., and Horak, J.A.	1971	A	4.2		0.005 interstitial C; specimen prepared from vacuum melted iron with <0.1 at.% impurities; drawn and swaged to 0.6 mm in diam and 13.3 cm long wire; annealed at 1023 K for 15 min; annealed 1058 K for 5 h in wet hydrogen and furnace cooled in dry hydrogen to reduce carbon and nitrogen to 0.004 and 0.0004 at.%, respectively; carbonized by heating at 998 K for 16 h in a hydrogen-methane mixture; quenched in brine.
126*	196	Wagenblast, H., et al.	1971	A	4.2		Similar to the above except containing 0.022 interstitial C.
127*	196	Wagenblast, H., et al.	1971	A	4.2		Similar to the above except containing 0.005 interstitial C.
128*	196	Wagenblast, H., et al.	1971	A	4.2		Similar to the above except containing 0.098 interstitial C.
129*	196	Wagenblast, H., et al.	1971	A	4.2		0.012 interstitial N; specimen preparation similar to the above except nitrogenized by heating at 748 K in a hydrogen-ammonia mixture.
130*	196	Wagenblast, H., et al.	1971	A	4.2		Similar to the above except containing 0.057 N.
131*	196	Wagenblast, H., et al.	1971	A	4.2		Similar to the above except containing 0.104 N.
132*	196	Wagenblast, H., et al.	1971	A	4.2		Similar to the above except containing 0.138 N.
133*	196	Wagenblast, H., et al.	1971	A	4.2		Similar to the above except containing 0.158 N.
134	80	Price, D.C. and Williams, G.	1973	A	4.2-276		99.9985 pure; 0.15 x 0.2 x 10 cm; supplied by Johnson and Matthey Co.; prepared by cold rolling rod stock between Melinex sheets; etched; annealed in vacuum at 1173 K for 2 h; quenched; resistivity calculated from reported $\rho(4.2\ K) = 0.3300 \times 10^{-8}\ \Omega m$ and temperature dependent part of the resistivity, ρ_T; $\rho = \rho_T + \rho(4.2\ K)$.
135	197	Vasil'eva, R.P. and Kadyrov, Ya.	1974		373-773		No details reported.
136	148	Schwerer, F.C. and Cuddy, L.J.	1970	V	4.2-1200		~1.8 mm in diam; zone-refined iron; swaged; average of two specimens; $\rho(4.2\ K) \sim 0.04 \times 10^{-8}\ \Omega m$; smoothed values from graph.
137*	94	Samarin, A.M.	1962	R	1811-2000		Measured by the rotating field method in a helium atm; apparatus calibrated against the resistivity value of molten iron reported in Data Set 139; resistivity value calculated from reported conductivity: $[1.47-0.50 \times 10^{-3}T(C)] \times 10^{4}\ \Omega^{-1}cm^{-1}$; upper temperature limit assumed 2000 K.
138	155	Powell, R.W.	1953	+	279-1793		"High purity" iron; measured under vacuum; resistivity above 1623 K are smoothed values from graph.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
139	155	Powell, R.W.	1953	→	1811		In molten liquid state; resistivity measured by immersing a specially constructed alumina tube in molten iron; current and potential contacts made by tungsten rods through separate holes, in the middle of the wall of the tube, which are open to the axial hole through small up-turned channels; reported value mean of 24 measurements with two heating rates of the specimen and with two different durations of the measuring current.
140*	108	Schimank, H.	1914	B	20–273	Fe I	High grade pure electrolytic iron; from Kalbaum; 1-2 m long; drawn by Heraeous of Hanau.
141*	108	Schimank, H.	1914	B	20–273	Fe II	Same as the above except annealed in nitrogen atm.
142*	198	Holborn, L.	1919		80–784	Fe I_1	Electrolytic iron, from vacuum melted iron supplied by Firma W.C. Heraeous; wire specimen 0.2 mm in diam; heated for several min at 773 K.
143*	198	Holborn, L.	1919		81-761	Fe I_2	Same as the above except annealed at 573 K for 3 h.
144*	198	Holborn, L.	1919		80–572	Fe II	0.004 Co, Cu and Ni each, 0.001 Mn, traces of C, O and Si; "Nitrateisen" made from iron nitrate by Firma C.A.F. Kalbaum; drawn from 5 mm to 0.2 mm in diam; annealed at 653 K for 3 h.
145*	104	Meissner, M. and Voigt, B.	1930	→	1.4–273	Fe 1	Specimen same as for Data Set 142; 0.2 mm in diam and 55 mm long; distance between potential contacts 50 mm; tempered; measured by compensation method; resistivity calculated from reported resistance ratio, ice point resistance (0.149 Ω) and sample dimensions.
146*	104	Meissner, M. and Voigt, B.	1930	→	1.4–273	Fe 2	Specimen same as for Data Set 144; 0.2 mm in diam and 59.7 mm long; distance between potential contacts 56.6 mm; tempered; measurement method and resistivity calculation same as above.
147	104	Meissner, M. and Voigt, B.	1930	→	1.4–273	Fe 2*	Same as the above specimen except 60 mm long and distance between potential contacts 56.3 mm.
148	104	Meissner, M. and Voigt, B.	1930	→	2.0–273	Fe 3	Specimen same as for Data Set 10; tempered; 1.0 mm in diam and 33.0 mm long; distance between potential contacts 30.0 mm; measurement method and resistivity calculation same as above.
149	104	Meissner, M. and Voigt, B.	1930	→	2.0–273	Fe 4	Electrolytic iron from Firma Heraeus; 1.0 mm in diam and 58.2 mm long; stretched; course grained; distance between potential contacts 53.4 mm; measurement method and resistivity calculation same as above.
150*	104	Meissner, M. and Voigt, B.	1930	→	1.4–273	Fe 5	Specimen obtained from Dr. Kreussler; 0.1 mm in diam and 58.6 mm long; distance between potential contacts 54.2 mm; measurement method and resistivity calculation same as above.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
151*	104	Meissner, M. and Voigt, B.	1930	→	1.4-273	Fe 6	Same as the above specimen except 58.4 mm long and annealed at 573 K for 3 h; distance between potential contact 54.4 mm.
152*	104	Meissner, M. and Voigt, B.	1930	→	1.4-273	Fe 7	Electrolytic (5 times) iron from Firma Siemens and Hatske; 0.3 mm in diam and 58.7 mm long; distance between potential contacts 54.0 mm; measurement method and resistivity calculation same as above.
153*	104	Meissner, M. and Voigt, B.	1930	→	1.3-273	Fe 10	The above specimen annealed at red-hot, 15 h and etched; 57.5 mm long; distance between potential contacts 51.7 mm.
154*	104	Meissner, M. and Voigt, B.	1930	→	1.4-273	Fe 8	Same as the above specimen except annealed at 573 K for 3 h; distance between potential contacts 54.4 mm.
155*	104	Meissner, M. and Voigt, B.	1930	→	1.4-273	Fe 9	Same as the above specimen etched; 57.8 mm long; distance between potential contacts 55.1 mm.
156*	125	Trussell, C.W., Christopher, J.E., and Coleman, R.V.	1970	A	0.3-1.2		<100> iron whisker; measured in a magnetic field of 570 Oe.
157*	6	Matthiessen, A. and Voigt, C.	1864		273		Hard-drawn; resistivity value calculated from reported ratio of resistivities of silver and iron, with ρ(silver) assumed to be 1.468 x 10^{-8} Ω m.
158*	199	Potter, H.H.	1937		20-1130		99.96 pure; chief impurities are O and Si; from Messr. Adam Hilger; U-shape specimen 2 mm in diam and 8 cm long.
159*	200	Ribbeck, F.	1926	→	273-1273		0.07 Mn, 0.014 P, and traces of Si, Cu, S and Cr; electrolytic; 0.3-0.4 cm^2 x 10 cm; measured by compensation method with current 2-3 A.
160*	201	Bhagat, S.M., Anderson, J.R., and Wu, N.	1967		84-297		<111> iron whiskers; about 0.2-0.4 mm wide and 8 mm long; grown by hydrogen reduction of $FeCl_2$ either at room temperature using hydrogen saturated with water vapor or at 1023 K with a hydrogen flow rate of 300 ml/min; electropolished; measured in a longitudinal magnetic field of 2 kG.
161*	202	Mannery-Tassy, G.	1950		194-1208		No details reported.
162*	203	Sudovtsov, A.I. and Semenenko, E.E.	1957	A	1.2-4.2		99.98 pure; polycrystalline specimen in the form of thin ribbons from Hilger; R(4.2K)/R(273K) = 3.9328 x 10^{-2}; resistance at 273 K, 0.5091 Ω; R(T)/R(273K) = 3.92930 x 10^{-2} with T extrapolated to 0 K.
	126	Semenenko, E.E. and Sudovtsov, A.I.	1962	A			
163	126	Semenenko, E.E. and Sudovtsov, A.I.	1962	A	1.3-20.3		>99.99 pure; grain size ~0.1 mm; ~0.1 mm "transverse dimension" 38 mm long; needle-shaped specimen grown by distillation in vacuum; R(T)/R(273K) = 3.9606 x 10^{-3} with T extrapolated to 0 K; measured under condition where the earth's magnetic field is compensated by Helmholtz coils; specimen demagnetized with a 50 cps magnetic field of decreasing amplitude after each reversal in measuring current.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
164	204	Semenenko, E.E., Sudovtsov, A.I., and Shvets, A.D.	1962	A	0.4-1.3		The above specimen measured at lower temperatures.
165*	116	Glaesser, W., Imgrund, H., and Wever, H.	1967		4.2		0.008 total impurities; pure iron from Firma HEK. Lübeck.
166	116	Glaesser, W., et al.	1967		4.2		The above material 1 time zone-melted.
167	116	Glaesser, W., et al.	1967		4.2		The above material 5 times zone-melted.
168*	116	Glaesser, W., et al.	1967		4.2		The above material 10 times zone-melted.
169*	116	Glaesser, W., et al.	1967		4.2		The above material co-worked.
170	116	Glaesser, W., et al.	1967		4.2		The above material recrystallized at glowing.
171*	118	Schindler, A.I. and LaRoy, B.C.	1966	A	4.2	Fe-2	99.999 pure; from United Mineral and Chemical Co.; 0.5 mm in diam; distance between potential leads 3.5 cm; annealed at about 673 K under vacuum (7 x 10^{-8} Torr); measured under zero applied magnetic field.
172*	118	Schindler, A.I. and LaRoy, B.C.	1966	A	4.2	Fe-2	The above specimen; resistivity value obtained by extrapolating its magnetoresistance to zero magnetic induction.
173*	118	Schindler, A.I. and LaRoy, B.C.	1966	A	4.2	Fe-2	Same as Data Set 171 except with a different set of potential contacts.
174*	118	Schindler, A.I. and LaRoy, B.C.	1966	A	4.2	Fe-2	Same as above; resistivity value obtained by extrapolating the magnetoresistance to zero magnetic induction.
175*	118	Schindler, A.I. and LaRoy, B.C.	1966	A	4.2	Fe-1	Same specimen material as above; about 4 mm in diam; twice electron beam, float-zone-refined under 10^{-9} Torr; distance between potential leads 4 cm; measured in zero applied magnetic field.
176*	118	Schindler, A.I. and LaRoy, B.C.	1966	A	4.2	Fe-1	Same as above; resistivity value obtained by extrapolating the magnetoresistance to zero magnetic induction.
177	118	Schindler, A.I. and LaRoy, B.C.	1966	A	4.2	Fe-3	"High purity" single crystal from Materials Research Corp.; 2 mm in diam; distance between potential contacts 1.5 cm; measured under zero applied magnetic field.
178*	98	Schröder, K. and Giannuzzi, A.	1969		879-1126		Thermocouple grade; annealed in Ar at about 1190 K for 2 h.
179*	124	Beitchman, J.G., Trussel, C.W., and Coleman, R.V.	1970	A	0.3-1.2	T-7	Single crystal; specimen axis in a <111> direction; measured in a magnetic field of 950 Oe.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
180*	124	Beitchman, J.G., Trussel, C.W., and Coleman, R.V.	1970	A	0.4-1.2	T-7	The above specimen measured in a longitudinal magnetic field of 1230 Oe.
181*	124	Beitchman, J.G., et al.	1970	A	0.3-1.2	T-7	The above specimen measured in a longitudinal magnetic field of 1520 Oe.
182*	124	Beitchman, J.G., et al.	1970	A	1.0-4.1	T-7	The above specimen measured in a longitudinal magnetic field of 1150 Oe.
183*	124	Beitchman, J.G., et al.	1970	A	1.4-4.3	B-1	Single crystal; specimen axis in a <111> direction; measured in a longitudinal magnetic field of 1200 Oe.
184*	124	Beitchman, J.G., et al.	1970	A	4.7-21	B-1	The above specimen, measured at higher temperatures.
185*	205	Swartz, J.C. and Cuddy, L.J.	1970	V	4.2		Zone-refined iron; 0.13-0.40 mm in diam and 5-10 cm long; resistivity value calculated from reported $\rho(295K)/\rho(4.2K) = 180$, with $\rho(295K)$ taken to be 10.19×10^{-8} Ω m.
186*	119	Arajs, S., Oliver, B.F., and Michalak, J.T.	1967	A	4.2	I	99.9966 pure; 0.0019 C, 0.0011 O and 0.0004 others (at.%); interfacial grain area 7.0 mm^{-1}; 1 mm in diam and about 80 mm long; produced by oxidation zone refining (oxygen activity ∿1).
187*	119	Arajs, S., et al.	1967	A	4.2	II	0.0019 C, 0.0018 O and 0.0042 others (at.%); polycrystalline; interfacial grain area 14.3 mm^{-1}, 80 cm long.
188*	119	Arajs, S., et al.	1967	A	4.2	II	Same as the above except interfacial grain area 16.5 mm^{-1}.
189*	112	Fujii, T. and Morimoto, I.	1968	A	4.2	Fe I	0.0300 C (determined by vacuum combustion method), 0.0100 N and O each (determined by vacuum fusion method, and 0.0015 total metallic impurity; polycrystalline material obtained from Johnson and Matthey Co.; formed into a bar 5 mm in diam and 20 cm long; swaged into cylindrical rod 2.7 mm in diam and 50 cm long; annealed at 1163 K; chemically polished in a 500-1-500 solution of H_2O-HF-C_2H_5OH, removing a surface layer of 0.1 mm; resistivity value calculated from reported $\rho(295K)/\rho(4.2K)$, with $\rho(295K)$ taken to be 9.91×10^{-8} Ω m.
190*	112	Fujii, T. and Morimoto, I.	1968	A	4.2	Fe I	Same specimen material as the above, prepared by a method similar to the above but exact treatment not given; resistivity calculated by some method as above.
191*	112	Fujii, T. and Morimoto, I.	1968	A	4.2	Fe II	0.0300 C, 0.0100 O, and 0.0015 N (determined by the same methods as for Data Set 189), and 0.0015 total metallic impurity; from the same specimen material as the above; zone-refined (1 pass at 3 mm min^{-1} in dry H_2); other preparations same as the above except annealed at 1123 K for 20 h in a vacuum of 2×10^{-6} mm before chemical polishing; resistivity calculated by same method as above.
192*	112	Fujii, T. and Morimoto, I.	1968	A	4.2	Fe III	0.0100 O, 0.0080 N, 0.0030 C (determined by same methods as for Data Set 189), and 0.0015 total metallic impurity; prepared from the same material and by a similar method as the above except decarbonized at 1023 K for 200 h in wet H_2; resistivity calculated by same method as above.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
193*	112	Fujii, T. and Morimoto, I.	1968	A	4.2		Prepared from the same specimen material and by a similar method as the above, but exact method not given; resistivity calculated by the same method as above.
194*	112	Fujii, T. and Morimoto, I.	1968	A	4.2		Same as the above.
195*	112	Fujii, T. and Morimoto, I.	1968	A	4.2		Same as the above.
196*	112	Fujii, T. and Morimoto, I.	1968	A	4.2	Fe IV	0.0030 C, <0.0005 N, 0.0004 C (determined by the same methods as for Data Set 189); and 0.0015 total metallic impurity; zone-refined (1 pass at 0.3 mm min^{-1} in dry H_2); other preparations same as above; resistivity calculated by same method as above.
197*	112	Fujii, T. and Morimoto, I.	1968	A	4.2		Prepared from the same specimen material and by a similar method as the above; but exact method not given; resistivity calculated by the same method as above.
198	112	Fujii, T. and Morimoto, I.	1968	A	4.2		Same as the above.
199*	112	Fujii, T. and Morimoto, I.	1968	A	4.2		Same as the above.
200*	112	Fujii, T. and Morimoto, I.	1968	A	4.2		Same as the above.
201	112	Fujii, T. and Morimoto, I.	1968	A	4.2		0.0020 C, 0.0001 O, 0.015 total metallic impurity and trace N (determined by same method as for Data Set 189); zone-refined (1 pass at 0.3 mm min^{-1} and 5 passes at 1 mm min^{-1} in dry H_2); other preparations and resistivity calculation same as the above.
202*	112	Fujii, T. and Morimoto, I.	1968	A	4.2		Prepared from the same specimen material and by a similar method as the above, but exact method not given; resistivity calculated by same method as above.
203	112	Fujii, T. and Morimoto, I.	1968	A	4.2		Same as the above.
204	112	Fujii, T. and Morimoto, I.	1968	A	4.2		<0.0010 C, 0.015 total metallic impurity and traces N and O (determined by the same methods as for Data Set 189); zone-refined (2 passes at 0.3 mm min^{-1} in wet H_2, 5 passes at 1 mm min^{-1} in vacuum and 2 passes at 1 mm min^{-1} in dry H_2); other preparations same as the above; resistivity calculated by same method as above.
205	87	Seydel, U. and Fucke, W.	1977	†	1007-2997		99.99 pure; 0.0003 Ca and Si each, 0.0002 Al, Cu, and Mg each, and 0.0001 Ag, Cr, Mn, and Ni each (chemical analysis); measured by an exploding wire technique; measurement error 4%; smoothed values from curve; values corrected for thermal expansion.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
206	92	Güntherodt, H.J. Hauser, E., Künzi, H.U., and Müller, R.	1975	→	1726-1915		99.999 pure from Johnson and Matthey Co.; measured with potential method in which the sample material was enclosed within an alumina tube with four protrusions serving as current and potential contacts.
	110	Müller, R.	1976				
207*	206	Holder, T.K.	1977	A	90-400		99.99 pure, 0.0025 C and N each, 0.0007 O and 0.0001 H; Material Research Corp. MARZ grade 3 pass zone refined iron; smoothed values from table; $\rho(273.15K)/\rho(4K) = 189$.
208	207	Ershov, G.S., Kasatkin, A.A., and Gavrilin, I.V.	1974		1828-2065		99.997^{+} pure; measured by a contact method in a helium atm with specimen inside a vertical alundum crucible; liquid metal column 40-50 mm long.
209	113	Volkenshtein, N.V. and Yakina, V.P.	1971	A	4.2-46	Fe-4	Polycrystalline specimen from Johnson and Matthey Co.; 0.1 mm thick, 3.0 mm wide and 15 mm long; vacuum (10^{-6} mmHg) annealed at 1273 K for 1 h, demagnetized; measuring current density 3.3 A mm^{-2}.
210*	113	Volkenshtein, N.V. and Yakina, V.P.	1971	A	4.5-494		The above measured in an applied longitudinal magnetic field of 1.1 kOe.
211*	113	Volkenshtein, N.V. and Yakina, V.P.	1971	A	4.4-46.1		The above measured in an applied transverse magnetic field of 1.1 kOe.
212	93	Kita, Y., Ohguchi, S., and Morita, Z.	1978	→	1695-1895		0.008 Ni, 0.006 S, 0.005 Si, <0.005 Cu and Cr each, 0.003 Mn and P each, and 0.002 C; measured with a four probe method in which the electrodes are made of the same material as the specimen, in a vacuum of 10^{-4} Torr; data points are taken at temperatures in the sequence: 1833, 1854, 1864, 1880, 1895, 1872, 1855, 1835, 1816, 1799, 1786, 1759, 1735, 1713, 1695 K; values from table supplied by authors; values corrected for thermal expansion.
213*	93	Kita, Y., et al.	1978	→	1676-1919		Same as the above; a second melt; temperature sequence: 1823, 1842, 1857, 1874, 1893, 1905, 1919, 1900, 1875, 1858, 1836, 1817, 1803, 1798, 1776, 1760, 1741, 1720, 1699 and 1676 K.
214*	93	Kita, Y., et al.	1978	→	1673-1973		Same as the above; a third melt; temperature sequence: 1823, 1843, 1866, 1876, 1889, 1905, 1915, 1937, 1915, 1896, 1869, 1850, 1833, 1814, 1829, 1845, 1863, 1878, 1893, 1910, 1894, 1879, 1864, 1850, 1841, 1817, 1802, 1777, 1764, 1748, 1728, 1708, and 1673 K.
215*	157	Arsentiev, P.P., Fillipov, S.I., and Litsitskii, B.S.	1970	→	1693-1874		Specimen produced from electrolytic powder of composition: 0.23 C, 0.015 O, 0.012 S, 0.005 P and Si each, and trace Mn; melted in a hydrogen atm; electrical resistivity reported is the same as that reported for a 0.005 C specimen; measured with a potential method with tungsten electrodes; experimental chamber evacuated before heating and then filled with pure Fe; measured while heating.

* Not shown on either figure.

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
216*	157	Arsentiev, P.P., Fillipov, S.I., and Litsitskii, B.S.	1970	+	1683-1874		The above; measured while cooling.
217	147	Lauchbury, M.D. and Saunders, N.H.	1976	A	373-1128		<0.03 Mn and <0.01 Cu, Si, Ca, and Mg each; cylindrical specimens 1.5 mm or 2 mm in diam and ~20 mm long, machined from 5 mm diam polycrystalline rods from Johnson and Matthey Co.; annealed at 1250 K for several hours in an argon atm; random measurement error 1%.
218	128	Janos, S., Kovac, L., and Mlynek, R.	1972		9.9-28		Only temperature dependent part of resistivity reported; values from graph.
219	115	Isshiki, M. and Igaki, K.	1978	A	1.7-271		High purity, prepared by floating zone refining and heated treated at 1073 K for 24 h in wet hydrogen described by authors in Trans. Jpn. Inst. Metals, 18, 413, 1977; specimen then electropolished in 95% acetic acid and 5% perchloric acid from a diam of 500 μm to 150 μm; about 10 cm in length; measured in a longitudinal applied magnetic field of 60 $KA\,m^{-1}$; values from graph.
220	115	Isshiki, M. and Igaki, K.	1978	A	1.7-301		Similar to the above except specimen diam reduction from 500 μm to 180 μm.
221	115	Isshiki, M. and Igaki, K.	1978	A	1.7-268		Similar to the above except specimen diam reduction from 500 μm to 190 μm.
222	115	Isshika, M. and Igaki, K.	1978	A	1.6-164		Similar to the above.
223	115	Isshiki, M. and Igaki, K.	1978	A	1.6-292		Similar to the above except specimen diam reduction from 500 μm to 350 μm.

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe

[Temperature, T, K; Electrical Resistivity, ρ, $10^{-8}\ \Omega\,m$]

DATA SET 1

T	ρ
2.1	1.46*
2.6	1.46*
3.0	1.46*
3.7	1.46*
4.3	1.46*
4.9	1.46*
5.5	1.46*
6.2	1.46*
7.1	1.46*
8.3	1.46*
10.4	1.46
12.3	1.46
15.0	1.47
17.0	1.47
18.6	1.44
21.4	1.44
23.7	1.44
25.4	1.47
27.7	1.48
30.0	1.51
33.1	1.51
36.4	1.51
38.9	1.50
41.5	1.51
44.0	1.51
49.5	1.59
51.9	1.61
53.9	1.68
56.8	1.80
58.9	1.84
61.2	1.89
62.9	1.92
66.7	2.02
69.2	2.08
72.6	2.14

DATA SET 2

T	ρ
90.2	1.09
194.7	5.78
273.2	9.06*
373.2	14.73

DATA SET 3

T	ρ
77.78	0.925
194.8	5.26
273.3	8.97*
298.8	10.33*

DATA SET 4*

T	ρ
323	11.5
373	14.5
423	17.8

DATA SET 5*

T	ρ
80	0.826
273	9.61

DATA SET 6*

T	ρ
80	0.826
273	10.3

DATA SET 7*

T	ρ
80	1.63
273	10.7

DATA SET 8*

T	ρ
21.2	0.1437
83.2	0.929
273.2	9.11

DATA SET 9*

T	ρ
21.2	1.060
83.2	1.917
273.2	9.95

DATA SET 10

T	ρ
21.2	0.0681
83.2	0.778
273.2	8.71

DATA SET 11

T	ρ
4.2	0.092
15.2	0.097
20.8	0.100
26.1	0.106
32.5	0.120
54.4	0.269
61.2	0.368
74.2	0.631
79.1	0.744
90.2	1.06
293.0	10.3

DATA SET 12*

T	ρ
323	11.7
373	14.7
423	17.9
473	21.6
523	25.6

DATA SET 13

T	ρ
323	11.9
373	14.9
423	18.2
473	21.8
523	25.8
573	30.3
673	41.0
773	53.3
873	67.9
973	85.2
1073	104.2

DATA SET 14*

T	ρ
323	15.8
373	18.7
423	22.0
473	25.9
523	30.0
573	34.6
673	45.0
773	57.1

DATA SET 14(cont.)*

T	ρ
873	71.0
973	87.5
1073	107.2

DATA SET 15

T	ρ
73	1.037*
189	5.17
273	9.04
296	10.29*
297	10.35*
310	11.06
373	14.74*
422	18.05*
473	21.92*
524	26.14*
573	30.67*
625	35.94*
671	41.07
723	47.38
774	53.98*
824	61.18*
871	68.33
924	77.02
973	85.85
995	90.25
1023	96.16
1023	96.18*
1047	102.06
1074	105.48*
1123	109.45*
1173	112.35*
1177	112.55*
1186	112.93
1190	112.21*
1191	112.20
1198	112.47
1237	113.92
1273	115.30

DATA SET 16

T	ρ
4	0.40
77.5	1.01

DATA SET 16(cont.)

T	ρ
194.1	5.31
273	9.04
323	11.72
373	14.70
423	18.06
473	21.84*
523	26.10
573	30.72
623	35.90
673	41.51
723	47.53
773	54.12
823	61.22
873	68.89
923	77.10
973	86.22
1023	96.46
1073	105.53
1123	109.58
1173	112.56*
1183	113.09
1193	112.54
1223	113.66
1273	115.49

DATA SET 17

T	ρ
4.2	0.0428
90	0.97
100	1.27*
120	1.95
140	2.67
160	3.47
180	4.31
200	5.20
220	6.11
240	7.04
260	8.00
273	8.61
280	8.99
300	10.01*
320	11.09
340	12.25
360	13.48

DATA SET 17(cont.)

T	ρ
380	14.77
400	16.09

DATA SET 18

T	ρ
1.63	0.0859
3.14	0.0899
4.33	0.0875
6.30	0.0955
9.02	0.0935
80.7	0.659

DATA SET 19

T	ρ
293	10.4
373	14.4*
473	22.0
573	31.4
673	42.2
773	54.8
873	69.4
973	86.1
1073	106.0
1173	111.8
1273	115.0*
1373	118.0

DATA SET 20

T	ρ
196.5	5.0
223.2	6.1*
245.3	7.1*
301.1	10.3*
349.7	13.2
406.6	16.6

DATA SET 21

T	ρ
298.2	10.37
323.2	11.86*
373.2	14.69*
423.2	18.08*
473.2	21.89*
523.2	26.20*

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

T	ρ
DATA SET 21(cont.)	
573.2	30.97
623.2	36.18
673.2	41.82
723.2	47.87
773.2	54.39
823.2	61.39
873.2	68.87*
923.2	76.96
973.2	85.85
1003.2	91.71
1023.2	96.03
1033.2	98.57
1036.2	99.41
1043.2	100.84
1053.2	102.23
1073.2	104.33*
1123.2	108.10*
1173.2	110.78
1223.2	112.79
1273.2	114.49
1323.2	116.04
DATA SET 22	
273	8.86*
293	9.81*
323	11.54*
373	14.53*
423	17.85*
473	21.55*
523	25.65*
573	30.2*
623	35.3
673	40.95*
723	47.0
773	53.7
823	60.9*
873	68.7*
923	76.85*
973	85.9*
1023	96.0*
1033	98.5*
1073	104.9
1123	108.7*
1173	111.6
1223	113.9*

T	ρ
DATA SET 22(cont.)	
1273	115.8
1323	117.5
1373	119.0
1423	120.4
1473	121.8
1523	123.1
DATA SET 23*	
90	1.08
195	5.15
290	9.95
DATA SET 24	
293.2	9.760*
323.2	10.80
373.2	13.4
393.2	14.85
413.2	16.39
423.2	17.20
433.2	18.01*
443.2	18.83*
453.2	19.66
463.2	20.49*
473.2	21.31*
483.2	22.14
493.2	22.98*
513.2	24.69*
523.2	25.58*
573.2	30.30*
623.2	35.50
673.2	41.19
723.2	47.39*
773.2	54.04
823.2	61.25*
873.2	69.05
883.2	70.68
893.2	72.34
903.2	74.03*
913.2	75.74
923.2	77.50*
933.2	79.32
943.2	81.21
953.2	83.18*
963.2	85.26

T	ρ
DATA SET 24(cont.)	
973.2	87.44*
983.2	89.76*
993.2	92.00
1003.2	93.96*
1013.2	95.65
1023.2	97.17*
1033.2	98.50*
1043.2	99.67
1053.2	100.70*
1063.2	101.60
1073.2	102.36*
1083.2	103.03
1093.2	103.66*
1103.2	104.25
1113.2	104.83*
1123.2	105.40*
1133.2	105.92
1143.2	106.41*
1153.2	106.85
1163.2	107.23*
1173.2	107.55
1183.2	107.83*
1193.2	108.07
1203.2	108.26
1213.2	108.43*
1223.2	108.57
1233.2	108.70*
1243.2	108.83
DATA SET 25*	
293.2	9.69
DATA SET 26*	
293.2	9.72
DATA SET 27*	
293.2	9.71
DATA SET 28*	
293.2	9.70

T	ρ
DATA SET 29*	
293.2	9.72
DATA SET 30*	
293.2	9.71
DATA SET 31	
4.2	0.248
17.5	0.258
20.2	0.261
22.6	0.263
24.0	0.266
28.8	0.276
33.3	0.290
36.6	0.300
53.1	0.439
64.4	0.593
73.6	0.689
88.9	1.18
105	1.81
122	2.24
122	2.45
151	3.64
186	5.10
221	6.87
282	10.1
293.2	10.0*
DATA SET 32	
0.452	0.339
0.643	0.346
0.752	0.339*
0.752	0.345
0.788	0.350
0.849	0.350
0.860	0.339
0.860	0.349
0.892	0.338
0.936	0.350
0.944	0.353
0.952	0.338
1.001	0.333
1.031	0.328
1.102	0.326

T	ρ
DATA SET 33	
293.2	10.00*
323.2	11.82*
373.2	14.85*
423.2	18.16*
473.2	21.97
523.2	26.20
573.2	30.89
623.2	35.97*
673.2	41.55
723.2	47.49
773.2	53.94
823.2	60.92
873.2	68.51
923.2	76.55
973.2	85.91*
998.2	90.95
1023.2	96.31*
1048.2	102.2
1073.2	105.5*
1098.2	107.8
1123.2	109.6*
1173.2	112.3*
1223.2	113.4
1273.2	115.0
1323.2	116.6
1373.2	118.2
1423.2	119.9
1473.2	122.1
1523.2	124.1
DATA SET 34	
90	1.30
133	2.48
152	3.19
172	4.06
192	5.15
211	6.01
231	6.95
251	7.95
271	8.92
291	10.00
DATA SET 35*	
977.6	83.5

T	ρ
DATA SET 35(cont.)*	
983.4	86.5
994.0	88.6
1001.1	90.2
1005.1	91.0
1011.0	92.0
1014.1	92.9
1016.0	93.3
1018.7	93.8
1019.8	94.2
1020.8	94.3
1021.8	94.5
1023.5	95.0
1025.1	95.4
1026.3	95.6
1027.6	95.9
1028.9	96.3
1031.6	96.9
1032.8	97.2
1034.2	97.6
1036.7	98.1
1038.1	98.6
1042.9	99.7
1045.9	100.5
1047.7	100.8
1050.8	101.2
1054.7	101.8
1061.7	102.7
1079.8	104.6
DATA SET 36*	
974.6	85.4
984.2	88.0
994.3	89.9
1002.4	91.5
1007.3	92.6
1012.3	93.6
1018.9	95.0
1022.2	95.7
1025.6	96.6
1028.0	97.3
1031.1	98.2
1035.1	99.1
1039.2	100.1
1044.9	101.4
1059.8	103.4
1078.8	105.3

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 37*		DATA SET 38(cont.)*		DATA SET 40		DATA SET 43(cont.)		DATA SET 47(cont.)*		DATA SET 49*	
1165.5	110.311	1183.6	110.589	1103	105.8	253	7.9	16	0.390	53.8	1.820
1167.3	110.345	1184.4	110.603	1123	107.3	273	8.8	18	0.390	76.1	2.341
1169.1	110.387	1186.2	110.624	1143	108.7	293	9.87	20	0.392		
1171.9	110.437	1187.0	110.638	1163	109.8	323	11.6	25	0.399	DATA SET 50	
1172.9	110.463	1187.9	110.652	1183	110.7	373	14.7	30	0.410		
1173.9	110.481	1189.7	110.676	1203	111.4	423	18.1	35	0.426	76.1	1.220
1174.6	110.494	1190.6	110.691	1223	112.0	473	21.4	40	0.450	191.3	5.318
1176.2	110.520	1191.4	110.701	1243	112.7	523	26.0	45	0.484	234.0	7.168
1177.3	110.544	1192.5	110.715	1263	113.3	573	30.1	50	0.528	273	9.065*
1178.2	110.567	1194.9	110.741	1283	114.0	623	35.0	55	0.585	273.85	9.115
1179.0	110.589					673	40.3	60	0.654	291.40	10.014
1179.8	110.604	DATA SET 39		DATA SET 41		723	46.8	65	0.737	333.40	12.359
1180.8	110.624					773	53.3	70	0.832	371.25	14.631
1181.7	110.640	73.2	1.0	1553	121.11	823	60.1	75	0.938	418.6	17.793
1183.5	110.666	123.2	2.5	1573	121.52*	873	68.0	80	1.0	469.3	21.499
1183.5	110.680	173.2	4.3	1593	121.92	923	76.0	85	1.188		
1185.3	110.697	223.2	6.6	1613	122.34	973	84.8	90	1.327	DATA SET 51*	
1186.1	110.696	273.2	9.0	1633	122.76	1023	94.2	95	1.476		
1187.0	110.696	323.2	11.8	1653	123.17	1073	102.1	100	1.632	51.0	0.660
1188.0	110.689	373.2	14.4	1659	123.31	1123	106.3	110	1.969	54.0	0.725
1188.9	110.689	423.2	17.9	1663	123.49	1173	109.0	120	2.330	76.1	1.220
1192.3	110.687	473.2	21.5	1673	123.74	1223	111.1	130	2.707	273.2	9.065
1193.2	110.698	523.2	25.5	1693	124.22	1273	113.1	140	3.10		
1194.0	110.709	573.2	30.6	1713	124.73			150	3.50	DATA SET 52*	
1195.0	110.719	623.2	35.8			DATA SET 44*		160	3.91		
1197.6	110.745	673.2	40.9	DATA SET 42*				170	4.32	50.5	0.644
		723.2	46.4			291	11.96	180	4.75	50.8	0.649
DATA SET 38*		773.2	52.8	83	1.22	373	16.81	190	5.18	76.1	1.220
		823.2	60.2	203	5.60			200	5.61		
1163.9	110.485	873.2	67.2	223	6.50	DATA SET 45*		220	6.52	DATA SET 53	
1165.5	110.519	923.2	75.6	248	7.65			240	7.44		
1167.4	110.553	973.2	84.2	273	8.96	273	9.64	260	8.42	76	0.608
1168.3	110.578	1023.2	93.8	293	10.0	373	15.09	280	9.43	91	1.067*
1169.2	110.595	1073.2	103.3	313	11.3					173	4.010*
1171.8	110.603	1123.2	108.1	333	12.5	DATA SET 46*		DATA SET 48*		274	8.659*
1171.9	110.598	1173.2	110.4	353	13.6					291.30	9.455
1172.7	110.582	1223.2	112.5			312.07	11.99	76.1	2.341	369.6	13.777
1173.7	110.552	1273.2	114.0	DATA SET 43				191.3	6.647		
1174.6	110.522	1323.2	115.3			DATA SET 47*		229.3	8.364	DATA SET 54	
1175.4	110.480	1373.2	116.6	93	1.1			273.0	10.512		
1176.4	110.476	1423.2	117.9	113	1.7	6	0.387	274.55	10.592	303	15.3
1177.3	110.491	1473.2	119.2	133	2.4	7	0.387	291.65	11.498	367	20.0
1178.2	110.514	1523.2	120.6	153	3.1	8	0.385	325.25	13.399	413	23.1
1180.1	110.531	1573.2	121.6	173	4.0	9	0.385	363.7	15.729	460	26.3
1180.9	110.546	1623.2	122.8	193	5.0	10	0.385	412.0	18.902	527	32.0
1181.8	110.566	1673.2	124.0	213	5.9	12	0.387	470.5	23.251	575	36.4
		1715.2	125.2	233	6.9	14	0.389			648	43.6

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 54(cont.)		DATA SET 55(cont.)*		DATA SET 56(cont.)*		DATA SET 58(cont.)*		DATA SET 63(cont.)		DATA SET 66(cont.)	
663	45.3*	784	58.1	1042.2	103.89	1182.9	113.16	1580	121.92	573	32.781
735	53.1	793	59.8	1043.2	104.06	1185.7	112.69	1600	122.35	598	35.235
800	61.6	831	65.1	1044.3	104.23	1186.7	112.74	1620	122.76	623	37.877
900	76.4	836	66.3	1044.8	104.32			1640	123.17	648	40.583
933	80.7	885	74.0	1046.8	104.60	DATA SET 59*		1660	123.56	673	43.345
973	90.2	894	75.2	1047.9	104.78						
982	92.1	901	76.7	1049.1	104.97	4.2	2.58	DATA SET 64		DATA SET 67*	
1015	98.7	918	79.8	1052.6	105.45						
1019	100.0*	951	85.9	1054.9	105.78	DATA SET 60		1700	125.80	293	9.7
1024	100.7*	975	90.9	1057.6	106.09			1720	126.13		
1033	102.2	979	91.5	1059.1	106.33	293	13.55	1740	126.4[illegible]	DATA SET 68*	
1045	105.8*	982	91.8	1059.9	106.32	1073	108	1760	126.71		
1062	108.6	987	92.8	1062.2	106.69	1123	112	1780	127.07	93	2.635
1083	110.3*	1000	94.6	1064.7	107.01	1173	114	1800	127.38		
1090	111.3*	1050	106.8	1065.9	107.09	1223	114			DATA SET 69*	
1124	112.9	1054	107.5	1068.4	107.39	1279	121	DATA SET 65			
1124	113.8*	1061	108.1			1378	125			93	1.647
1135	114.5*	1067	108.9	DATA SET 57*		1480	124	1700	124.87		
1161	115.1	1076	110.0			1578	135	1720	125.22	DATA SET 70*	
1163	115.8*	1085	110.6	1151.9	113.48	1698	135	1740	125.54		
1174	117.0	1100	111.3	1156.2	113.71			1760	125.83	93	2.25
		1123	113.3	1162.8	114.07	DATA SET 61*		1780	126.08		
DATA SET 55*		1141	114.6	1165.8	114.23			1800	126.30	DATA SET 71*	
		1150	115.0	1173.7	114.63	313	11.65				
300	10.8	1213	115.0	1175.5	114.70	323	12.21	DATA SET 66		77	0.7786
311	11.5	1229	115.7	1177.5	114.79	333	12.77				
347	13.4	1247	116.2	1180.8	114.13	343	13.33	84	2.653	DATA SET 72*	
358	14.1	1291	117.9	1182.9	113.52			98	3.091		
373	15.1			1185.2	112.97	DATA SET 62		123	3.988	77	0.7686
389	16.3	DATA SET 56*		1187.7	112.77			148	4.962		
434	19.6			1189.5	112.84	1500	121.12	173	5.929	DATA SET 73*	
451	20.8	1017.6	97.78	1190.6	112.90	1520	121.59	198	6.937		
478	22.9	1018.9	98.04	1194.6	113.05	1540	122.05	223	8.147	77	0.7410
503	25.2	1019.9	98.24	1197.3	113.16	1560	122.51	248	9.368		
510	25.8	1022.8	98.83			1580	122.95	273	10.681	DATA SET 74*	
523	27.2	1023.4	99.04	DATA SET 58*		1600	123.39	298	12.063		
562	31.0	1023.6	99.09			1620	123.82	323	13.504	1.8	0.137
569	31.7	1025.5	99.56	1151.0	113.73	1640	124.25	348	15.022	2.6	0.137
584	33.0	1028.6	100.42	1161.7	114.30	1660	124.66	373	16.630	4.1	0.137
628	38.3	1029.5	100.56	1167.9	114.62			398	18.235	5.3	0.138
636	38.8	1031.1	100.99	1171.5	114.82	DATA SET 63		423	20.012	6.2	0.138
644	40.0	1034.0	101.76	1174.1	114.92			448	21.504	7.3	0.138
675	43.6	1036.0	102.27	1175.7	114.74	1500	120.13	473	23.928	8.5	0.146
687	45.2	1038.7	103.13	1177.8	114.42	1520	120.59	498	26.000	10.1	0.148
725	50.1	1039.5	103.26	1180.4	113.78	1540	121.04	523	28.196	11.8	0.148
752	54.0	1041.0	103.58	1181.7	113.47	1560	121.49	548	30.357	14.0	0.148

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 74(cont.)*		DATA SET 76*		DATA SET 79(cont.)*		DATA SET 80		DATA SET 86(cont.)		DATA SET 91(cont.)	
16.8	0.155	1160	111.69	87.1	0.88	76	0.8	22.5	0.1048	927	82.3
20.0	0.155	1167.4	111.99	90.9	1.06	.11	1.8	98.0	1.27	949	85.8*
27.5	0.164	1169.5	111.97	96.4	1.22	168	4.1	105.5	1.53	964	88.9
36.3	0.188	1173.0	112.07	98.7	1.30	230	6.9	111.1	1.71	980	91.4*
40.2	0.228	1174.6	111.92	101.6	1.39	300	10.7	115.2	1.81	1002	95.8*
54.3	0.327	1175.9	111.82	111.8	1.79			124.1	2.15	1013	98.4*
65.9	0.503	1178.4	111.34	115.0	1.89	DATA SET 81*		134.3	2.59	1028	100.8
76.6	0.734	1180.6	111.43	118.5	1.90			178.4	4.47	1037	103.1
		1182.8	111.61	124.6	2.22	77	0.57	199.3	5.43	1060	106.9
DATA SET 75		1184.8	111.70	126.9	2.31	273	9.61	226.8	6.44	1076	109.1
		1186.4	111.77	138.0	2.75			251.6	7.71	1094	110.8
1088	107.16	1187.9	111.86	143.9	3.02	DATA SET 82*		273	8.77	1107	112.2
1102	108.03	1189.7	111.83	155.1	3.52			295	9.92	1125	113.6
1123.3	109.41	1191.3	111.85	157.8	3.62	4.2	0.24			1144	115.1
1142.1	110.62			159.7	3.64	293	9.60	DATA SET 87*		1167	115.7
1150.2	111.24	DATA SET 77		162.9	3.85						
1158.7	111.64			165.2	3.93	DATA SET 83*		293	10.87	DATA SET 92	
1160.9	111.75	4.00	0.25	168.4	4.04						
1162.5	111.75*	20.2	0.26	170.6	4.15	4.2	0.090	DATA SET 88*		1448	122.8
1164.5	111.86*	77.2	0.82	172.6	4.25	293	9.90			1677	128.8
1165.1	111.86*	273	9.1*	174.7	4.33			293	10.75	1755	126.1
1166.4	112.03*	473	21.4	177.2	4.45	DATA SET 84				1814	116.5
1167.3	112.11*	673	41.0	179.8	4.55			DATA SET 89*		1862	117.2
1169.5	112.22	873	68.2	182.8	4.69	4.2	0.084			2046	122.6
1171.4	112.29*	1073	106.4	184.8	4.82	293	10.92	293	12.5	2094	129.9*
1173.4	112.38			189.8	5.00						
1175.3	112.52*	DATA SET 78*		194.9	5.25	DATA SET 85*		DATA SET 90*		DATA SET 93	
1176.5	112.60			199.5	5.42						
1178.4	112.64*	76.7	0.63	204.7	5.70	4.2	0.057	293	8.93	1808	140.00
1179.4	112.74*	85.5	0.86	209.6	5.90	293	9.69				
1180.7	112.83	91.6	1.03	219.7	6.32			DATA SET 91		DATA SET 94	
1181.8	112.98*	102.6	1.37	224.6	6.52	DATA SET 86					
1182.7	112.98	112.7	1.74	229.2	6.83			288	10.8*	344	14.4
1183.4	112.73	118.1	1.85	234.2	7.08	4.2	0.0953	373	15.5	405	16.1
1184.1	112.37*	127.3	2.21	239.3	7.21	4.9	0.0956	411	17.7	457	20.3
1185.1	112.14	139.0	2.68	249.4	7.76	5.5	0.0957	462	21.6	533	26.8
1185.7	111.88	156.6	3.35	254.6	8.01	6.3	0.0957	537	27.7	598	33.6
1186.8	111.84*	172.2	4.00	259.4	8.36	7.1	0.0959	589	32.8	694	45.0
1189.1	111.89*	180.9	4.38	264.5	8.59	8.1	0.0961	626	37.1	842	65.1
1191.3	111.94	191.0	4.80	269.7	8.81	8.8	0.0963	690	45.9*	944	85.0
1192.8	112.02*			274.6	9.04	9.6	0.0966	769	56.7	1015	101.1
1193.9	112.06*	DATA SET 79*		279.3	9.31	10.6	0.0969	793	59.9*		
1196.1	112.12			284.3	9.65	11.9	0.0930	813	62.1*	DATA SET 95	
		77	0.63	289.5	9.77	13.0	0.0979	828	65.4		
		82.0	0.78	292.5	10.02	15.2	0.0990	845	68.0*	928	80.7
		84.6	0.84	294.5	10.12	17.8	0.1007	889	75.0	933	81.6
				299.5	10.41	19.0	0.1015	917	79.4*	937	82.4

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 95(cont.)		DATA SET 96(cont.)*		DATA SET 98*		DATA SET 99(cont.)*		DATA SET 101(cont.)*		DATA SET 103(cont.)*	
942	83.2	1040	103.8	1174.7	117.711	1175.6	117.682	483.5	27.68	959.5	81.30
947	84.1	1046	104.8	1175.6	117.735	1176.5	117.663	486	27.88	1009	89.00
952	85.0	1092	110.2	1176.5	117.771	1177.4	117.663	527.5	41.30	1189	112.80
956	85.9	1155	114.8	1177.4	117.802	1178.3	117.632	646	43.45	1158.5	110.60
960	86.8	1158	115.0	1178.3	117.843	1179.2	117.651	803.5	61.55		
965	87.6	1164	115.2	1179.2	117.869	1180.0	117.655	808.5	61.55	DATA SET 104*	
970	88.6	1168	114.8	1180.0	117.920	1181.0	117.655	916	77.40		
975	89.5	1172	114.9	1181.0	117.963	1181.9	117.665	947	83.40	273	10.50
980	90.3	1176	115.0	1181.9	118.002	1182.8	117.690	1025	96.70	284.1	11.10
984	91.4	1181	115.1	1182.8	118.036	1183.6	117.713	1036	99.70	325	13.21
989	92.3	1186	115.1	1183.6	118.061	1184.5	117.741			374	11.41
999	93.2	1190	115.2	1184.5	118.077	1185.5	117.773	DATA SET 102*		401.5	18.44
998	94.3	1194	115.3	1185.5	118.098	1186.4	117.800			463.5	23.28
1008	96.2	1198	115.5	1186.4	118.112			273	12.500	525.5	28.66
1012	97.2	1203	115.6	1187.2	118.105	DATA SET 100*		289	13.58	587.5	34.92
1016	98.3	1207	115.8	1188.2	118.082			291	13.82	631.5	39.80
1026	100.5	1211	115.9	1189.0	118.070	325	12.43	444.5	23.48	686.5	45.90
1031	101.6	1217	116.1	1189.6	118.056	375	14.88	474.5	25.13	739.5	52.70
1036	102.7	1221	116.2	1190.7	118.045	425	18.33	594	36.28	790	59.25
1050	105.8			1191.5	118.047	475	22.78	600	36.76	828	64.40
1054	106.4	DATA SET 97*		1192.4	118.052	525	26.23	603.5	37.00	834	65.40
1059	106.9			1193.2	118.092	575	30.68	777.5	55.50	878.5	71.95
1063	107.6	1003	95.4	1194.0	118.108	625	36.13	779	55.70	922	78.90
1068	108.1	1021	99.6	1194.8	118.125	675	41.58	893	71.35	952	83.75
1073	108.6	1040	104.4	1195.5	118.142	725	48.03	926	75.60	987.5	89.30
1077	109.0	1045	105.4	1196.4	118.158	775	54.48	979	84.40	1012.5	94.20
1082	109.5	1091	110.5	1197.0	118.198	825	61.93	997.5	86.60	1024.0	96.20
1085	110.0	1155	114.2	1197.7	118.230	875	69.38	1034	92.60	1037.0	98.60
1095	110.6	1159	114.4	1198.5	118.258	925	77.83	1059	97.20	1095	100.00
1100	111.0	1164	114.7			975	86.28	1078	101.10	1059.5	103.00
1104	111.3	1167	115.4	DATA SET 99*		1025	94.73	1081.5	101.10	1073	106.10
1109	111.6	1172	115.4			1075	102.18	1154	110.00	1099	108.30
1114	111.8	1177	115.6	1163	117.263	1125	107.63	1143	109.40		
1118	112.2	1181	115.7	1164	117.318	1175	111.08	1209	113.10	DATA SET 105	
1123	112.5	1185	115.6	1164.8	117.381	1225	113.53	1223.5	114.20		
1127	112.8	1190	115.8	1165.7	117.429	1275	114.98	1273	115.00	273	10.50
1131	113.1	1195	115.9	1166.6	117.473	1325	116.43	1299.5	115.80	291	11.14
1137	113.3	1198	116.0	1167.5	117.540	1375	117.88	1323	115.80	357	15.39
1141	113.5	1203	116.2	1168.5	117.600	1425	120.33			413.5	19.41
1146	113.9	1207	116.4	1169.4	117.661			DATA SET 103*		469.5	24.02
1150	114.2	1211	116.4	1170.1	117.704	DATA SET 101*				525.5	29.00
		1216	116.7	1171.1	117.721			289.8	13.510	568.5	34.02
DATA SET 96*		1220	116.8	1172.0	117.718	273	13.600	293	13.94	634	40.58
				1173.0	117.712	291	14.61	903	72.90	659	43.40
1004	94.9			1173.9	117.689	400	22.15	905.5	72.40	679	45.72
1022	99.1			1174.7	117.690	462	26.30	954	79.75	727.5	51.77

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 105(cont.)		DATA SET 107(cont.)		DATA SET 108(cont.)		DATA SET 110(cont.)		DATA SET 113(cont.)		DATA SET 113(cont.)	
776.5	57.85	5.4	0.084	1044	91.6	873	79.55	477	20.6	1397	114.8*
826.5	64.85	6.2	0.084	1053	97.5	923	89.70	499	22.7	1417	115.8
827	64.80	6.7	0.086	1063	100.2	973	103.3	524	24.6	1445	116.4*
867	70.05	7.3	0.086	1073	101.5	1023	113.2	545	26.8*	1472	117.2*
903.5	76.40	8.1	0.089	1093	103.6	1073	118.6	574	29.0	1497	117.8
910	77.40	9.1	0.086	1123	106.0	1123	120.4	597	31.2*	1524	118.3*
931	80.85	10.1	0.086			1173	121.2	623	33.9	1544	119.0
970	87.20	11.2	0.086	DATA SET 109*		1223	122.0	647	36.6*	1573	119.6*
998.5	92.05	12.1	0.088			1273	122.4	671	38.9	1597	120.4*
1017	95.65	13.1	0.090	273	8.53			699	41.9*	1618	121.1
1037.5	99.85	14.1	0.087	293	19.91	DATA SET 111		721	44.2	1645	121.6*
1038.5	100.00	15.1	0.093	323	11.64			750	47.4	1656	121.7
1043	100.90	16.2	0.091	373	15.53	273	9.35	775	50.9*	1668	122.8*
1054	103.40	17.1	0.094	423	20.21	293	10.95	802	53.8	1676	122.2
1060	104.60	19.3	0.095	473	25.00	323	11.92*	829	57.4*	1686	123.5*
1065.5	105.60	21.4	0.097	523	29.87	373	15.49	845	60.7	1697	123.8
1086.5	108.40	22.2	0.098	573	35.41	423	18.81	869	64.1*	1718	125.0
1097.5	109.60	24.1	0.103	623	40.75	473	22.76*	897	68.0		
1117	111.40	25.2	0.098	673	46.80	523	26.79	925	71.4*	DATA SET 114	
1131	112.50	26.1	0.105	723	53.50	573	31.93	953	75.2		
1144	113.40	28.2	0.110	773	59.85	625	37.07	976	79.8*	1551	126
1164.5	114.50	30.2	0.114	823	67.55	673	43.20	995	83.6	1575	124
1189.5	116.20	33.9	0.125	873	76.35	723	50.30	1016	89.0*	1601	126
1199.5	116.60	34.3	0.127	923	85.20	773	56.70	1028	91.0	1617	127
1219.5	117.20	40.4	0.157	973	96.65	823	63.95	1031	92.3*	1642	127
1245	118.20	40.9	0.163	1023	104.8	873	71.05	1031	93.2*	1685	127
1256	118.35	49.0	0.217	1073	107.8	923	79.40	1031	94.4	1710	129
1262.5	118.55	100	1.28	1123	109.9	973	92.9	1044	94.4*	1711	127
1273.0	118.80	150	3.14	1173	111.1	1023	105.1	1046	95.8*	1729	129
1287.5	119.10	200	5.38	1223	112.8	1073	111.0	1049	96.6	1748	129
1309	119.65	250	7.74	1273	113.6	1123	114.5	1073	100.2	1775	130
1331.5	120.05	300	10.33			1173	117.8	1096	102.8*	1784	129
1344.5	120.35			DATA SET 110				1124	105.1	1806	131
1368.5	120.60	DATA SET 108				DATA SET 112		1145	106.1	1806	135
1388.5	120.85			273	9.57			1165	107.0*	1817	137
1415	121.00	78	2.07	323	12.06	1923	138	1175	107.5*	1821	135
1423	120.60	178	5.81	373	15.39*			1182	108.3	1833	134
		273	10.1*	423	19.09	DATA SET 113		1195	108.0*	1852	135
DATA SET 106		370	15.5	473	23.67			1198	108.7	1877	137
		471	22.4	523	28.72	304	10.0	1225	109.9*	1886	136
4.2	0.23	570	30.6	573	34.15	327	11.5	1253	110.7	1925	136
		681	41.6	623	40.95	355	13.1	1274	111.1*	1929	139
DATA SET 107		783	53.9	673	47.80	376	14.1	1296	112.1*	1976	139
		864	64.7	723	54.85	402	15.7	1321	112.6	1996	138
4.2	0.080	982	82.7	773	62.35	425	17.2*	1347	113.5*	2018	140
4.5	0.083	1033	92.9	823	70.30	451	19.0	1373	114.3*		

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

T	ρ
DATA SET 115	
1773	129.9
1797	131.0
1822	138.1
1832	140.0
1842	138.4
1847	139.2
1852	141.3
1862	139.3
1872	140.8
1882	140.2
1892	142.1
1898	141.1
DATA SET 116	
993.8	91.101
993.4	91.422*
996.4	91.636*
996.7	91.707*
997.7	91.885*
998.2	91.921*
998.8	92.171*
1001.4	92.812
1003.4	93.347*
1003.5	93.419*
1004.4	93.561*
1005.5	92.527*
1005.7	93.704
1006.2	93.918*
1007.1	94.239*
1008.2	94.417*
1008.8	94.666*
1010.4	94.916*
1011.4	95.130*
1012.2	95.415*
1013.4	95.665*
1014.0	95.914*
1015.7	96.271*
1016.5	96.521*
1017.1	96.628*
1017.8	96.877*
1019.3	97.412*
1020.5	97.697
1021.1	97.911*
1021.9	98.268*
1022.4	98.339*

T	ρ
DATA SET 116(cont.)	
1023.4	98.589*
1024.7	98.981*
1026.0	99.409*
1027.1	100.015*
1027.2	99.694*
1028.5	100.122*
1029.6	100.443*
1030.4	100.764*
1031.0	100.978*
1032.1	100.263*
1032.6	100.512*
1033.4	101.833*
1034.0	102.012*
1034.4	102.226*
1035.0	102.368*
1035.7	102.618*
1036.0	102.760*
1036.7	102.974*
1037.4	103.295*
1038.2	103.519*
1038.8	103.687*
1039.2	103.830*
1039.7	103.973*
1040.0	104.187
1040.3	104.294*
1040.8	104.508*
1041.3	104.650*
1041.9	114.828*
1042.4	104.864*
1042.8	105.007*
1043.2	105.042*
1043.7	105.114*
1044.3	105.185*
1045.2	105.399*
1045.7	105.542*
1046.0	105.613*
1046.7	105.684*
1047.3	105.791*
1048.2	105.862*
1049.2	105.969*
1049.8	106.005*
1050.4	106.041
1051.0	106.112*
1052.2	106.148*
1052.9	106.183*
1053.7	106.290*

T	ρ
DATA SET 116(cont.)	
1054.4	106.326*
1055.4	106.433*
1056.3	106.504*
1057.4	106.611*
1059.0	106.825*
1059.6	106.896*
1060.5	106.896
1061.2	106.932*
1062.1	106.968*
1063.3	107.003*
1064.0	107.039*
1065.2	107.075*
1066.0	107.146*
1067.0	107.253*
1068.0	107.324*
1069.1	107.396*
1069.9	107.431*
1070.3	107.503*
1071.4	107.574*
1072.3	107.610*
1073.0	107.645*
1073.6	107.681*
1074.7	107.752*
1076.0	107.824*
1077.0	107.895*
1077.9	107.930*
1078.7	108.037*
1079.7	108.144*
1080.4	108.251
1081.4	108.323*
1082.4	108.394*
1083.2	108.430*
1084.3	108.501*
1085.5	108.572*
1086.5	108.608*
1088.1	108.751
DATA SET 117	
1873	110
DATA SET 118	
1809	134

T	$\rho - \rho_0$
DATA SET 119*	
2.438	0.00009942
3.062	0.0001421
4.159	0.0002509
5.000	0.0003850
7.674	0.0007771
10.00	0.001326
11.32	0.001720
15.92	0.004041
18.84	0.006088
29.31	0.02007
38.90	0.04770
49.77	0.1184
62.66	0.2776
DATA SET 120*	
2.366	0.0001022
2.951	0.0001554
4.130	0.0002732
4.989	0.0004004
7.379	0.0008138
11.02	0.001700
19.01	0.005909
30.90	0.01993
39.45	0.04041
47.64	0.07789
77.62	0.5514

T	ρ
DATA SET 121*	
1573	133.8
1873	136.4
DATA SET 122*	
77	0.580
298	9.80
DATA SET 123*	
77	0.620
298	9.80

T	ρ
DATA SET 124*	
77	0.700
298	9.80
DATA SET 125*	
4.2	0.236
DATA SET 126*	
4.2	0.353
DATA SET 127*	
4.2	0.553
DATA SET 128*	
4.2	0.726
DATA SET 129*	
4.2	0.367
DATA SET 130*	
4.2	0.641
DATA SET 131*	
4.2	0.924
DATA SET 132*	
4.2	1.086
DATA SET 133*	
4.2	1.298
DATA SET 134	
4.2	0.3300
16.3	0.3417
18.1	0.3455
19.9	0.3465
22.3	0.3522

T	ρ
DATA SET 134(cont.)	
25.4	0.3583
26.2	0.3549*
26.5	0.3553*
30.9	0.37608
33.6	0.3802
37.2	0.4146
40.7	0.4484
46.8	0.4977
51.6	0.5521
59.0	0.6562
64.6	0.7590
70.6	0.8995
71.9	0.9374*
75.2	1.037*
79.4	1.120
82.2	1.218
86.3	1.359*
90.6	1.509*
95.1	1.690
102.1	1.920*
108.9	2.173*
117.5	2.461
126.8	2.915*
137.4	3.34
150.0	3.85
166.3	4.66*
175.4	5.067
181.6	5.548*
195.9	6.321
218.3	7.336
239.3	8.581
252.3	9.253
259.4	9.482
276.1	10.136
300.0	10.33
DATA SET 135	
373	16.1
473	22.8
573	30.8
673	42.6
773	55.4

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

T	ρ
DATA SET 136	
4.2	0.04
100	1.3
200	5.4
300	9.7
400	15.6
500	23.1
600	32.4
700	43.7
800	56.6
900	71.6
1000	90.3
1043	99.7
1100	106.5
1185	111.6
118[illegible]	110.3
1200	110.3
DATA SET 137*	
1811	142.7
1900	152.3
2000	164.9
DATA SET 138	
279	9.7
432	19.4
565	31.3
668	42.3
766	54.5
983	89.7
1050	101.5
1075	104.3
1107	106.8
1123	108.0
1131	109.1
1148	109.4
1170	111.3
1200	111.6
1213	112.1
1260	112.9
1352	115.4
1410	117.2
1442	118.3
1458	119.0
1479	119.8

T	ρ
DATA SET 138(cont.)	
1511	120.5
1532	121.1
1546	121.8
1572	122.1
1595	122.5
1623	124.0
1673	125.0
1723	126.1
1773	127.1
1793	127.9
DATA SET 140*	
20.4	-0.64286
80.6	0.97180
198.3	5.1537
273.1	8.57
DATA SET 141*	
20.4	-0.64286
80.6	0.97180
198.3	5.1337
273.1	8.57
DATA SET 142*	
80.3	0.963
80.5	0.969
194.6	4.980
273	8.57
293	9.6100
373	14.296
373	14.296
373	14.296
373	14.296
472.1	21.393
581.6	31.094
682.5	41.954
784.2	54.956
DATA SET 143*	
81.0	0.9836
194.9	4.9928
195.0	4.9969

T	ρ
DATA SET 143(cont.)*	
273.0	8.57
293.0	9.6100
373.0	14.296
373.0	14.296
373.0	14.296
472.6	21.432
580.8	31.015
671.4	36.259
760.7	51.759
DATA SET 144*	
80.3	0.962
194.9	4.9928
273.0	8.57
373	14.296
373	14.296
572.4	30.215
DATA SET 145*	
1.38	0.2020
4.21	0.2022
20.40	0.2136
78.85	0.8602
87.42	1.094
273.16	9.36
DATA SET 146*	
1.38	0.1252
3.71	0.1252
4.21	0.1252
20.40	0.1341
83.90	0.8898
273.16	8.88
DATA SET 147	
1.38	0.0896
4.21	0.0887
20.40	0.0974
83.90	0.828
273.16	8.70

T	ρ
DATA SET 148	
1.98	0.0556
4.21	0.0565
20.40	0.0692
78.20	0.6751
273.16	9.11
DATA SET 149	
1.98	0.0723
4.21	0.0723
20.40	0.0795
78.24	0.6751
273.16	8.93
DATA SET 150*	
1.38	0.1604
4.21	0.1614
20.40	0.1781
77.74	0.8610
273.16	9.84
DATA SET 151*	
1.38	0.1631
3.71	0.1641
4.21	0.1674
20.40	0.1772
77.74	0.8935
273.16	10.87
DATA SET 152*	
1.38	0.6166
3.71	0.6166
4.21	0.6176
20.40	0.6425
81.73	1.421
90.46	1.66
273.16	9.59
DATA SET 153*	
1.29	0.5123
4.21	0.5167
20.40	0.5235

T	ρ
DATA SET 153(cont.)*	
77.79	1.288
85.19	1.520
273.16	11.04
DATA SET 154*	
1.38	0.6696
3.71	0.6696
4.21	0.6712
20.40	0.6967
81.73	1.982
90.46	2.391
273.16	15.98
DATA SET 155*	
1.38	0.8806
3.71	0.8806
4.21	0.8806
20.40	0.9348
81.73	2.755
273.16	22.58
DATA SET 156*	
0.302	0.006210
0.400	0.006211
0.500	0.006212
0.600	0.006215
0.700	0.006217
0.805	0.006221
0.908	0.006225
1.004	0.006229
DATA SET 157*	
273	8.73
DATA SET 158*	
20	0.180
90	1.046
273	8.572
373	14.[illegible]42
566	29.1[illegible]9
578.3	30.26[illegible]

T	ρ
DATA SET 158(cont.)*	
719.5	45.434
830.6	60.230
837.8	61.241
955.9	80.392
989.1	86.787
1012.2	91.467
1012.25	92.762
1023.8	94.296
1026.1	94.828
1028.9	95.539
1031.0	96.233
1033.4	96.709
1034.3	96.887
1035.3	97.086
1036.6	97.345
1037.1	97.444
1038.3	97.684
1039.1	97.843
1039.9	98.003
1040.6	98.143
1041.6	98.344
1043.0	98.625
1044.2	98.866
1045.9	99.208
1047.5	99.531
1049.2	99.875
1051.4	100.32
1053.6	100.77
1057.5	101.56
1061.6	102.40
1078.4	105.90
1080.4	106.32
1093.9	107.28
1095.2	109.47
1129.6	117.03
DATA SET 159*	
273	8.57
293	9.61
373	14.296
473	21.5
573	30.3
673	40.8
773	53.4
873	68.1

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

DATA SET 159(cont.)*

T	ρ
973	85.2
1073	105
1173	127
1273	152

DATA SET 160*

T	ρ
84.9	0.735
88.7	0.766
87.4	0.784
93.0	0.816
94.4	0.856
98.1	0.978
103.2	1.09
108.7	1.19
114.0	1.26
119.1	1.33
123.7	1.42
129.1	1.53
132.9	1.73
139.5	1.86
147.7	1.91
154.7	2.39
163.1	2.63
167.4	2.87
173.0	3.04
178.4	3.33
183.3	3.54
186.0	3.78
198.0	4.30
206.3	4.69
214.3	5.12
219.8	5.43
227.2	5.77
234.6	6.01
240.2	6.40
244.3	6.75
252.8	7.08
259.1	7.51
266.4	7.80
270.5	8.39
274.7	8.83
279.4	9.16
287.2	9.33
291.5	9.60
297.2	9.60

DATA SET 161*

T	ρ
193.8	5.06
292.8	9.6
398.0	15.9
491.8	23.0
586.6	31.6
684.6	42.2
784.6	55.0
887.8	70.5
988.9	88.1
1085.8	107.5
1207.7	135.4

DATA SET 162*

T	ρ
1.16	0.03368
1.23	0.03368
1.27	0.03368
1.29	0.03368
1.34	0.03368
1.39	0.03368
1.51	0.03368
1.58	0.03368
1.63	0.03368
1.67	0.03368
1.72	0.03368
1.89	0.03368
2.00	0.03368
2.09	0.03369
2.13	0.03369
2.16	0.03369
2.35	0.03369
2.46	0.03369
2.58	0.03369
2.60	0.03369
2.73	0.03369
2.83	0.03369
2.98	0.03369
3.01	0.03369
3.09	0.03369
3.19	0.03370
3.28	0.03369
3.43	0.03370
3.57	0.03370
3.78	0.03370
3.87	0.03370
3.97	0.03370

DATA SET 162(cont.)*

T	ρ
4.17	0.03370
4.19	0.03370
4.19	0.03371

DATA SET 163

T	ρ
1.26	0.03399*
1.46	0.03400
1.64	0.03401
1.84	0.03403
2.01	0.03404
2.21	0.03405
2.44	0.03406
2.85	0.03408
3.05	0.03411
3.25	0.03412
3.47	0.03414
3.67	0.03417
3.84	0.03417
4.07	0.03421
4.26	0.03423
14.01	0.03702
14.30	0.03719
14.88	0.03737
15.27	0.03771
15.94	0.03805
16.40	0.03831
16.87	0.03857
17.31	0.03882
17.89	0.03925
18.39	0.03959
18.95	0.03994
19.40	0.04028
20.32	0.04096

DATA SET 164

T	ρ
0.38	0.03395
0.49	0.03396
0.95	0.03398
1.08	0.03399
1.27	0.03400

DATA SET 165*

T	ρ
4.2	0.2255

DATA SET 166

T	ρ
4.2	0.0599

DATA SET 167

T	ρ
4.2	0.0381

DATA SET 168*

T	ρ
4.2	0.0368

DATA SET 169*

T	ρ
4.2	0.0390

DATA SET 170

T	ρ
4.2	0.0317

DATA SET 171*

T	ρ
4.2	0.2810

DATA SET 172*

T	ρ
4.2	0.2637

DATA SET 173*

T	ρ
4.2	0.2261

DATA SET 174*

T	ρ
4.2	0.2116

DATA SET 175*

T	ρ
4.2	0.0371

DATA SET 176*

T	ρ
4.2	0.0136

DATA SET 177

T	ρ
4.2	0.0354

DATA SET 178*

T	ρ
879	70.79
901	73.82
903	74.84
927	78.98
928	77.97
951	81.51
951	83.13
976	87.58
979	86.57
1000	91.02
1000	92.03
1022	95.67
1022	97.39
1045	101.13
1050	102.65
1072	103.25
1071	104.87
1094	105.68
1100	106.19
1126	107.30

DATA SET 179*

T	ρ
0.28	0.005688
0.41	0.005694
0.49	0.005699
0.59	0.005709
0.69	0.005716
0.80	0.005729
0.90	0.005742
1.01	0.005761
1.10	0.005773
1.20	0.005794

DATA SET 180*

T	ρ
0.38	0.005876
0.42	0.005879
0.49	0.005881
0.70	0.005888
0.80	0.005891
0.90	0.005898
1.01	0.005905
1.10	0.005910
1.20	0.005917

DATA SET 181*

T	ρ
0.310	0.005887
0.338	0.005890
0.423	0.005894
0.504	0.005896
0.601	0.005900
0.699	0.005905
0.807	0.005911
0.909	0.005915
1.01	0.005922
1.10	0.005928
1.20	0.005938

DATA SET 182*

T	ρ
1.02	0.005216
1.17	0.005230
1.29	0.005239
1.38	0.005250
1.49	0.005259
1.59	0.005272
1.68	0.005285
1.78	0.005297
1.89	0.005310
2.00	0.005329
2.08	0.005342
2.20	0.005363
2.29	0.005376
2.40	0.005396
2.50	0.005411
2.60	0.005430
2.70	0.005450
2.79	0.005465
2.90	0.005485
3.00	0.005503
3.10	0.005523
3.20	0.005542
3.30	0.005564
3.40	0.005585
3.51	0.005606
3.60	0.005629
3.70	0.005650
3.79	0.005673
3.89	0.005699
4.11	0.005745

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

DATA SET 183*

T	ρ
1.41	0.012080
1.51	0.012093
1.61	0.012093
1.72	0.012099
1.82	0.012098
1.89	0.012119
2.05	0.012124
2.22	0.012148
2.32	0.012165
2.39	0.012166
2.50	0.012183
2.52	0.012193
2.63	0.012215
2.78	0.012238
2.99	0.012266
3.09	0.012296
3.26	0.012329
3.41	0.012364
3.62	0.012405
3.86	0.012458
4.08	0.012516
4.31	0.012571

DATA SET 184*

T	ρ
4.7	0.01271
5.0	0.01283
5.3	0.01288
5.8	0.01304
6.1	0.01315
6.2	0.01329
6.6	0.01329
7.0	0.01346
7.5	0.01373
8.1	0.01395
8.6	0.01421
9.2	0.01448
9.6	0.01479
10.3	0.01514
11.1	0.01565
11.95	0.01622
12.81	0.01678
13.96	0.01765
15.0	0.01850
15.6	0.01892
16.4	0.01973

DATA SET 184(cont.)*

T	ρ
17.6	0.02097
19.05	0.02248
20.7	0.02454

DATA SET 185*

T	ρ
4.2	0.0566

DATA SET 186

T	ρ
4.2	0.0246

DATA SET 187*

T	ρ
4.2	0.0402

DATA SET 188*

T	ρ
4.2	0.0491

DATA SET 189*

T	ρ
4.2	0.283

DATA SET 190*

T	ρ
4.2	0.134

DATA SET 191*

T	ρ
4.2	0.109

DATA SET 192*

T	ρ
4.2	0.0926

DATA SET 193*

T	ρ
4.2	0.0884

DATA SET 194*

T	ρ
4.2	0.0799

DATA SET 195*

T	ρ
4.2	0.0635

DATA SET 196*

T	ρ
4.2	0.0615

DATA SET 197

T	ρ
4.2	0.0516

DATA SET 198*

T	ρ
4.2	0.0429

DATA SET 199*

T	ρ
4.2	0.0384

DATA SET 200

T	ρ
4.2	0.0358

DATA SET 201*

T	ρ
4.2	0.0336

DATA SET 202*

T	ρ
4.2	0.0296

DATA SET 203

T	ρ
4.2	0.0257

DATA SET 204

T	ρ
4.2	0.0248

DATA SET 205

T	ρ
1007	94.3*
1044	102.8*
1098	107.6*
1182	112.6*
1182	113.6*
1295	116.4*
1421	119.1*
1501	120.4*
1627	122.5*
1677	123.0*

DATA SET 205(cont.)

T	ρ
1677	123.5*
1736	124.3*
1816	125.3
1816	131.3
2001	133.2
2198	134.9
2375	136.6
2505	137.8
2699	139.4
2825	140.3
2964	141.5*
2997	142.0

DATA SET 206

T	ρ
1726	126.7
1748	126.7
1772	127.6
1775	127.6
1797	128.5
1813	135.1
1822	135.2*
1832	135.1*
1838	135.5
1852	135.9
1873	136.1
1884	136.9
1901	136.3*
1915	137.0

DATA SET 207

T	ρ
90	0.907
100	1.218
120	1.907
140	2.654
160	3.452
180	4.299
200	5.172
220	6.070
240	7.000
260	7.964
280	8.966
300	10.002
320	11.102
340	12.255

DATA SET 207(cont.)

T	ρ
360	13.446
380	14.699
400	16.009

DATA SET 208

T	ρ
1828	137.5
1854	138.4
1877	138.4
1894	139.1
1915	139.7
1953	141.9
1980	142.6
2010	143.2*
2033	143.9*
2065	144.5*

DATA SET 209

T	ρ
5.0	0.0416
6.2	0.0419
7.2	0.0420
8.2	0.0423
9.1	0.0423
10.0	0.0429
10.8	0.0425
11.6	0.0429
12.6	0.0433
15.0	0.0449
17.1	0.0458
20.7	0.0482
21.8	0.0499
23.1	0.0507
24.6	0.0520
26.2	0.0544
27.5	0.0561
28.6	0.0579
30.0	0.0603
31.2	0.0632
31.7	0.0650
33.1	0.0679
34.3	0.0708
35.4	0.0746
36.7	0.0788
37.7	0.0834
39.3	0.0893

DATA SET 209(cont.)

T	ρ
40.1	0.0941
41.3	0.0996
42.3	0.1047
43.0	0.1083
43.7	0.1134
44.9	0.1216
45.7	0.1253

DATA SET 210*

T	ρ
4.5	0.027
5.8	0.027
6.7	0.027
8.0	0.028
8.9	0.028
9.6	0.028
10.5	0.028
11.4	0.029
12.3	0.029
14.3	0.030
16.1	0.032
19.7	0.035
20.9	0.036
21.6	0.037
22.9	0.038
24.3	0.039
26.0	0.042
27.2	0.044
28.3	0.046
29.9	0.048
31.2	0.051
31.9	0.053
33.0	0.056
34.2	0.059
35.3	0.063
36.7	0.068
37.8	0.073
39.0	0.079
40.3	0.085
41.6	0.096
42.6	0.096
43.2	0.099
44.0	0.105
44.9	0.114
47.8	0.135
49.4	0.146

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

DATA SET 211*

T	ρ
4.4	0.057
6.6	0.057
8.2	0.057
10.0	0.058
11.1	0.059
12.4	0.058
14.4	0.059
16.3	0.059
18.7	0.060
23.2	0.064
26.6	0.067
29.9	0.071
33.0	0.076
35.7	0.084
38.2	0.090
40.5	0.100
42.8	0.112
46.1	0.130

DATA SET 212

T	ρ
1695	126.4
1713	126.65
1735	127.0
1759	127.35
1786	129.9
1799	134.1
1816	135.65
1833	135.85
1835	135.9*
1854	136.2
1855	136.2*
1864	136.35
1872	136.5*
1880	136.55
1895	136.8

DATA SET 213*

T	ρ
1676	126.9
1699	127.25
1720	127.55
1741	127.9
1760	128.15
1776	129.4
1798	135.5

DATA SET 213(cont.)*

T	ρ
1803	135.9
1817	136.1
1823	136.2
1836	136.4
1842	136.45
1857	136.65
1858	136.75
1874	136.9
1875	137.0
1893	137.2
1900	137.35
1905	137.4
1919	137.6

DATA SET 214*

T	ρ
1673	127.05
1708	127.65
1728	127.95
1748	128.2
1764	128.55
1777	133.45
1802	136.2
1814	136.2
1817	136.4
1822	136.15
1829	136.4
1833	136.45
1841	136.75
1843	136.45
1845	136.65
1850	136.7
1850	136.95
1863	136.95
1864	137.1
1866	136.8
1869	137.05
1876	137.0
1878	137.2
1879	137.35
1889	137.2
1893	137.45
1894	137.55
1896	137.35
1905	137.45
1910	137.75

DATA SET 214(cont.)*

T	ρ
1915	137.6
1915	137.7
1937	138.05

DATA SET 215*

T	ρ
1693	125.8
1773	127.1
1813	132.1
1832	133.7
1874	137.6

DATA SET 216*

T	ρ
1683	121.167
1692	122.332
1703	121.577
1713	122.358
1723	121.986
1732	121.998
1743	123.935
1752	124.332
1762	123.960
1783	126.678
1793	126.306
1808	126.709
1808	134.402
1812	134.792
1823	135.960
1833	134.819
1843	131.369
1849	138.685
1853	131.382
1853	139.075
1858	138.697
1864	133.704
1864	139.088
1869	138.326
1874	139.486

DATA SET 217

T	ρ
373.2	14.62*
393.2	15.88
413.2	17.23*
433.2	18.66
453.2	20.18*
473.2	21.82*
483.2	22.69*
493.2	23.58*
503.2	24.51*
513.2	25.46*
523.2	26.41*
533.2	27.38*
543.2	28.33*
553.2	29.29
563.2	30.22*
573.2	31.18*
583.2	32.16*
593.2	33.16*
603.2	34.18*
613.2	35.22*
623.2	36.28*
633.2	37.37*
643.2	38.46*
653.2	39.56
663.2	40.67*
673.2	41.80*
683.2	42.96*
693.2	44.14*
703.2	45.35*
713.2	46.62*
723.2	47.86*
733.2	49.11*
743.2	50.38*
753.2	51.63
763.2	52.93*
773.2	54.26*
783.2	55.61*
793.2	57.00*
803.2	58.39*
813.2	59.83*
823.2	61.27*
833.2	62.70*
843.2	64.17*
853.2	65.67
863.2	67.20*
873.2	68.76*
883.2	70.35*
893.2	71.99*
903.2	73.64
913.2	75.33*
923.2	77.04*
933.2	78.77*
943.2	80.54*
948.2	81.44*
953.2	82.40
958.2	83.30*
963.2	84.21*
968.2	85.12*
973.2	85.92*
978.2	86.87*
983.2	87.85*
988.2	88.84
993.2	89.56*
995.2	90.07*
998.2	90.60*
1000.2	91.12*
1003.2	91.64*
1005.7	92.17*
1008.2	92.72
1010.7	93.27*
1013.2	93.83*
1015.7	94.38*
1018.2	94.95*
1020.7	95.52*
1023.2	96.11*
1025.7	96.70*
1028.2	97.31*
1030.7	97.93
1033.2	98.57*
1034.45	98.90*
1035.7	99.24
1036.95	99.58*
1038.2	99.92*
1039.45	100.28
1039.7	100.33*
1040.2	100.47*
1040.7	100.62*
1041.2	100.79*
1041.7	100.95*
1043.2	101.39*
1043.7	101.56
1044.2	101.70*
1044.7	101.83*
1045.2	101.95*
1045.7	102.09*
1046.2	102.21*
1046.95	102.33*
1048.2	102.58*
1049.45	102.79*
1050.7	103.00
1053.2	103.40*
1055.7	103.77*
1058.2	104.13*
1063.2	104.98
1068.2	105.63*
1073.2	106.37*
1078.2	106.89
1083.2	107.38*
1088.2	107.85
1093.2	108.31*
1098.2	108.73*
1103.2	109.14
1108.2	109.53*
1113.2	109.93*
1118.2	110.29*
1123.2	110.63*
1128.2	110.96

DATA SET 218*

T	$\rho_T - \rho_0$
9.91	0.68
10.49	0.90
11.13	1.13
11.89	1.17
12.75	1.38
13.20	1.57
13.88	1.84
14.60	2.42
15.32	2.91
16.32	3.18
17.17	3.72
17.99	3.98
18.84	4.66
19.39	4.97
19.88	5.29
20.47	5.69
21.10	6.14

* Not shown on either figure.

TABLE 9. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF IRON Fe (continued)

T	$\rho_T-\rho_0$	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 218(cont.)*		DATA SET 219(cont.)*		DATA SET 221*		DATA SET 222(cont.)*		DATA SET 223(cont.)*	
21.78	6.64	48.7	15.0×10^{-2}	1.72	0.233×10^{-2}	2.20	0.158×10^{-2}	5.41	0.122×10^{-2}
22.46	7.12	52.8	19.2	1.85	0.235	2.40	0.159	7.61	0.190
22.91	7.44	58.8	26.6	2.12	0.237	2.59	0.162	10.4	0.300
23.23	7.80	68.5	37.7	2.24	0.239	2.88	0.168	13.3	0.458
23.45	8.07	73.7	51.5	2.41	0.241	3.13	0.171	14.7	0.545
23.95	8.74	89.8	90.0	2.49	0.241	3.36	0.176	18.2	0.839
24.40	9.06	137	249	2.70	0.243	3.68	0.177	22.2	1.28
24.90	9.64	172	393	2.86	0.248	4.06	0.184	25.0	1.75
25.26	9.87	213	567	3.07	0.248	4.45	0.189	29.1	2.41
25.81	10.32	271	840×10^{-2}	3.30	0.252	5.68	0.223	35.1	4.38
26.26	10.90			3.48	0.257	6.39	0.251	39.5	6.15
26.76	11.58	DATA SET 220*		3.68	0.259	6.93	0.265	43.6	7.88
27.35	12.30			3.92	0.264	8.23	0.309	52.3	16.4
27.89	13.07	1.70	0.645×10^{-2}	4.32	0.271	9.69	0.375	60.4	24.8
		1.88	0.645	4.73	0.276	12.6	0.512	70.4	46.8
		2.02	0.651	5.77	0.300	14.6	0.632	80.6	68.9
T	ρ	2.21	0.657	7.17	0.337	18.6	0.928	84.3	82.7
		2.48	0.656	8.28	0.370	24.5	1.45	92.2	102
		2.77	0.662	9.23	0.401	32.5	2.84	98.2	118
DATA SET 219*		2.97	0.662	10.8	0.469	39.7	5.30	115	168
		3.22	0.668	13.1	0.590	47.5	10.9	124	203
1.73	2.68×10^{-2}	3.40	0.674	14.9	0.696	60.0	21.2	147	291
1.88	2.70	3.66	0.674	16.0	0.770	70.0	33.8	173	413
2.02	2.70	3.83	0.673	21.3	1.20	82.6	60.8	200	529
2.19	2.70	4.23	0.686	24.6	1.55	88.9	77.9	237	709
2.35	2.73	4.79	0.685	27.2	2.00	114	151	276	934
2.64	2.73	5.54	0.710	33.5	3.23	134	214	292	1020×10^{-2}
3.00	2.73	7.13	0.757	37.4	4.80	164	335×10^{-2}		
3.40	2.73	8.85	0.829	47.4	9.92				
3.89	2.70	10.5	0.867	52.4	13.6	DATA SET 223*			
4.18	2.73	14.2	1.06	60.1	22.7				
5.52	2.75	18.9	1.36	73.5	42.0	1.59	0.0631×10^{-2}		
6.38	2.78	20.9	1.54	106	123	1.70	0.0631		
7.43	2.78	33.5	3.79	119	180	1.82	0.0643		
8.35	2.83	49.2	11.8	127	192	1.92	0.0643		
10.0	2.88	54.9	17.3	172	358	2.11	0.0661		
11.0	2.93	67.1	30.0	200	517	2.24	0.0673		
11.9	2.99	79.1	56.5	240	645	2.45	0.0692		
14.2	3.10	99.4	116	268	782×10^{-2}	2.64	0.0718		
16.3	3.24	107	133			2.76	0.0738		
17.5	3.33	138	237	DATA SET 222*		2.91	0.0765		
21.1	3.69	165	345			3.21	0.0801		
27.4	4.85	191	446	1.62	0.154×10^{-2}	3.58	0.0846		
37.5	7.60	258	718	1.75	0.155	3.84	0.0894		
40.3	8.96	301	981×10^{-2}	1.88	0.158	4.17	0.0953		
43.3	11.0×10^{-2}			2.06	0.158×10^{-2}	4.52	0.103×10^{-2}		

* Not shown on either figure.

3.4. Nickel

There are more than 100 data sets available for the electrical resistivity of nickel. The information on specimen characterization and measurement condition for each of the data sets is given in table 11. The data are tabulated in table 12 and shown partially in figures 7 and 8.

Since nickel belongs to the same group in the periodic table as iron and is also ferromagnetic, the electrical resistivity of nickel is expected to resemble that of iron. For example, the solute resistivities of dilute nickel alloys are similar to those of dilute iron alloys in magnitude and in temperature dependence (Schwerer and Cuddy [148]). However, since nickel is not as strongly magnetic as iron (with a spontaneous magnetization of 6.4 kG as compared to 21.8 kG for iron), the magnetic effect on the electrical resistivity is not as strong in nickel as it is in iron. While the minimum in the longitudinal magnetoresistance at 4 K of a pure iron specimen occurs at $\gtrsim$750 Oe ($\sim$60 x 10^3 A m^{-1}) (for example, see Fujii and Morimoto [112]), it occurs at $\sim$250 Oe for pure nickel (Wycisk and Feller-Kniepmeier [209] and Fujii [210]). Furthermore, for iron the resistivity at the minimum can be as low as one third of the value at zero applied magnetic field. For nickel, it was only about 18% lower [209,210].

The electrical resistivity of nickel has not been investigated as widely as that of iron, and there has been apparently lesser effort spent in its purification. In fact, among the data sources reporting the electrical resistivity of nickel, less effort was made to analyze the impurity content of the specimen than those reporting the electrical resistivity of iron. Nonetheless, there are a few data sets which show very good agreement on the residual resistivity of pure nickel: $\sim$0.0033 x 10^{-8} Ωm at 2.32 K from White and Tainsh [210] (data set 31), $\sim$0.0031 x 10^{-8} Ωm at 1.85 K from Ehrlich et al. [212] (data set 73), and 0.0033 x 10^{-8} Ωm from Wycisk and Feller-Kniepmeier [209] (data set 96). The recommended values for the residual resistivity (at 1 K) is based on these data sets. The specimens of the first two sources were described as "high purity" and "pure", respectively. The specimen of the last source was 99.999% pure and was five-time electron beam zone-refined.

The temperature-dependent part of the electrical resistivity has been reported to contain mostly of a T^2 component at low temperatures ($\leq$10 K): see, for example, White and Woods [21] (data sets 33-34), Ehrlich and Rivier [213] (data set 10), Greig and Harrison [214] (data set 4), Fert and Campbell [215] (data set 48), Price and Williams [80] (data set 55), and Sudovtsov and Semenenko [203] (data sets 77,78). An analysis similar to that applied in treating the low-temperature data on the electrical resistivity of iron, i.e., plotting the quantity

$$\rho - \rho_0 - A\left(\frac{T}{\theta_R}\right)^5 \int_0^{\theta_R/T} \frac{x^5 e^x}{(e^x-1)^2}\, dx$$

with values of A and θ_R equal to 39.1 x 10^{-8} Ωm and 456 K, respectively, gives very similar results. It increases as T^2 at temperatures below $\sim$50 K. It then varies much less rapidly with temperature: with some data sets (e.g., data sets 55,57) there is a plateau at $\sim$110 K, and with some (e.g., data sets 3,43) there is a minimum at around the same temperature. At temperatures above 150 K, it increases more rapidly and approaches a T^3 dependence. The coefficient of the T^2 term (for temperatures below about 50 K) varies between $\sim$1.5 x 10^{-5} Ωm K^{-2} (data set 48) and $\sim$3.5 x 10^{-5} Ωm K^{-2} (data set 57), and furthermore there is no discernible correlation between these coefficients and the residual resistivities of the specimens. However, the agreement between data sets with the lowest reported residual resistivities are good. The data set of White and Tainsh [211] (data set 31) yields a coefficient of 2.7 x 10^{-5} Ωm K^{-2} and a residual resistivity of $\sim$0.0033 x 10^{-8} Ωm, that of Ehrlich and Rivier [213] (data set 10) yields 2.4 x 10^{-5} Ωm K^{-2} and 0.0031 x 10^{-8} Ωm, respectively. The data set of Farrell and Greig [216] (data set 11) yields 2.6 x 10^{-5} Ωm K^{-2} and 0.0095 x 10^{-8} Ωm, and that of Ehrlich et al. [212] (data set 73) yields 2.3 x 10^{-5} Ωm K^{-2} and 0.0031 x 10^{-8} Ωm. The recommended values below 60 K are based on the above four data sets, with the values of the coefficient, 2.6 x 10^{-5} Ωm K^{-2} is also the mean of the above four values. It should be mentioned that the plateau or the minimum region in the quantity

$$\rho - \rho_0 - A\left(\frac{T}{\theta_R}\right)^5 \int_0^{\theta_R/T} \frac{x^5 e^x}{(e^x-1)^2}\, dx$$

at around 110 K could not be eliminated by an effort in adjusting the values of A and θ_R. As a consequence, the value of θ_R was taken to be 456 K and the value of A was chosen so that the range of applicability of the T^2 term could be extended to as high a temperature as practicable. As an illustration, the data of Farrell and Greig [216] (data set 11) deviate from the T^2 line by $+0.005 \times 10^{-8}\ \Omega m$ at 50 K; this deviation increases to $-0.02 \times 10^{-8}\ \Omega m$ at 60 K.

In the temperature range from about 60 K to room temperature, a number of authors reported data sets which agree well with each other: White and Woods [21] (data sets 33,34), Farrell and Greig [216] (data set 11), Laubitz et al. [217] (data set 52). In particular, the last two data sets merge very well at 90 K. The recommended values in this temperature range is based on the above four data sets, with more weight given to the last two.

For temperatures from the ice point up to the Curie point, a number of data sets agree to within $\sim\pm 4\%$: Pallister [218] (data set 14), Powell et al. [219] (data sets 17,20), Kierspe et al. [78] (data set 37), Schroeder and Giannuzzi [98] (data set 51), Laubitz et al. [217] (data set 52), Potter [199] (data set 53), Schwerer and Cuddy [148] (data set 65), and Ahmad and Greig [220] (data sets 89,90). Of these, the data of Laubitz et al. and of Potter show particularly good agreement ($\pm 2\%$). The recommended values in this temperature range are based on these results, with more weight given to those of Laubitz et al. [13] (data set 52) and of Potter [199] (data set 53).

The Curie temperature of nickel has been reported to be 631 K by Zumsteg and Parks [221] (data set 91), 631 K by Standley and Reich [222] (data set 2), 630 K by Dutta-Roy and Subrahmanyam [223] (data set 3), $\sim$630 K by Laubitz et al. [13] (data set 52), 632.7 K by Jackson and Saunders [224] (data set 103), and from 629.3 to 629.8 K, depending on specimen, by Potter [199] (data set 53). Judging from the resistivity data of Pallister [218] (data set 14), the Curie temperature is $\sim$627 K, of Kirichenko and Mikryukov [225] (data set 27), $\sim$631 K, of Schwerer and Cuddy [148] (data set 65), $\sim$628 K, of Kaul [226] (data set 67), 620-640 K, of Shirakawa [141] (data set 76), $\sim$633 K, and of Schroeder and Giannuzzi [98] (data set 51), $\sim$638 K. Among these sources, only two, Potter [199] (data set 53) and Zumsteg and Parks [221] (data set 91), give in detail the change of electrical resistivity at around the Curie temperature. The agreement between these are very good: $\pm 0.5\%$ below and $\pm 1\%$ above the Curie temperature. The recommended values in the vicinity (± 25 K) of the Curie temperature are based on this reference, with more weight given to the result of Zumsteg and Parks at temperatures above the transition. The resultant values are within 0.3% of those calculated on the basis of the $d\rho/dT$ values reported by Jackson and Saunders [224].

At temperatures from the Curie point to about 1300 K, the following data sets fall into a band of width ∿2 x 10^{-8} Ωm: Pallister [218] (data set 14), Bode [227] (data set 16), Powell et al. [219] (data set 20), Davis et al. [228] (data set 32), Laubitz et al. [217] (data set 52), and Potter [199] (data set 53). The recommended values in this temperature range are based on these data sets, with more weight given to the data of Laubitz et al. [217] (data set 52). Data set 52 is also used as basis for recommendation for lower temperatures.

Unfortunately, most of the data sets mentioned in the previous paragraph are for temperatures below 1300 K. For higher temperatures, the available data sets show large discrepancies. In addition, the resistivity values for lower temperature given in these sets are quite different from the recommended values (for example, data sets 37,72). However, for temperatures slightly below the melting point, the data of Güntherodt et al. [92] (data set 93) and of Kita et al. [93] (data sets 100-101) are within ∿0.5 x 10^{-8} Ωm of each other. Extrapolations, either graphically or numerically using a cubic expression, from recommended values for lower temperatures give values that are also within 0.5 x 10^{-8} Ωm of the values reported by these authors. The recommended values are, therefore, obtained from the numerical extrapolation.

At temperatures immediately above the melting point, the available data sets show a spread of about 6 x 10^{-8} Ωm. Between the data of Güntherodt et al. [92] (data set 93) and of Kita et al. [93] (data sets 100-102), which well agree below the melting point, the difference is about 4 x 10^{-8} Ωm. The recommended value for the liquid phase at the melting point is based on the results of Güntherodt et al. [92] (data set 93), Seydel and Fucke [87] (data set 92), and Mokrovskii and Regel [158] (data set 56), which agree to within 0.2 x 10^{-8} Ωm. The temperature dependence of the electrical resistivity in the molten state has been generally reported to be linear, e.g., Kita et al. [93] (data sets 100,101), Güntherodt et al. [92] (data set 93), Seydel and Fucke [87] (data set 92), Samarin [94] (data set 87), Mokrovskii and Regel [158] (data set 56), Eliutin et al. [88] (data set 49), and Ono and Yagi [89] (data set 61). The recommended values are generated with a temperature coefficient of 0.011 x 10^{-8} Ωm K^{-1}, which is slightly (6%) lower than that given by Kita et al. [93], and slightly higher (∿1%) than that determined from the data of Güntherodt et al. [92] (data set 93).

The recommended values for the solid state both uncorrected and corrected for thermal expansion of the material and those for the liquid state corrected for thermal expansion are presented in table 10, and the values except those corrected for thermal expansion of the solid are also shown in figures 7 and 8 along with the experimental data. These values at temperatures above 100 K are for nickel of purity 99.99% or higher, while those below 100 K are applicable only to highly purified zone-refined nickel having a residual resistivity of $0.00320 \times 10^{-8}\ \Omega\,m$. The estimated uncertainty in the recommended values is ±5% below 150 K, ±3% from 150 to 1300 K, ±5% from 1300 K to the melting point, and ±10% for the liquid state.

For slightly less pure nickel having different residual resistivity, its electrical resistivity values can be calculated from the recommended values using the Matthiessen's rule, which will not introduce serious errors. For example, the data of Ahmad and Greig [220] (data set 90) show that for a specimen with a residual resistivity less than $0.009 \times 10^{-8}\ \Omega\,m$, the application of Matthiessen's rule causes an error of about 2% at 40 K and about 1% at 260 K. Also the data of Greig and Harrison [214] (data set 4), Ahmad and Greig [220] (data set 89), Berger and Rivier [229] (data set 23), White and Woods [21] (data sets 33,34), and of Kemp et al. [130] (data set 43), which are for specimens with residual resistivities of the order of a few tenths of a $n\Omega\,m$, show that the application of Matthiessen's rule causes errors generally of about 3% for temperatures below 300 K. The most interesting comparison is made with the data of Rowlands [230] (data set 57), since his data extend from liquid-helium temperatures up to above the Curie temperature. For this data set, the errors are less than 1% below 20 K, 10% at ∿60 K, ∿6% from ∿100 to ∿300 K, and drop to ∿3% from ∿500 K to above the Curie temperature. This behavior is consistent with the solute resistivities for dilute nickel alloys (see, for example, Schwerer and Cuddy [148]). Thus, when the Matthiessen's rule is used for calculating the electrical resistivity of less-pure nickel with a residual resistivity less than $0.05 \times 10^{-8}\ \Omega\,m$, the values are likely to be lower by ∿3% than the true values from 40 K to room temperature, and are likely to lower by <1% at temperatures below 40 K and above the Curie temperature. For specimens of even lower purity, with a residual resistivity of about $0.3 \times 10^{-8}\ \Omega\,m$, the probable errors are about 2% at high and at low temperatures, but may be as high as -10% at intermediate temperatures (40-300 K).

The recommended values for the solid state uncorrected for thermal expansion and those for the liquid state given in table 10 can be represented approximately by the following expressions to within ±0.5%.

1-60 K:

$$\rho = 0.0032 + 2.5 \times 10^{-5}T^2 + 39.1\left(\frac{T}{456}\right)^5 \int_0^{456/T} \frac{x^5 e^x}{(e^x-1)^2}\,dx \qquad (35)$$

60-150 K:

$$\rho = 0.4214558798 - 2.07384562 \times 10^{-2}T + 3.48017305 \times 10^{-4}T^2 - 8.609303313 \times 10^{-7}T^3 \qquad (36)$$

150-500 K:

$$\rho = -1.355285714 + 2.103190475 \times 10^{-2}T + 1.141428571 \times 10^{-5}T^2 + 4.523809524 \times 10^{-6}T^3 \qquad (37)$$

500-600 K:

$$\rho = -50.1320558 + 2.978166536 \times 10^{-1}T - 5.156360117 \times 10^{-4}T^2 + 3.824418489 \times 10^{-7}T^3 \qquad (38)$$

600-630 K:

$$\rho = 28.71 - 1.2315000 \times 10^{-1}(T_C-T) + 5.749999984 \times 10^{-4}(T_C-T)^2 \qquad (39)$$

631-670 K:

$$\rho = 28.71 + 9.060833333 \times 10^{-2}(T-T_C) - 1.809583333 \times 10^{-3}(T-T_C)^2 + 3.941666667 \times 10^{-5}(T-T_C)^2 - 3.541666667 \times 10^{-7}(T-T_C)^4 \qquad (40)$$

670-1400 K:

$$\rho = -6.329325957 + 8.023011038 \times 10^{-2}T - 4.451156858 \times 10^{-5}T^2 + 1.201757591 \times 10^{-8}T^3 \qquad (41)$$

1400-1728 K:

$$\rho = -9.255955877 + 7.140577598 \times 10^{-2}T - 2.771379283 \times 10^{-5}T^2 + 5.589224949 \times 10^{-9}T^3 \qquad (42)$$

1728-3000 K:

$$\rho = 63.22 + 1.10 \times 10^{-2}T \qquad (43)$$

It should be emphasized that these expressions do not necessarily suggest any theoretical justification, and should be treated, most appropriately, as numerical aids only. It should also be understood that giving these expressions does not imply a recommendation for the temperature derivative of the electrical resistivity.

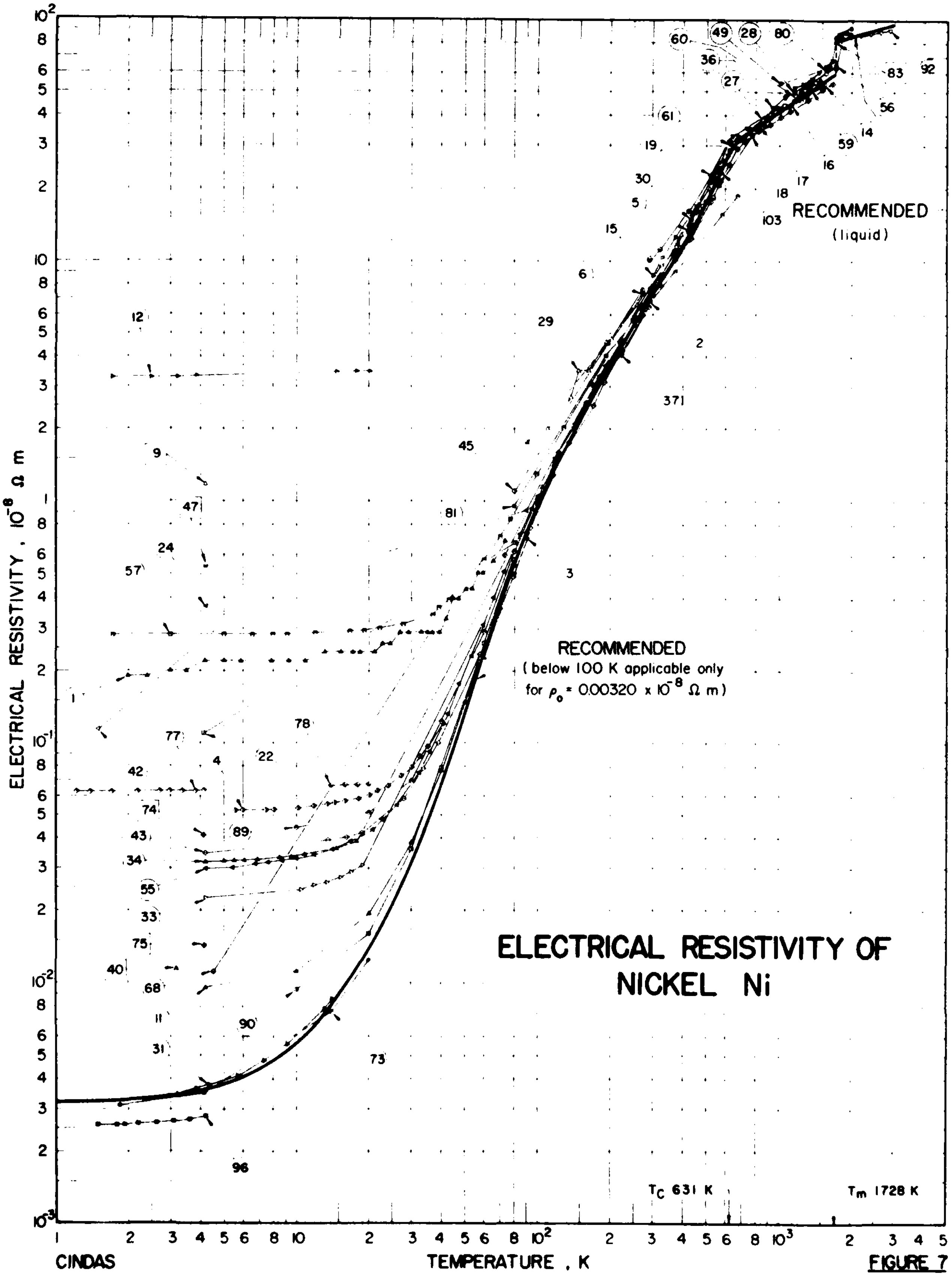
TABLE 10. RECOMMENDED VALUES FOR THE ELECTRICAL RESISTIVITY OF NICKEL[a]

[Temperature, T, K; Electrical Resistivity, ρ, $10^{-8}\,\Omega\,m$]

T	ρ		T	ρ	
	uncorrected	corrected		uncorrected	corrected
1	0.00320	0.00320	630	28.71	28.86
4	0.00360	0.00359	670	31.06	31.24
7	0.00443	0.00442	700	32.14	32.34
10	0.00573	0.00572	800	35.52	35.80
15	0.00901	0.00899	900	38.58	38.95
20	0.0140	0.00140	1000	41.41	41.88
25	0.0212	0.0212	1100	44.06	44.65
30	0.0317	0.0316	1200	46.62	47.33
40	0.0678	0.0676	1300	49.15	50.00
50	0.135	0.134	1400	51.73	52.73
60	0.242	0.242	1500	54.36	55.54
70	0.377	0.376	1600	56.94	58.31
80	0.545	0.544	1700	59.50	61.07
90	0.741	0.739	1728	60.22(s)	61.85(s)
100	0.959	0.957	1728		82.23[b](ℓ)
150	2.21	2.20	1800		83.02[b]
200	3.67	3.67	1900		84.12[b]
250	5.32	5.32	2000		85.22[b]
273	6.16	6.16	2500		87.72[b]
293	6.93	6.93	3000		90.22[b]
300	7.20	7.20			
350	9.34	9.35			
400	11.78	11.80			
500	17.67	17.72			
600	25.54	25.66			

[a] The values are for nickel of purity 99.99% or higher, but those below 100 K are applicable only to nickel having a residual resistivity of $0.00320 \times 10^{-8}\,\Omega\,m$. The columns headed uncorrected and corrected refer to values uncorrected and corrected for thermal expansion, respectively. Solid line separating tabular values indicates solid to liquid state transformation.

[b] Provisional value.


ELECTRICAL RESISTIVITY OF NICKEL Ni
RECOMMENDED (liquid)
RECOMMENDED
(below 100 K applicable only for ρ_0 = 0.00320 x 10^{-8} Ω m)
ELECTRICAL RESISTIVITY, 10^{-8} Ω m
TEMPERATURE, K
T_C 631 K
T_m 1728 K
CINDAS
FIGURE 7

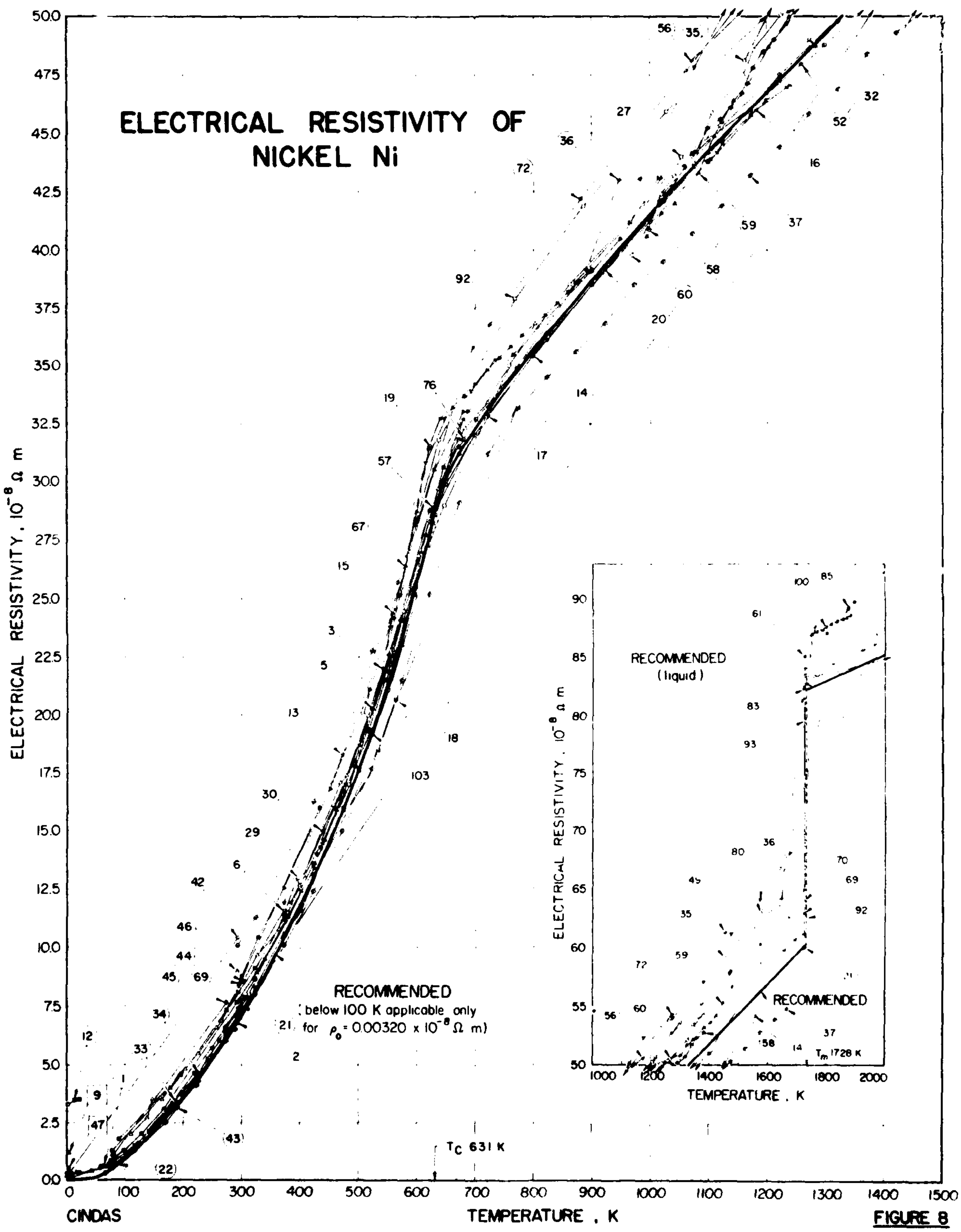

ELECTRICAL RESISTIVITY OF NICKEL Ni
ELECTRICAL RESISTIVITY, 10⁻⁸ Ω m
TEMPERATURE, K
RECOMMENDED
(below 100 K applicable only for ρ₀ = 0.00320 x 10⁻⁸ Ω m)
Tc 631 K
RECOMMENDED (liquid)
RECOMMENDED
Tm 1728 K
CINDAS

FIGURE 8

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
1	129	Kondorskii, E.I., Galkina, O.S., and Chernikova, L.A.	1958	A	2-73	Ni	Chemically pure; wire specimen 0.1 to 0.2 mm in diam and 150 to 160 mm long; annealed in vacuum at 1173 K for 1 h; slowly cooled at 100 K/h; residual resistivity 0.20×10^{-8} Ω m.
2	222	Standley, K.J. and Reich, K.H.	1955		293,473	Ni	Ingot heated in argon to about 1273 K for 12 h; slowly cooled; rolled to a sheet about 0.5 mm thick; discs of the required diameter punched out; polished on fine emery, annealed in vacuo and electrolytically polished, then annealed in vacuum; T_C = 631 K.
3	223	Dutta-Roy, S.K. and Subrahmanyam, A.V.	1969	V	80-735		"Spectrographically pure," from Johnson Matthey Co.; 6 x 0.3 x 30 mm; annealed for 24 h at 1073 K in a vacuum furnace; cleaned in aqua regia; T_C = 630 K.
4	214	Greig, D. and Harrison, J.P.	1965	G	5.6-41	JM 893; A	Pure; 0.0016 total impurity (mostly Fe and Si); polycrystalline; grain size ~0.1 mm; from Johnson Matthey Co. (JM 893); annealed at 1023 K for 12 h; resistivity values calculated from reported ideal resistivity and ρ_0/L_0 ratio ($2.11 \pm 0.01\ W^{-1} cm^2/K^{-2}$).
5	231	Svensson, B.	1936	B	323-623		0.102 Fe, 0.036 Al and Si each; from Hilger of London; 1 mm in diam and 1 cm long; annealed at 1173 K; resistivity values calculated from measured resistance ratios and a ρ(273 K) value of 6.58×10^{-8} Ω m from Landolt-Börnstein: Physik-Chem. Tabellen 5 Auft. 5, 1050 (1923).
6	161	Broom, T.	1952	B	90-373		0.12 Mg, <0.05 Cr, Cu and Mn each, 0.03 C, and 0.01 Co; wire specimen 0.056 cm in diam; annealed at 873 K for 2 h, furnace cooled.
7*	232	Lavine, J.M.	1961	A	73-633	499 alloy	99.9 pure; from Driver Harris Co.; T_C = 631 K.
8*	176	Kondorskii, E.I. and Sedov, V.L.	1960	A	4.2		Electrolytically pure; 5.9 mm in diam and 112 mm long.
9	176	Kondorskii, E.I. and Sedov, V.L.	1960	A	4.2		Technically pure; cylindrical specimen 5.9 mm in diam and 112 mm long; vacuum annealed at 1273 K for 8 h; furnace cooled.
10*	213	Ehrlich, A.C. and Rivier, D.	1968		1.6-19		"High purity"; polycrystalline plate, electropolished to a thickness of 0.19 mm; ρ(293 K)/ρ(4.15 K) = 2200; only ρ(T) - ρ(0) reported where ρ(0) is the resistivity extrapolated to 0 K from data in the 1.75 to 4.15 K range, in which the resistivity is reported to be proportional to T^2.
11	216	Farrell, T. and Greig, D.	1968	A	4.2-273		Pure; 3 mm in diam and 9 cm long; annealed for 15 h at 1123 K; resistivity values calculated from reported ρ(0) and tabular values of ρ(T).
12	233	Kondorskii, E.I., Galkina, O.S., and Chernikova, L.A.	1957	A	1.7-20	Ni	99.9 pure; wire specimen 0.1 to 0.2 mm in diam; supplied by Central Scientific Research Institute of Ferrous Metallurgy; cold drawn; annealed in neutral gas at 1173 K for 1 to 12 h; residual resistivity 1.54×10^{-8} Ω m.

* Not shown in figure.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
13	234	Kurbanniyazov, N., Cheremushkina, A.V., and Akmuradov, B.A.	1973	A	373-773		Pure; specimen of dimensions 3 x 6 x 100 mm; homogenize annealed in vacuum at 1273 K for 24 h, slow cooled in furnace; values from graph.
14	218	Pallister, P.R.	1965	A	273-1550	E	99.84 Ni, <0.03 Fe, <0.01 Al, Co, Cr, Cu, Mg, Mn, Mo, Si, Sn, Ti, Zn, and Zr each, <0.005 Pb and <0.002 B; supplied by International Nickel Co. (Mond) Ltd.; annealed; measurements made in vacuum; smooth values from table; reported electrical resistivities based upon room temperature dimensions.
15	235	Sager, G.F.	1930	B	327-1016		Pure; wire specimen about 0.2 cm in diam and 35 cm long; electrolyzed from Mond anodes; vacuum melted under a pressure of 0.3 mmHg, chill cast, forged, hot rolled and cold drawn through a steel die plate; flash annealed, held at 1023 K for "considerable periods" and "later more thoroughly annealed"; current and potential leads of nickel silver soldered to specimen; density 8.74 g cm^{-3}.
16	227	Bode, K.H.	1961	+	1098-1241		99.95 pure; wire specimen 1 mm in diam; vacuum melted, cast, polished, annealed for 12 h at about 1273 K; measured by compensation method.
17	219	Powell, R.W., Tye, R.P., and Hickman, M.J.	1965	A	293-1123	Sample 1	<0.03 Fe, <0.01 Al, Cr, Co, Cu, Mg, Mn, Mo, Si, Sn, Ti, Zn, and Zr each, <0.005 Pb, and <0.002 B; spectroanalyzed by International Nickel Co.; tubular specimen of 1.272 cm I.D., 1.908 cm O.D. and 20 cm long; supplied by the Castner Kellner Alkali Co.; density 8.61 g cm^{-3}.
18	219	Powell, R.W., et al.	1965	A	373-773	Sample 2	"Very high purity"; electrolytic; tubular specimen of 0.634 cm I.D., 2.801 cm O.D., and 19 cm long; supplied by National Engineering Lab.; density 8.90 g cm^{-3}.
19	219	Powell, R.W., et al.	1965	A	293-623	Sample 4	Commercial Ni; rod specimen 2.54 cm in diam and about 20 cm long; supplied by Explosives Research and Development Establishment.
20	219	Powell, R.W., et al.	1965	A	293-1323	Sample 5 JM Lab. No. 4497	"High spectrographic purity"; trace amounts of Al, Ca, Cu, Li, Mg, Si, Ag, and Na; rod 0.5 cm in diam and 15 cm long; supplied by Johnson, Matthey and Co.; density 8.91 g cm^{-3}.
21	236	Martynyuk, M.M. and Tsapkov, V.I.	1973	+	298,1726		99.93 pure; specimen 0.3-1 mm in diam and 50 cm long; specimen heated in air by a 400 μsec pulse of 1-4 kAmp; voltage and current measured by double beam pulse oscilloscope; resistivity at melting point determined from break points corresponding to the onset and end of fusion on the relative resistance curve; data not corrected at higher temperature.
22	229	Berger, L. and Rivier, D.	1962	B	4.2-292	Ni 5011 (I)	Specimen 0.15 cm in diam and 5.2 cm long; supplied by Johnson, Matthey and Co.; annealed for 4 h at 1273 K in a vacuum of 10^{-5} mmHg; furnace-cooled at a rate of 150 K/h; $\rho(273\ K)/\rho(4.2\ K) = 60$.
23*	229	Berger, L. and Rivier, D.	1962	B	4.2-273	Ni 5011 (II)	Specimen 0.19 cm in diam and 5.0 cm long; from the same stock as the above specimen; annealed for 10 h at 1573 K in hydrogen at 1573 K in a vacuum of 10^{-2} mmHg for 2 h; $\rho(273\ K)/\rho(4.2\ K) = 298$.

* *Not shown in figure.*

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF *NICKEL* *Ni* (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
24	237	Kronmueller, H. and Buck, O.	1964	A	4-273		99.99 pure; from Johnson, Matthey and Co.; single crystal with one axis parallel to <111>; specimen 3.2 mm in diam and 120 mm long.
25*	238	Neimark, B.E. and Bykova, T.I.	1965		293-773	No. 1	99.87 (Ni + Co); tube 8.51 mm O.D. and 8.025 mm I.D.; smoothed values from table.
26*	238	Neimark, B.E. and Bykova, T.I.	1965		373-748	No. 2	Tube 12.96 mm O.D. and 11.025 mm I.D.; smoothed values from table.
27	225	Kirichenko, P.I. and Mikryukov, V E.	1964		313-1172		99.999$^+$ pure; 0.3 cm in diam and 30 cm long; forged from sheet; annealed in vacuum for 48 h at 1173 K; furnace cooled.
28	239	Jain, S.C., Goel, T.C., and Chandra, I.	1967	+	1152-1320		99.95 pure; filaments 0.05 cm thick, 1 cm wide, and 14 cm long; obtained from Johnson, Matthey and Co.; data from figure; experimental method same as Jain and Krishnan, Proc. R. Soc. London, A225, 7, 1954.
29	240	Watson, T.W. and Robinson, H.E.	1964	V	110-803		99.85 Ni, 0.11 Co, 0.026 Cu, 0.006 Fe, 0.001 Al, <0.004 Si, <0.002 Ti, <0.001 Cr and Mg each, and <0.0005 Mn; electroformed nickel from International Nickel Co.; 2.54 cm in diam and 37 cm long; smoothed values from table.
30	240	Watson, T.W. and Robinson, H.E.	1964	V	384-680		The above specimen measured with decreasing temperature.
31	211	White, G.K. and Tainsh, R.J.	1967		2.3-14		"High purity"; speicmen 0.1 cm x 0.1 cm x 7 cm; prepared by Bell Telephone Laboratories; annealed in vacuum of 10^{-7} Torr at 773 K; $\rho(273\ K)/\rho(4\ K) = 2500$.
32	228	Davis, M., Densem, C.E., and Rendall, J.H.	1955		293-1273		0.01-0.2 O, 0.07 C, 0.016 Si, 0.013 Fe, 0.003 S, 0.0005 Mn, and 0.0003 Mg; grade A carbonyl nickel powder; supplied by Mond Nickel Co.; sintered and annealed; density 8.9 g cm^{-3}; Curie point 626 K.
33	21	White, G.K. and Woods, S.B.	1959	G	4.2-298	Ni 2	99.997 pure, 0.0010 Fe, 0.0010 Si, 0.0003 Cr and Mg each, 0.0002 Ca, Cu, and Mn each, and 0.0001 Ag, from Johnson, Matthey and Co. (JM 10389); rod specimen 2 mm in diam and 6 to 8 cm long; vacuum annealed at 1073 K; resistivity values calculated from reported ρ_i, $\rho(4.2\ K)/\rho(295\ K) = 3.23 \times 10^{-3}$ and $\rho_i(295\ K) = 7.04 \times 10^{-8}\ \Omega\ m$.
34	21	White, G.K. and Woods, S.B.	1959	G	4.2-252	Ni 3	Similar to the above specimen except (1) specimen 0.63 mm in diam, (2) resistivity ratio $\rho(4.2\ K)/\rho(295\ K) = 4.51 \times 10^{-3}$, (3) $\rho_i(295\ K) = 7.33 \times 10^{-8}\ \Omega\ m$; because of slight uncertainty in ℓ/A, ρ_i was normalized to the value for the above specimen for which ℓ and A are more accurately known.
35	241	Reddy, B.K. and Goel, T.C.	1975	V	1163-1641		99.95 pure; tubular specimen 0.75 cm I.D., 0.3 mm wall thickness, and 18 cm long; obtained from Johnson, Matthey and Co.; specimen heated for about 1 h at ~1630 K and cooled to room temperature repeatedly for 6 or 7 times.

* Not shown in figure.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
36	97	Kovenskii, I.I. and Samsonov, G.V.	1963	+	891-1673		99.86 Ni, 0.10 C, 0.01 Co, 0.008 Cu, 0.004 Fe, and 0.002 Si and S each; wire specimen; measured in argon atmosphere, specimen heated by passing an electric current through; smoothed values from figure.
37	78	Kierspe, W., Kohlhaas, R., and Gonska, H.	1967	B	73-1668		<0.0003 Si, 0.0002 Fe and Mg each, <0.0001 Al, Cu and Ag each; obtained from Koch-Light Laboratories Ltd.; smoothed values from figure.
38*	242	Birss, R.R. and Dey, S.K.	1961		78-1306		Smoothed values from graph of ρ vs. T/θ, with θ apparently equal to 370 K.
39*	243	Franklin Institute, Laboratories for Research and Development	1953		73-830		*No details reported.*
40	244	Coltman, R.R., Klabunde, C.E., and Redman, J.K.	1967		3.2		99.99^+ nominal purity; 0.025 cm in diam and 5 cm long; annealed at 1223 K in air at a pressure of 8×10^{-6} Torr; furnace-cooled.
41*	179	Niccolai, G.	1908	B	84-673		Wire specimen 0.5 mm in diam and 8 m long wound on an insulating spool.
42	245	Sharma, J.K.N.	1967	D	1.5,293		99.995 pure; polycrystalline; wire specimen obtained from Johnson, Matthey and Co.; ℓ/A ratio 2.88×10^3 cm^{-1}.
43	130	Kemp, W.R.G., Klemens, P.G., and White, G.K.	1956	G	4.2-293		99.99^+ pure, traces of Al, Ca, Cu, Si and Ag, and very faint traces of Li, Mg, and Na; 2 mm in diam; obtained from Johnson, Matthey and Co.; annealed in vacuum at 1023 K for 4 h; ideal electrical resistivity, ρ_i, from figure; ρ_0 taken as 0.0347×10^{-8} Ω m, $\rho = \rho_i + \rho_0$.
44	246	Masumoto, H.	1927		303		0.10 Fe, 0.037 C, 0.019 S, 0.013 Cu, 0.006 Si, and traces of Al, Co, Mn, and P; 5 mm in diam and 20 cm long; obtained from Mond & Co.; cast and machined; annealed at 1073 K for 40 min.
45	163	Eucken, A. and Dittrich, K.	1927	V	80,273		Electrolytic.
46	247	Rubanenko, I.R. and Grossman, M.I.	1969		293		7 x 7 x 28 mm; measuring temperature assumed 293 K.
47	248	Mitchell, M.A., Klemens, P.G., and Reynolds, C.A.	1971	A	4.2		99.9 pure; single crystal, grown by a variation of the Bridgman method; specimen axis along <111> direction; annealed in vacuum at 1203 K for 48 h.
48*	215	Fert, A. and Campbell, I.A.	1968		4-79		Ideal resistivity reported only.

* Not shown in figure.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
49	88	Eliutin, V.P., Turov, V.D., and Maurakh, M.A.	1965	R	1013-1997		98.5-99.0 pure; electrolytic; liquid state obtained by melting in graphite crucible either in an atmosphere of helium or in vacuum.
50*	249	Starr, C.D.	1969		811	Nickel 270	100 nominal purity; temperature coefficient of resistivity $\alpha(298,378)$ = 0.00565 and $\alpha(218,298)$ = 0.00461/deg; data from table at 811 K only.
51*	98	Schroeder, K. and Giannuzzi, A.J.	1969		375-825		99.999 pure; wire specimen; annealed in an inert gas atmosphere (92 He, 8 Ar) for 2 h at ~150 K above the Curie temperature; resistivity values calculated from reported $\rho(T)/\rho(T_C)$, with $\rho(T_C) = 29.288 \times 10^{-8}\ \Omega$ m, taken from data set 52.
52	217	Laubitz, M.J., Matsumura, T., and Kelly, P.J.	1976	A	90-1250		99.999 pure (nominal); 0.0016 C, 0.0014 Si, 0.0007 Fe, 0.0006 Cu, 0.0005 Al and O_2, 0.0003 F, 0.0002 K, Na, and S each, 0.0001 Ta, 0.00007 Cl, 0.00005 Ca, 0.00003 Ti and N_2 each, 0.00002 Cr and Mn each, 0.00001 Pb, Mg and Ag each, 0.000004 V and 0.000002 B by mass spectrographic analysis; from Metals Research Ltd.; polycrystalline; specimen 2 cm in diam and 20 cm long; annealed in vacuum of 5×10^{-6} Torr at 1400 K for 2 h; slow cooled for measurements between 300 and 1250 K; machined to 1 cm in diam and 10 cm long, unannealed for measurements between 90 and 370 K; density 8.908 ± 0.001 g cm^{-3} at 293 K; T_C about 630 K; residual resistivity ratio 220 ± 10; smoothed values from table.
53*	199	Potter, H.H.	1937	V	77-1153		99.971 pure; 0.018 Fe and 0.010 C; obtained from Adam Hilger; specimen 2 mm in diam and 8 cm long, bent into U shape; resistance ratio R/R_{273K} reported; reference value of $\rho(273\ K) = 6.16 \times 10^{-8}\ \Omega$ m assumed; T_C reported to be 629.3 or 629.8 K, depending on specimen.
54*	250	Araj, S.	1961	V	0-1000		Pure; 0.01 Fe and Cu each, and traces of C, Co, S, and Si; wire specimen 1.5 mm in diam; enclosed in silica tubes evacuated to 10^{-5} mmHg; annealed for 68 h at 1400 K; quenched in saline solution at room temperature; original data reported graphically; extracted from the reported smooth curve.
55	80	Price, D.C. and Williams, G.	1973	A	4-300		99.998 pure; specimen 0.15 x 0.2 x 10 cm; supplied by Johnson, Matthey and Co.; cold rolled between Melinex sheets, etched and annealed for 24 h in vacuo at 873 K; ideal resistivity reported graphically; total resistivity obtained by adding the reported residual resistivity $\rho(4.2\ K) = 0.0299 \times 10^{-8}\ \Omega$ m to the reported ideal resistivity.
56	158	Mokrovskii, N.P. and Regel, A.R.	1953	R	1073-1964		99.7 pure; specimen contained in corundum crucible ~12 mm in diam and 25 mm high; smoothed values from graph.
57	230	Rowlands, J.A.	1973	A	1.7-672		Pure; from Sherritt Gordon Mines, annealed; $\rho_0 = 0.28195 \times 10^{-8}\ \Omega$ m; data in tabular form supplied by author.

* Not shown in figure.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
58	251	Wong, H.Y.	1966	→	998-1381		99.92 pure; wire specimen 0.081 cm in diam and 61 cm long; supplied by British Driver-Harris Co. Ltd.; electrically heated in air at 1173 K for 5 min, oxide formed had olive-gree color; measured in vacuum of about 2×10^{-6} Torr; data extracted from figure.
59	251	Wong, H.Y.	1966	→	993-1479		Similar to the above specimen except electrically heated in air at 1173 K for 15 min.
60	251	Wong, H.Y.	1966	→	970-1408		Similar to the above specimen except electrically heated in air at 1173 K for 25 min.
61	89	Ono, Y. and Yagi, T.	1972	R	1728-1898		99.9^+ pure; in liquid state; contained in a 10 mm I.D. recrystallized alumina crucible; density data of Saito et al. (Bull. Res. Inst. Min. Dress. Metall., Tohoku Univ., 25, 67, 109, 1969) used to calculate specimen volume; data given as the formula $\rho(10^{-8}\,\Omega\,m) = 0.0280\,T(C) + 44.32$.
62*	252	Schindler, A.I., Smith, R.J., and Salkovitz, E.I.	1956	B	6-292		99.99 pure; material obtained from International Nickel Co.; specimen 2.0 mm in diam and 16.3 cm long; fabricated from spectrographic rod; vacuum annealed at 1073 K for 2 h then gradually cooled for 24 h.
63*	138	Dewar, J. and Fleming, J.A.	1893	B	76-469		Pure; prepared by Mr. Mond, nickel tubes formed by passing vapor of nickel carbonyl through heated glass tube, portion of nickel tube cut into a very fine spiral on lathe; resistance ratio reported; data uncorrected for thermal expansion; data extracted from table; $\rho(273\text{ K}) = 12.323 \times 10^{-8}\,\Omega\,m$, Matthiesen's value as given in Everett's "Physical Units" used to convert resistance ratio to resistivity; temperatures at 76.1, 191.3, and 229.6 K measured by platinum resistance thermometer.
64*	253	Dewar, J. and Fleming, J.A.	1892	B	91-368		Pure, carbonyl nickel; wire specimen had probable dimensions of 0.0076 cm in diam and 50 to 100 cm long; from Johnson, Matthey and Co.; measurement of resistance repeated several times, mean observed resistivity reported; data uncorrected for thermal expansion; data extracted from table.
65*	148	Schwerer, F.C. and Cuddy, L.J.	1970	V	4-940		"High purity"; rod specimen 1.8 mm in diam; $\rho(4.2\text{ K}) = 0.024 \times 10^{-8}\,\Omega\,m$; measurement made "quasi-statically" with temperature decreasing at 1 C min^{-1}.
66	254	Kalinovich, D.F., Kovenskii, I.I., Smolin, M.D., and Statsenko, V.M.	1972		657-1291		Pure; original data reported graphically.
67	226	Kaul, S.N.	1974	G	84-900		Values from table supplied by author.

* Not shown in figure.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
68	103	Norak, J.A. and Blewitt, T.H.	1972	A	4.5,295		Polycrystalline; wire 0.025 cm in diam and 5 cm long; data from table.
69	255	Borodovskaia, L.N. and Lebedev, S.V.	1955	→	293,1726		Wire specimen 0.015 cm in diam; measured by pulse heating of the wire with current density 6×10^4 to 5×10^6 Amp cm^{-2}; voltage and current measured by pulse oscillogram.
70	255	Borodovskaia, L.N. and Lebedev, S.V.	1955	→	293,1726		Similar to the above except measured by heating the wire slowly in vacuum.
71	256	Köster, W. and Gmöhling, W.	1951	→	293		99.9 pure; Mond Nickel; vacuum melted in a high frequency oven; outgassed; measured by compensation method.
72	257	Vedernikov, M.V. and Kolomoets, N.Y.	1961	A	295-1473	N-00	99.8 pure; electrolytic.
73	212	Ehrlich, A.C., Huguenin, R., and Rivier, D.	1967		1.9-20	Ni III	"Pure", polycrystal in the form of flat plates; from Johnson, Matthey and Co.; annealed at 1273 K; cooled at a rate of 3 K min^{-1}; resistivity value calculated from reported ρ(293 K)/ρ(T) ratio; ρ(293 K) = 6.93×10^{-8} Ω m.
74	212	Ehrlich, A.C., et al.	1967		4.2	Ni I	Similar to the above specimen except annealed at 1473 K and coded at a rate of 5 K min^{-1}.
75	212	Ehrlich, A.C., et al.	1967		4.2	Ni I	A different specimen cut from the same stock as the above; annealed at 1273 K and cooled at a rate of 5 K min^{-1}.
76	141	Shirakawa, Y.	1939	V	78-1123		0.02 Fe, 0.01 C, 0.003 S, 0.002 Si, and 0.001 P and Mn each; electrolytic nickel from Monson and Co.; 0.0608 cm in diam and 3.95 cm long; annealed at 1273 K for 1 h in vacuum, with specimen in the east-west direction; slowly cooled; lead wire of nickel soldered by pure silver; reannealed at 1123 K for 1 h in vacuum; slow cooled; measurement done with specimen in the east-west direction.
77	203	Sudovtsov, A.I. and Semenenko, E.E.	1956	A	1.2-4		Polycrystalline specimen in the form of this ribbon; from Hilger; R(4.2 K)/R(273 K) reported to be 1.0148×10^{-2}; resistivity value calculated from reported resistance ratio, with resistivity at 273 K taken to be 6.16×10^{-8} Ω m.
78	203	Sudovtsov, A.I. and Semenenko, E.E.	1962	A	14-20		The above specimen measured at hydrogen temperatures; specimen described at 99.94 pure; sealed in glass tube with helium gas; values calculated from reported R(T)/R(273 K) = $1.00986 \times 10^{-2} + 2.88 \times 10^{-6}T^2 + 4.85 \times 10^{-11}T^5$; with ρ(273 K) taken to be 6.16×10^{-8} Ω m.
79*	258	Panakhov, T.M., Peninov, R.I., Muradov, T.I., and Ibragimov, A.I.	1974		339-1042		99.99 pure; electrolytic; measured in a vacuum of $\sim 10^{-4}$ mmHg.

* Not shown in figure.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
80	259	Tyagunov, G.V., Baum, B.A., and Kushniv, M.N.	1972	R	1573,1973		99.98 pure.
81	198	Holborn, L.	1919		80-672		Wire specimen 0.5 mm in diam; resistivity values calculated from reported R(T)/R(273 K), with ρ(273 K) taken to be 6.16×10^{-8} Ω m.
82*	108	Schimank, H.	1914	A	20-273		Wire specimen 1-2 m long; from Hartmann and Braun; resistivity value calculated from reported R(T)/R(273 K), with ρ(273 K) taken to be 6.16×10^{-8} Ω m.
83	187	Güntherodt, H.J. and Künzi, H.U.	1973	C	1726		99.998 pure; from Johnson, Matthey and Co.; in liquid state; temperature = 1726 K assumed.
84*	260	Busch, G., Güntherodt, H.J., Künzi, H.U., Meier, H.A., and Schlapbach, L.	1970		1726		No details reported.
85	159	Baum, B.A., Tyagunov, G.V., Gel'd, P.V., and Khasin, G.A.	1971	R	1573,1873		99.99 pure; zone refined; specimen contained in either an alumina or zirconia crucible; measured in an atmosphere of helium.
86*	193	Dubini, E., Esin, O.A., and Vatolin, N.A.	1969		1873		"High purity"; measured in purified helium.
87*	94	Samarin, A.M.	1962	R	1728-1900		Measured in an atmosphere of helium; rotating field apparatus calibrated against an iron specimen with resistivity value at melting taken from R.W. Powell, Philos. Mag. 44, 772, 1953; resistivity values calculated from reported conductivity = $(32.35 - 0.88 \times 10^{-3} T(C)) \times 10^{4} (\text{ohm cm})^{-1}$; (this equation is apparently erroneous).
88*	261	Schwerer, F.C. and Silcox, J.	1968		16.4-56.3		No details reported; ρ(273 K)/ρ(4.2 K) ∿1400; values of ρ(T)-ρ(1.4 K) reported only.
89	220	Ahmad, H.M. and Grieg, D.	1974	A	10-873	Pure Ni(I)	"Spec-pure" nickel from Johnson, Matthey and Co.; 0.5 mm in diam and 10 cm long; annealed in vacuum at 1223 K for 24 h; T_C = 631 K; data below 260 K supplied by author; values from table.
90	220	Ahmad, H.M. and Grieg, D.	1974	A	10-260	Pure Ni(II)	Similar to the above; data supplied by author.
91*	221	Zumsteg, F.C. and Parks, R.D.	1970	V	623-650		99.999 pure; 0.005 cm thick, 0.05 cm wide and 50 cm long; swaged; annealed 1-30 days in situ before measurement; sample mounted on fiberglass; resistivity values calculated from reported $R(T)/R(T_C)$ and $\rho(T_C)$ taken to be 28.70×10^{-8} Ω m.

* Not shown in figure.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
92	87	Seydel, U. and Fucke, W.	1977	→	508–2989		99.99 pure; 0.0015 Fe, 0.0003 Cu, 0.0002 Si, 0.0001 Ag, Al and Ca each, and <0.0001 Cr, Mg, Mn, and Sn each (chemical analysis); measured by an exploding wire technique; measurement error 4%; smoothed values from curve.
93	92 110	Güntherodt, H.J., Hauser, E., Künzi, H.U., and Müller, R. Müller, R.	1975 1976	→	1723–1843		99.999 pure, from Johnson, Matthey and Co.; measured with a potential method in which the sample material was enclosed in an alumina tube with four protrusions setting as current and potential contacts.
94*	262	Yao, Y.D., Arajs, S., and Anderson, E.E.	1975	A	4–300		0.0010 Fe, 0.0007 Al, 0.0005 Si, 0.0002 Ca, Cu, and Mg each, and <0.0001 Ag and Mn; from Johnson, Matthey and Co., R(4.2 K)/R(298 K) = 3.3×10^{-5}.
95*	209	Wycisk, W. and Feller-Kniepmeier, M.	1976	A	295–1390		99.999 pure, <0.0005 Si, 0.0003 Fe, <0.0001 Mg and Ag each, 0.00001 Co, and 0.00005 Ca, Cd, Cu and Pb each; 5 mm diam and 150 mm long rod from Gallard-Schlesinger Chemical Corp.; zone-refined 5 times in electron beam; rolled and drawn to 60 μm diam wire with diamond tools; electrolytically cleaned after each rolling and drawing with a 77% acetic acid and 23% perchloric acid solution; annealed 1/2 to 1 h at 573–673 K in a vacuum of $<10^{-7}$ Torr; flushed with helium; then slowly lowered over a liquid helium bath, with copper guard roof the ends of which are immersed in liquid helium; heated to 1073 K for 40 min; then 1273–1373 for 5 min and 1473 K for 1 min; potential leads knotted and sintered to wire specimen at the highest temperature; ρ(4.2 K) reported to be 0.0027×10^{-8} Ω m is a longitudinal magnetic field of 250 Oe; resistivity values calculated from reported R(T)/R(296 K), with ρ(296 K) calculated from reported R(696 K)/R(4.2 K) = 1923.
96	209	Wycisk, W. and Feller-Kniepmeier, M.	1976	A	1.5–4.2		Similar to the above, except R(296 K)/R(4.2 K) = 1845; resistivity values calculated from reported ΔR/R(4.2 K); measured wire a current density of $\sim 3.5 \times 10^{4}$ A cm^{-2}, and in a magnetic field of 250 Oe.
97*	209	Wycisk, W. and Feller-Kniepmeier, M.	1976	A	4.2		Similar to the above, except measured without a longitudinal magnetic field, resistivity value calculated from reported R(296 K)/R(4.2 K), with ρ(296 K) = 5.191×10^{-8} Ω m from data set 96.
98*	209	Wycisk, W. and Feller-Kniepmeier, M.	1976	A	4.2		Similar to the above, except single crystal 5 mm in diam and 10 cm long.
99*	209	Wycisk, W. and Feller-Kniepmeier, M.	1976	A	4.2		Similar to the above, except measured in a longitudinal magnetic field of 250 Oe.
100	93	Kita, Y., Ohguchi, S., and Morita, Z.	1978		1654–1882		0.08 Co, 0.007 Fe, 0.005 Si, 0.0025 Cu, 0.[illegible]2 Mg, 0.001 Al, and 0.0007 S; measured with a four probe method in which the electrodes are made of the same material as the specimen; measured in a vacuum of 10^{-6} Torr; data points taken at temperatures in the sequence: 1770, 1788, 1796, 1814, 1840, 1857, 1869, 1882, 1867, 1852, 1836, 1817, 1799, 1791, 1767, 1748, 1711, 1692, 1772, and 1654 K; values corrected for thermal expansion; values from table supplied by authors.

* Not shown in figure.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

Data Set No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), Specifications and Remarks
101*	93	Kita, Y., Ohguchi, S., and Morita, Z.	1978	→	1648-1872		Same as the above; a second melt; temperature sequence: 1755, 1780, 1798, 1818, 1838, 1856, 1872, 1855, 1836, 1821, 1805, 1793, 1769, 1756, 1740, 1693, 1667, and 1648 K.
102*	93	Kita, Y., et al.	1978	→	1720-1888		Same as the above; a third melt; temperature sequence: 1751, 1766, 1782, 1800, 1811, 1826, 1844, 1865, 1888, 1873, 1857, 1841, 1823, 1808, 1795, 1781, 1765, 1741, and 1720 K.
103	224	Jackson, P.J. and Saunders, N.H.	1968		293-673		99.999 pure (10 ppm metallic impurities); polycrystalline; annealed; data from table supplied by N.H. Saunders.
104*	263	Sherif, I.I., Ibrahim, A.F., Ghani Awad, A.A., Ammar, A.S., and Esmail, S.A.	1976	→	373-873		Polycrystalline spectroscopic nickel supplied by the National Research Center, Cairo; either dumbell-shaped specimen with long ends about 3 cm long and 0.9 cm in diam or wire specimen of gauge length 2.5 cm; measured by a four probe method in an over flushed with inert gas.
105*	210	Fujii, T.	1970	A	4.2		0.0050 C, 0.0007 O, 0.0004 H, 0.0003 N and Fe each, 0.0002 Si and Mg each, and <0.0001 Ag, Al, Ca and Cu each; supplied by Johnson, Matthey and Co.; carbon impurity determined by vacuum combution method, nitrogen and oxygen impurities determined by vacuum fusion method with high purity silicon; metallic impurities determined by the supplier; 5 mm in diam and 20 mm long; annealed at 1273 K for 1 h; grain size reported to be 9 grams cm^{-2}; resistivity value calculated from reported $\rho(295\ K)/\rho(4.2\ K)$ with $\rho(295\ K)$ taken to be $7.004 \times 10^{-8}\ \Omega$ m.
106*	210	Fujii, T.	1970	A	4.2		0.0040 C, 0.0010 O, <0.0002 H, and 0.0001 N; metallic impurities not determined; the above material after surface oxidation treatment to remove carbon in an air atmosphere for 2 h at 1173 K; "this treatment is aimed to remove carbon easily by volatization in vacuum, with a chemical reaction to the forms of CO or CO_2 from NiO in the process of molten containing excessive oxygen during zone melting"; 1 pass zone-refined in vacuum at 3 mm min^{-1}; 1.5 mm in diam and 50 mm long, made by diameter controlled operation in zone refining process; gaseous impurities determined by the methods given above; grain size 4 grains cm^{-2}; resistivity value calculated by the same method as above.
107*	210	Fujii, T.	1970	A	4.2		Similar to the above except containing 0.0020 C, <0.0002 O, <0.0001 H, and trace amount of N and 3 pass zone-refined in vacuum at 1 mm min^{-1}; grain size 3-5 grain cm^{-2}.
108*	210	Fujii, T.	1970	A	4.2		Similar to the above except containing 0.0010 C, <0.0002 O and trace amounts of hydrogen and nitrogen and 5 pass zone-refined in vacuum at 1 mm min^{-1}; grain size 4 grain cm^{-2}.
109*	210	Fujii, T.	1970	A	4.2		Similar to the above except oxygen content is reduced to 0.0001; 10 pass zone-refined in vacuum at 1 mm min^{-1}; grain size 4 grain cm^{-2}.

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni

[Temperature, T, K; Electrical Resistivity, ρ, $10^{-8}\ \Omega$ m]

T	ρ
DATA SET 1	
2.0	0.19
2.4	0.19
3.0	0.20
3.5	0.20
4.2	0.22
5.0	0.22
5.9	0.22
7.9	0.22
9.3	0.22
10.9	0.22
13.2	0.24
15.4	0.24
17.3	0.24
18.5	0.24
21.1	0.24
22.8	0.26
24.8	0.26
26.9	0.29
29.4	0.29
31.4	0.29
33.0	0.29
35.0	0.29
36.6	0.29
39.3	0.29
41.9	0.33
44.7	0.40
47.0	0.40
48.7	0.42
50.7	0.44
53.9	0.44
56.6	0.51
59.2	0.51
62.8	0.54
65.3	0.57
67.3	0.58
69.9	0.62
73.1	0.69
DATA SET 2	
293.2	6.8
473.2	16.0

T	ρ
DATA SET 3	
80	0.570
90	0.600
98	0.776
120	1.34
141	1.72
159	2.29
180	3.06
201	3.63
220	4.40
249	5.35
272	6.31
295	7.46
304	7.84
375	11.29
429	13.97
458	15.88
480	17.03
542	22.01
556	23.92
585	26.98
616	30.62
648	32.72
693.177	33.876
734	35.024
DATA SET 4	
5.6	0.0523
6.0	0.0523
7.5	0.0526
8.1	0.0529
10.2	0.0533
10.2	0.0535*
11.8	0.0544
12.1	0.0544*
13.5	0.0551
13.6	0.0555*
14.2	0.0555*
14.5	0.0564
15.1	0.0564*
16.3	0.0569*
16.3	0.0572
17.2	0.0585*
18.2	0.0586

T	ρ
DATA SET 4(cont.)	
18.7	0.0592*
20.2	0.0606
20.5	0.0613*
21.7	0.0631
22.3	0.0629*
22.3	0.0636*
24.2	0.0661
24.4	0.0667*
24.4	0.0692*
25.1	0.0684*
27.4	0.0733
30.3	0.0793
30.3	0.0807
32.6	0.0884
35.2	0.0973
40.8	0.1222
DATA SET 5	
323.2	8.65
423.2	13.6
523.2	20.3
623.2	28.8
DATA SET 6	
90	1.77
194.7	4.59
273	7.37
373	11.56
DATA SET 7*	
74	0.4
84	0.6
92	0.8
101	1.0
118	1.3
125	1.6
145	2.4
173	3.0
197	3.6
205	4.0
232	4.9

T	ρ
DATA SET 7(cont.)*	
240	5.2
245	5.3
260	6.1
279	6.7
298	7.6
321	8.4
329	8.8
363	10.4
411	12.7
475	16.6
493	17.5
508	18.8
528	20.3
548	21.8
565	23.2
574	23.9
579	24.2
585	24.8
591	25.3
597	25.9
602	26.6
610	27.3
614	27.7
628	29.4
634	30.0
643	30.6
DATA SET 8*	
4.2	0.034
DATA SET 9	
4.2	1.18
T	**$\rho_T-\rho_0$**
DATA SET 10*	
1.612	0.0000777
1.736	0.0000852
1.924	0.000105

T	$\rho_T-\rho_0$
DATA SET 10(cont.)*	
1.965	0.000108
2.537	0.000188
2.560	0.000194
3.056	0.000271
3.131	0.000276
3.552	0.000362
3.587	0.000357
3.974	0.000450
3.993	0.000448
13.79	0.00470
14.64	0.00520
15.54	0.00591
16.42	0.00658
16.62	0.00691
17.09	0.00711
17.53	0.00749
17.93	0.00784
18.44	0.00832
19.04	0.00887
19.77	0.00961
19.77	0.00965
T	**ρ**
DATA SET 11	
4.2	0.0095
10	0.0115
20	0.0195
30	0.0385
40	0.0775
50	0.1495
60	0.2295
70	0.3695
80	0.5495
90	0.7495
273	6.31
DATA SET 12	
1.73	0.329
2.50	0.329

T	ρ
DATA SET 12(cont.)	
3.24	0.329
3.89	0.333
14.84	0.345
15.92	0.345*
16.53	0.345
16.97	0.345*
17.49	0.345*
17.99	0.346
19.42	0.346*
20.24	0.346
DATA SET 13	
373	11.9
473	18.3
573	25.2
673	32.5
773	47.5*
DATA SET 14	
273	6.36
293	7.01
300	7.31
400	11.65
500	17.6
550	21.1
600	25.25
627	28.15
650	29.9
700	32.0
800	35.45
900	38.5
1000	41.25
1100	43.8
1200	46.4
1300	48.75
1400	50.95
1550	54.25
DATA SET 15	
300	8.77
327	10.42

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA N THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

T	ρ
DATA SET 15(cont.)	
373	12.55
452	16.81
519	21.10
558	24.39
568	25.13
630	30.49
680	33.00
688	33.00
766	35.46
803	36.76
803	36.50
900	39.06
949	40.49
1016	43.10
1018	43.10
DATA SET 16	
1098	43.8
1104	43.9
1115	44.2
1124	44.6
1174	45.8
1183	46.0
1235	47.0
1241	47.1
DATA SET 17	
293	7.1
323	8.3
423	13.0
523	19.4
623	28.0
723	32.8
823	36.1
923	39.3
1023	42.4
1123	45.2
DATA SET 18	
373	10.6
533	18.5
563	20.7
773	33.2
DATA SET 19	
293	10.1
323	11.3
423	16.3
523	22.8
623	31.5
DATA SET 20	
293	7.1
323	8.3
423	13.1
523	19.4
623	28.3
723	33.2
823	36.4
923	39.2
1023	42.1
1123	44.7
1223	47.5
1323	49.8
DATA SET 21	
298	7.50*
1726	60
1726	84
DATA SET 22	
4.18	0.11
80.5	0.676
292	7.16
DATA SET 23*	
4.18	0.0213
80.5	0.60
273	6.35
298	6.48
DATA SET 24	
4.2	0.37
90	0.92
198	4.12
273	7.46*
DATA SET 25*	
293	7.90
323	9.30
373	11.50
423	14.16
473	17.24
498	18.71
523	20.70
548	22.50
573	24.70
598	27.19
623	28.88
648	30.51
673	31.84
698	32.69
723	33.63
748	34.57
773	35.36
DATA SET 26*	
293	8.08
323	9.36
373	11.60
423	14.11
473	17.29
498	18.70
523	20.54
548	22.51
573	24.74
598	26.91
623	29.18
648	30.75
673	32.01
698	32.70
723	33.23
748	33.98
DATA SET 27	
313	8.3
364	10.9
373	11.5
411	13.0
483	17.2
505	18.7
535	20.7
DATA SET 27(cont.)	
579	24.2
631	29.3
647	29.1
555	35.3
794	36.4
864	38.8
993	42.3
1053	44.4
1124	45.9
1172	46.1
DATA SET 28	
1152	50.3
1178	51.1
1209	51.6
1236	51.5
1277	53.7
1305	54.6
1320	55.7
DATA SET 29	
110	2.0
138	2.7
147	3.5
164	3.5
194	4.6
203	4.8
225	5.5
256	6.6
265	6.9
327	9.7
363	10.8
395	13.0
399	12.7
405	13.1
438	14.5
469	17.1
479	17.4
517	20.0
554	22.2
559	22.8
637	29.7
683	32.3
721	33.4
803	36.8
DATA SET 30	
384	11.9
438	15.0
493	18.0
551	22.6
615	27.7
680	32.7
DATA SET 31	
2.32	0.00329
2.97	0.00339
3.24	0.00346
3.83	0.00366
4.36	0.00377
5.72	0.00417
7.31	0.00476
9.12	0.00553
13.1	0.00780
14.1	0.00859
DATA SET 32	
293	6.8*
1073	44
1273	49
DATA SET 33	
4.2	0.022
10.5	0.024
11.8	0.025
13.4	0.026
15.3	0.027
16.8	0.029
18.6	0.030
177.0	3.06
188.3	3.41
204.3	3.87
233.4	4.79
272.2	6.17
295.0	7.06
298.1	7.24
DATA SET 34	
4.2	0.0319
5.0	0.0321
DATA SET 34(cont.)	
5.5	0.0322
6.1	0.0323
6.9	0.032
7.7	0.0328
8.5	0.033
9.5	0.0335
10.4	0.0338
10.8	0.0342
14.7	0.0363
17.9	0.0391
105.6	1.15
115.1	1.36
123.8	1.60*
134.1	1.87
179.1	3.17
199.5	3.78
226.6	4.62
252.2	5.41
DATA SET 35	
1163	48.1
1217	50.7
1300	53.7
1400	57.1
1454	59.2
1502	60.7
1560	61.8
1606	63.1
1641	63.7
DATA SET 36	
891.2	39.1
947.2	43.0
983.2	43.0
1077.2	47.8
1174.2	52.3
1273.2	54.0
1378.2	57.1
1475.2	61.2
1574.2	64.1
1673.2	68.1
DATA SET 37	
73	0.6

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

T	ρ
DATA SET 37(cont.)	
123	1.6
173	3.0
223	4.1
273	6.0
323	8.0
373	10.1
423	12.4
473	15.0
523	17.7
573	21.5
623	25.2
673	29.1
723	31.2
773	33.1
823	34.5
873	35.6
923	36.8
973	38.5
1023	39.5
1073	40.7
1123	41.9
1173	43.2
1223	44.4
1273	45.8
1323	46.9
1373	48.4
1423	49.3
1473	50.3
1523	51.4
1573	52.8
1623	53.9
1668	54.9
DATA SET 38*	
78	0.6
129.5	2.2
148	2.5
162.8	2.9
185	3.6
196.1	4.0
214.6	4.4
233.1	5.2
281.2	7.3
336.7	9.5
340.4	9.8

T	ρ
DATA SET 38(cont.)*	
355.2	10.3
362.2	10.9
370	11.4
377.4	12.0
388.5	12.7
395.9	13.0
432.9	15.4
484.7	18.7
499.5	19.4
543.9	23.0
543.9	23.6
584.6	26.6
584.6	27.9
592.0	28.6
614.2	29.3
651.2	30.1
666.0	31.7
688.2	32.6
714.1	33.6
751.1	34.9
780.70	36.2
821.4	37.1
851.0	38.1
895.4	39.2
932.4	40.4
962.0	41.4
1036.0	43.1
1061.9	43.6
1113.7	44.7
1154.4	45.2
1176.6	46.1
1209.9	46.6
1243.2	47.2
DATA SET 39*	
73	0.3
134	1.8
208	3.9
240	5.0
274	6.2
298	7.2
330	8.4
375	10.3
431	13.1
469	15.1

T	ρ
DATA SET 39(cont.)*	
496	16.8
541	19.9
568	22.0
588	23.5
613	26.3
636	28.3
665	29.5
701	30.9
762	34.1
822	36.4
DATA SET 40	
3.2	0.0104
DATA SET 41*	
84	2.186
98	2.703
123	3.748
148	4.866
173	6.049
198	7.352
223	8.825
248	10.257
273	12.005
298	13.808
323	15.723
348	17.946
373	20.207
398	22.514
423	25.025
448	27.688
473	30.464
498	33.337
523	36.352
548	39.480
573	42.729
598	46.243
623	49.722
648	53.390
673	57.257
DATA SET 42	
1.5	0.1044
293.2	10.44

T	ρ
DATA SET 43	
4.2	0.0347
13.6	0.0391
16.2	0.0402
18.7	0.0422
24.3	0.0510
28.0	0.0587
33.7	0.0787
38.9	0.101
57.8	0.235
67.3	0.325
79.3	0.491
93.3	0.778
117	1.29
136	1.76
171	2.50
190	3.14
226	4.29
290	6.52
290	7.14
293.2	7.22
DATA SET 44	
303.2	8.58
DATA SET 45	
80	1.109
273	7.663
DATA SET 46	
293.2	9.0
DATA SET 47	
4.2	0.544

T	$\rho_T-\rho_0$
DATA SET 48*	
4.17	0.00017
5.86	0.00035
DATA SET 48(cont.)*	
7.67	0.00057
7.96	0.00066
10.2	0.00116
12.2	0.00173
18.7	0.00512
20.8	0.00682
24.0	0.0103
41.5	0.0638
49.7	0.1128
79.3	0.6032

T	ρ
DATA SET 49	
1013	54.6
1456	61.3
1647	64.3
1713	81.3
1760	87.7
1997	92.3
DATA SET 50*	
811	7.8
DATA SET 51*	
375	10.05
388	11.08
419	13.12
424	12.20
475	15.50
489	17.23
515	19.09
520	18.06
548	21.56
560	21.39
575	23.69
597	24.40
600	26.27
625	27.50
630	28.39
638	28.71
DATA SET 51(cont.)*	
650	29.57
658	29.43
675	31.09
687	30.95
700	31.84
716	32.04
721	32.67
744	32.96
768	34.19
771	33.62
791	34.80
825	35.57
DATA SET 52	
90	0.762*
100	0.986*
125	1.585*
150	2.237*
200	3.703
250	5.384
300	7.237*
400	11.814
500	17.704
600	25.554
630	28.862*
635	29.288*
650	30.142
'00	32.237
800	35.637
900	38.676
1000	41.496
1100	44.166
1200	46.728
1250	47.972
DATA SET 53*	
77	0.554
90	0.770
169	2.71
273	6.16
373	10.35
435	13.52
483.5	16.50
526	19.40

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

DATA SET 53(cont.)*

T	ρ
551.5	21.25
617.5	27.06
621.5	27.48
624	27.80
626.9	28.15
627.8	28.27
628.6	28.39
628.9	28.43
629.2	28.47
629.4	28.50
630.5	28.59
631.1	28.61
633.2	28.76
633.4	28.79
635.2	28.89
637.1	28.99
638.7	29.09
641.1	29.24
642.3	29.32
643.8	29.41
651.8	29.80
675.3	30.83
701.2	31.82
724.8	32.66
740.1	33.17
760.0	33.84
785.8	34.66
815.3	35.57
839.5	36.33
898.6	38.06
939.7	39.22
972.6	40.12
1016.0	41.29
1044.0	42.04
1102.0	43.51
1128.2	44.17
1143.1	44.52
1153.1	44.75

DATA SET 54*

T	ρ
100	1.1
200	4.0
300	8.0
400	12.7
500	18.7

DATA SET 54(cont.)*

T	ρ
600	27.0
637	30.8
700	33.4
800	36.8
900	40.1
1000	43.3

DATA SET 55

T	ρ
4.2	0.0299
5.41	0.0306
5.70	0.0308*
6.07	0.0310*
6.53	0.0311*
6.75	0.0313
7.33	0.0316*
7.64	0.0316
8.24	0.0319*
8.79	0.0322
9.44	0.0325
9.95	0.0328
11.0	0.0336*
11.8	0.0341
12.8	0.0346*
14.1	0.0357
15.6	0.0374*
16.9	0.0390
18.8	0.0411*
20.6	0.0437
22.9	0.0480
26.1	0.0551
28.8	0.0627*
32.2	0.0756
35.8	0.0923
38.7	0.1109*
42.9	0.1339
47.9	0.1787
53.1	0.2310
59.6	0.3127
65.6	0.4036
72.8	0.5157
77.5	0.5813*
81.5	0.6601*
84.9	0.7338
89.5	0.8178*
94.8	0.9367

DATA SET 55(cont.)

T	ρ
100.2	1.052
105.7	1.177*
113.5	1.368*
122.2	1.566
133.4	1.835*
143.2	2.107
150.3	2.339*
174.2	3.019*
182.0	3.300
191.4	3.699
204.2	4.165*
227.0	5.094*
251.8	5.885
259.4	6.361*
267.9	6.509*
291.1	7.266*
300.0	7.34*

DATA SET 56

T	ρ
1073	48.1
1173	50.6
1273	52.8
1373	55.2
1473	57.8
1573	60.3
1673	62.7
1722	65.0
1723	82.5
1728	83.5
1773	84.5
1873	85.6
1968	86.1

DATA SET 57

T	ρ
1.74	0.2820
3.0	0.2821
5.2	0.2826
6.6	0.2831
8.0	0.2837
9.2	0.2844
12	0.2872
16.6	0.2913
19.1	0.2944
22.3	0.3002

DATA SET 57(cont.)

T	ρ
27.85	0.3122
37	0.3411
39	0.3654
43	0.3918
60	0.5753
70	0.7175
77	0.8404
99.5	1.303
129	2.020
167	3.073
292	7.700
297	7.770
326	8.874
379	11.31
435	14.29
493	17.78
519	19.32
546	21.54
561	22.59
578	24.12
598	25.59
608	26.97
628	28.89
646	30.63
672	31.80

DATA SET 58

T	ρ
998	40.9
1016	42.1
1040	42.7
1059	43.6
1077	44.2
1099	45.2
1121	45.6
1140	46.1
1158	46.7
1177	47.8
1195	48.5
1214	49.0
1250	50.2
1265	50.2
1294	50.2
1318	50.7
1339	51.7
1357	52.3
1381	52.7

DATA SET 59

T	ρ
993	40.6
1020	41.6
1042	42.0
1083	43.3
1110	44.9
1143	46.4
1168	46.9
1204	48.7
1239	50.0
1281	50.8
1305	50.8
1325	51.7
1348	52.2
1382	53.2
1406	53.6
1422	54.2
1448	55.3
1479	56.7

DATA SET 60

T	ρ
970	39.8
1001	41.3
1021	42.4
1042	43.2
1076	43.7
1106	45.9
1161	47.5
1178	48.6
1225	50.1
1267	50.5
1287	51.1
1327	52.1
1360	53.8
1385	54.5
1408	55.1

DATA SET 61

T	ρ
1728	85.06
1800	87.08
1873	89.12
1898	89.82

DATA SET 62*

T	ρ
6	-0.08
65	0.41
77	0.63
272	6.13
292	6.84

DATA SET 63*

T	ρ
76.1	1.908
191.3	7.242
229.6	9.456
273	12.323
274.30	12.402
291.9	14.653
324.9	16.185
363.50	19.419
406.9	23.250
468.5	29.730

DATA SET 64*

T	ρ
91	1.900
173	6.110
193	7.470
274.4	12.350
293	13.494
367.7	18.913

DATA SET 65*

T	ρ
4.2	0.024
100	1.0
200	3.6
300	7.3
400	11.9
500	17.9
600	25.6
628	29.3
700	32.4
800	36.0
900	38.8
940	40.1

DATA SET 66

T	ρ
657	35.2
668	35.4

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

T	ρ
DATA SET 66(cont.)	
673	35.2*
683	36.0
696	37.1*
704	37.4
711	37.6*
733	38.2
742	38.5*
749	38.9*
764	39.5
766	40.0*
777	39.5*
787	39.5*
795	40.2
806	40.4*
817	41.6*
855	43.0
861	43.3*
873	43.5*
902	44.5
945	45.2
952	45.4*
962	45.6*
997	47.5
1019	47.5*
1036	48.0*
1078	49.1
1089	49.4*
1127	51.0
1141	51.4*
1165	51.3
1173	52.0*
1187	52.6*
1200	52.8
1211	53.0*
1222	53.4*
1270	54.8
1273	54.7*
1281	54.9*
1291	55.2
DATA SET 67	
80	0.75
100	1.25*
120	1.65*
140	2.05
DATA SET 67(cont.)	
160	2.50*
180	3.10
200	3.70*
220	4.38
240	5.10
260	5.95
280	6.75*
300	7.65*
320	8.50*
340	9.45
360	10.35*
380	11.35*
400	12.40
420	13.50
440	14.65
460	15.90
480	17.15*
500	18.50
520	20.25*
540	22.00*
560	24.10
580	26.30*
600	28.75
620	31.25
640	32.75
660	33.25
680	33.75
700	34.25
720	34.75
740	35.25
760	35.75
780	36.25
800	36.75
820	37.25
840	37.75
860	38.25
880	38.75
900	39.25
DATA SET 68*	
4.5	0.0116
295	7.51
DATA SET 69	
293	8.5*
1726	63
DATA SET 70	
1726	64
1726	81.5
DATA SET 71	
293	7.61
DATA SET 72	
295	8.4
432	16.0
568	25.7
696	35.8
725	36.8
881	42.2
1063	47.7
1273	54.3
1473	58.0
DATA SET 73	
1.85	0.00308
4.15	0.00346
14.1	0.00753
20.1	0.01237
DATA SET 74	
4.15	0.0407
DATA SET 75	
4.15	0.0141
DATA SET 76	
78	1.28
178	4.02
273	7.36*
294	8.13
323	9.14
DATA SET 76(cont.)	
373	11.35
482	17.1*
562	21.9
596	25.6
621	27.3
633	28.6
642	29.1*
654	30.5
666	31.3*
680	31.8
702	32.7
772	34.9
873	38.6
966	41.2
1073	44.1
1123	45.5
DATA SET 77	
1.23	0.0628
1.23	0.0629*
1.30	0.0628*
1.40	0.0629
1.58	0.0629*
1.62	0.0629*
1.73	0.0629
2.01	0.0629*
2.20	0.0629
2.41	0.0629*
2.52	0.0629*
2.73	0.0630
3.00	0.0630
3.18	0.0630*
3.38	0.0630
3.52	0.0630*
3.55	0.0630*
3.64	0.0631*
3.81	0.0631
3.84	0.0631*
3.93	0.0631*
4.18	0.0631
DATA SET 78	
14	0.0665
16	0.0666
DATA SET 78(cont.)	
18	0.0669
20	0.0673
DATA SET 79*	
339	9.5
381	10.7
450	14.2
503	18.3
536	21.5
583	24.0
618	27.8
662	29.2
695	30.9
731	32.0
776	33.4
865	36.7
928	39.0
999	40.4
1042	42.0
DATA SET 80	
1573	63
1973	87
DATA SET 81	
80.2	0.9510
80.9	0.9666
194.7	4.0486
373	9.1092
581.4	15.7036
671.8	18.7782
DATA SET 82*	
20.2	1.2726
80.4	1.8063
195.4	4.1811
273.1	6.2200
DATA SET 83	
1726	82.3
DATA SET 84*	
1726	85.1
DATA SET 85	
1573	58.6
1873	89.4
DATA SET 86*	
1873	125
DATA SET 87*	
1728	3.24
1800	3.25
1900	3.26
T	**$\rho_T - \rho_{1.4K}$**
DATA SET 88*	
16.4	0.00521
19.5	0.00801
23.5	0.0123
28.3	0.0214
32.7	0.0325
37.4	0.0497
41.6	0.0720
46.3	0.102
51.8	0.147
56.3	0.192
T	**ρ**
DATA SET 89	
10	0.044
20	0.0512
30	0.0698
40	0.1124
60	0.294
80	0.625
100	1.033

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

T	ρ	T	ρ	T	ρ	T	ρ	T	ρ	T	ρ
DATA SET 89(cont.)		DATA SET 91(cont.)*		DATA SET 92(cont.)		DATA SET 94(cont.)*		DATA SET 94(cont.)*		DATA SET 95(cont.)*	
160	2.584	631.6	28.78	1496	57.1	74.1	0.30	271.2	6.35	875.2	26.360
200	3.784*	631.7	28.80	1589	59.4	76.6	0.30	276.2	6.35	897.0	26.728
260	5.831*	631.8	28,82	1725	62.6	80.3	0.29	281.2	6.99	905.7	26.910
293	7.092*	632.0	28.83	1725	83.6	84.1	0.29	288.7	7.31	914.5	27.097
333	8.747*	632.1	28.85	1949	84.6	86.6	0.94	295.0	7.31	923.2	27.279
373	10.54*	632.5	28.88	2176	86.1	89.1	0.61	301.3	7.63	940.6	27.647
433	12.52	632.7	28.91	2391	87.6	91.6	0.93			971.2	28.016
473	14.69*	633.2	28.94	2606	88.7*	94.1	0.61	DATA SET 95*		993.0	28.572
533	18.37*	633.7	28.97	2719	89.6*	99.2	0.93			1006.1	28.753
573	21.20*	634.3	29.00	2875	90.6*	102.9	0.93	294.8	5.161	1010.5	28.753
673	29.93*	634.8	29.05	2989	91.3	106.7	1.25	303.5	5.348	1019.2	28.940
77·	33.32*	635.5	29.08			111.7	1.25	312.3	5.530	1027.9	29.122
873	36.94	635.9	29.11	DATA SET 93		116.7	1.25	321.0	5.898	1049.7	29.678
		636.3	29.14			120.5	1.57	329.7	5.898	1058.5	29.859
DATA SET 90		636.9	29.20	1723	57.0	124.3	1.24	338.5	6.267	1062.8	29.859
		637.7	29.23	1723	60.8	128.0	1.89	382.1	7.741	1089.0	30.228
10	0.00937	638.2	29.25	1724	79.6	129.3	1.89	390.8	7.741	1097.7	30.415
20	0.016	638.8	29.31	1733	83.4	134.3	1.89	399.5	8.110	1106.5	30.597
30	0.036	639.5	29.34	1757	83.4	139.3	1.56	408.3	8.465	1115.2	30.597
40	0.0792	640.1	29.37	1779	83.5	143.1	2.21	434.5	9.584	1115.2	30.965
60	0.2623	640.5	29.40	1782	83.5*	146.9	2.20	451.9	10.140	1132.6	30.965
80	0.5764	641.1	29.46	1812	83.6	153.2	2.20	456.3	10.509	1145.7	31.339
100	0.985	641.5	29.46	1843	83.7	160.7	2.20	478.1	11.615	1158.8	31.708
160	2.503*	642.1	29.48			165.7	2.84	499.9	12.352	1180.6	31.889
200	3.683	642.8	29.54	DATA SET 94*		169.5	2.84	521.7	13.458	1193.7	32.076
260	5.735	643.2	29.54			175.8	2.84	547.9	14.932	1198.1	32.258
		644.0	29.60	7.5	0.10	180.8	3.16	569.7	16.407	1206.8	32.258
DATA SET 91*		644.7	29.66	8.7	0.10	183.3	3.16	587.2	17.326	1224.3	32.627
		645.3	29.69	10.2	0.11	188.3	3.80	591.5	17.694	1241.7	32.627
622.9	27.73	646.9	29.74	14.6	0.11	193.3	3.80	595.9	17.694	1267.9	33.364
623.7	27.82	647.4	29.77	23.1	0.12	197.1	3.80	600.3	17.881	1276.6	33.364
624.4	27.91	648.0	29.83	28.2	0.13	203.4	3.80	604.6	18.063	1302.8	34.101
625.7	28.05	648.5	29.83	33.0	0.14	207.1	4.12	617.7	19.169	1337.7	34.470
626.2	28.11	649.1	29.86	35.9	0.15	213.4	4.44	622.1	19.169	1355.2	35.025
626.9	28.17	649.6	29.89	38.8	0.16	217.2	4.76	635.2	19.538	1363.9	35.207
627.3	28.25	650.1	29.91	41.7	0.18	221.0	4.76	635.2	20.275	1390.1	35.576
627.7	28.31			44.1	0.20	226.0	4.76	643.9	20.643		
628.2	28.37	DATA SET 92		45.9	0.21	232.2	4.75	670.1	21.199	DATA SET 96	
628.8	28.42			50.2	0.30	236.0	5.40	687.5	21.936		
629.2	28.48	508	20.0*	52.7	0.30	239.8	5.40	709.4	22.487	1.51	0.002574
629.8	28.54	638	31.8*	55.2	0.30	243.5	5.39	735.5	22.855	1.79	0.002581
630.2	28.60	769	37.9*	59.0	0.30	247.3	5.72	761.7	23.592	1.93	0.002593
630.7	28.68	886	41.9*	62.8	0.30	252.3	6.04	787.9	24.330	2.08	0.002600
631.0	28.71	1029	45.9*	65.3	0.30	256.1	6.03	814.1	24.698	2.20	0.002626*
631.2	28.74	1206	50.3	67.8	0.30	262.4	6.35	840.3	25.436	2.44	0.002638*
631.4	28.77	1345	53.5	70.3	0.30	266.1	6.35	857.7	25.991	2.64	0.002647*

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF NICKEL Ni (continued)

T	ρ	T	ρ	T	ρ
DATA SET 96(cont.)		DATA SET 101(cont.)*		DATA SET 103(cont.)	
2.88	0.002653	1693	61.4	573	23.03
3.09	0.002675	1740	87.35	623	27.86
3.3[illegible]	0.002705	1755	87.45	673	31.18
3.60	0.002735	1756	87.55		
3.80	0.002761	1769	87.65	DATA SET 104*	
3.97	0.002782	1780	87.7		
4.21	0.002814	1793	87.95	373	8.54
		1798	87.95	422	10.67
DATA SET 97*		1805	88.05	471	13.60
		1818	88.2	522	17.19
4.2	0.003185	1821	88.25	571	20.56
		1836	88.45	617	24.27
DATA SET 98*		1838	88.45	666	26.74
		1855	88.7	718	28.76
4.2	0.003053	1856	88.65	770	31.01
		1872	88.85	821	33.26
DATA SET 99*				873	35.06
		DATA SET 102*			
4.2	0.002588			DATA SET 105*	
		1720	87.15		
DATA SET 100		1741	87.4	4.2	0.0233
		1751	87.45		
1654	59.85	1765	87.7	DATA SET 106*	
1692	60.75	1766	87.65		
1711	61.2	1781	87.85	4.2	0.0145
1748	87.05	1792	87.8		
1767	87.25	1795	88.05	DATA SET 107*	
1770	87.25*	1800	88.05		
1772	60.3*	1808	88.2	4.2	0.00834
1788	87.4	1811	88.2		
1791	87.55*	1823	88.35	DATA SET 108*	
1796	87.55*	1826	88.35		
1799	87.65	1841	88.6	4.2	0.00584
1814	87.8	1844	88.6		
1817	87.9*	1857	88.8	DATA SET 109*	
1836	88.1	1865	88.85		
1840	88.1*	1873	89.1	4.2	0.00424
1852	88.3*	1888	89.3		
1857	88.3				
1867	88.45*	DATA SET 103			
1869	88.45				
1882	88.65	293	7.00		
		323	8.22		
DATA SET 101*		373	10.48		
		423	13.00*		
1648	60.35	473	15.86		
1667	60.8	523	19.16		

* Not shown in figure.

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5. APPENDICES

5.1. Methods for the Measurement of Electrical Resistivity

At the Center for Information and Numerical Data Analysis and Synthesis (CINDAS) of Purdue University, the experimental methods for the measurement of electrical resistivity have been classified into various categories according to a similar scheme used by CINDAS for the classification of methods for the measurement of thermal conductivity [264, pp. 13a-25a]. This classification scheme of CINDAS is presented below. Note that the letters in parentheses following the respective methods are the code letter used in the "Method Used" column of the Table of Measurement Information for indicating the experimental methods used by the various authors.

Methods for the Measurement of Electrical Resistivity

A. Steady-State Methods

1. Voltmeter and ammeter direct reading method (V) [265, p. 159; 266, pp. 244-5]
2. Direct-current potentiometer method (A) [267, pp. 151-8]
    a. 4-probe potentiometer method
3. Direct-current bridge methods (B) [267, pp. 144-51]
    a. Kelvin double bridge method
    b. Mueller bridge method
    c. Wheatstone bridge method
4. Van der Pauw method (P) [268,269]
5. Galvanometer amplifier method (G) [270, pp. 159-62]

B. Non-Steady-State Methods

1. Periodic current method
    a. Direct connection to sample
        (1) Alternating-current potentiometer method (C) [267, pp. 161-2]
        (2) Alternating-current bridge method (D) [267, p. 162]
    b. No connection to sample
        (1) Mutual inductance method (M) [271]
        (2) Self-inductance method (S) [272]
        (3) Rotating field method (R) [273]

2. Non-periodic current method

   a. Direct connection to sample

      (1) Transient (subsecond) method (T) [154]

   b. No connection to sample

      (1) Eddy current decay method (E) [273; 267, p. 103]

5.2. Conversion Factors for the Units of Electrical Resistivity

The recommended values and experimental data for the electrical resistivity tabulated in this work are in the units: $10^{-8}\ \Omega\,m$. Conversion factors for the units of electrical resistivity, which may be used to convert the values given in ($10^{-8}\ \Omega\,m$) to values in other units, are given below.

Conversion Factors for the Units of Electrical Resistivity

Units to be Converted to	Multiply the Value Given in ($10^{-8}\ \Omega\,m$) by
ohm-meter (Ω m)	1×10^{-8}
ohm-centimeter (Ω cm)	1×10^{-6}
ohm-inch (Ω in.)	3.937×10^{-7}
ohm-foot (Ω ft)	3.281×10^{-8}
microohm-centimeter ($\mu\Omega$ cm)	1
abohm-centimeter (abΩ cm)	1×10^{3}
statohm-centimeter (statΩ cm)	1.113×10^{-18}
emu (= abΩ cm)	1×10^{3}
esu (= statΩ cm)	1.113×10^{-18}
ohm-circular mil per foot (Ω cmil ft^{-1})	6.015

Example: $1.000 \times 10^{-8}\ \Omega\,m = 3.937 \times 10^{-7}\ \Omega$ in..

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