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Electrical Resistivity of Alkali Elements

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This paper presents and discusses the available data and information on the electrical resistivity of alkali elements (lithium, sodium, potassium, rubidium, cesium, and francium) and contains recommended reference values (or provisional or typical values). The compiled data include all the experimental data available from the literature and cover the temperature dependence, pressure dependence, and magnetic flux density dependence. The temperature range covered by the compiled data is from cryogenic temperatures to above the critical temperature of the elements. The recommended values are generated from critical evaluation, analysis, and synthesis of the available data and information and are given for both the total electrical resistivity and the intrinsic electrical resistivity. For most of the elements, the recommended values cover the temperature range from 1 K to 2000 K.

Key words: Alkali elements; cesium; electrical resistivity; francium; lithium; magnetic flux density dependence; potassium; pressure dependence; rubidium; sodium; temperature dependence.

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List of Symbols

a	Constant
A	Code for dc potentiometer method
b	Constant
B	Magnetic flux density; code for dc bridge method
c	Constant
C	Code for ac potentiometer method
d	Constant
D	Code for ac bridge method
E	Code for eddy current method
G	Code for galvanometer amplifier method
I	Code for Induction method
L_F	Latent heat
M	Atomic weight
P	Pressure
Q	Code for Q-meter method
R	Resistance
T	Temperature
T_k	Knot temperature
T_m	Melting point
T_c	Critical temperature
T'	Reduced temperature
ρ	Electrical resistivity
ρ_0	Residual electrical resistivity
ρ_i	Intrinsic electrical resistivity
σ	Electrical conductivity
σ'	Reduced electrical conductivity
θ_D	Debye temperature
θ_R	Empirical temperature
$\rightarrow$	Code for miscellaneous methods

1. Introduction

The purpose of this work is to present and discuss the available data and information on the electrical resistivity of alkali elements, to critically evaluate, analyze, and synthesize the data, and to make recommendations for the best values for using of the electrical resistivity over a wide temperature range. Experimental electrical resistivity data are available in the world literature for elements Li, Na, K, Rb, and Cs, and there exist estimated values for Fr. These elements are of much interest to both engineers and scientists since liquid alkali metals have excellent heat transfer characteristics. For instance, sodium has been used as a coolant for nuclear reactors and nuclear powered submarines.

Table 1 contains information on the crystal structures, transition temperatures, and certain other pertinent physical constants of the alkali elements. This information is very useful in data analysis and synthesis. For example the electrical resistivity of a material changes abruptly when the material undergoes any transformation. One must, therefore, be extremely cautious in attempting to extrapolate the electrical resistivity value across any transition temperature. No attempt has been made to critically evaluate the temperatures and constants given in table 1, and they should not be considered as recommended values.

This work is organized in six sections. In the theoretical background section, the elementary theory of electrical resistivity is discussed. In the section on data evaluation and generation of recommended values, the general procedures and methods for data evaluation and for the generation of recommended values are outlined.

In the data presentation section, the electrical resistivity of each of the alkali elements is presented separately in the order of increasing atomic number. Values of electrical resistivities are given for both the solid and liquid states. For an element at moderate and high temperatures the true electrical resistivity values for different high-purity (99.9^+) samples at each temperature should be but little different; therefore, a set of recommended electrical resistivity values can be given for a high-purity element. At low temperatures, however, the electrical resistivity for different samples with small differences in impurity and/or imperfection differ greatly, and a set of recommended or provisional values applies only to a sample with that particular amount of impurity

TABLE 1. PHYSICAL CONSTANTS OF ALKALI ELEMENTS[a]

Name	Atomic No.	Atomic[b] Weight	Density[c] Kg m^{-3}x10^{-3}	Crystal[d] Structure	Phase Transition	Debye[e] Temperature at 0 K	Debye[e] Temperature 298 K	Melting Point, K	Normal Boiling Point, K	Critical Temp., K
Lithium (Li)	3	6.941	0.534	b.c.c.	Martensitic transformation at low temp.	352 ± 1.7	448	453.7	1617	3720
Sodium (Na)	11	22.989	0.9712	b.c.c.	Martensitic transformation at low temp.	157 ± 1	155 ± 5	371.0	1157	2733
Potassium (K)	19	39.098	0.871	b.c.c.		89.4 ± 0.5	100	336.35	1032	2280.8 ± 3
Rubidium (Rb)	37	85.4678	1.53	b.c.c.		54 ± 4	59	312.64	961	2106 ± 5
Cesium (Cs)	55	132.9054	1.873	b.c.c.		40 ± 5	43	301.55	944	2051.1 ± 4.4
Francium (Fr)	87	(223)	2.14			39		300.2	950	

[a] Information taken from Ref. [1].

[b] Atomic weights based on $^{12}C = 12$ as adopted by the International Union of Pure and Applied Chemistry in 1971. The number in parentheses is the mass number of the isotope of longest known half life.

[c] Density values given for 293 K.

[d] Structure at room temperature.

[e] Deduced from specific heat measurements.

and imperfection. Thus, the low-temperature electrical resistivity of an element may be presented as a family of curves, each of which is recommended for a sample with a particular amount of impurity and degree of imperfection, and hence a particular residual resistivity, ρ_0. In this work, to well-defined curves are recommended for the full temperature range: one representing the intrinsic electrical resistivity, ρ_i, which is a unique function of temperature and is zero at absolute zero, and the other representing the total resistivity, ρ, for the purest form of each element on which measurements have been made. The latter curve at low temperatures is only applicable to the particularly characterized specimen with residual electrical resistivity clearly specified in the Remarks. These two curves come together at temperatures above about 100 K. Figure 1 shows the relationship beteen ρ_i, ρ_0, and ρ.

The recommended or provisional electrical resistivities are tabulated with uniform but step-wise increasing increments in temperature as the temperature increases. The estimated accuracy of the recommended or provisional values for each element in each different temperature range is given in the discussion. The asterisked values in the tables are interpolated, extrapolated, or estimated in the temperature ranges where no experimental data are available.

From the recommended values of ρ and ρ_i which are tabulated in this report, the electrical resistivity of a particular sample at low temperatures can be predicted by either of the following to ways. One way is to find the difference between the measured resistivity value and the recommended ρ value at the same low temperature, then add this difference to the recommended ρ values at other temperatures. The second way is to compare the measured low temperature (i.e. below 100 K) value with ρ_i and get the difference which is the residual resistivity of this particular sample, then add this ρ_0 to the recommended ρ_i at the other temperatures.

In the figure showing experimental data, a data set that consists of a single point is denoted by a number enclosed by a square, and a curve that connects a set of data points is denoted by a ringed number. These numbers correspond to those in the accompanying table on specimen characterization and measurement information and in the data table. When several sets of data are too close together to be distinguishable, some of the data sets or data points, those listed in the table, are omitted from the figure for the sake of clarity. For all elements except francium, both logarithmic plotting and linear plotting of electrical resistivity are used in order that details may be clearly shown for both the low and high temperature regions. The recommended values are presented in the same figure. The heavy solid curves represent recommended values, and the dashed curves give provisional values in the temperature ranges where few experimental data or none are available. In the figure, the melting point (M.P.), normal boiling point (N.B.P.), and critical temperature (C.T.) of the elements are indicated. Some of these transition points are also mentioned in the text. At the melting point the resistivity exhibits sharp discontinuity.

The tables on specimen characterization and measurement information give for each set of data the folloing information: the publication reference number, author's name, year of publication, experimental method used for the measurement, temperature range covered by the data, substance name and specimen designation, as well as the detailed description and characterization of the specimen and information on measurement conditions that are reported in the original paper. In these tables the code designations used for the experimental methods for electrical resistivity determination are as follows:

A DC Potentiometer Method
B DC Bridge Method
C AC Potentiometer Method

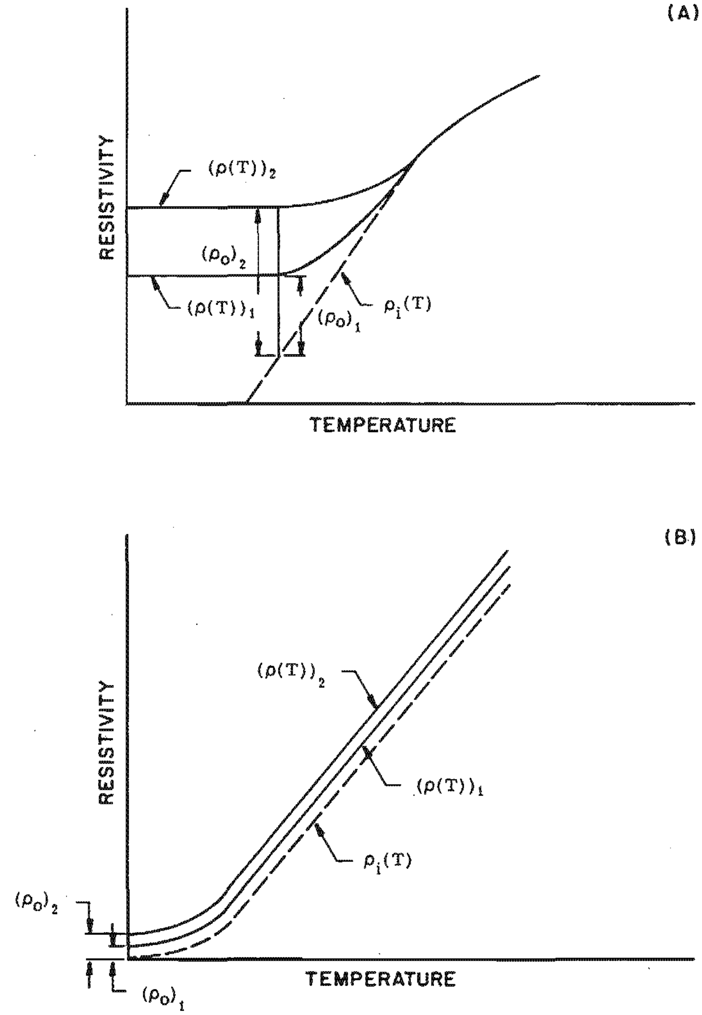


Figure 1. Relationship between intrinsic resistivity $\rho_i(T)$, residual resistivity, ρ_o, and total resistivity, $\rho(T)$. (A) logarithm scale, (B) linear scale.

D AC Bridge Method
E Eddy Current Method
G Galvonometer Amplifier Method
I Induction Method
Q Q-Meter Method
V Voltmeter and Ameter Direct Reading
→ Other than above and described in the remarks

For a comprehensive yet concise review of all these methods, the reader is referred to the references of Appendix 8.1.

The available data and information for the pressure dependence and magnetic flux density dependence of the electrical resistivity are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only experimental data are presented in this report.

In the Thirteenth General Conference on Weights and Measures held in October 1967 in Paris, the unit "ohm-meter" (symbol: Ω m) as adopted as the SI unit for electrical resistivity. In this work, the SI units are used. Table 2 gives conversion factors which may be used to convert the electrical resistivity values in Ω m presented in this work to values in any of the several other units listed. Conversion tables for units of temperature, pressure, and magnetic flux density are listed in Appendix 8.2. It should be noted that certain of these conversion factors are not exact relationship.

In the summary and conclusions section, figures are presented in which all the recommended curves on the intrinsic electrical resistivity are grouped together in order to facilitate a visual comparison.

The complete bibliographic citation for the 129 references are given in the references section. Most of the references are available at CINDAS which are listed at the end of reference citations with numbers prefixed with the letter E or T.

2. Theoretical Background

The electrical resistivity, $\rho(T)$, of a metal is often described approximately by the Matthiessen rule [2][1]

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

[1] Figures in brackets indicate literature references in section 7.

TABLE 2. CONVERSION FACTORS FOR UNITS OF ELECTRICAL RESISTIVITY*

MULTIPLY by appropriate factor to OBTAIN →	abΩ cm	μΩ cm	Ω cm	statΩ cm	Ω m	Ω cir. mil ft^{-1}	Ω in.	Ω ft.
abohm-centimeter (emu)	1	0.001	10^{-9}	1.113×10^{-21}	10^{-11}	6.015×10^{-3}	3.937×10^{-10}	3.281×10^{-11}
microohm-centimeter	1000	1	10^{-6}	1.113×10^{-18}	10^{-8}	6.015	3.937×10^{-7}	3.281×10^{-8}
ohm-centimeter	10^{9}	10^{6}	1	1.113×10^{-12}	0.01	6.015×10^{6}	0.3937	0.0328
statohm-centimeter (esu)	8.987×10^{20}	8.987×10^{17}	8.987×10^{11}	1	8.987×10^{9}	5.406×10^{18}	3.538×10^{11}	2.949×10^{10}
ohm-meter	10^{11}	10^{8}	100	1.113×10^{-10}	1	6.015×10^{8}	39.37	3.281
ohm-circular mil per foot	166.2	0.1662	1.662×10^{-7}	1.850×10^{-19}	1.662×10^{-9}	1	6.54×10^{-8}	5.45×10^{-9}
ohm-inch	2.54×10^{9}	2.54×10^{6}	2.54	2.827×10^{-12}	0.0254	1.528×10^{7}	1	0.083
ohm-foot	3.048×10^{10}	3.048×10^{7}	30.48	3.3924×10^{-11}	0.3048	1.833×10^{8}	12	1

*This table is based on the universal constants from "The International System of Units (SI)," National Bureau of Standards, NBS Special Publication 330, 43 pp, 1974.

where ρ_0 is the residual resistivity at absolute zero and $\rho_i(T)$, the intrinsic resistivity, is the temperature-dependent resistivity of an ideally pure sample of the metal. The quantity ρ_0 arises from the presence of impurities, defects, and strains in the metal lattice, while $\rho_i(T)$ is caused by the interaction of the conduction electrons with the thermally induced vibrations of the lattice ions; that is, the phonons in the crystal. For a pure annealed sample at room temperature, ρ_0 is only a small fraction of the total resistivity. There are a number of mechanisms that could produce deviation from the Matthiessen rule, i.e., a term $\Delta\rho$ which could appear on the right-hand side of equation (1). The first comprehensive survey of such deviation as made by J. Bass [128]. A more recent study by Cimberle, et al. [129] brings references up to date.

The intrinsic resistivity due to electron-phonon interactions may be approximated by the Grüneisen-Bloch relation [3]

$$\rho_i(T) = \frac{C}{M\,\theta_R}\left(\frac{T}{\theta_R}\right)^5 \int_0^{\theta_R/T} \frac{z^5\,dz}{(e^z-1)(1-e^{-z})}, \qquad (2)$$

where C is a constant, M is the atomic eight, T is the absolute temperature, and θ_R is an empirical temperature characterizing the metal's ideal electrical resistivity in the same way that the Debye temperature, θ_D, characterizes a solid's lattice specific heat. It is often true that $\theta_R \approx \theta_D$. Below about 0.1 θ_R this relation reduces to

$$\rho_i(T) \approx 124.4\,\frac{C}{M}\,\frac{T^5}{\theta_R^{\,6}} \qquad (3)$$

At high temperatures, as $T \geq \theta_R$,

$$\rho_i(T) \approx \frac{C}{4M}\,\frac{T}{\theta_R^{\,2}}. \qquad (4)$$

The Grüneisen-Bloch equation is derivable for idealized monovalent metals with Debye phonon spectra and spherical Fermi surfaces totally neglecting the effect of Umklapp processes. However, because of its comparative simplicity, the Grüneisen-Bloch equation provides a most valuable tool for analyzing and discussing experimental data.

The Grüneisen-Bloch equation never holds over the entire temperature range for the alkali metals. It is approximately valid only at low and high temperatures. By inverting the computation, one may intercompare the behavior of different metals by treating the experimental results as deviations from the Grüneisen-Bloch equation which is done by employing θ_R as a variable parameter and computing the value that it must possess at any temperature in order for the Grüneisen-Bloch equation to agree with the experiment.

In all alkali metals the electrical resistivity increases abruptly on passing through the melting point and continues to rise in the liquid phase. The sudden change is due to the greater disorder of the liquid state and the disappearance of any definite crystal structure.

Mott [4] has presented a simple and fairly successful theory of molten metals. He ignored the disordered positions and diffusive movements of the vibrating ions and assumed that near the melting point the ions of the liquid metal still maintain a more or less regular pattern. Using an Einstein model, he obtained

$$\left(\frac{\rho_L}{\rho_S}\right)_{T_m} = \exp\left(\frac{80L_F}{T_m}\right), \tag{5}$$

where ρ_L and ρ_S are the electrical resistivities of the liquid and solid phases, T_m is the melting point, and L_F is the latent heat of fusion in kilojoules per mole. The calculated values of $(\rho_L/\rho_S)_{T_m}$ according to this formula compare moderately well with experimental data for alkali metals.

To estimate the electrical conductivity of molten alkali metals from the melting point to the critical point, Grosse [5] has proposed an empirical equation of the form of a simple equilateral hyperbola:

$$(\sigma' + b)(T' + b) = a \tag{6}$$

where $\sigma' = \sigma/\sigma_m$ is the reduced electrical conductivity and $T' = (T - T_m)/(T_c - T_m)$ is the reduced temperature, σ_m being the electrical conductivity of the liquid at the melting point and T_c the critical temperature; the quantities a and b are constants determined by the distances of the vertex of the hyperbola from the axes. The estimated values by Grosse's equation are valid for sodium, potassium, rubidium, and cesium, but not valid for lithium.

3. Data Evaluation and Generation of Recommended Values

Data analysis and synthesis were performed in this work whenever possible. This included critical evaluation of available data and related information, reconciliation of disagreements in conflicting data, correlation of data in terms of various parameters, and curve fitting with theoretical or empirical equations. Besides critical evaluation and analysis of the existing data, semiempirical techniques have been employed to fill gaps and to extrapolate existing data so that the resulting recommended values are internally consistent and cover as wide a range of temperature as possible.

In the critical evaluation of the validity of electrical resistivity data, any unusual dependence or anomaly was carefully investigated, the experimental techniques were reviewed to see whether the actual boundary conditions in the experiment agreed with those assumed in the theory, and the author's estimations of uncertainty were checked to ensure that all the possible sources of errors were considered. The sources of errors may have included uncertainty in the measurement of specimen dimensions and of the distance between the potential probes, uncertainty due to the effects of thermal expansion, uncertainty in temperature measurements, uncertainty in the sensitivity of measuring circuits, and so on.

Many authors have included detailed error estimates in their published papers, and from these it is possible to evaluate the uncertainty for a particular method. However, experience has shown that the uncertainty estimates of most authors are unreliable. In many cases the difference between the results of two sets of data is much larger than the sum of their stated uncertainties.

Besides evaluating and analyzing individual data sets, correlating data in terms of various relevant parameters is a valuable technique and has frequently been used in data analysis. These parameters may include purity, density, residual electrical resistivity, and so on.

For meaningful data correlation, information on specimen characterization is very important. A full description of the specimen should include, wherever applicable, the following: purity or chemical composition, type of crystal, crystal axis orientation for a single crystal, microstructure, grain size, preferred grain orientation, inhomogeneity or additional phases for a polycrystalline specimen, specimen shape and dimensions, method and procedure of fabrication, sample history or treatment, test environment, and pertinent physical properties such as density, hardness, and transition temperature. Data on poorly characterized materials can hardly be analyzed or used for data correlation.

Besides specimen characterization, a full description of experimental details should be given by the author in order that his data can be meaningfully evaluated and fully utilized. Sometimes, as an initial method of evaluating the quality of a paper, consideration might be given to the amount of experimental detail reported in the paper; lack of experimental detail might lead to the results being given less weight.

Our preliminary recommended values for the electrical resistivity of the alkali elements were derived from experimental data that were considered reliable, using computer least square fits and graphing aid. These values are then corrected for thermal linear expansion and smoothing with a cubic spline function of variable knots in the form of equation (7) and the final recommended values are obtained.

$$\log\rho_i = a + b(\log T - \log T_k) + c(\log T - \log T_k)^2 + d(\log T - \log T_k)^3 \tag{7}$$

where T = variable temperature in a given interval and T_k = minimum temperature in the interval.

Thermal linear expansion correction is necessary since the electrical resistivity measurements are ordinarily made at constant pressure on a sample with dimensions that change with temperature. In deriving the resistivity ρ from a measured resistance R using an equation such as

$$\rho = RA/\ell \tag{8}$$

where ℓ is length of the specimen and A its cross-section. It is common to use for A and ℓ the values measured at room temperature. This will not cause serious error in the results of measurements over not-too-large a temperature range, but the difference between

$$\rho_{\text{uncorrected}}(T) = R(T)A(293 \text{ K})/\ell(293 \text{ K}) \quad (9)$$

and

$$\rho_{\text{corrected}}(T) = R(T)A(T)/\ell(T) \quad (10)$$

should not be ignored. In the present work it has been important to determine which quantity is being reported in the research paper and to bring the results to a common basis by using a relation such as

$$\rho_{\text{uncorrected}}(T) = \rho_{\text{corrected}}(T) \cdot \left(\frac{A(T)}{A(293\ K)} \cdot \frac{\ell(293 \text{ k})}{\ell(T)}\right)^{-1}$$

$$\cong \rho_{\text{corrected}}(T)\left[1 + \frac{\ell(T) - \ell(93K)}{\ell(293 \text{ k})}\right]^{-1} \quad (11)$$

before making comparisons. It should be noted that not all the methods of measuring ρ are equivalent to measuring R, A, and ℓ, and that the correction for dimensional changes with temperature may differ with different experimental set up. It has been most convenient to convert the data reported as $\rho_{\text{corrected}}(T)$ to that of $\rho_{\text{uncorrected}}(T)$ and to carry out the synthesis of all data as $\rho_{\text{uncorrected}}(T)$. The final results have, however, been corrected to and reported as $\rho_{\text{corrected}}(T)$.

In estimating the uncertainty of our recommended values, the accuracy that can be achieved by the various experimental technique, the scatter of data, and the purity of the materials, among other factors, were taken into consideration. The uncertainty of a value is the maximum percentage deviation of the value from its true value. The ranges of uncertainties of recommended and provisional values are less than or equal to ±5% and greater than ±5%, respectively.

4. Electrical Resistivity of Alkali Elements

4.1. Lithium

Lithium, with atomic number 3, is a silvery white, soft alkali metal. It is the lightest of all metals with a density of 0.534 g cm^{-3} at 293 K. Except at low temperature, it has a body-centered cubic crystalline structure. It melts at 453.7 K and boils at about 1620 K. Its critical temperature has been estimated to be about 3720 K. Upon cooling through 75 K, body-centered cubic crystalline lithium undergoes a spontaneous martensitic transformation to a close-packed hexagonal structure. The transformation does not take place completely and staking faults are usually present. At 4 K possibly as much as 90% has transformed to this second phase. On reheating, reversion to the body-centered crystalline structure does not begin until 90 K and will not be complete until 160 K. Naturally occurring lithium is composed of two stable isotopes: ^{7}Li (92.58%) and ^{6}Li (7.42%). Three other radioactive isotopes are known to exist. Lithium ranks [illegible] in the order of abundance of elements in the continental crust of the earth (0.002% by weight).

a. Temperature Dependence

There are 44 sets of experimental data available for the electrical resistivity of lithium. The information on specimen characterization and measurement conditions for each of the data sets is given in table 4. The data are tabulated in table 5 and shown in figures 2 and 3. Determinations of the electrical resistivity of lithium for the solid and liquid phases cover continuously the temperature range from 1.2 to 1700 K.

There are 22 data sets obtained below 90 K. Among these, eight sets are single data points at liquid helium temperature. Dugdale, Gugan, and Okumura [6] reported the data for Li consisting of over 99% ^{6}Li (curve 34). Krill [7] (curve 29) had the purest material (99.98% pure). There are seven sets of intrinsic resistivity values belo 80 K, but these disagree by as much as a factor of 9. It is evident that these are large deviations from Matthiessen's Rule. The data of Krill and Lapierre [127] on dilute solutions of Ag in Li indicates that $\rho - \rho_o$ may exceed ρ_i by a factor of 3 or more below 30 K, and that $\rho - \rho_i$ may exceed ρ_o by a factor of 2 or more above 80 K: at intermediate T deviations from Matthiessen's Rule are of the order of 20% of the total resistivity. In addition, Li undergoes a martensitic transition (b.c.c.-h.c.p.) at low T, as a result of which electrical resistivity values depend somewhat on the thermal history of the samples; see Dugdale and Gugan [21]. Because of these difficulties, Krill's data for ρ have been relied on at the lowest temperatures, since his material had the lowest ρ_o. In view of Krill's lack of attention to the martensitic transition, his values for ρ must be considered as provisional. In view of the deviations from Matthiessen's Rule, useful values of ρ_i at the lowest temperatures can be derived only by a more elaborate analysis, and are omitted here.

There are 21 data sets from 80 to 453.7 K. They agree with one another within 5%. Dugdale and Gugan [8] reported electrical resistivities at constant volume (curve 7), which are very close to those at zero pressure (curve 6). A least-mean-square error fit to the selected experimental data in this range was made with a Bloch-Grüneisen equation. The resulting values were corrected for thermal linear expansion, and then fitted with the cubic spline function equation (7) to obtain the final recommended values in this temperature range. The coefficients of equation (7) obtained in this manner are as follows:

Temperature range, K	a	b	c	d
40 – 81.06	−1.173	3.193	7.549	−17.43
81.06 – 92.295	0.0139	2.904	−8.494	38.64
92.295 – 453.6	0.1575	2.314	−1.962	1.127

There are 17 data sets available for the liquid state. They agree with one another within about 10%. Freedman and Robertson [9] (curve 5) give the lowest values while Rigney et al. [10] (curve 11) give the highest values. Grosse [5] derived electrical resistivity values (curve 45) in the range from the melting point to his estimated critical temperature, 4150 K, by fitting the experimental data of Freedman and Robertson [9] (curve 5) and Kapelner et al. [11] (curve 38) to a hyperbola equation. All the experimental data except Rigney's data ere used here for fitting the cubic spline function equation (7) to obtain the final recommended values. The coefficients of equation (7) are the following:

Temperature range, K	a	b	c	d
453.7 – 1080.5	1.395	0.622	−0.228	0.430
1080.5 – 2200	1.620	0.634	0.258	0.314

The resistivity values represented by these equations are not corrected for thermal linear expansion of the container, which in most cases is not specified.

At the melting point (463.7 K), the electrical resistivity of Li in the liquid state is about 60% higher than that of the solid state.

The recommended values for the total and intrinsic electrical resistivities of lithium are listed in table 3, and those for the total electrical resistivity are also shown in figures 2 and 3. The recommended values for the total resistivity are for 99.98⁺% pure lithium and those at temperatures below 50 K are applicable only to a specimen with residual resistivity of 0.00724×10^{-8} Ωm. The recommended values for the liquid state are for the saturated liquid. The recommended values from 1 to 453.7 K are corrected for thermal linear expansion. The correction amounts to −0.79% at 1 K, −0.72% at 80 K, and 0.85% at 453.7 K. The uncertainty of the recommended values for the total electrical resistivity is believed to be within ±20% from 1 K to 60 K, within ±5% from 60 K to 1500 K and within ±10% from 1500 K to 2000 K. Above 40 K the uncertainty of the recommended values for the intrinsic resistivity is a little higher than that of the total electrical resistivity; below 40 K, because of the deviations from Matthiessen's Rule, the uncertainty of ρ_i is too large and values are not listed in the table.

b. Pressure Dependence

There are 10 sets of experimental data available for the electrical resistivity of lithium as a function of pressure. The information on specimen characterization and measurement condition for each of the data sets is given in table 6. The data are tabulated in table 7 and shown in figure 4.

The available data and information for the pressure dependence of electrical resistivity of lithium are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only the available experimental data are presented here.

c. Magnetic Flux Density Dependence

There are 9 sets of experimental data available for the electrical resistivity of lithium under the influence of magnetic field. The information on specimen characterization and measurement information for each of the data sets is given in table 8. The data are tabulated in table 9 and shown in figure 5.

The available data and information for the magnetic flux density dependence of electrical resistivity of lithium are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only experimental data are presented here.

TABLE 3. RECOMMENDED ELECTRICAL RESISTIVITY OF LITHIUM
(Temperature Dependence)

[Temperature, T, K; Total Resistivity, ρ, 10^{-8} Ωm; Intrinsic Resistivity, ρ_i, 10^{-8} Ωm]

Solid					Liquid	
T	ρ	T	ρ	ρ_i †	T	ρ
1	0.00724*	35	0.047*		453.7	24.80
2	0.00724*	40	0.074*	0.067*	500	26.33
3	0.00725*	45	0.109*	0.102*	600	29.34
4	0.00727*	50	0.162*	0.155*	700	32.10
5	0.00730*	60	0.345*	0.338*	800	34.71
6	0.00735*	70	0.636	0.629	900	37.22
7	0.00740*	80	1.000	0.993	1000	39.69
8	0.00745*	90	1.36	1.35	1100	42.13
9	0.00751*	100	1.73	1.72	1200	44.61
10	0.00760*	150	3.72	3.71	1300	47.41
11	0.00773*	200	5.71	5.70	1400	49.97
12	0.00792*	250	7.65	7.64	1500	53.00
13	0.00817*	273.15	8.53	8.52	1600	56.34*
14	0.00849*	293	9.28	9.27	1700	60.03*
15	0.00889*	300	9.55	9.54	1800	64.12*
16	0.00936*	350	11.45	11.44	1900	68.67*
18	0.0106*	400	13.40	13.39	2000	73.73*
20	0.0122*	450	15.44	15.43	2100	79.44*
25	0.0185*	453.7	15.59	15.58	2200	85.59*
30	0.0300*					

† At temperatures below 40 K, the uncertainty of ρ_i is so large that values are not listed.

* Provisional values.

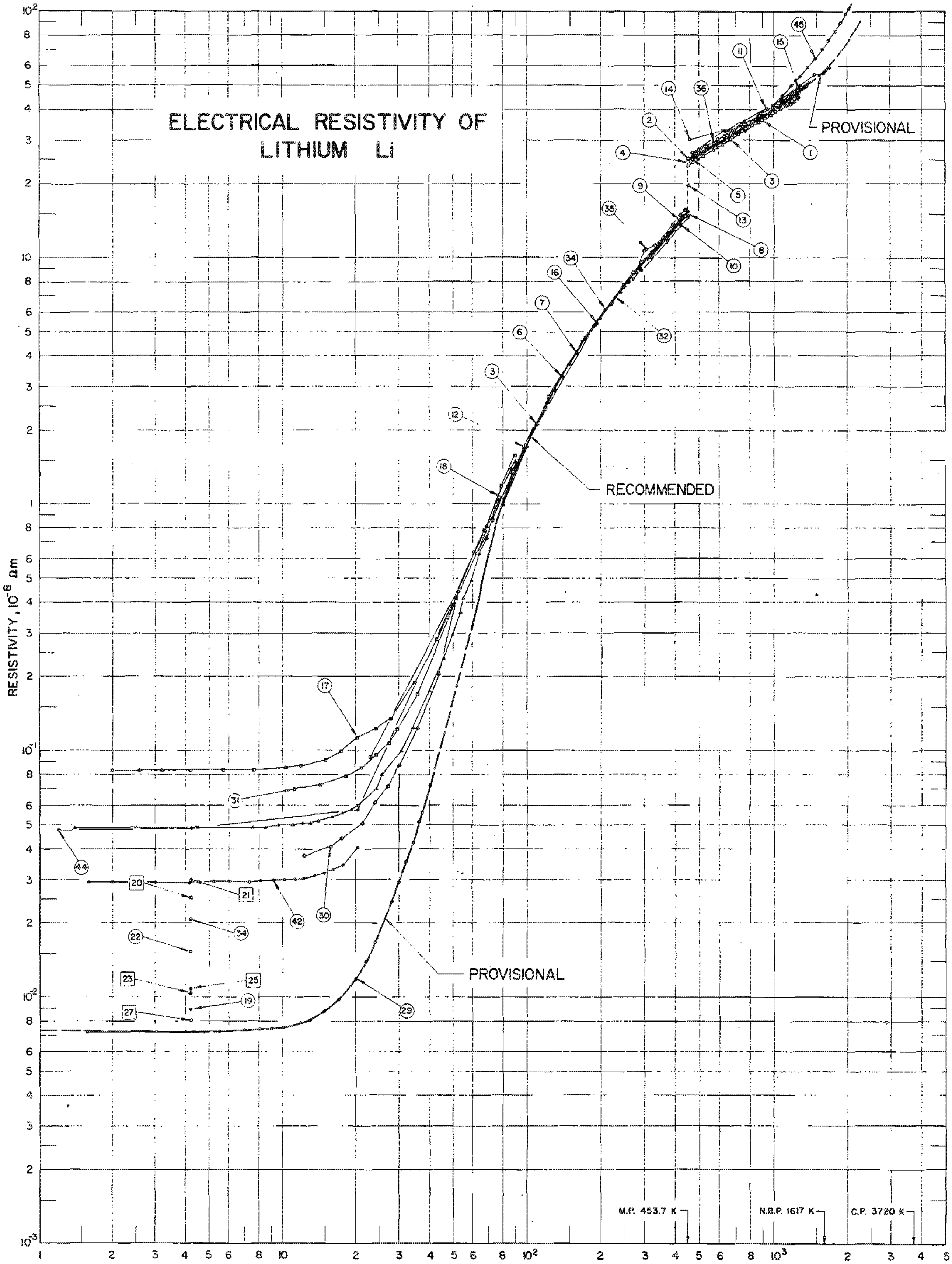

ELECTRICAL RESISTIVITY OF
LITHIUM Li
RESISTIVITY, 10^{-8} Ωm
TEMPERATURE, K
RECOMMENDED
PROVISIONAL
PROVISIONAL
M.P. 453.7 K
N.B.P. 1617 K
C.P. 3720 K
CINDAS

FIGURE 2

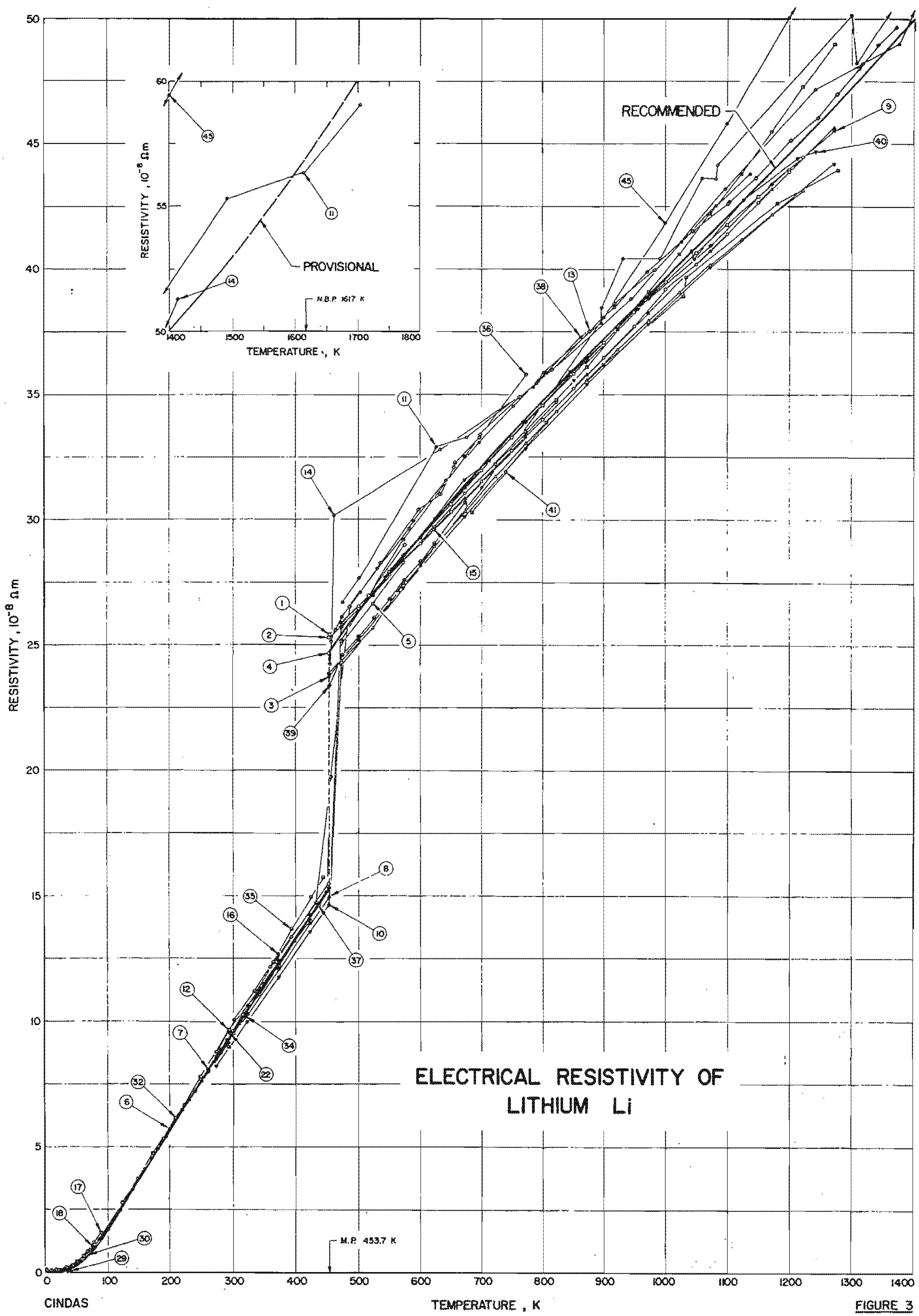

RESISTIVITY, 10^{-8} Ωm
TEMPERATURE, K
RECOMMENDED
PROVISIONAL
N.B.P. 1617 K
M.P. 453.7 K
ELECTRICAL RESISTIVITY OF
LITHIUM Li
CINDAS

FIGURE 3

TABLE 4. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF LITHIUM Li (Tempe. ependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent ications, and Remarks
1	12	Shpil'rain, E'.E'., Soldatenko, Yu.A., Yakimovich, K.A., Fomin, V.A., Savchenko, V.A., Belova, A.M., Kagan, D.N. and Krainova, I. F.	1965	A	454-1223	Li(I)	99.6⁺ Li, 0.26 Na, 0.0011 K, 0.0013 (0.015 other impurities; specimen was in liquid state which was enclos stainless steel tube; specimen density = [0.5368 -1.0208 x10^{-4} (T-273.15)] melting point = 453.65 K, boiling point = 1603 K; resistivity was mea: the insert atmosphere and the experiment results was presented as the f equation. ρ = 20.96 + 2.4705 x 10^{-2} (T-273.15) ρ in units of 10^{-8} Ω m,
2	12	Shpil'rain, E'.E'., et al.	1965	A	454-1223	Li(II)	99.8⁺ Li, 0.13 Na, 0.01 Ca, 0.001 K ; 15 other impurities; specimen was in liquid state which was enclosed i less steel tube; other specifications similarly as above specimen; ρ = 1 .053 x10^{-2} (T-273.15) -4.81 x 10^{-6} (T-273.15)^2
3	12	Shpil'rain, E'.E'., et al.	1965	A	454-1223	Li(III)	Similar to the above specimen; ρ = 17. !7 x10^{-2} (T-273.15) -8.447x10^{-6} (T-273.15)^2
4	13	Faber, T.E.	1966	A	273-573		Nominally pure Li was supplied by A.I .y Inc.; specimen was forced by dry helium gas into a clean stainless st 2.5 mm inner diameter and 11.5 cm in length; for measurements at elev perature, the tube was enclosed in a furnace filled with helium.
5	9	Freedman, J.F. and Robertson, W.D.	1961	B	473-923		99.⁺ Li, major impurity Na; vacuum d specimen was supplied by Nuclear Development Corp.; specimen was state and was enclosed in 304 stainless steel tube with 0.349" in diam 20" in length.
6	8	Dugdale, J.S. and Gugan, D.	1962	A	80-290		Pure Li specimen was obtained from tl m Corporation of America; 0.05 cm in diameter and 10 cm in length; re: was measured at zero pressure condition.
7	8	Dugdale, J.S. and Gugan, D.	1962	A	80-290		Similar to the above specimen; resisti calculated at constant density.
8	14	Shpil'rain, E'.E'. and Savchenko, V.A.	1968	A	273-1273	Li 1	0.8 Na, 0.0054 K, 0.003 Ca, <0.003 .8 Mg, 0.001 Si, <0.0003 Mn, 0.003 Fe, 0.0036 Ni, 0.0069 Cr, 0.03 Zr)05 C; specimen was filled in a 1Kh18N9T stainless steel test tube, .n diameter and 500 mm long with a wall thickness of 0.75 mm; data pre s smooth value by least squares method.
9	14	Shpil'rain, E'.E'. and Savchenko, V.A.	1968	A	273-1273	Li 2	0.1 Na, 0.0015 K, <0.002 Ca, <0.005 '12 Mg, <0.003 Si, 0.002 Mn, <0.13 Fe, 0.016 Ni, 0.024 Cr, <0.00025 '12 N_2 and 0.096 O_2; other specifications similar to the above specimen.
10	14	Shpil'rain, E'.E'. and Savchenko, V.A.	1968	A	273-1273	Li 3	0.1 Na, 0.0015 K, <0.003 Ca, <0.005)6 Mg, 0.025 Si, 0.00082 Mn, <0.01 Fe, <0.01 Nb, <0.01 Cr, <0.01 Zr N_2 and 0.045 O_2; other specifications similar to the above specimen.
11	10	Rigney, D.V., Kapelner, S.M., and Cleany, R.E.	1965	A	479-1703		0.24 O_2, <0.003 N_2, <0.0002 C, <0.0(0.01 Nb, 0.013 Na, <0.01 Fe and <0.001 Ni; specimen was in liquid s was filled in Nb-1 Zr capsule.
12	15	Bidwell, C.C.	1926		73-423		Specimen 1.10 cm in diameter and 25 (igth was produced by extrusion through a die.
13	16	Tepper, F., Felenak, J., Roehlieh, F. and May, V.	1965	A	308-1360		Li specimen was filled in a Hyan lindrical cell; density (g/cm^3) = 0.5345 - 0.30884 x10^{-4} (T-30 .
14	17	Roehlieh, F. and Tepper, F.	1965	A	463-1366		Liquid Li specimen placed in a H / cylindrical cell 0.5" outside diameter 0.063" in wall and 26" i vere extracted from the smooth curve.

TABLE 4. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF LITHIUM Li (Temperature De; nce) (continued)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), ; ications, and Remarks
15	18	Semyachkin, B. E. and Solov'ev, A.N.	1964	A	453-1273		Li specimen TV8774-58 was placed in 1 N9T 0.8/0.5 mm capillary with 600 mm in length.
16	19	Guntz, A. and Broniewski, W.	1909		86-372		Pure
17	20	Rosenberg, H.M.	1956		2-293	Li 1	Pure Li was distilled into a stainless st pillary 0.83 mm inside diameter, copper leads were in direct contact w e specimen.
18	20	Rosenberg, H.M.	1956		2-293	Li 2	Similar to the above specimen; except th per contacts was soldered outside the capillary.
19	21	Dugdale, J.S. and Gugan, D.	1961	A	4.2, 80	Li 18C	Pure Li wire specimen 3 mm in diamet 10 cm in length; specimen was obtained from the Lithium Corporatic merica; it was heated at 423 K for 20 hrs.
20	21	Dugdale, J.S. and Gugan, D.	1961	A	4.2	Li 7A	Similar to the above specimen; except th neter is 0.5 mm and no heat treatment.
21	21	Dugdale, J.S. and Gugan, D.	1961	A	4.2	Li 16A	Similar to the above specimen.
22	21	Dugdale, J.S. and Gugan, D.	1961	A	4.2	Li 8B	Similar to the above specimen.
23	21	Dugdale, J.S. and Gugan, D.	1961	A	4.2	Li 12C	Similar to the above specimen.
24*	21	Dugdale, J.S. and Gugan, D.	1961	A	4.2	Li 13C	Similar to the above specimen.
25	21	Dugdale, J.S. and Gugan, D.	1961	A	4.2	Li 15C	Similar to the above specimen.
26	21	Dugdale, J.S. and Gugan, D.	1961	A	4.2	Li 19C	Similar to the above specimen.
27	21	Dugdale, J.S. and Gugan, D.	1961	A	4.2	Li 17C	Similar to the above specimen; except th neter is 5 mm and specimen was heat treated for 24 hrs at 423 K.
28	22	Krautz, E.	1950	A	273		Pure.
29	7	Krill, G.	1971	A	1.3-40		99.98 pure; <0.0045 K, <0.004 Cl, <0.(ı, <0.003 N_2, <0.001 Ca and <0.0003 Fe; specimen was 0.5 mm i ieter and 50 cm in length; ρ_0/ρ_{300} = 7×10^{-4}.
30	23	MacDonald, D.K.C., White, G.K., and Woods, S.B.	1955	A	12-295	Li 2	Pure Li specimen was obtained from Me , A.D. Mackay, Inc.; specimen was extruded with a hydraulic press into a less steel tube with a film of Vaseline lubricating the inside wall of the tube imen diameter 1.4 mm.
31	23	MacDonald, D.K.C., et al.	1955	A	12-295	Li 3	Pure Li specimen was supplied by New I s an Chemicals Ltd. (London); other specifications were similar to the ab ecimen.
32	6	Dugdale, J.S., Gugan, D., and Okumura, K.	1961	A	4.2-320	Li 1	92.7+ ^{7}Li; 7.3 ^{6}Li; 0.012 Al; 0.058 Ca; (Na; 0.011 K; 0.008 Fe, 0.004 Cu, 0.14 Mg and 0.04 N; the specimen wa ruded into the form of wire about 0.5 mm in diameter and 100 cm in le the results of electrical resistivity was taken from the ideal resistivity p e residual resistivity .
33	6	Dugdale, J.S., et al.	1961	A	4.2-320	Li 2	0.043 Na, 0.011 K, 0.006 Cu and 0.061 other specifications similar to the above specimen.
34	6	Dugdale, J.S., et al.	1961	A	4.2-320	^{6}Li	99.3 ^{6}Li, 0.7 ^{7}Li, 1.46 Ca, 0.066 Na, (, 0.2 Cu, 0.035 Mg, 0.13 Sr, 0.2 Ba and trace Al, Cr and F; speci vas obtained from Oak Ridge National Lab.; specimen was extruded in the f f wire about 0.5 mm in diameter and 100 cm in length; electrical resis was taken from the ideal resistivity plus the residual resistivity.

* Not shown in figure.

TABLE 4. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF ... ence) (continued)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation		...fications, and Remarks
35	24	Grube, G., Vosskübler, H., and	1932		273-443		99.0 pu densi	5 SiO_2, 0.32 Li_3N, and trace of Al_2O_3;
36	25	Ioannides, P., Nanyen, V.T., and Enderby, J.E.	1973		473-773		Pure; li	
37	11	Kapelner, S. and Bratton, W.	1961	A	299.9-452.6		99.9+ Li speci purif taine to tr (0.7	).002 each Cl, Cr, 0.005 Fe; the p. of America; the specimen was itanium sponge and was then main- timate contact with the sponge prior ntainer was type 347 stainless steel ll thickness.
38	11	Kapelner, S. and Bratton, W.	1961	A	454.6-1137.6		Same as	
39	26	Arnol'dov, M.N., Ivanovskii, M.N., Pleshivtsev, A.D., Subbotin, V.I., and Shmatko, B.A.	1970		454-623		0.5 Na, and < as th T in	)01 C_2, 0.006 Ca, 0.03 Cr, 0.04 Si, ectrical resistivity data were reported 8 (T-273 K) ρ in units of 10^{-2} Ωm and
40	27	Savchenko, V.A. and Shpil'rain, E'.E'.	1970		543.5-1243.9		0.1 Na, 0.00 speci	Cr, 0.003 Fe, 0.0013 K, 0.0027 Mg, 0.1 O_2, and 0.0001 Zr; liquid state
41	27	Savchenko, V.A. and Shpil'rain, E'.E'.	1970		543.5-1243.9	Li + 0.1 Na	0.1 Na,	Cr, 0.13 Fe, 0.001 Mg, 0.002 Mn, and 0.00025 Zr; liquid state specimen.
42	28	MacDonald, D.K.C. and Mendelsohn, K.	1950	G	1.6-20	Li 1	Pur	ned from Dr. R. A. Hull; relative lectrical resistivity were calculated and the thermal expansion correction
43*	29	Meissner, W. and Voigt, B.	1930		20.4-273.16	Li 1	Pur	nple dimension 0.5 mm in diameter ta were reported; electrical resis- l resistivity at 273.16 K and the ing temperature.
44	29	Meissner, W. and Voigt, G.	1930		1.19-273.16	Li 2	Pure; sample dimension 1 x 3 x 28 m stivity data were calculated b he thermal expansion correc	re resistance were reported; electrical e electrical resistivity at 273.16 K measuring temperature.
45	5	Grosse, A.V.	1966		454-4150		] al resistivity data were calc 0.302) (T' + 0.302) = 0.392	n the semiempirically equation = σ/σ_m and T' = T-T_m/($T_{c.t.}$-$T_{m.p.}$).

*Not shown in figure.

TABLE 5. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF LITHIUM Li (Ten e Dependence)

[Temperature, T, K; Resistivity, ρ, 10^{-8} Ωm]

T	ρ
CURVE 1	
454	25.43
500	26.57
550	27.81
600	29.05
650	30.29
700	31.52
750	32.76
800	34.00
850	35.24
900	36.47
950	37.71
1000	38.95
1050	40.19
1100	41.42
1150	42.66
1200	43.90
1223	44.47
CURVE 2	
453.65	25.33
500	26.50
550	27.90
600	29.29
650	30.61
700	31.97
750	33.29
800	34.56
850	35.83
900	37.07
950	38.28
1000	39.47
1050	40.64
1100	41.77
1150	42.89
1200	43.98
1223	44.48*
CURVE 3	
453	23.77
473	24.40
523	25.95
573	27.45
623	28.91
673	30.33
723	31.70
773	33.04
CURVE 3 (cont.)	
873	34.33
873	35.58
823	36.79
973	37.95
1023	39.07
1073	40.15
1123	41.19
1173	42.18
1223	43.14
CURVE 4	
273.15	8.7
369.15	12.4
453.15	15.5
453.15	24.7
516.15	27.0
575.15	29.0
CURVE 5	
473.15	25.06
523.15	26.6
573.15	28.28
623.15	29.70
673.15	31.04
723.15	32.22
773.15	33.44
823.15	34.68
CURVE 6	
80	0.995
100	1.714
120	2.497
140	3.303
160	4.113
180	4.910
200	5.704
220	6.472
240	7.231
260	7.995
273.15	8.495
280	8.753
290	9.135
CURVE 7	
80	0.993*
100	1.710*
120	2.490*
140	3.294*
160	4.104
180	4.91*
200	5.710*
220	6.503*
240	7.286*
260	8.076
273.15	8.591
280	8.862
290	9.257
CURVE 8	
273	8.49*
323	10.29
373	12.10
423	13.90
453	14.97
473	25.90
573	28.37
673	30.84
773	33.31
873	35.78
973	38.25
1073	40.72
1173	43.19
1273	45.16
CURVE 9	
273	8.61*
323	10.62
373	12.43
423	14.24
453	15.33
473	25.74
573	28.55
673	31.26
773	33.88
873	36.41
973	38.83
1073	41.16
1173	43.40
1273	45.54
CURVE 10	
273	8.18
323	9.97
373	11.76
423	13.55
453	14.62
473	24.24
573	27.25
673	30.11
773	32.82
873	35.38
973	37.80
1073	40.08
1173	42.20*
1273	44.19
CURVE 11	
475.6	26.73
501.0	27.68
626.2	32.91
676.0	33.28
790.3	35.44
793.8	35.55
802.0	35.87
896.4	37.86
897.5	38.47
932.9	40.44
991.4	40.41
1060.5	43.62
1082.0	43.60
1085.0	44.15
1299.8	50.15
1308.4	48.24
1491.3	55.31
1613.6	56.34
1703.1	59.07
CURVE 12	
23	0.095
73	0.862
98	1.73
123	2.77
148	3.72
173	4.74
198	5.71*
223	6.67
248	7.78
CU (cont.)	
273	8.66*
293	9.66
323	0.59*
348	1.49
373	2.24
398	3.21
423	4.01
(13	
359.	2.16
393.	3.36
432	4.74
451.	5.54*
456.	9.76
486.	3.54
536.	8.30
597.	0.39
632	1.02
655	2.10
657	2.28
697	3.29
698	3.40
763	4.90
815	5.99
877.	7.53
918	3.61
983	9.97
1045.	1.53
1102.	2.62
1103.	2.68
1146.	3.64
1203.	5.13
1246.	3.05
1278.	3.99
1312.	3.03
1318.	3.21
1342.	3.96
1372.	9.67
(.4	
359.	2.2*
393.	3.36*
432	4.7*
451.	5.5*
461.	0.2
633.	2.8
CURVE 14 (cont.)	
785.9	35.3
944.8	38.8
1097.6	43.2
1243.7	47.2
1376.5	49.0
1414.3	51.3
CURVE 15	
453	25.3*
473	25.8*
523	27.0
573	28.3*
623	29.6
673	30.8*
723	32.2*
773	33.5
823	34.8
873	36.1
923	37.6
973	39.1
1023	40.6
1073	42.2
1123	43.8
1173	45.5
1223	47.3
1273	49.0
CURVE 16	
86.15	1.34
194.85	5.40
273.15	8.55*
372.45	12.7
CURVE 17	
2.0	0.084
2.6	0.084
3.2	0.084
4.2	0.084
5.7	0.084
7.6	0.084
8.9	0.086*
10.3	0.086
11.9	0.088
14.0	0.092*
15.1	0.092

* Not shown in figure.

TABLE 5. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY ΓHIUM Li (Temp ependence) (continued)

CURVE 17 (cont.)

T	ρ
17.5	0.100
20.3	0.114
24.2	0.124
27.7	0.138
34.9	0.190
43.0	0.285
51.2	0.419
61.2	0.646
68.7	0.817
78.9	1.200
89.7	1.584
293	8.98

CURVE 18

T	ρ
1.4	0.049
2.5	0.049
3.5	0.049
4.5	0.049
5.6	0.049*
6.1	0.049*
7.5	0.049
8.5	0.049
8.6	0.049*
8.8	0.049*
9.0	0.049*
9.6	0.050
10.1	0.049*
10.3	0.050*
11.1	0.050
12.1	0.051
13.0	0.051
14.0	0.052
15.9	0.054
16.6	0.054*
17.6	0.056
18.3	0.057*
19.1	0.058
20.2	0.060
20.3	0.061*
24.3	0.070
25.5	0.080
30.6	0.100
34.1	0.125
39.7	0.175
45.3	0.237
49.9	0.297
53.6	0.366

CURVE 18 (cont.)

T	ρ
54.7	0.409
55.4	0.441*
56.0	0.436
57.3	0.467*
58.2	0.516*
59.9	0.494
62.8	0.661*
63.9	0.634
68.6	0.732
72.8	0.881*
76.8	1.045
79.6	1.144*
79.6	1.183*
81.3	1.142*
82.8	1.256*
83.8	1.308*
86.0	1.415
87.3	1.415*
89.9	1.517
293	9.17

CURVE 19

T	ρ
4.2	0.009
80	1.047*
80	1.034

CURVE 20

T	ρ
4.2	0.0256

CURVE 21

T	ρ
4.2	0.03

CURVE 22

T	ρ
4.2	0.0155
295	9.52*

CURVE 23

T	ρ
4.2	0.0106

CURVE 24*

T	ρ
4.2	0.0106

CURVE 25

T	ρ
4.2	0.0109

CURVE 26*

T	ρ
4.2	0.0106

CURVE 27

T	ρ
4.2	0.0082

CURVE 28

T	ρ
273	8.55*

CURVE 29

T	ρ
1.67	0.007311
1.95	0.007312*
2.45	0.007303
2.70	0.007318*
3.02	0.007318
3.18	0.007308*
3.45	0.007301*
3.77	0.007311*
3.97	0.007300
4.34	0.007333*
4.45	0.007314*
4.740	0.007367
5.01	0.007330*
5.48	0.007359
6.02	0.007385*
6.48	0.007401*
6.99	0.007416
7.47	0.007431
7.99	0.007456
8.47	0.007479*
8.99	0.00751
9.48	0.00754*
10	0.00759
6.78	0.007406*
7.68	0.007442*
8.83	0.007510*
9.75	0.00759*
10.58	0.00768*
11.92	0.00787
12.96	0.00812
13.89	0.00844*
14.93	0.00882

CURVE 29 (cont.)

T	ρ
15.91	0.00925*
16.94	0.00977
17.94	0.01042*
18.86	0.01107*
19.95	0.01199
22.0	0.01407
24.0	0.01680
26.04	0.02025*
27.92	0.02446
29.95	0.02946
31.89	0.03567
34.04	0.04288
36.0	0.0520
37.92	0.0619

CURVE 30

T	ρ
12.27	0.0383
13.61	0.0392*
14.42	0.040*
15.59	0.041
16.52	0.043*
17.50	0.0445
19.77	0.049*
21.43	0.052
23.22	0.057*
23.93	0.062
27.04	0.072
30.20	0.088
35.72	0.124
41.78	0.206
55.97	0.424
66.83	0.688
78.16	1.028*
295	9.63*

CURVE 31

T	ρ
11.32	0.0702
12.73	0.071*
14.26	0.073
16.67	0.076*
18.11	0.079
19.81	0.082*
21.08	0.0854
22.18	0.089*
24.38	0.097
27.16	0.1077

31 (cont.)

T	ρ
	0.124
	0.170
	0.979
	9.25

/E 32

T	ρ
	0.0264*
	1.021*
	1.368
	1.740*
	2.127
	2.523*
	2.924
	3.329*
	3.734*
	4.139*
	4.537
	4.937*
	5.334
	5.730*
	6.114
220	6.497*
	6.879
	7.258*
	7.639
	8.020*
	8.401
	8.78*
	9.160*
	9.536
	9.926
	10.306

/E 33

T	ρ
4	0.011*
80	1.006*
90	1.353*
100	1.725*
110	2.112
120	2.508*
130	2.909*
140	3.314*
150	3.719*
160	4.124*
170	4.522*
180	4.922*

CURVE 33 (cont.)

T	ρ
190	5.322
200	5.715*
210	6.099*
220	6.482*
230	6.864*
240	7.243*
250	7.624
260	8.005*
270	8.386*
280	8.765*
290	9.145*
300	9.521*
310	9.911
320	10.291*

CURVE 34

T	ρ
4.2	0.021
80	1.016*
90	1.363*
100	1.735*
110	2.122*
120	2.514*
130	2.919
140	3.524*
150	3.729*
160	4.134*
170	4.532*
180	4.932*
190	5.332*
200	5.725*
210	6.109
220	6.492*
230	6.874*
240	7.253*
250	7.634*
260	8.015
270	8.396*
280	8.775*
290	9.155*
300	9.53*
310	9.92*
320	10.19*

CURVE 35

T	ρ
273	8.75
303	10.08

* Not shown in figure.

T	ρ
CURVE 35 (cont.)	
333	11.22
363	12.35
393	13.66
423	14.96
443	15.74
CURVE 36	
473	25.2
573	29.2
673	32.5
773	35.8
CURVE 37	
299.9	9.64
316.5	10.26
341.8	11.06
372.1	12.19*
421.5	14.05
436.8	14.64
449.6	15.16
452.6	15.29*
CURVE 38	
454.6	24.25
456.8	25.18
463.8	25.61
472.4	25.81*
474.3	26.13
476.8	26.19*
503.5	27.11
531.3	28.09
582.6	29.65
589.9	29.96
642.6	31.55
696.8	33.10
752.1	34.54
806.3	35.88
862.6	37.29
917.4	38.49
971.5	[illegible]

T	ρ
550	[illegible]
575	27.60
600	28.34
623	29.03
CURVE 40	
543.5	27.68
621.5	29.62*
624.1	30.02
674.3	31.56
714.2	32.35
769.1	33.90
845.3	35.90
851.3	35.55
871.9	36.27
957.0	38.42
1044.3	40.74
1047.1	40.36
1127.9	42.75
1214.6	44.44
1243.9	44.70
CURVE 41	
564.5	27.18
602.5	28.38*
673.1	30.69
682.8	30.26
740.6	31.89
806.3	33.89
899.3	36.17
1029.0	38.90
1034.4	39.67
1181.6	42.62
1279.4	43.96
CURVE 42	

T	ρ
12.28	0 4
13.51	0.0310
14.78	0.0317
16.04	0.0328
17.73	0.0345
20.43	0.0405
CURVE 43*	
20.42	0.060
80.13	1.06
90.89	1.41
273.16	8.55
CURVE 44	
1.19	0.0475
4.21	0.0485
20.41	0.0578
77.74	1.04
86.32	1.28*
273.16	8.55*
CURVE 45	
453.7	23.89
500.0	25.23
600.0	28.17
700.0	31.28
800.0	34.59*
900.0	38.09
1000.0	41.83
1100.0	45.80
1200.0	50.04
1300.0	54.58
1400.0	59.47
1500.0	64.72
1600.0	[illegible]
1700.0	
1800.0	
1900.0	
2000.0	
2200.0	1
2400.0	1

T	ρ
	*
	*
	*
	*
	*
3600.0	627.5*
3800.0	1049.6*
4000.0	2782.0*

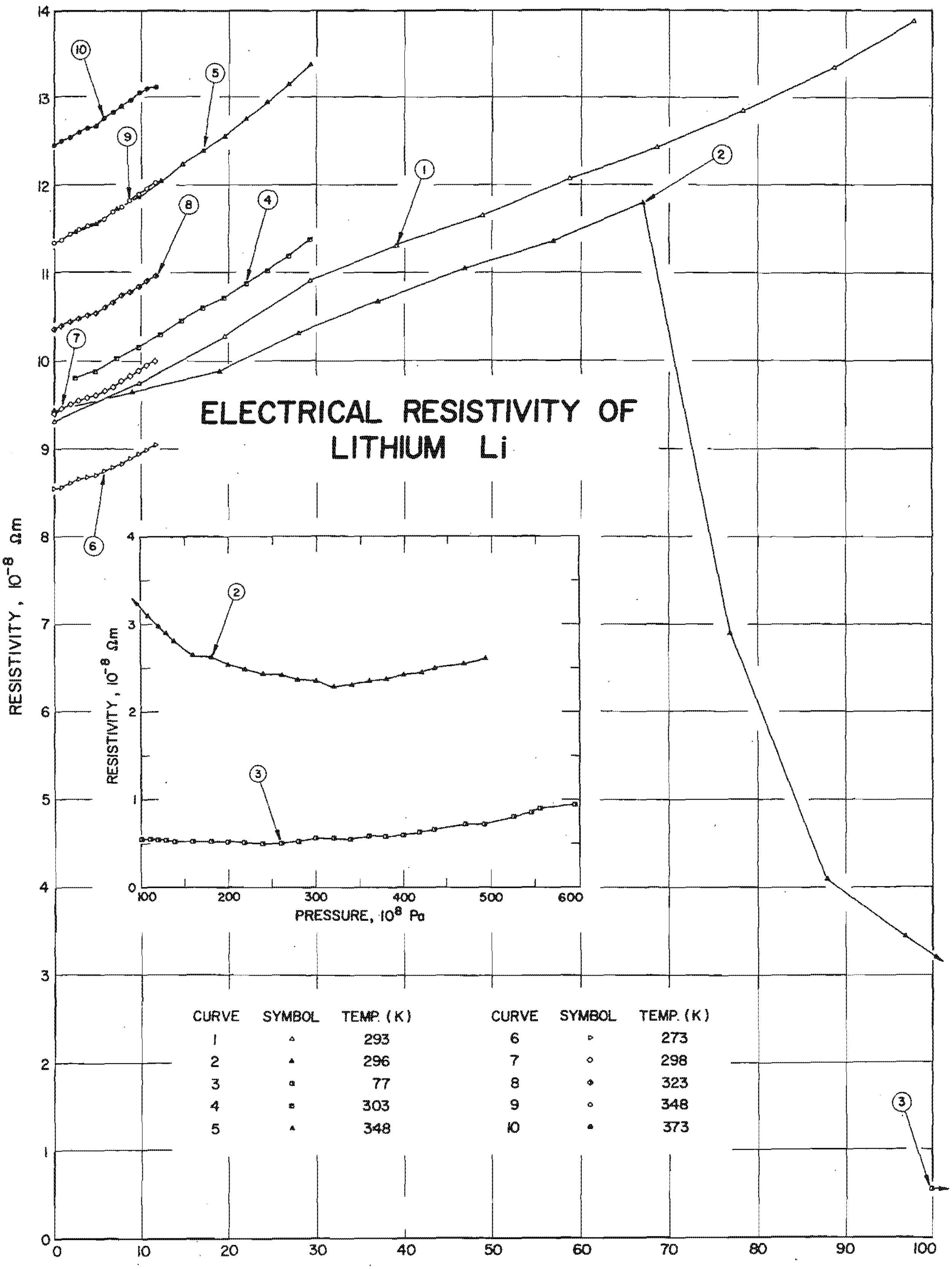

ELECTRICAL RESISTIVITY OF LITHIUM Li
RESISTIVITY, 10^-8 Ωm
PRESSURE, 10^8 Pa
CURVE SYMBOL TEMP. (K)
1 293
2 296
3 77
4 303
5 348
6 273
7 298
8 323
9 348
10 373
CINDAS

FIGURE 4

TABLE 6. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIV Dependence)

's)	Year	Method Used	Pressure Range, 10^8 Pascal	Temperature Range, K	Name and Specimen Designation		Specifications, and Remarks
'.W.	1952	A	0-98	~293		Pure; oil tiv re on	it to final dimension under a heavy 'essure within the cell is AgCl; rela- s a function of pressure; electrical ig the compressibility and the rec- vity at one atm pressure and 293 K.
and H.G.	1963	A	9-500	296		Comr re bil an	e as a function of pressure were were obtained by using compressi- ie of electrical resistivity at 296 K
and H.G.	1963	A	100-600	77		The a Pr	after first pressing to 100 x 10^8
'.W.	1930	A	0-29.4	303		Pure ab of	Kahlbaum; it was extruded into a wire tive electrical resistance as a function
'.W.	1930	A	0-29.4	348		The	
'.W.	1921	A	0-11.76	273		0.7 re	ined from Merck; relative electrical
'.W.	1921	A	0-11.76	298		The	
'.W.	1921	A	0-11.76	323		The	
'.W.	1921	A	0-11.76	348		The	
'.W.	1921	A	0-11.76	373		The	

TABLE 7. EXPERIMENTAL DATA ON THE ELECTRICAL RESIST LITHIUM Li (Pressure Dependence)

[Temperature, T, K; Pressure, P, 10^8 Pa; , ρ, 10^{-8} Ωm]

CURVE 1
T = 293

P	ρ
0.0	9.326
9.8	9.75
19.6	10.29
29.4	10.92
39.2	11.32
49.0	11.66
58.8	12.08
68.6	12.44
78.4	12.85
88.2	13.35
98.0	13.89

CURVE 2
T = 296

P	ρ
0	9.44
9	9.65
19	9.88
28	10.32
37	10.68
47	11.06
57	11.37
67	11.81
77	6.90
88	4.09
97	3.43
108	3.10
119	2.98
128	2.90
137	2.81
159	2.65
180	2.63
199	2.54
218	2.49
239	2.44
[illegible]	[illegible]

CURVE 2 (cont.)
T = 296

P	ρ
468	2.56
494	2.61

CURVE 3
T = 77

P	ρ
100	0.554
110	0.550
119	0.546
128	0.543
138	0.539
159	0.533
180	0.528
199	0.524
218	0.518
239	0.515
260	0.510
280	0.527
299	0.564
320	0.562
339	0.559
360	0.586
379	0.585
399	0.612
418	0.640
435	0.665
471	0.723
494	0.721
526	0.806
546	0.861
567	0.918
595	0.941

CURVE 4
T = 303

CURVE 4 (cont.)
T = 303

P	ρ
24.5	11.03
26.95	11.20
29.4	11.39

CURVE 5
T = 348

P	ρ
2.45	11.47
4.9	11.56
7.35	11.73
9.8	11.88
12.25	12.05
14.7	12.24
17.15	12.40
19.6	12.56
22.05	12.76
24.5	12.95
26.95	13.16
29.4	13.38

CURVE 6
T = 273

P	ρ
0.00	8.55
0.98	8.56
1.96	8.61
2.94	8.66
3.92	8.68
4.90	8.70
5.88	8.75
6.86	8.79
7.84	8.83
8.82	8.89
9.80	8.94
10.78	8.99
[illegible]	9.06

JRVE 7
= 298

P	ρ
	9.
	9.
	9.
	9.
	9.

CU nt.)

P	ρ
4	.62
5.oo	.67
6.86	.71
7.84	.79
8.82	.84
9.80	.90
10.78	.96
11.72	.01

CURV
T = 3

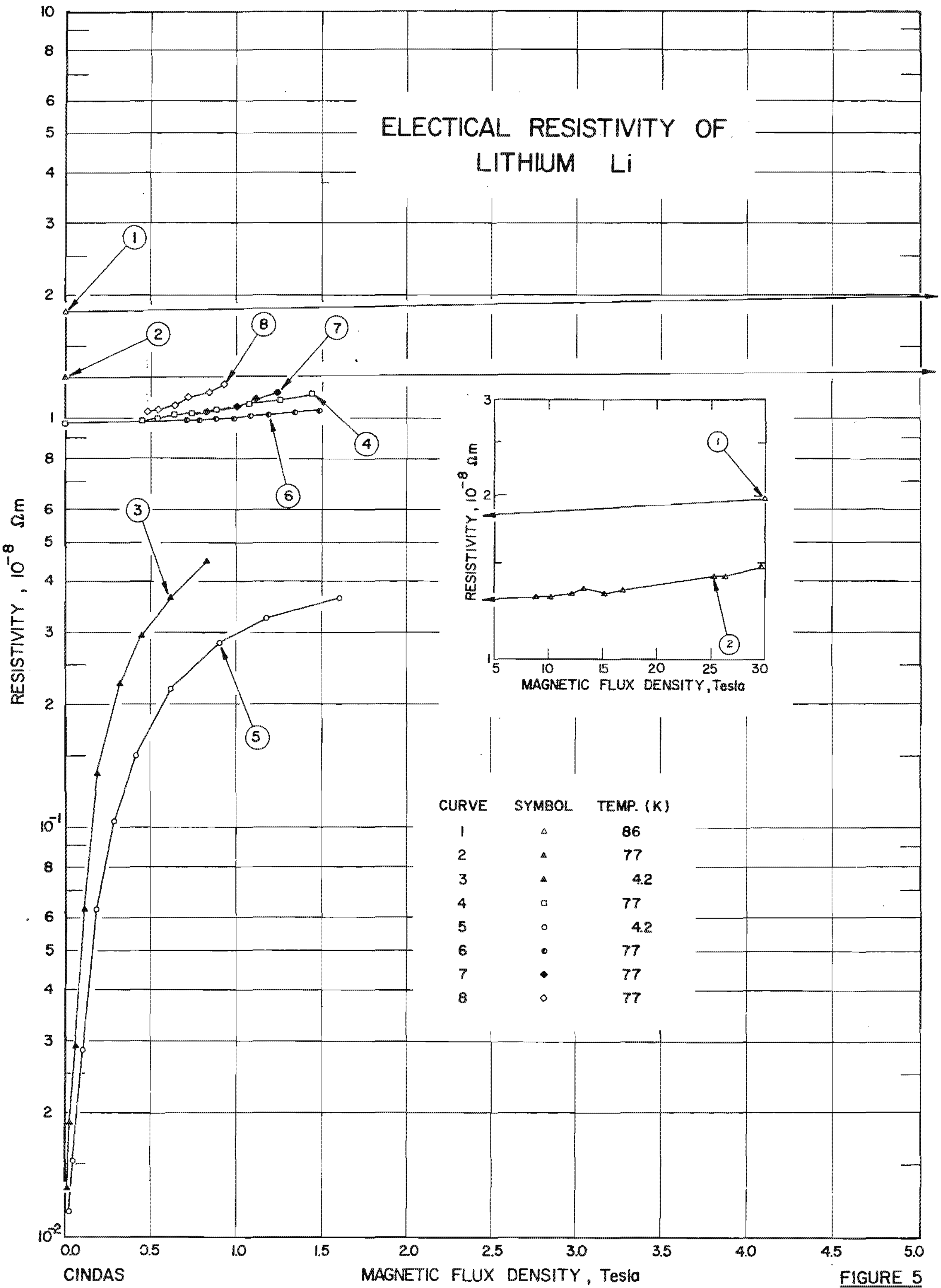
P	ρ
0.00	.36
0.98	.40
1.96	.45
2.94	.49
3.92	.53
4.90	.55
5.88	.62
6.86	.68
7.84	.76
8.82	.80
9.80	.86
10.78	.92
11.72	.98

CURV
T = 3

P	ρ
0.00	.35
0.98	.38
1.96	.45
2.94	.50
3.92	.54
4.90	.56*
5.88	.62
6.86	.70
[illegible]	.76
	.83
	.91
	.97
	.03

CURVE 10
T = 373

P	ρ
0.00	12.46
0.98	12.50
1.96	12.56
2.94	12.62
3.92	12.66
4.90	12.68
5.88	12.77
6.86	12.84
7.84	12.91
8.82	12.98
9.80	13.07
10.76	13.13
11.76	13.21



ELECTICAL RESISTIVITY OF LITHIUM Li
RESISTIVITY, 10^{-8} Ωm
MAGNETIC FLUX DENSITY, Tesla
CURVE SYMBOL TEMP. (K)
1 △ 86
2 ▲ 77
3 ▲ 4.2
4 □ 77
5 ○ 4.2
6 ◦ 77
7 ◆ 77
8 ◇ 77
RESISTIVITY, 10^{-8} Ωm
MAGNETIC FLUX DENSITY, Tesla
CINDAS

FIGURE 5

TABLE 8. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF LITHIUM Li (Magr Density Dependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Magnetic Flux Density Range, Tesla	Temperature Range, K	Name and Specimen Designation	Composition (we	ent), Specifications, and Remarks
1	34	Kapitza, P.	1929		0,30	86	Li_I	99.9 pure; specimen measurements we 0.195, where Rr :	ıned from Kahlbaum; magnetoresistance ın a transverse magnetic field; R/Rr = istance at room temperature.
		Kapitza, P.	1929		0-30	77	Li_{II}		ned from Kahlbaum; magnetoresistance n a transverse magnetic field; R/Rr = istance at room temperature.
		Gugan, D. and Jones, B.K.	1963	A	0-0.83	4.2			ıen dimension 1.0 mm x 50 cm; the m an ingot of low sodium content from the Lithium Corp. of America; by extrusion under liquid paraffin at y were rinsed with Analar benzene; at room temperature for a week; the 293 K/$R_{4.2\ K}$ = 985; the magneto- ıs in a transverse field; data were curve.
		Gugan, D. and Jones, B.K.	1963	A	0-1.43	77			ıd conditions.
		Gugan, D. and Jones, B.K.	1963	A	0-1.60	4.2			similar conditions except it was mea- .
6	35	Gugan, D. and Jones, B.K.	1963	A		77			ıd conditions.
7	35	Gugan, D. and Jones, B.K.	1963	A	0.	77			except it was pure bcc phase.
8	35	Gugan, D. and Jones, B.K.	1963	A	0.4	77			ıd similar conditions except it was eld.
9	36	Justi, E.	1948	A		20.4			/$R_{273.15\ K}$ = 0.0243; measured in a

ı (Magnetic Flux Density Dependence)

ity, ρ, 10^{-8} Ωm]

CURVE 1
T = 86

0.0	1.8185
30.0	1.9822

CURVE 2
T = 77

0.0	1.2777
8.9	1.3033
10.3	1.3033
12.1	1.3394
13.1	1.3567
15.1	1.3290
16.7	1.343
25.3	1.4222
26.4	1.4222
29.6	1.4849

CURVE 3
T = 4.2

0.014	0.0109
0.023	0.0131
0.037	0.0190
0.052	0.0292
	).0633
	).131
	).225
	).296
	).367
0.[illegible]	0.451

CURVE 4
T = 77

0.000	0.975
0.455	0.994
0.535	1.00
0.640	1.01
0.742	1.02

CURVE 5
T = 4.2

0.029	0.0117
0.047	0.0154
0.090	0.0287
0.178	0.0628
0.285	0.104
(	
(	
(	
:	
:	

CURVE 6
T = 77

0.000	0.975*
0.709	0.992
0.788	0.996
0.884	1.001
0.983	1.006
1.06	1.012
1.18	1.021
1.33	1.034
1.49	1.050

CURVE 7
T = 77

0.459	0.999*
0.535	1.01*
0.623	1.02*
0.735	1.04*
0.821	1.05
1.00	1.08
1.10	1.11
1.24	1.16

CURVE 8
T = 77

CURVE 8 (cont.)
T = 77

0.840	1.169
0.925	1.211

CURVE 9
T = 20.4

0.00	0.2078
3.04	0.2306

4.2. Sodium

Sodium, with atomic number 11, is a soft, silver-white, lustrous alkali metal. It is a very reactive element and never found free in nature. Except at low temperatures it has a body-centered cubic crystalline structure, with a density of 0.971 g cm^{-3} at 293 K. It melts at 371.0 K and boils at about 1156 K. Its critical temperature has been estimated to be about 2733 K. Sodium contracts on freezing in a normal manner. The volume change on melting is about 2.71% at one atmosphere. Sodium undergoes a partial martensitic transformation to hexagonal close-packed structures at about 36 K and therefore has a mixed phase below this temperature. Sodium has only one stable isotope, ^{23}Na, but six other radioactive isotopes are known to exist. The metal is the sixth most abundant element in the continental crust of the earth (2.36% by weight.)

Sodium is the metal which the quasi-free electron model describes the best. Its Fermi surface is not influenced by zone boundaries and therefore is spherical. Electrical resistivity measurements indicate that, despite the martensitic transformation, sodium retains its spherical Fermi surface.

a. Temperature Dependence

There are 65 sets of experimental data available for the electrical resistivity of sodium. The information on specimen characterization and measurement conditions for each of the data sets is given in table 11. The data are tabulated in table 12 and shown in figures 6 and 7. Determinations of the electrical resistivity of sodium for the solid and liquid phases cover continuously the temperature range from 1.8 to 1366 K.

There are 27 experimental data sets obtained below 100 K. Among these, White and Woods [37] (Curve 38) give the lowest residual resistivity. There are 17 sets of intrinsic resistivity available. Dugdale and Gugan [38] (curves 45 and 46) have reported the intrinsic resistivity of the separate bcc and hcp phases between 16 and 52 K. The resistivity of the hcp phase is lower than that of the bcc phase. In deriving the smoothed most probable values of intrinsic resistivity from the available data, the following overlapping temperature ranges were considered: below 14 K, 9–21 K, 14–30 K, 20–50 K, 30–100 K, 40–100 K, 50–100 K, etc. Within each range, a least-mean-square fraction error fit with the semiempirical equation $\rho_i = aT^b$ was made to all the available intrinsic resistivity data. The resulting values for adjacent ranges were intercompared and the values were corrected for thermal linear expansion. These preliminary values were then fitted with the cubic spline function equation (7) to generate the final recommended intrinsic resistivity values. The coefficients of equation (7) obtained are given in the following table:

Temperature range, K	a	b	c	d
1 – 8.26	−8.523	5.582	−0.572	0.299
8.26– 11.04	−3.654	5.288	0.252	−10.15
11.04– 12.29	−3.003	4.874	−3.537	21.47
12.29– 36.71	−2.783	4.684	−0.546	−17.98
36.71– 65.89	−0.873	2.947	−3.109	3.606
65.89– 73.44	−0.265	2.066	−0.361	−10.52
73.44–100	−0.170	1.962	−1.849	1.554

Below 15 K, the intrinsic resistivity ρ_i approximately follows Bloch's T^5 law. Because martensitic transformation effects of sodium affects the electrical resistivity values [38], the values below 40 K are provisional and are for a specimen of mixed phases.

There are 24 data sets in the temperature region from 100 K to the melting point 371 K. They agree with each other within 10%. Dugdale and Gugan [8] reported electrical resistivities at constant volume (curve 22), which they deduced from their measurements. These are lower than those at zero pressure (curve 23). Only one set of data were measured on single crystals by Fritsch and Luscher [39] (curve 30), and there is little difference in electrical resistivity values between the polycrystalline specimens and the single crystal specimen. A least-mean-square error fit to the totality of experimental data in this range was made with a third order polynomial. The resulting values were corrected for thermal linear expansion and then fitted with the cubic spline function equation (7) to obtain the final recommended values in this temperature range. The coefficients of equation (7) obtained are as follows:

Temperature range, K	a	b	c	d
73.44–371	−0.170	1.962	−1.849	1.554

There are 27 data sets available for the liquid state. Endo [40] (curve 25), Lien and Silversten [41] (curve 18), and Swalin [42] (curve 48) have investigated the electrical resistivity at constant volume conditions and they agree with one another within 5%. The rest of the data are apparently measured at the saturated vapor pressure. At least nine sets of experimental values below 1300 K agree to within 10%. Semyachikin and Solov'ev [18] (curve 31) give the highest values while Freeman and Robertson [9] (curve 19) give the lowest values. Grosse [5] derived electrical resistivity (curve 65) values in the range from the melting point to his estimated critical temperature, 2800 K, by fitting the data of Kapelner and Bratton [43] (curve 17) to a hyperbolic equation. All the experimental data sets except those measured at constant volume were used here for the cubic spline function equation (7) to obtain the final recommended values. The coefficients of equation (7) are as follows:

Temperature range, K	a	b	c	d
371 –1548.9	0.974	1.440	−0.365	1.041
1548.9–2000	1.996	2.219	1.602	24.77

The resistivity values represented by this equation are not corrected for thermal linear expansion of the container, which in most cases is not specified.

At the melting point (371 K), the electrical resistivity of sodium in the liquid state is about 40% higher than that of the solid state.

The recommended values for the total and intrinsic electrical resistivities are listed in table 10, and those for the total electrical resistivity are also shown in figures 5 and 6. The recommended values for the liquid state are for the saturated liquid. The recommended values for the total resistivity for the solid state are for a 99.99+% pure sodium and those at temperatures below 40 K are applicable only to a specimen with residual resistivity $\rho_0 = 0.000887 \times 10^{-8} \Omega$ m. The recommended values from 1 K to 371 K are corrected for thermal linear expansion. The correction amounts to −1.48% at 1 K, −1.2% at 100 K and 0.56% at 371 K. The uncertainty of the recommended total electrical resistivity is believed to be within ±20% from 1 K to 40 K, within ±5% from 40 K to 1500 K, and ±10% from 1500 K to 2000 K. Above 50 K the uncertainty of the recommended values for the intrinsic resistivity is about the same as that of the total electrical resistivity; below 50 K this uncertainty is higher than that of the total electrical resistivity.

b. Pressure Dependence

There are 16 sets of experimental data available for the electrical resistivity of sodium as a function of pressure. The information on specimen characterization and measurement conditions for each of the data sets is given in table 13. The data are tabulated in table 14 and shown in figure 8.

The available data and information for the pressure dependence of electrical resistivity of sodium are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only experimental data are presented here.

c. Magnetic Flux Density Dependence

There are 21 sets of experimental data available for the electrical resistivity of sodium under the influence of magnetic field. The information on specimen characterization and measurement information for each of the data sets is given in table 15. The data are tabulated in table 16 and shown in figure 9.

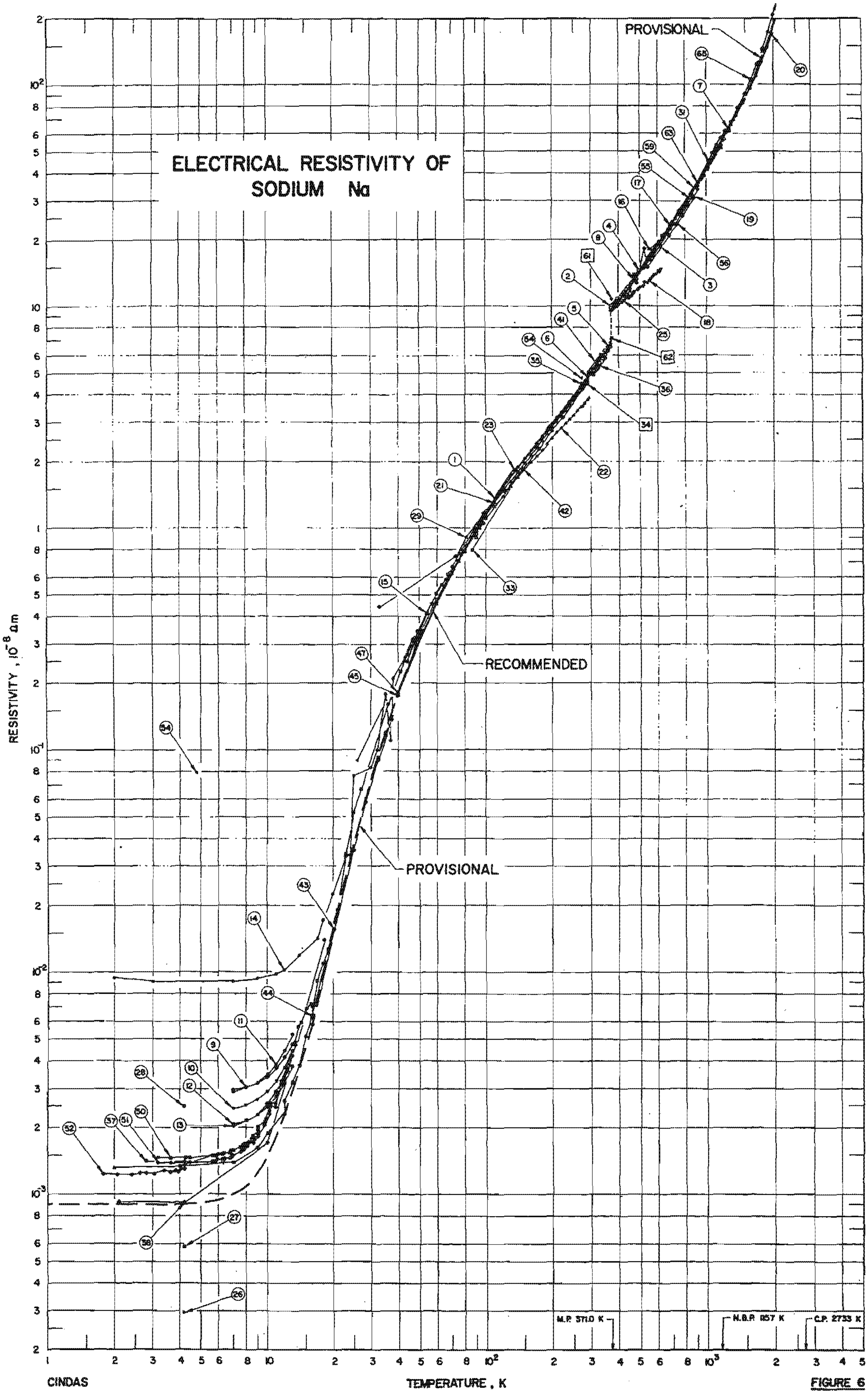
The available data and information for the magnetic flux density dependence of electrical resistivity of sodium are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only experimental data are presented here.

TABLE 10. RECOMMENDED ELECTRICAL RESISTIVITY OF SODIUM (Temperature Dependence)

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

Solid						Liquid	
T	ρ	ρ_i	T	ρ	ρ_i	T	ρ
1	8.87 x 10⁻⁴*		35	0.117*	0.116*	371	9.43
2	8.87 x 10⁻⁴*	1.3 x 10⁻⁷*	40	0.172*	0.171*	400	10.50
3	8.88 x 10⁻⁴*	1.1 x 10⁻⁶*	45	0.233	0.232	500	14.36
4	8.92 x 10⁻⁴*	5.0 x 10⁻⁶*	50	0.300	0.299	600	18.56
5	9.03 x 10⁻⁴*	1.59 x 10⁻⁵*	60	0.447	0.446	700	23.20
6	9.28 x 10⁻⁴*	4.12 x 10⁻⁵*	70	0.615	0.614	800	28.38
7	9.80 x 10⁻⁴*	9.26 x 10⁻⁵*	80	0.796	0.795	900	34.19
8	0.00107*	1.87 x 10⁻⁴*	90	0.978	0.977	1000	40.73
9	0.00123*	3.49 x 10⁻⁴*	100	1.158	1.157	1100	48.12
10	0.00149*	6.03 x 10⁻⁴*	150	2.03	2.03	1200	56.45
11	0.00186*	0.00097*	200	2.89	2.89	1300	65.85
12	0.00237*	0.00148*	250	3.86	3.86	1400	76.44
13	0.00303*	0.00214*	273.15	4.33	4.33	1500	88.37
14	0.00391*	0.00302*	293	4.77	4.77	1600	101.8*
15	0.00503*	0.00414*	300	4.93	4.93	1700	117.1*
16	0.00644*	0.00555*	350	6.23	6.23	1800	135.1*
18	0.0102*	0.00934*	371	6.86	6.86	1900	157.1*
20	0.0156*	0.0147*				2000	184.4*
25	0.0370*	0.0361*					
30	0.0711*	0.0702*					

* Provisional values.


ELECTRICAL RESISTIVITY OF
SODIUM Na
PROVISIONAL
RECOMMENDED
PROVISIONAL
RESISTIVITY, 10^{-8} Ω m
TEMPERATURE, K
M.P. 371.0 K
N.B.P. 1157 K
C.P. 2733 K
CINDAS
FIGURE 6

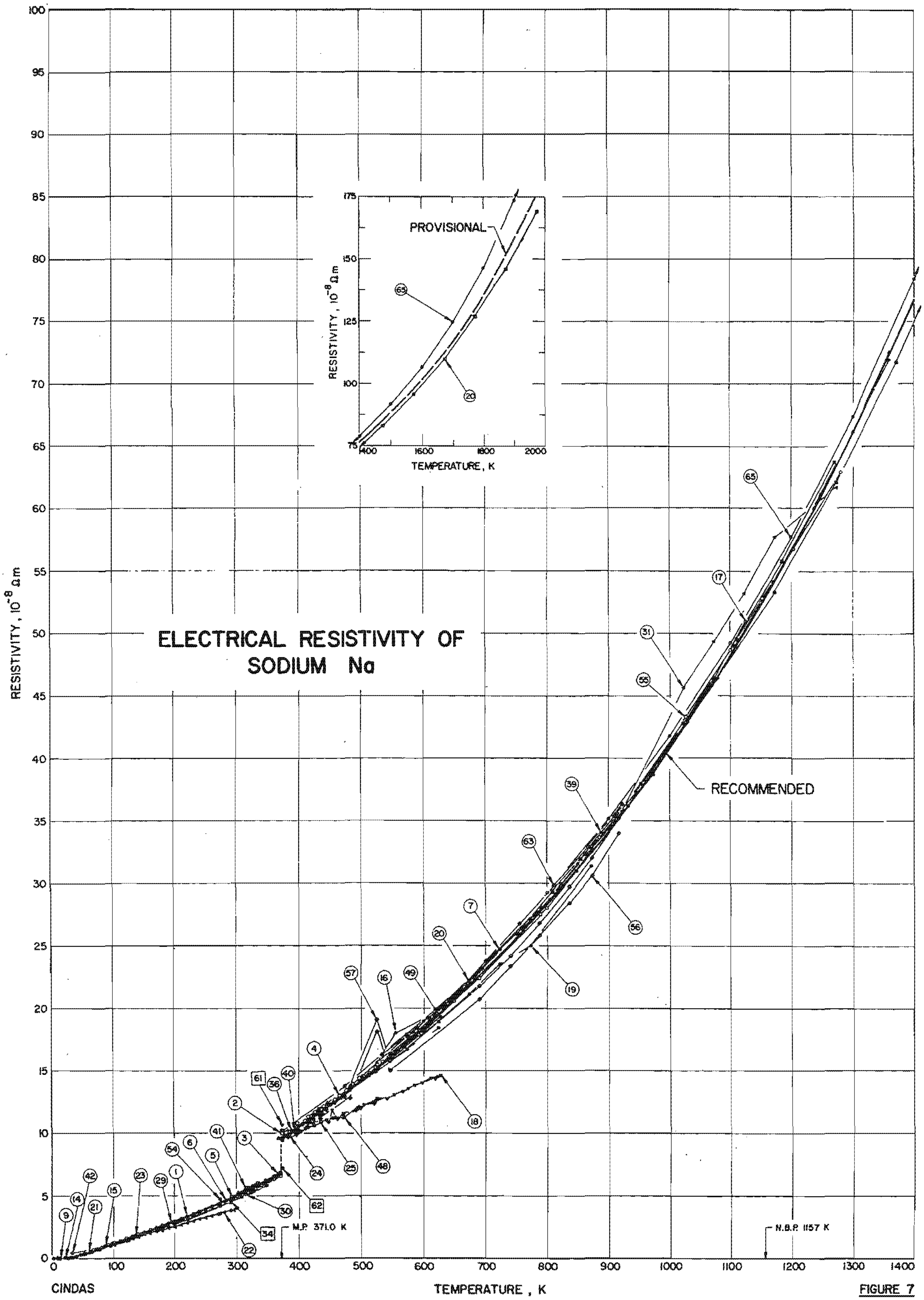

ELECTRICAL RESISTIVITY OF
SODIUM Na
RESISTIVITY, 10^{-8} Ω m
TEMPERATURE, K
PROVISIONAL
RECOMMENDED
M.P. 371.0 K
N.B.P. 1157 K
CINDAS
FIGURE 7

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF SODIUM Na (Temperat ependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent cifications, and Remarks
1	44	Bradshaw, F.J. and Pearson, S.	1956	A	78-370		0.0025 K and < 0.0005 O_2; specimen ıbtained from the Atomic Energy Research Establishment, Harwel :el tube 0.5 mm in diameter, 0.025 mm wall thickness and 16 mm long; w ɜd to contain sodium.
2	45	Hennephof, J., Van Der Lugt, W., and Wright, G.W.	1971	B	373.15-398		99.95 pure specimen was supplied b ı Light Co.; resistivity was a linear function of temperature from me oint to 125 C; described by $d\rho/dT$ = 0.034 x 10^{-8} Ωm/K.
3	46	Bornemann, K. and Rauschenplat, G.	1912		367-623		Pure; liquid state.
4	47	Addison, C.C., Creffield, G.K., Hubberstey, P., and Pulham, R.J.	1969	B	371-570		Pure; < 0.04 Ca, < 0.001 O; l pecimen was contained in AISA 321 stainless steel tubes 0.14(m diameter, 11.249 and 12.427 cm long; density at 390.95 K i :$^{-3}$.
5	47	Addison, C.C., et al.	1969	B	292-370		Similar to above specimen ex ı solid state; density at 390.95 K is 0.9514 g cm^{-3}.
6	48	Savenchenko, V.A. and Shpil'rain, E'.E'.	1969	A	283-357		0.006 H_2, 0.0049 O_2, 0.0042 e, Ni, 0.0014 N_2, 0.001 Ca, Si, Ti, V, 0.0004 Cr, 0.0003 Li, Mg . Al, Cd, Zr, 0.00001 Cs; the specimen was obtained from the Inst :hemistry and Technology of Rare Elements and Raw Minera ıents made in a stainless steel tube 10.5 cm in external diame wall thickness.
7	48	Savenchenko, V.A. and Shpil'rain, E'.E'.	1969	A	384-1271		Similar to above specimen ex :ate.
8	49	Aksenova, L.I. and Belashchenko, D.K.	1971		383-473		99.9 pure; liquid state; meas de with capillary cell.
9	50	Holzhauser, W.	1970	G	7.0-13	1a	Specimen consisted of 41% he ɜ packed crystal structure, the remainder being body cent ctrical resistivity data obtained from $\rho = \rho_0 + aT^5$ with ρ_0 = 2.88 a = 5.13 x 10^{-17} Ωm/K^5.
10	50	Holzhauser, W.	1970	G	7.0-13	1b	Specimen consisted of 19% he ɜ packed crystal structure, the remainder being body cent ctrical resistivity data obtained from $\rho = \rho_0 + aT^5$ with ρ_0 = 2.35 a = 5.61 x 10^{-17} Ωm/K^5.
11	50	Holzhauser, W.	1970	G	7.0-13	4a	Specimen consisted of 8% hex packed crystal structure, the remainder being body cent ctrical resistivity data obtained from $\rho = \rho_0 + aT^5$ with ρ_0 = 2.80 a = 6.63 x 10^{-17} Ωm/K^5.
12	50	Holzhauser, W.	1970	G	7.0-13	3a	Specimen consisted of 52% he ɜ packed crystal structure, the remainder being body cent ctrical resistivity data obtained from $\rho = \rho_0 + aT^5$ with ρ_0 = 2.00 a = 4.84 x 10^{-17} Ωm/K^5.
13	50	Holzhauser, W.	1970	G	7.0-13	3b	Specimen consisted of 12% he ɜ packed crystal structure, the remainder being body cent ctrical resistivity data obtained from $\rho = \rho_0 + aT^5$ with ρ_0 = 1.95 a = 6.13 x 10^{-17} Ωm/K^5.
14	51	Berman, R. and MacDonald, D.K.C.	1951		2-46	Na I	Approximately 0.01 to 0.1 Al ılied by British-Thomson-Houston Research Lab.; cast unde oft glass tubes.
15	51	Berman, R. and MacDonald, D.K.C.	1951		2-90	Na II	Trace of Ag; supplied by Mes ; Ltd., Mitcham; cast under vacuum in soft glass tubes.
16	16	Tepper, F., Zelenk, J., Roehlich, F., and May, V.	1965	A	302-1360		Pure; density 0.8997, 0.8255 7881, 0.7640, 0.7381 and 0.6967 g cm^{-3} at 483.8, 804.1, 8' 1085, 1189 and 1384 K, respectively.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF SODIUM Na (Temperatur ice) (continued)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight perc	ifications, and Remarks
17	43	Kapelner, S.M. and Bratton, W.D.	1962	B	371-1126		< 0.0375 Cs, K, < 0.015 Li, 0.0(< 0.001 Cr; specimen was pur purified by melting and forcin filter under purified argon; th for 2 hr prior to measurement	)048 N_2, 0.0032 O_2, 0.0022 N_2 and m U.S. Industrial Chemical Co.; quid through a 20 μ stainless steel heated to about 550 C and then held
18	41	Lien, S.Y. and Silversten, J.M.	1969	A	373-623		99.95 pure; specimen was suppli tivity specimen cell was made end, four tungsten current anc measurements at constant vol	. Mackay Inc.; the electrical resis- ision quartz capillary open on one leads were sealed into the capillary;
19	9	Freedman, J.F. and Robertson, J.F.	1961	B	373-873		0.01 K, 0.003 Cl, 0.002 Li, Cs, DuPont de Nemours Co.; spec cell material, 0.349 in. diam	ıers; sample was supplied by E.I. ıuid state; 304 stainless steel was the . length.
20	52	Solov'ev, A.N.	1963		373-1973		Pure; density 0.928 g cm^{-3} at 37: were extrapolated.	g cm^{-3} at 1273 K; data above 1293 K
21	8	Dugdale, J.S. and Gugan, D.	1962	A	50-295	Na(6)	Pure; specimen was supplied by specimen was made in the for length; $R_{4.2}/R_{300}$ = 3.0 x 10^{-4}; pressure.	. D. Mackay and Co., New York; wire, 0.5 mm in diameter, 1 mm in resistivity was measured at zero
22	8	Dugdale, J.S. and Gugan, D.	1962	A	50-295	Na(6)	Same as the above specimen exce constant volume.	ctrical resistivity was obtained at
23	8	Dugdale, J.S. and Gugan, D.	1962	A	44-273.15	Na(4)	Pure; specimen was supplied by glass capillary; $R_{4.2}/R_{300}$ = 2. at zero pressure.	lips, Eindhoven Co.; specimen in lectrical resistivity was measured
24	40	Endo, H.	1963	A	373-448		Pure; sample was supplied by A. of soft glass and consisted to bulbs equipped with platinum e at constant pressure condition	y Ltd.; specimen container was made tube (I.D. 0.7 mm) between two electrical resistivity was measured
25	40	Endo, H.	1963	A	373-448		Same as above specimen except e volume.	esistivity was obtained at constant
26	53	Stern, R., Natale, G.G., and Rudnick, I.	1966	A	4.2-273	Na 1	High purity polycrystalline sampl diameter and 11.05 cm in leng	distilled; annealed; 0.104 cm in
27	53	Stern, R., et al.	1966	A	4.2-273	Na 2	Similar to above specimen; 0.109	meter, 11.55 cm in length.
28	53	Stern, R., et al.	1966	A	4.2-273	Na 3	Similar to above specimen; unanr	
29	54	McLennan, J.C. and Niven, C.D.	1927	B	20.6-273		Pure.	
30	39	Fritsch, G. and Lüscher, E.	1969	B	308-371		99.99 pure; < 0.017 K, < 0.021 M crystal specimen with crystal in V2A steel tube 0.1 mm wall	12 Fe, and < 0.00087 Ca; single [100] direction; specimen was put ameter; 12 cm long.
31	18	Semgachkin, B.E. and Solov'ev, A.N.	1964	A	373-1273		Pure; TU 1664-50 sample was pl	0.8/0.5 mm capillary, 600 mm long.
32*	55	Packard, D.R. and Verhoeven, J.D.	1968	–	373-473		99.99 pure; electrical resistivity	ured by capillary-receiver technique.
33	19	Guntz, A. and Bronieski, W.	1909		86-323		Pure; solid specimen.	

* Not shown in figure.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF SODIUM Na (Temperature D ıce) (continued)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent ifications, and Remarks
34	56	Hackspill, L.	1910	A	290.15	1	Pure; distilled sample was placed ı about 1-2 cm in diameter, 10-20 cm long.
35	56	Hackspill, L.	1910	A	273.15, 291.15	2	Similar to the above specimen.
36	56	Hackspill, L.	1910	A	93-389	3	Similar to the above specimen.
37	37	White, G.K. and Woods, S.B.	1956	A	2.1-18.6	Na 3	Pure; cast in soft glass; 0.13 mm ı ter, $\rho_0/\rho_{295} = 3 \times 10^{-3}$.
38	37	White, G.K. and Woods, S.B.	1956	A	2.1-18.6	Na 4	Pure; cast in soft glass; 0.35 mm ı ter.
39	17	Roehlieh, F. and Tepper, F.	1965	A	379-1366		Pure; specimen was placed in a Hay ılloy cylindrical cell 0.5 in. O.D. with wall thickness 0.065 in. anc long.
40	57	Regel, A.R.	1958		273-473		Pure; data were extracted from the curve.
41	58	Hornbeck, J.W.	1913		279-361		Pure; supplied by Eimer and Amenc
42	15	Bidwell, C.C.	1926		33-348		Pure; 0.2921 cm in diameter, 51.3 g, extruded bare wires.
43	38	Dugdale, J.S. and Gugan, D.	1960	A	16-37.35	Na(7)	Pure; specimen was obtained from] s A. D. Mackay and Co., New York; $R_{4.2}/R_{273} = 3.8 \times 10^{-4}$; by cooling ıealed sample to 4 K and measuring its resistance up to 40 K ideal el l resistivity data were extracted from table.
44	38	Dugdale, J.S. and Gugan, D.	1960	A	16-37.35	Na(7)	Same as above specimen, subseque ce warming to 80 K and cooling to 4 K.
45	38	Dugdale, J.S. and Gugan, D.	1960	A	16-52	ideal B.C.C. Na	Pure; body center cubic phase; idea ical resistivity was calculated from 16 K to 40 K.
46*	38	Dugdale, J.S. and Gugan, D.	1960	A	16-52	ideal H.C.P. Na	Pure; hexagonal close packed phase resistivity was calculated from 16 to 52 K.
47	59	Cook, J.G., Van der Meer, M.P., and Laubitz, M.J.	1972		40-360	NRC 3	0.004 K, 0.0015 Si, < 0.001 Zr, Rb ı5 Ca, < 0.0005 B, Co, Sn, Pb, Y, Ti, Mo, Bi, < 0.0003 Ba, 0.000: a, 0.0002 Al, Cu, 0.0001 Mg, <0.0001 Mn, Cr, Ni, V, Be, Ag i; specimen was obtained from Mine Safety Appliance Corp.
48	42	Swalin, R.A.	1967		371-623		Pure; liquid state electrical resisti e calculated under constant volume condition.
49	42	Swalin, R.A.	1967		371-623		Pure; liquid state electrical resisti e calculated under constant pressure (1 atm) condition.
50	23, 60	MacDonald, D.K.C., White, G.K., and Woods, S.B.	1955, 1956	G	2.5-16	Na 1	Pure; specimen was cast in a fine s s capillary, 0.9 mm in diameter, 7 cm long continuous with a 50 cı ıelically wound tube of about 0.2 mm I.D.; $\rho_0/\rho_{295} = 3.60 \times 10^{-4}$.
51	23, 60	MacDonald, D.K.C., et al.	1955, 1956	G	2.5-16	Na 2	Similar to the above specimen excep apillary was 0.5 mm in diameter, 7 cm in length and $\rho_0/\rho_{295} = 2.92$
52	61, 62	Garland, J.C. and Bower, R.	1968, 1969	A	1.8-4.2		Pure; specimen was prepared by dr ıolten sodium into a teflon tube, the voltage and current probes were serted through the side of tube; $\rho_{290}/\rho_0 =$ 3800, ρ_0 was obtained by using ρ_{29} 3 x 10^{-8} Ωm.
53*	63	Greenfield, A.J.	1964	A	371		99.999+ pure; liquid state; density 0 cm^{-3}.
54	64	Collman, R.R., Blewitt, T.H., Klabunde, C.E., Redman, J.K., and McDonald, D.L.	1961		4.8, 273		Pure; specimen was prepared by ca under vacuum in a 0.125 in. O.D. and 0.004 in. wall and 1.50 in. l nless steel tube.

* Not shown in figure.

TABLE 11. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF SODIU … nce) (continued)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Com … cifications, and Remarks
55	65	Evangelisti, R. and Isacchini, F.	1965	A	371-1273	Na	Pure; speci … in a type 316 stainless steel container.
56	66	Belashchenko, D.K. and Vol'deit, A.V.	1972	A	393-917	1	0.005 Cd; sp … denum glass on 1 Kh18N9T stainless steel cap … s 1-2 mm, the length of the column was 40 m … ed for the establishment of a steady state, at … e sample was quenched in oil; elec- trical res … om the smooth curve.
57	66	Belashchenko, D.K. and Vol'deit, A.V.	1972	A	393-917	2	0.39 Cd; oth … e above specimen.
58*	22	Krautz, E.	1950	A	273	Na	Pure.
59*	67	Northup, E.F.	1911	B	293.15, 373.15		Pure; speci … mple was filled in a glass tube with platinum … s; electrical resistivity data were obtained … sistance of mercury and sodium.
60*	68	Van der Lugt, W., Devin, J.F., Hennephof, J., and Leenstra, M.R.	1973	B	373.15, 473.15	Na	Pure.
61	69	Tamaki, S., Ross, R.G., Cusack, N.E., and Endo, H.	1973	A	373.15	Na	Pure; liquid … y was measured at pressure equal to 1 bar.
62	69	Tamaki, S., et al.	1973	A	373.15	Na	Same as abo … sistivity was measured at pressure equal to …
63	70	Bonilla, C.F., Lee, D., and Foley, P.J.	1965	V	533-922	Na	0.002 N_2, 0. … e, 0.0001 P_3O_4, and 0.0001 heavy metals; l … ined in a 316 stainless steel tube with O.D. of … about 8 in. long; Chromel-Alumel thermocc … e temperature.
64*	71	Savchenko, V.A. and Shpil'rain, É.É.	1974	A	372-556		Pure; 0.000 … fitted by the equation ρ = 6.69 + 26.092 x … $T-273)^2$ - 39.962 x 10^{-9} $(T-273)^3$ + 43.854 x … $^5 T^5$ (10^{-8} Ωm) where T is in units of K.
65	5	Grosse, A.V.	1966		372-2800		Calculated e … the data of Kapelener and Bratton to a hype … = a, where $\sigma' = \rho_{m.p.}/\rho$ and T' = $(T - T_{m.}$ … 2 and b = 0.118.

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF SODIUM Na (Te[illegible]ature Dependence)

[Temperature, T, K; Resistivity, ρ, 10^{-8} Ωm]

CURVE 1

T	ρ
70	0.676
80	0.854
90	1.033
100	1.211
110	1.389
120	1.567
130	1.743
140	1.919
150	2.095
160	2.271
170	2.450
180	2.629
190	2.808
200	2.988
210	3.174
220	3.361
230	3.550
240	3.741
250	3.934
260	4.132
270	4.333
273.15	4.396
280	4.535
290	4.739
300	4.945
310	5.159
320	5.374
330	5.598
340	5.830
350	6.070
360	6.319
370	6.571

CURVE 2

T	ρ
373.2	10.00
398.2	10.85

CURVE 3

T	ρ
367	6.75
371	9.60*
373	9.65
423	11.4
473	13.18
523	14.90
573	16.70
623	18.44

CURVE 4

T	ρ
371	9.79
375	9.90*
379	9.98*
385	10.1
397	10.5
405	10.7
409	11.0
414	11.3
425	11.7
435	11.9
439	12.2
450	12.3
457	12.7
465	13.0
475	13.4
486	13.9
497	14.4
513	14.8
522	15.3
534	15.7
544	16.1
559	16.7
566	17.0
570	17.1

CURVE 5

T	ρ
292	4.95
330	5.79
347	6.21
359	6.51
362	6.57
364.5	6.61
366	6.65*
367	6.67*
368.5	6.70*
370	6.84

CURVE 6

T	ρ
283.4	4.64
290.4	4.82
291.0	4.80*
291.0	4.82*
291.9	4.85*
293.2	4.88*
318.0	5.43
329.4	5.68*

CURVE 6 (cont.)

T	ρ
351.2	6.20*
352.0	6.21*
353.2	6.27*
354.0	6.23*
354.6	6.26
357.4	6.28

CURVE 7

T	ρ
384.0	10.1*
473.4	13.4*
545.9	16.3
546.3	16.4*
616.8	19.5
639.4	20.6
723.6	24.7
751.0	26.0
809.8	29.3
855.7	31.9
862.8	32.3
953.1	37.9
1023.4	42.8
1111.5	49.5
1186.6	55.8
1270.6	63.7

CURVE 8

T	ρ
383	10.1*
423	11.4
473	13.2

CURVE 9

T	ρ
7	0.00297
8	0.00305
9	0.00318
10	0.00339
11	0.00371
12	0.00416
13	0.00478

CURVE 10

T	ρ
7	0.00244
8	0.00253
9	0.00268
10	0.00291

CURVE 10 (cont.)

T	ρ
11	0.00325
12	0.00375
13	0.00443

CURVE 11

T	ρ
7	0.00291
8	0.00302*
9	0.00319*
10	0.00346
11	0.00387
12	0.00445
13	0.00526

CURVE 12

T	ρ
7	0.00208
8	0.00216
9	0.00229
10	0.00248
11	0.00278
12	0.00320
13	0.00379

CURVE 13

T	ρ
7	0.00253
8	0.00215
9	0.00231
10	0.00256
11	0.00293
12	0.00347
13	0.00423

CURVE 14

T	ρ
2	0.00943
3	0.00943
7	0.00943
9	0.00954
11	0.0098
12	0.0103
14	0.0119
17	0.0143
18	0.0172
20	0.0227
23	0.0333
24	0.0337

CU[illegible] (cont.)

T	ρ
[illegible]	0.0769
[illegible]	0.0833
[illegible]	0.10
35	0.179
38	0.212
43	0.263
46.7	0.317

CU[illegible] 15

T	ρ
2	0.00132*
4	0.00134
7	0.00139
9	0.00163
10	0.00188
12	0.00231
12	0.00265
13	0.00321
14	0.00383
15	0.00518
16	0.00613
16	0.007
17	0.00919
18	0.0109
19	0.0129
21	0.0192
23	0.034
25	0.0526
27	0.067
32	0.10*
36	0.161
41	0.227
44	0.270
46	0.294
48	0.323

CU[illegible] 16

T	ρ
302	5.23
324	5.72
356	6.54*
365	6.70*
370	6.82*
406	1.04*
413	1.10
431	1.99
444	2.42
501	4.54

CURVE 16 (cont.)

T	ρ
525	15.61
542	16.25*
554	18.01
630	20.09
668	21.86
726	24.76*
790	28.01
850	31.54
913	35.31
945	37.35
1009	41.76
1079	46.44
1108	48.94
1171	54.16
1238	60.10
1300	66.17
1334	69.59
1360	72.48

CURVE 17

T	ρ
371.2	9.64
424.5	11.44*
482.5	13.78
585.7	17.98
693.9	23.16
804.4	28.68
908.7	34.91
1012.8	41.86
1072.8	46.40
1126.0	51.00

CURVE 18

T	ρ
372.95	9.56
382.05	9.67
396.55	9.88
403.35	10.16
420.25	10.38
444.35	11.03
447.55	10.89
453.15	11.88
461.65	11.17
471.85	11.41
471.85	11.61
492.75	11.79
499.45	11.95
505.05	12.27

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF SODIUM Na (Temperatu ndence) (continued)

CURVE 18 (cont.)

T	ρ
521.75	12.31
526.35	12.77
542.05	12.71
553.35	13.03
567.45	13.33
575.95	13.55
586.95	13.82
598.35	13.98
611.45	14.44
618.55	14.32
627.85	14.62

CURVE 19

T	ρ
373.15	9.44
423.15	11.10
473.15	12.90
523.15	14.78
573.15	16.78
623.15	18.92
673.15	21.12
723.15	23.50
773.15	26.00
823.15	28.56
873.15	31.36

CURVE 20

T	ρ
373.15	10.20
473.15	13.79
573.15	17.88
673.15	22.18
773.15	27.00
873.15	32.50
973.15	38.76
1073.15	46.15
1173.15	53.30
1273.15	62.09
1373.15	71.7
1473.15	83.1
1573.15	95.6
1673.15	110
1773.15	127
1873.15	146
1973.15	169

CURVE 21

T	ρ
50	0.3169
60	0.4568

CURVE 21 (cont.)

T	ρ
70	0.6307*
80	0.8050
90	0.9752
100	1.1455
110	1.3151
120	1.4840
130	1.6534
140	1.8235
150	1.9942
160	2.1656
170	2.3387
180	2.5138
190	2.6925
200	2.8742
210	3.0599
220	3.2472
230	3.4357
240	3.6261
250	3.8215
260	4.0223
270	4.2663*
273.15	4.2893*
280	4.4318
290	4.6437
295	4.7501

CURVE 22

T	ρ
50	0.3142*
60	0.4689*
70	0.62678*
80	0.7876*
90	0.94882*
100	1.108
110	1.264*
120	1.416
130	1.5652
140	1.7123
150	1.8573
160	2.0004
170	2.1428
180	2.2838
190	2.4249
200	2.5662
210	2.7077
220	2.8481
230	2.9865
240	3.1234
250	3.2617
260	3.4013

CURVE 22 (cont.)

T	ρ
270	3.5394
273.15	3.5823
280	3.6756
290	3.8132
295	3.8822

CURVE 23

T	ρ
44.00	0.251
50.10	0.349
59.63	0.509
76.41	0.805*
89.50	1.043*
97.12	1.173
136.00	1.858
180.50	2.654*
273.15	4.395*

CURVE 24

T	ρ
371.6	9.50*
384.8	9.89
398.3	10.35
413.6	10.86
425.2	11.31*
436.0	11.63
443.2	11.91

CURVE 25

T	ρ
384.8	9.82*
398.3	10.13*
413.3	10.49
424.4	10.66
435.9	10.90
443.1	11.09*

CURVE 26

T	ρ
4.2	0.000295
77.6	0.8075
273	4.28*

CURVE 27

T	ρ
4.2	0.000585
77.6	0.8075*
273	4.28*

CURVE 28

T	ρ
4.2	0.0025
77.6	0.8075*
273	4.28*

CURVE 29

T	ρ
20.6	0.09
81	0.91
195	2.9
273	4.3*

CURVE 30

T	ρ
308.55	5.13*
314.25	5.17
321.65	5.49
331.05	5.71*
339.25	5.77*
347.65	6.11*
352.85	6.26*
364.25	6.51*
369.75	6.60*
370.45	6.81*
371.05	9.56*
373.05	9.69*

CURVE 31

T	ρ
373.15	10.01*
423.15	11.78*
473.15	13.63*
523.15	15.56*
573.15	17.70
623.15	19.90
673.15	22.22*
723.15	24.70*
773.15	27.23*
823.15	29.94
873.15	32.76
923.15	35.72
973.15	38.87*
1023.15	45.64
1073.15	49.36
1123.15	53.21
1173.15	57.7
1273.15	61.57

CURVE 32*

T	ρ
371.15	9.70

CURV cont.)*

T	ρ
422.	.52
472.	.29

C 33

T	ρ
86.	.8
194.	.86
273.	.30*
323.	.33*

C 34

T	ρ
290.	.5

C 35

T	ρ
273.	.5
291.	.9*

C 36

T	ρ
93	.0
198	.8*
273	.2
291	.6*
308	.9
328	.4
389	.2

C 37

T	ρ
2.	.00142
4.	.00136
4.	.00140
8.	.00172

C 38

T	ρ
2.	.000930
4.	.000920
10.	.00172
18.	.0140

C 39

T	ρ
379.	.87
584.	.8*
755	.9
888	.06
1030	.90

CURVE 39 (cont.)

T	ρ
1134	52.58
1248	61.16
1360	71.89

CURVE 40

T	ρ
273.15	4.19*
313.15	5.15*
353.15	6.13*
371.15	6.50*
393.15	10.17
433.15	11.49
476.15	12.92*

CURVE 41

T	ρ
278.9	4.66*
294.7	5.06
315.3	5.63
334.6	6.04
361.3	6.63*

CURVE 42

T	ρ
33	0.442
73	0.750
98	1.066
123	1.493
148	1.869
173	2.304
198	2.762
223	3.185
273	4.255
293	4.717*
323	5.291
348	5.85

CURVE 43

T	ρ
16.10	0.00584
20.35	0.01563
25.00	0.03546
28.55	0.05844
32.55	0.09095
37.55	0.13837

CURVE 44

T	ρ
16.10	0.00640
20.35	0.01664

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF SODIUM Na (Temperatur[illegible] [illegible]endence) (continued)

CURVE 44 (cont.)

T	ρ
25.00	0.03702
28.55	0.06046
32.55	0.09342
37.35	0.14137

CURVE 45

T	ρ
16	0.0067
18	0.011
20	0.0165
22	0.0237
24	0.0329
26	0.0445
28	0.0583
30	0.0736
32	0.0908
36	0.1094
36	0.1296
40	0.1762
44	0.2296
48	0.287
52	0.3475

CURVE 46*

T	ρ
16	0.0035
18	0.0064
20	0.0103
22	0.0158
24	0.0232
26	0.0329
28	0.0448
30	0.0583
32	0.0738
34	0.0909
36	0.1094
40	0.152
42	0.1758
44	0.2007
46	0.2266
48	0.254
50	0.282
52	0.311

CURVE 47

T	ρ
40	0.1822
50	0.3217
60	0.4783

CURVE 47 (cont.)

T	ρ
70	0.6428
80	0.8109*
90	0.9806*
100	1.115*
120	1.491*
140	1.835*
160	2.181*
180	2.534*
200	2.897*
220	3.270*
240	3.657*
260	4.056*
273	4.330*
280	4.475*
300	4.915*
320	5.365*
340	5.849*
360	6.359*

CURVE 48

T	ρ
367.1	9.60
369.3	9.50*
370.3	9.62*
382.7	9.79
394.8	9.94*
397.0	10.19
402.8	10.20*
412.7	10.32*
416.0	10.44*
429.3	10.84
435.6	10.82*
442.9	11.05*
445.5	10.90*
453.4	11.17
458.1	11.29
469.3	11.47*
472.7	11.28
472.9	11.45*
493.8	11.95
496.1	12.08
498.5	11.97*
519.4	12.44
522.0	12.54
540.1	12.82*
555.4	12.98*
567.5	13.26*
576.6	13.52*
587.5	13.86*

CURVE 48 (cont.)

T	ρ
598.5	14.01*
613.2	14.50*
620.0	14.45

CURVE 49

T	ρ
371.8	9.52*
378.0	9.74*
381.4	9.89*
387.6	10.04*
393.1	10.23*
405.1	10.60*
405.1	10.71*
416.8	11.03*
421.7	11.27
423.1	11.18*
433.5	11.64*
445.6	12.03*
457.0	12.44
467.0	12.83
476.4	13.29*
482.8	13.45
499.7	14.21
513.4	14.60
527.3	15.18
548.7	15.95
571.2	17.07*
626.4	18.35

CURVE 50

T	ρ
3.17	0.001474
3.63	0.001475
4.25	0.001478
4.44	0.001477
5.65	0.001500
5.74	0.001502
5.83	0.001506
5.94	0.001524
6.28	0.001523
6.32	0.001525
6.32	0.001534
6.76	0.001555
6.78	0.00156
6.86	0.00157
6.99	0.00158
7.59	0.00164
7.75	0.00168
7.83	0.00169

CURVE 50 (cont.)

T	ρ
7.89	0.0017
8.15	0.00174*
8.57	0.00185
8.67	0.00181
9.08	0.00191
9.08	0.00196
9.08	0.00201
9.70	0.00214
9.82	0.00220
10.21	0.00239
10.37	0.00258
10.91	0.00257
11.19	0.00294*
11.64	0.00324
11.83	0.00337*
12.33	0.00369
13.40	0.00486
13.83	0.00570
14.39	0.00594
15.10	0.00690
15.81	0.00718

CURVE 51

T	ρ
3.17	0.001391
3.63	0.001392
4.25	0.001395*
4.44	0.001394
5.65	0.001417
5.74	0.001419
5.83	0.001423
5.94	0.001441
6.28	0.001440
6.32	0.001442
6.32	0.001451
6.76	0.001472
6.78	0.00148
6.86	0.00149
6.97	0.00150
7.59	0.00156
7.75	0.00160
7.83	0.00161
7.89	0.00162
8.15	0.00166
8.57	0.00177
8.67	0.00173
9.08	0.00183
9.08	0.00188
9.08	0.00193*

CUR[illegible] (cont.)

T	ρ
9.7[illegible]	0.00206
9.8[illegible]	0.00212*
10.2[illegible]	0.00231
10.3[illegible]	0.00250
10.9[illegible]	0.00249
11.1[illegible]	0.00286
11.6[illegible]	0.00316
11.8[illegible]	0.00329*
12.2[illegible]	0.00361
13.4[illegible]	0.00478
13.8[illegible]	0.00562*
14.3[illegible]	0.00586*
15.1[illegible]	0.00682*
15.8[illegible]	0.0071*

C[illegible] 52

T	ρ
1.7[illegible]	0.001244
2.0[illegible]	0.001239
2.4[illegible]	0.001238
2.6[illegible]	0.001254
2.8[illegible]	0.001256
3.0[illegible]	0.001249
3.3[illegible]	0.001284
3.6[illegible]	0.001270
3.8[illegible]	0.001284
3.9[illegible]	0.001277
4.0[illegible]	0.001310
4.2[illegible]	0.001315

C[illegible] 53*

T	ρ
371	9.57

C[illegible] 54

T	ρ
4.8	0.0794
273	4.76

C[illegible] 55

T	ρ
369	6.8*
374	9.9*
411	1.0*
473	3.4*
497	4.1
552	6.3
592	7.9
648	0.6

CURVE 55 (cont.)

T	ρ
689	22.4
751	25.7
789	27.8
798	28.0
848	31.0
885	33.7
932	36.2
971	38.8*
1027	43.3
1100	48.7
1153	52.8
1204	56.8
1280	62.9

CURVE 56

T	ρ
373	9.6*
434	11.2*
482	12.8
546	15.0
525	18.1
689	20.7
740	23.4
787	25.8
835	28.4
873	30.6
917	34.0

CURVE 57

T	ρ
373	9.6*
434	11.7*
482	13.4*
546	15.8
525	19.1
689	21.8
740	24.2
789	26.8
835	29.7
873	32.0
917	35.2

CURVE 58*

T	ρ
273	4.34

CURVE 59*

T	ρ
293.15	4.875
373.15	9.705

* Not shown in figure.

TABLE 12. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF SODIUM Na (Temperatı Dependence) (continued)

T	ρ
CURVE 60*	
373.15	9.6
473.15	13.4
CURVE 61	
373.15	10.7
CURVE 62	
373.15	7.2
CURVE 63	
533	16.27
589	18.41
644	20.75
700	23.80
755	26.80
811	29.84
866.5	32.90
922	36.31
CURVE 64*	
372.4	9.64
378.4	9.83
388.4	10.15
392.1	10.29
440.5	11.97
443.3	12.09
452.1	12.44
496.0	14.10
515.3	14.93
542.1	16.02
567.4	17.08
573.5	17.28
656.2	20.96
CURVE 65	
400	10.52*
500	14.57*
600	18.99
700	23.85*
800	29.22
900	35.16
1000	41.79
1100	49.24

T	ρ
CURVE 65 (cont.)	
1200	57.65
1300	67.24
1400	78.26
1500	91.07
1600	106.1
1700	124.1
1800	145.9
1900	173.0
2000	207.4
2100	252.7*
2200	314.9*
2300	405.8*
2400	551.0*
2500	820.0*
2600	1488.0*
2700	6033.0*

* Not shown in figure.

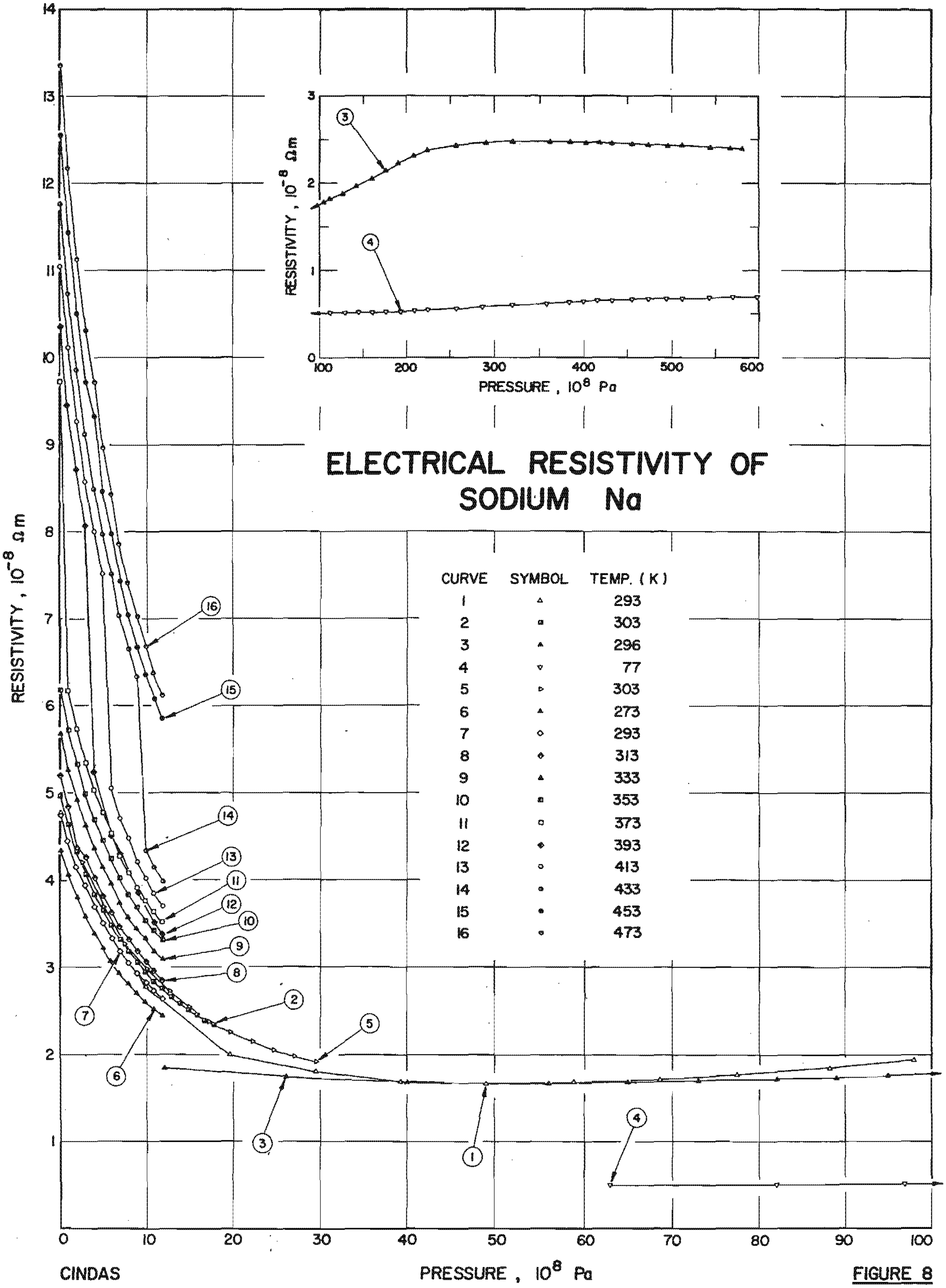

ELECTRICAL RESISTIVITY OF SODIUM Na
RESISTIVITY, 10^{-8} Ω m
PRESSURE, 10^8 Pa
CURVE SYMBOL TEMP. (K)
1 △ 293
2 ◻ 303
3 ▲ 296
4 ▽ 77
5 ▷ 303
6 ▲ 273
7 ◇ 293
8 ◆ 313
9 ▲ 333
10 ◼ 353
11 ◻ 373
12 ◆ 393
13 ○ 413
14 ● 433
15 ● 453
16 ○ 473
CINDAS

FIGURE 8

TABLE 13. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF SODIUM Na (P ependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Pressure Range, 10^8 Pa	Temperature Range, K	Name and Specimen Designation	Composition (weight	Specifications, and Remarks
1	30	Bridgman, P.W.	1952	A	0-98	293	Na	Pure; the solid medium t the relative resistance trical resistivity were electrical resistivity d	g pressure within the cell is AgCl; reported at room temperature; elec- y using compressibility data and pressure.
2	72	Bridgman, P.W.	1930	A	0-17.64	303	Na	Pure; solid, bar wires.	
3	31	Stager, R.A. and Drickamer, H.G.	1963	A	12-600	296		Commercial purity speci reported.	tance as a function of pressure were
4	31	Stager, R.A. and Drickamer, H.G.	1963	A	50-600	77		The above specimen; afte then cooled and measu	ssing to 50 kbar at room temperature .
5	32	Bridgman, P.W.	1938	A	0-29.4	303		Pure; specimen was extru relative electrical res reported.	ire about 1.3 mm in diameter; the a function of pressure data were
6	33	Bridgman, P.W.	1921	A	0-11.76	273		Pure; bare wire specimer relative electrical resi	meter of 0.015 in. and 0.030 in.; re reported.
7	33	Bridgman, P.W.	1921	A	0-11.76	293		The above specimen.	
8	33	Bridgman, P.W.	1921	A	0-11.76	313		The above specimen.	
9	33	Bridgman, P.W.	1921	A	0-11.76	333		The above specimen.	
10	33	Bridgman, P.W.	1921	A	0-11.76	353		The above specimen.	
11	33	Bridgman, P.W.	1921	A	0-11.76	373		The above specimen.	
12	33	Bridgman, P.W.	1921	A	0-11.76	393		The above specimen.	
13	33	Bridgman, P.W.	1921	A	0-11.76	413		The above specimen.	
14	33	Bridgman, P.W.	1921	A	0-11.76	433		The above specimen.	
15	33	Bridgman, P.W.	1921	A	0-11.76	453		The above specimen.	
16	33	Bridgman, P.W.	1921	A	0-11.76	473		The above specimen.	

TABLE 14. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF SODIUM Na ... Dependence)

[Temperature, T, K; Pressure, P, 10^8 Pa; Resistivity, ρ, 10^{-8} Ωm]

CURVE 1
T = 293

P	ρ
0.0	4.789
9.8	2.785
19.6	2.001
29.4	1.818
39.2	1.690
49.0	1.662
58.8	1.680
68.6	1.715
78.4	1.777
88.2	1.848
98.0	1.943

CURVE 2
T = 303

P	ρ
0.00	4.972
0.98	4.643
1.96	4.330
2.94	4.071
3.92	3.848
4.90	3.652
5.88	3.480
6.86	3.326
7.84	3.187
8.82	3.065
9.80	2.950
10.78	2.846
11.76	2.750
12.74	2.663
13.72	2.587
14.70	2.517
15.68	2.453
16.66	2.394
17.64	2.341

CURVE 3
T = 296

P	ρ
12	1.859
26	1.755
40	1.690
56	1.675
65	1.689
73	1.700
82	1.728

CURVE 3 (cont.)
T = 296

P	ρ
89	1.738
95	1.765
104	1.784
111	1.823
127	1.883
142	1.971
160	2.054
176	2.147
191	2.233
208	2.312
224	2.379
257	2.434
290	2.463
320	2.482
361	2.476
384	2.471
402	2.465
418	2.463
432	2.457
455	2.450
473	2.444
495	2.436
512	2.430
544	2.415
567	2.401
581	2.403

CURVE 4
T = 77

P	ρ
63	0.507
82	0.504
97	0.509
112	0.510
129	0.511
145	0.523
161	0.525
177	0.534
194	0.532
210	0.548
225	0.548
257	0.569
287	0.584
320	0.600
359	0.613

CURVE 4 (cont.)
T = 77

P	ρ
384	0.639
400	0.647
416	0.651
433	0.653
455	0.668
474	0.671
494	0.672
512	0.675
543	0.688
570	0.694
599	0.692

CURVE 5
T = 303

P	ρ
2.45	4.202
4.90	3.695
7.35	3.270
9.80	2.973
12.25	2.723
14.70	2.533
17.15	2.380
19.60	2.253
22.05	2.143
24.50	2.056
26.95	1.983
29.40	1.926

CURVE 6
T = 273

P	ρ
0.00	4.350
0.98	4.066
1.96	3.814
2.94	3.591
3.92	3.399
4.90	3.225
5.88	3.071
6.86	2.933
7.84	2.812
8.82	2.707
9.80	2.602
10.78	2.523
11.76	2.447

CURVE 7
T = 293

P	ρ
0.00	4.763
0.98	4.445
1.96	4.166
2.94	3.955
3.92	3.709
4.90	3.518
5.88	3.346
6.86	3.194
7.84	3.059
8.82	2.942
9.80	2.833
10.78	2.735
11.76	2.647

CURVE 8
T = 313

P	ρ
0.00	5.207
0.98	4.850
1.96	4.386
2.94	4.270
3.92	4.036
4.90	3.825
5.88	3.636
6.86	3.467
7.84	3.321
8.82	3.190
9.80	3.070
10.78	2.9[illegible]
11.76	2.8[illegible]

CURVE 9
T = 333

P	ρ
0.00	5.6[illegible]
0.98	5.2[illegible]
1.96	4.9[illegible]
2.94	4.630
3.92	4.371
4.90	4.157
5.88	3.963
6.86	3.747
7.84	3.587
8.82	3.443
9.80	3.310
10.78	3.191
11.76	3.086

E 10
353

ρ
6.189
5.723
5.330
4.994
4.706
4.469
4.257
4.023
3.844
3.692
3.548
3.420
3.306

E 11
373

ρ
9.735
6.180
5.740
5.357
5.035
4.771
4.542
4.287
4.095
3.929
3.776
3.640
3.522

E 12
393

ρ
10.368
9.472
8.720
8.075
5.258
4.781*
4.620
4.309
4.072*
3.865
3.677*

CURVE 12 (cont.)
T = 393

P	ρ
10.78	3.523
11.76	3.386

CURVE 13
T = 413

P	ρ
0.00	11.05
0.98	10.12
1.96	9.27
2.94	8.583
3.92	8.003
4.90	7.527
5.88	5.053
6.86	4.711
7.84	4.480
8.82	4.224
9.80	4.017
10.78	3.850
11.76	3.700

CURVE 14
T = 433

P	ρ
0.00	11.770
0.98	10.740
1.96	9.860
2.94	9.120
3.92	8.501
4.90	7.982
5.88	7.527
6.86	7.041
7.84	6.665
8.82	6.344
9.80	4.340
10.78	4.151
11.76	3.988

CURVE 15
T = 453

P	ρ
0.00	12.550
0.98	11.440
1.96	10.510
2.94	9.710
3.92	9.033

* Not shown in figure.

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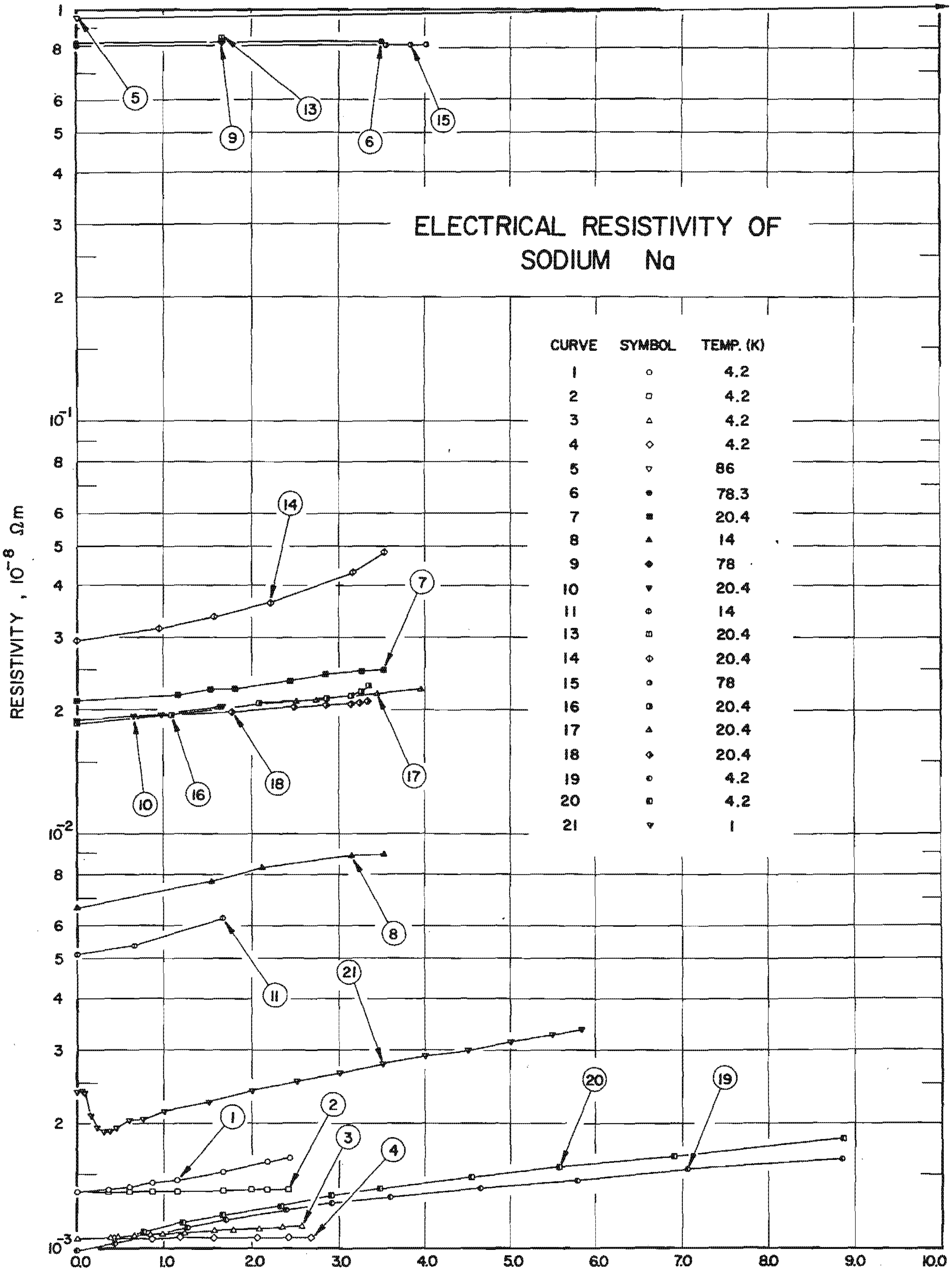
TABLE 14. EXPERIMENTAL DATA ON THE ELECTI ... ssure Dependence) (continued)

P	ρ
CURVE 15 (cont.)	
T = 453	
4.90	8.471
5.88	7.982
6.86	7.448
7.84	7.041
8.82	6.694
9.80	6.375
10.78	6.095
11.76	5.857
CURVE 16	
T = 473	
0.00	13.360
0.98	12.180
1.96	11.140
2.94	10.312
3.92	9.722
4.90	8.973
5.88	8.441
6.86	7.868
7.84	7.426
8.82	7.039
9.80	6.694
10.78	6.388
11.76	6.120



CINDAS MAGNETIC FLUX DENSITY, Tesla FIGURE 9

TABLE 15. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF SODIUM Na (Magnetic l ısity Dependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Magnetic Flux Density Range, Tesla	Temperature Range, K	Name and Specimen Designation	Composition (weigh	nt), Specifications, and Remarks
1	73	MacDonald, D.K.C.	1957		0-2.41	~4.2	Na, No. 1	Pure; the specimen was mold; platinum elect: 10^{-4}; resistance was pendicular to magnet	ıder high vacuum into a soft glass ere used; $R_{4.2\,K}/R_{294\,K} = 2.85 \times$ ·ed with the plane of specimen per- H.
2	73	MacDonald, D.K.C.	1957		0-2.41	~4.2	Na, No. 1	Same as the above speci plane of specimen pa	ɪe resistance was measured with the ɔ magnetic field H.
3	73	MacDonald, D.K.C.	1957		0-2.54	~4.2	Na, No. 2	Pure; the specimen was mold; platinum elect: resistance was measur to magnetic field H.	ıder high vacuum into a soft glass re used; $R_{4.2\,K}/R_{294\,K} = 2.2 \times 10^{-4}$; th the plane of specimen perpendicular
4	73	MacDonald, D.K.C.	1957		0-2.65	~4.2	Na, No. 2	Same as the above specim plane of specimen para	ɪe resistance was measured with the ɔ the magnetic field H.
5	34	Kapitza, P.	1929		0,30	86		Pure; specimen was obtair measurements were ma 0.2, where Rr is the re	·om Kahlbaum; magneto resistance a transverse magnetic field; R/Rr = ınce at room temperature.
6	36	Justi, E.	1948	A	0,3.5	78.4	Na 4	Pure; $R_{78.4\,K}/R_{273.15\,K}$	.894; measured in a transverse field.
7	36	Justi, E.	1948	A	0-3.51	20.4	Na 4	Same as the above specim 0.00483.	d conditions; $R_{20.4\,K}/R_{273.15\,K} =$
8	36	Justi, E.	1948	A	0-3.51	14.0	Na 4	Same as the above specim 0.00152.	d conditions; $R_{14.0\,K}/R_{273.15\,K} =$
9	36	Justi, E.	1948	A	0,1.65	78	Na 5	Similar to the above speci 0.01893.	ınd conditions; $R_{78\,K}/R_{273.15\,K} =$
10	36	Justi, E.	1948	A	0-1.65	20.4	Na 5	Same as the above specim 0.00435.	d conditions; $R_{20.4\,K}/R_{273.15\,K} =$
11	36	Justi, E.	1948	A	0-1.65	14.0	Na 5	Same as the above specim 0.00117.	d conditions; $R_{14.0\,K}/R_{273.15\,K} =$
12*	36	Justi, E.	1948	A	0,1.65	78	Na 5	Same as the above specim netic field.	was measured in a longitudinal mag-
13	36	Justi, E.	1948	A	0,1.65	20.4	Na 5	Same as the above specim netic field.	was measured in a longitudinal mag-
14	36	Justi, E.	1948	A	0-3.51	20.4	Na 10	Similar to the above speci was measured in a tran	$R_{20.4\,K}/R_{273.15\,K} = 0.00675$; it ıe field.
15	36	Justi, E.	1948	A	0-4.02	78	Na 11	Similar to the above speci	$R_{78\,K}/R_{273.15\,K} = 0.186$.
16	36	Justi, E.	1948	A	0-3.32	20.4	Na 11 mitt.	Similar to the above speci	$R_{20.4\,K}/R_{273.15\,K} = 0.00432$.
17	36	Justi, E.	1948	A	0-3.95	20.4	Na 11 max	Similar to the above speci	ınd conditions.
18	36	Justi, E.	1948	A	0-3.32	20.4	Na 11 min	Similar to the above speci	ınd conditions.
19	74	Babiskin, J. and Siebenmann, P.G.	1969		0-9	4.2		Pure; wire sample 1 to 1.! 3-in. diameter form; R from the smooth curve.	long and were helically wound on a ·/$R_{4.2\,K}$ = 5000; data were extracted

* Not shown in figure.

JREMENT INFORMATION ON T ... ty Dependence) (continued)

	Year	Method Used	Magneti Flux Dens Range, Te	... ercent), Specifications, and Remarks
	1969		0-9	ien except it was distorted, i.e., about
e	1957		0-5.8	ontained in a soft-glass capillary with ich two currents and two potential probes the sodium capillary was 80 μ (microns) long; since the sodium solidified slowly preparation, it is to be a single crystal specimen was obtained through S. B. rch Council of Canada; the magnetic field Solenoid and it was known to 1% and en to better than 0.1%; the specimen ndicular to H to within 1°.

TABLE 16. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF SOD a (Magnetic Flux Density Dependence)

[Temperature, T, K; Magnetic Flux Density, B, Tesla; Res ρ, 10^{-8} Ωm]

CURVE 1
T = 4.2

B	ρ
0.00	0.001371
0.35	0.001385
0.60	0.001408
0.87	0.001440
1.13	0.001469
1.65	0.001539
2.15	0.001613
2.41	0.001659

CURVE 2
T = 4.2

B	ρ
0.00	0.001371*
0.35	0.001372
0.60	0.001373
0.87	0.001375
1.13	0.001376
1.65	0.001379
1.98	0.001381
2.15	0.001382
2.40	0.001383

CURVE 3
T = 4.2

B	ρ
0.00	0.001058
0.38	0.001066
0.46	0.001068
0.65	0.001073
0.83	0.001078
0.98	0.001082
1.21	0.001089
1.55	0.001100
1.77	0.001107
2.08	0.001118
2.32	0.001126
2.54	0.001135

CURVE 4
T = 4.2

CURVE 4 (cont.)
T = 4.2

B	ρ
2.03	0.001065
2.40	0.001066
2.65	0.001067

CURVE 5
T = 86

B	ρ
0.0	0.9578
30.0	1.0248*

CURVE 6
T = 78.3

B	ρ
0.00	0.8239
3.50	0.8290

CURVE 7
T = 20.4

B	ρ
0.00	0.0210
1.15	0.02188
1.52	0.02262
1.80	0.02268
2.43	0.0236
2.83	0.0243
3.26	0.0248
3.51	0.0250

CURVE 8
T = 14.0

B	ρ
0.00	0.00661
1.52	0.00771
2.10	0.00832
3.13	0.00888
3.51	0.00897

CURVE 9
T = 78

CURVE 10
T = 20.4

B	ρ
0.00	0.01892
0.65	0.01940
0.97	0.01957
1.65	0.02046

CURVE 11
T = 14.0

B	ρ
0.00	0.00509
0.65	0.00538
1.65	0.00623

CURVE 12*
T = 78

B	ρ
0.00	0.8235
1.65	0.8240

CURVE 13
T = 20.4

B	ρ
0.00	0.8235*
1.65	0.8474

CURVE 14
T = 20.4

B	ρ
0.00	0.02936
0.936	0.03155
1.56	0.03378
2.20	0.03629
3.15	0.04163
3.51	0.04413

CURVE 15
T = 78

B	ρ
0.00	0.8090
3.54	0.8119
3.84	0.8123
4.02	0.8124

CURVE 16 (cor
T = 20.4

B	ρ
1.08	0.01
2.08	0.02
2.83	0.02
3.12	0.02
3.24	0.02
3.32	

(

B	ρ
0.00	0.01
1.60	0.02
2.50	0.02
2.72	0.02
3.11	0.02
3.43	0.02
3.95	0.02

CURVE 18
T = 20.4

B	ρ
0.00	0.01
1.08	0.01
1.77	0.01
2.49	0.02
2.83	0.02
3.12	0.02
3.24	0.02
3.32	0.02

CURVE 19
T = 4.2

B	ρ
0.00	0.00
0.42	0.00
0.81	0.00
1.25	0.00
1.69	0.00
2.37	0.00
2.90	0.00
3.58	0.00
4.65	0.00

CURVE 20
T = 4.2

B	ρ
0.00	0.0009898*
0.41	0.001050*
0.76	0.001098
1.20	0.001151
1.65	0.001203
2.31	0.001273
2.90	0.001333
3.47	0.001393
4.54	0.001488
5.59	0.001571
6.90	0.001678
8.86	0.001835

CURVE 21
T = 10

B	ρ
0.00	0.002394
0.05	0.002394
0.07	0.002381
0.14	0.002088
0.21	0.001965
0.30	0.001910
0.37	0.001910
0.45	0.001942
0.60	0.002029
0.76	0.002038
1.00	0.002134
1.50	0.002267
2.00	0.002404
2.50	0.002532
3.00	0.002659
3.50	0.002797
4.00	0.002915
4.50	0.003043
5.00	0.003167
5.50	0.003299
5.83	0.003381

4.3. Potassium

Potassium, with atomic number 19, is a silvery, soft, very reactive alkali metal, easily cut with a knife. Next to lithium, it is the second lightest known metal. It has a body-centered cubic crystalline structure with a density of 0.862 g cm^{-3} at 293 K. It melts at 336.35 K and boils at about 1047 K. Its critical temperature has been determined to be 2280.8±3 K. Naturally occurring potassium is composed of two stable isotopes, ^{39}K (93.10%) and ^{41}K (6.88%), and one radioactive isotope ^{40}K (0.00118%), which has a half-life of 1.28 × 10^9 years. The radioactivity of ^{40}K presents no appreciable hazard. Potassium has six other radioactive isotopes known to exist. The metal is the eighth most abundant element in the continental crust of the earth (2.09% by weight).

a. Temperature Dependence

There are 49 sets of experimental data available for the temperature dependence on the electrical resistivity of potassium. The information on specimen characterization and measurement conditions for each of the data sets is given in table 18. The data are tabulated in table 19 and shown in figures 10 and 11. Determinations of the electrical resistivity of potassium for the solid, liquid, and gas phases cover the continuous temperature range from 1 to 2366 K.

There are 21 data sets obtained below 100 K. Among these, three sets are single data points at liquid helium temperature. Dugdale [76] (curve 1) gave the lowest residual resistivity, $\rho_0 = 0.00087 \times 10^{-8}\Omega$ m. Dugdale and Gugan [8] tabulated electrical resistivities at constant volume (curve 17), which are lower than those at zero pressure (curve 18). Thirteen sets of intrinsic electrical resistivity values are obtained by subtraction of residual resistivity ρ_0 from the measured resistivity. In deriving the smoothed most probable values of intrinsic resistivity from the available data, the following overlapping temperature ranges were considered: below 10 K; 5–20 K; 10–40 K; 20–80 K; 30–150 K; etc. Within each range, a least-mean-square fraction error fit of the equation $\rho_i = aT^b$ was made to all the available intrinsic resistivity data. The resulting values for adjacent ranges were intercompared and the values were corrected for thermal linear expansion. These preliminary values were then fitted with the cubic spline function equation (7) to generate the final recommended values. The coefficients of equation (7) obtained in the fitting are given in the following table:

Temperature range, K	a	b	c	d
1 – 2.86	−6.796	5.219	0.164	−0.186
2.86– 6.42	−4.391	5.252	−0.092	0.442
6.42– 7.14	−2.547	5.350	0.372	−182.8
7.14– 8.00	−2.316	4.193	−25.19	198.8
8.00– 10.50	−2.147	3.157	4.027	−16.89
10.50–100	−1.745	3.399	−1.978	0.603

[illegible] approximately [illegible]

There are 16 data sets in the temperature region from 100 K to the melting point, 336.35 K. Dugdale and Gugan [8] also tabulated electrical resistivities at constant volume (curve 17), which are lower than those at zero pressure (curve 18). A least-mean-square-error fit to the totality of experimental data except those measured at constant volume in this range was made with a third order polynomial. The resulting values were corrected for thermal linear expansion, and then fitted the cubic spline function of equation (7) to obtain the final recommended values in this temperature range. The coefficients of equation (7) obtained are as follows:

Temperature range, K	a	b	c	d
10.5 –270.65	−1.745	3.399	−1.978	0.603
270.65–336.35	−0.807	1.418	0.574	22.28

There are 23 data sets available for the liquid state. Endo [40] (curve 29), and Lien and Silversten [41] (curve 30) also tabulated the electrical resistivities at constant volume. Freyland and Hansel [77] (curves 41 to 44) have measured the electrical resistivity at several constant pressure conditions from the melting point up to the critical temperature and above. The rest of the data are apparently measured at the saturated vapor pressure. Below 1000 K they agree with one another within 10%; the error may be somewhat higher above 1000 K. Roehlich and Tepper [17] (curve 26) give the highest value while Solov'ev [52] (curve 31) gives the lowest values. Below 1300 K, all the experimental data except those measured at constant volume and at constant pressure were fitted by a logarithmic third order polynomial. Above 1300 K, the resistivity values were obtained by extrapolating the fitted values and following the experimental trend. These values were then fitted with the cubic spline function equation (7) to generate the final recommended values. The coefficients of equation (7) obtained are as follows:

Temperature range, K	a	b	c	d
336.35–1090.3	1.146	1.154	0.494	0.287
1090.3 –2000	1.901	1.882	0.933	13.67

At the melting point (336.35 K), the electrical resistivity of potassium in the liquid state is about 50% higher than that of the solid state.

The recommended values for the total and intrinsic electrical resistivity are listed in table 17, and those for the total electrical resistivity are also shown in figures 9 and 10. The recommended values for the liquid state are for the saturated liquid. The recommended values of the total resistivities for the solid state are for a 99.99+% pure potassium and those at temperatures below 40 K are only applicable to a specimen with residual resistivity $\rho_0 = 0.00085 \times 10^{-8}\Omega m$. The recommended values from 1 K to 336.8 K are corrected for thermal linear expansion. The correction amounts to −1.74% at 1 K, −1.1% at 135 K, and 0.35% at 336.35 K. Because there is a strong indication for deviation from the Matthiesen's rule for the electrical resistivity of potassium [128], the values of ρ and ρ_i below 30 K are considered provisional. The uncertainty of the recommended total electrical resistivity is believed to be within ±20% from 1 K to 30 K, within ±50% from 40 K to 1500 K and within ±10% from 1500 K to 2000 K. Above 30 K the uncertainty of the recommended values for the intrinsic resistivity is about the same as that of the total electrical resistivity; below 30 K this uncertainty is higher than that of the total electrical resistivity.

b. Pressure Dependence

There are 12 sets of experimental data available for the electrical resistivity of potassium as a function of pressure. The information on specimen characterization and measurement conditions for each of the data sets is given in table 20. The data are tabulated in table 21 and shown in figure 12.

The available data and information for the pressure dependence of electrical resistivity of potassium are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only experimental data are presented here.

c. Magnetic Flux Density Dependence

There are 35 sets of experimental data available for the electrical resistivity of potassium under the influence of magnetic field. The information on specimen characterization and measurement information for each of the data sets is given in table 22. The data are tabulated in table 23 and shown in figure 13.

The available data and information for the magnetic flux density dependence of electrical resistivity of potassium are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only experimental data are presented here.

TABLE 17. RECOMMENDED ELECTRICAL RESISTIVITY OF POTASSIUM
(Temperature Dependence)

[Temperature, T, K; Total Resistivity, ρ, 10^{-8} Ωm; Intrinsic Resistivity, ρ_i, 10^{-8} Ωm]

Solid						Liquid	
T	ρ	ρ_i	T	ρ	ρ_i	T	ρ
1	0.00085*		35	0.379	0.378	336.35	13.95
2	0.00086*	6.1×10^{-6}*	40	0.480	0.479	350	14.64
3	0.00091*	5.1×10^{-5}*	45	0.583	0.582	400	17.18
4	0.00109*	2.3×10^{-4}*	50	0.689	0.688	500	22.91
5	0.00161*	0.00076*	60	0.905	0.904	600	29.58
6	0.00284*	0.00199*	70	1.12	1.12	700	37.31
7	0.00523*	0.00437*	80	1.34	1.34	800	46.20
8	0.00804*	0.00719*	90	1.56	1.56	900	56.36
9	0.0114*	0.0106*	100	1.79	1.79	1000	67.94
10	0.0160*	0.0152*	150	2.99	2.99	1100	81.05
11	0.0218*	0.0209*	200	4.26	4.26	1200	96.04
12	0.0286*	0.0278*	250	5.74	5.74	1300	114.0
13	0.0366*	0.0357*	273.15	6.49	6.49	1400	136.3
14	0.0455*	0.0446*	293	7.20	7.20	1500	164.6
15	0.0554*	0.0545*	300	7.47	7.47	1600	201.4*
16	0.0661*	0.0652*	336.35	9.22	9.22	1700	249.7*
18	0.0900*	0.0891*				1800	313.8*
20	0.117*	0.116*				1900	399.6*
25	0.195*	0.194*				2000	575.3*
30	0.283*	0.282*					

* Provisional values.

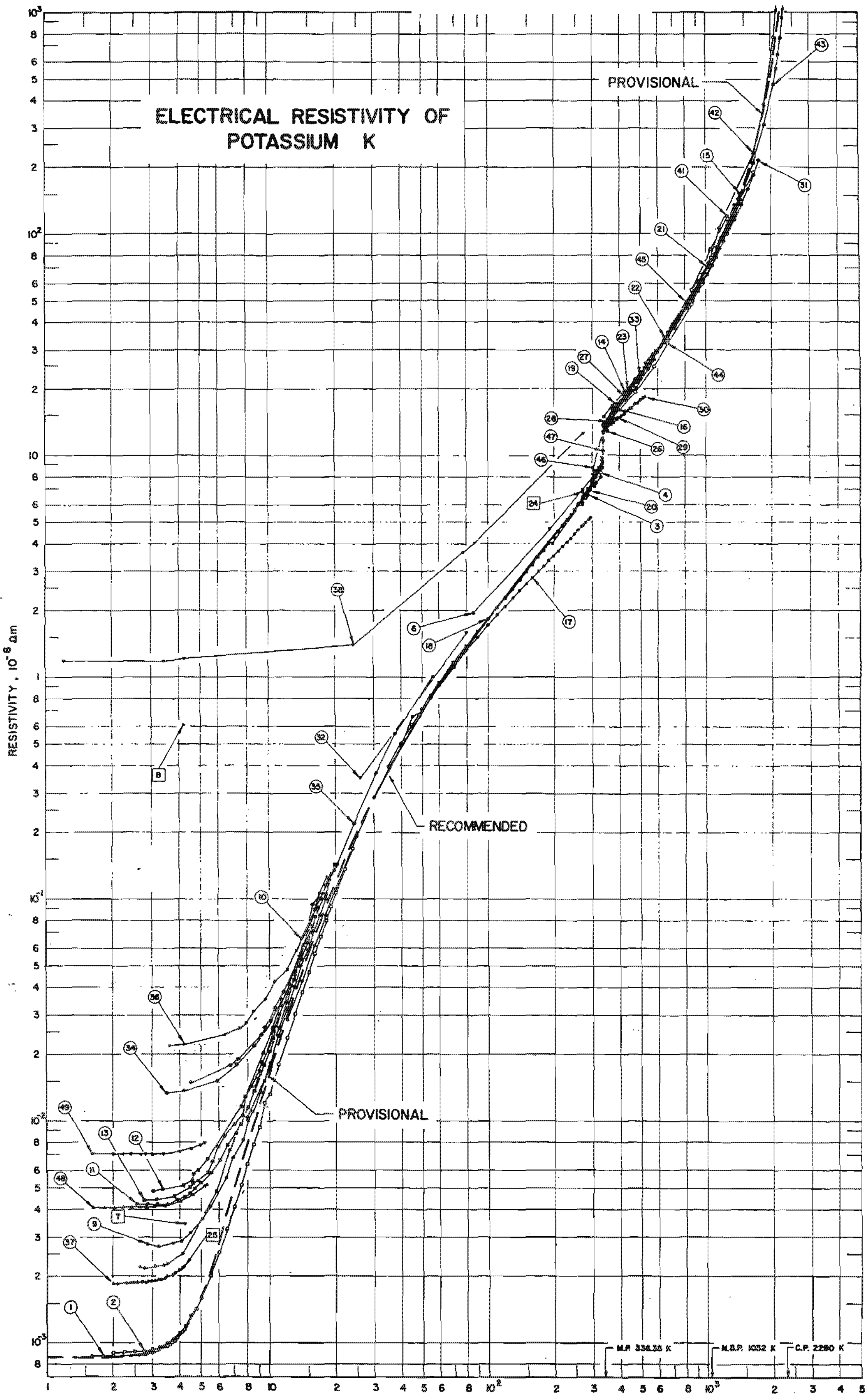

ELECTRICAL RESISTIVITY OF
POTASSIUM K
PROVISIONAL
RECOMMENDED
PROVISIONAL
RESISTIVITY, 10^{-8} Ωm
TEMPERATURE, K
M.P. 336.35 K
N.B.P. 1032 K
C.P. 2280 K
CINDAS

FIGURE 10

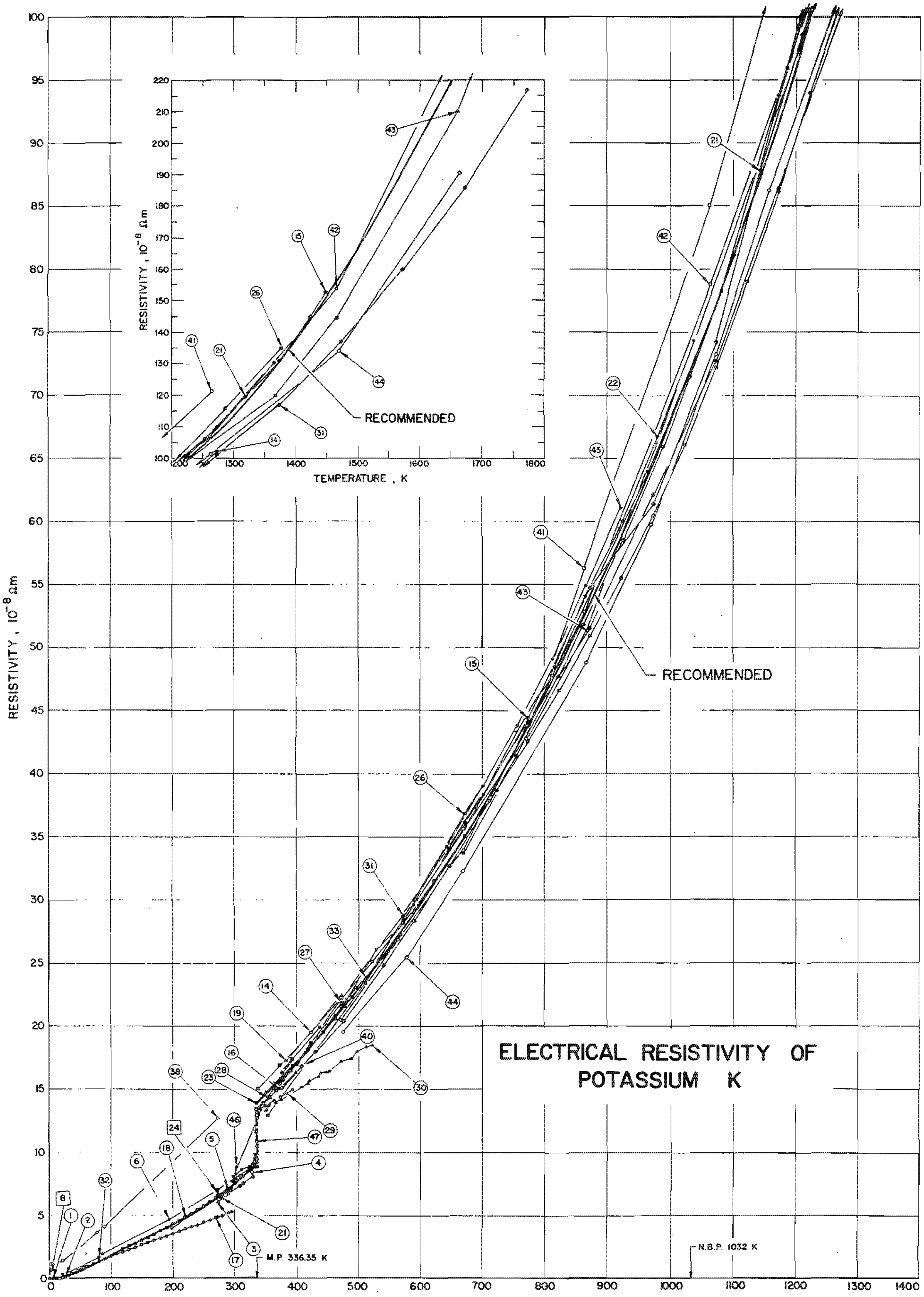

ELECTRICAL RESISTIVITY OF
POTASSIUM K
RESISTIVITY, 10^{-8} Ωm
TEMPERATURE, K
RECOMMENDED
M.P. 336.35 K
N.B.P. 1032 K
CINDAS

FIGURE 11

TABLE 18. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF POTASSIUM re Dependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weigh	ecifications, and Remarks
1	76	Gugan, D.	1971		1.2-4.2	K3(c)	Pure; low sodium grade ı polycrystalline wire s| was fully annealed at ؛	upplied by Mine Safety Appliance Co.; in diameter and 20 cm long; sample
2	78	Ekin, J.W. and Maxfield, B.W.	1971	C	1-25		High purity polycrystallir obtained from Mine Sa	ıen was extruded from the potassium , Ltd.
3	56	Hackspill, L.	1910	A	273,291	1	Pure.	
4	56	Hackspill, L.	1910	A	292,328	2	Pure.	
5	56	Hackspill, L.	1910	A	198,289	3	Pure.	
6	19	Gantz, A. and Bronieswki, W.	1909		86-323		Pure.	
7	79	Natale, G.G. and Rudnick, I.	1968	A	4.2	K1	99.98 pure; specimen wa cm in diameter and 10	n M.S.R. Research Corp.; sample 0.208 h; unannealed; $\rho_{273}/\rho_{4.2}$ = 1790.
8	79	Natale, G.G. and Rudnick, I.	1968	A	4.2	K11	Similar to the above spec	ıe length was 10.3 cm; $\rho_{273}/\rho_{4.2}$ = 10.
9	79	Natale, G.G. and Rudnick, I.	1968	A	2.5-20	K1B	Similar to the above spec 105 K for 1 hr; ρ_{273}/ρ_{4}	length 10.9 cm and was annealed at
10	79	Natale, G.G. and Rudnick, I.	1968	A	2.5-20	K12	Similar to the above spec	length 9.8 cm; $\rho_{273}/\rho_{4.2}$ = 2440.
11	79	Natale, G.G. and Rudnick, I.	1968	A	2.5-20	K13	Similar to the above spec	length 9.6 cm; unannealed; $\rho_{273}/\rho_{4.2}$ = 1342.
12	79	Natale, G.G. and Rudnick, I.	1968	A	2.5-20	K18	Similar to the above spec	length 10.0 cm; $\rho_{273}/\rho_{4.2}$ = 1187.
13	79	Natale, G.G. and Rudnick, I.	1968	A	2.5-20	K19	Similar to the above spec	= 1276.
14	18	Semyachkin, B.E. and Solov'ev, A.N.	1964	A	338-1273		Pure; TUMK HP 2010-5 s capillary, 60 mm in le	ıced in an 0.8/0.5 mm 1Kh 18Ng T steel
15	80, 81	Lemmon, A.W. Jr., Deem, H.W., Eldridge, E.A., Hall, E.H., Matolich, J. Jr., and Walling, J.F.	1963		301-1448		0.1 Na, 0.0053 O_2, 0.00:	, 0.001 Cs, Zr, Fe, Co.
16	45	Hennephof, J., Van der Lugt, W., and Wright, G.W.	1971	B	373.2-398		Pure; resistivity was a li to 125 C; described by	of temperature from melting point up 3 x 10^{-8} Ωm K^{-1}.
17	8	Dugdale, J.S. and Gugan, D.	1962	A	8-295.1	K(3), K(4)	Pure; specimens were ob specimens were made 0.5 mm in diameter; e condition; $\rho(0)/\rho(293)$	ine Safety Appliance Ltd., Toronto; the bare wires about 100 cm long and stivity was obtained at constant density
18	8	Dugdale, J.S. and Gugan, D.	1962	A	8-295.1	K(3), K(4)	Similar to the above spec at zero pressure condi	he electrical resistivity was measured
19	49	Akenova, L.I. and Belaschenko, D.K.	1971		383-473		99.9 pure; measurements	llary cell; liquid state specimen.
20	58	Hornbeck, J.W.	1913		278-331		Pure; trace of Na; suppli	ıd Amend.
21	16	Tepper, F., Zelenak, J., Roehlich, F., and May, V.	1965	A	296-1365		Pure; liquid state specim 0.6276, 0.6024, and 0 1206, 1302, and 1374]	7851, 0.7434, 0.7161, 0.6889, 0.6664, at 520.5, 701.3, 827.7, 944.3, 1048, .

TABLE 18. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF POTASSIUM K (Temperature endence) (continued)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), cifications, and Remarks
22	43	Kapelner, S.M. and Bratton, W.D.	1962	B	298-1037		0.32 Na, 0.02 Fe, and 0.04 O_2; mc specimen contained in 347 stainless steel tube; specimen was supplie Fisher Scientific Co.
23	57	Regel, A.R.	1958		273-433		Pure; data were extracted from the oth curve.
24	22	Krautz, E.	1950	A	273		–
25	82	Archibald, M.A., Dunick, J.E., and Jericho, M.H.	1967		4.2		'e; specimen was supplied T. Baker Chemical Co.; sample was l in a nylon tube with 1 mm e.
26	17	Roehlich, F. and Tepper, F.			341-1366		Pure; specimen was placed in a Ha 5 alloy cylindrical cell 0.5" in O.D., 0.063" in wall thickness, and 26 length.
27	46	Bornemann, K. and Rauschenplat, G.	1912		337-623		Pure potassium; liquid state.
28	40	Endo, H.	1963	A	330-390		Pure; sample was supplied by A. D ckay Ltd.; specimen container was made of soft glass capillary tube). 0.3 mm); electrical resistivity was measured at constant press ondition.
29	40	Endo, H.	1963	A	330-390		Same as above specimen except the trical resistivity was obtained at constant volume.
30	41	Lien, S.Y. and Silversten, J.M.	1969	A	373-623		99.95 pure; sample was supplied by D. Mackay Inc.; specimen cell was made from precision quartz cap ' open on one end; constant volume.
31	52	Solov'ev, A.N.	1963		373-1773		Pure; liquid state specimen; densit 29 g cm^{-3} at 337 K, 0.676 g cm^{-3} at 973 K; electrical resistivity data ve 973 K were extrapolated.
32	54	McLennan, J.C. and Niven, C.D.	1927	B	20.6-273		Pure.
33	83	Itami, T. and Shimoji, M.	1970	A	373-533		99.98 pure; the measuring cell was e of balio glass and four tungsten wires were sealed as the curren potential probes.
34	23	MacDonald, D.K.C., White, G.K., and Woods, S.B.	1955	A	3.5-12.6	K1	Pure; specimen was obtained from 'ure Metals Research Committee of the United Kingdom; specimen was r d in vacuo and run into soft-glass tubes with platinum leads sealed ample effective diameter 1.3 mm; ρ_0/ρ_{295} = 1.88 x 10^{-3}.
35	23	MacDonald, D.K.C., et al.	1955	A	4.5-56.4	K2	Similar to the above specimen exce e effective diameter was 2.1 mm and ρ_0/ρ_{295} = 1.95 x 10^{-3}.
36	23	MacDonald, D.K.C., et al.	1955	A	3.6-17.5	K4	Similar to the above specimen exce e effective diameter was 1.3 mm and ρ_0/ρ_{295} = 3.08 x 10^{-3}.
37	61, 62	Gorland, J.C. and Bower, R.	1968	A	2-4.2		Pure; specimen was prepared by cc xtruding vacuum distilled potassium under oil; copper wire current a ltage probes were then inserted into the extruded wire; residual resi y was obtained by using ρ_{290} = 7.10 x 10^{-8} Ωm.
38	29	Messiner, W. and Voigt, B.	1930	–	1.22-273	K2	Pure; specimen was obtained by me in vacuum; sample diameter 4.8 mm and 123 mm long; the resistance measured by compensation method with a mirror galvanometer.
39*	67	Northup, E.F.	1911	B	293.15, 373.15		Pure; specimen was supplied by Me sample was filled in a glass tube supplied with platinum potential urrent terminals; the electrical resistivity data were obtained by parison with the electric resistance data of mercury and potassium.

* Not shown in figure.

TABLE 18. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF POTASSIUM K (Temperatu: pendence) (continued)

Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent ecifications, and Remarks
'an der Lugt, W., Devin, J.F., Iennephof, J., and Leenstra, M.R.	1972	B	338.15,408.15		Pure.
'reyland, W.F. and Hansel, F.	1972		337-1265		Pure; liquid potassium was filled in a irical tungsten-rhenium container with thin wall; the electrical resistivity fluid metal within the cell is measured parallel to the known resistance of irrounding metallic container; measurement was taken at pressure equal tc iar.
'reyland, W.F. and Hansel, F.	1972		471-2173		Same as the above specimen; the elect: resistivity was measured at pressure equal tc
'reyland, W.F. and Hansel, F.	1972		670-2366		Same as tl resistivity was measured at pressure equal tc
'reyland, W.F. and Hansel, F.	1972		475-1665		Same as tl resistivity was measured at pressure equal tc
Bonilla, C.F., Lee, D.I., nd Foley, P.J.	1965	V	533-922		99.97 pure 'as obtained from MSA Research Corp; liquid s 316 type stainless steel tube with 7/16 in. O.I long; chromel-alumel thermocouples were us
Kurnakow, N.S. and Nikitinsky, A.J.	1914	B	273-373		Pure; Tho measuring the electrical resistivity; the spe id immersed in Vaslin thermostat; mercur libration.
Addison, C.C., Creffield, G.K., and Pulham, R.J.	1971		302-569		99.9 purity hed free of protective oil with light petrole ration at just above the melting point through en was contained in a steel capillary of know
eksandrov, B.N., Lomonos, I., and Semenova, E.D.	1973	A	1.6-5.2	K1	99.99 puri is capillaries of diameter 1.2 mm and length 4 tential and current leads in the form of plati e resistivity data were reported; data were ex
eksandrov, B.N., et al.	1973	A	1.6-5.2	K2	Similar to

TABLE 19. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF POTASSIUM K (Temp[illegible]ire Dependence)

[Temperature, T, K; Resistivity, ρ, 10^{-8} Ωm]

CURVE 1

T	ρ
0.0	0.00087*
1.6	0.00087018
1.8	0.00087044
2.0	0.0008711
2.2	0.00087253
2.4	0.0008754
2.6	0.0008804
2.8	0.000889
3.0	0.0009019
3.2	0.0009326
3.3	0.0009467*
3.4	0.0009667
3.5	0.0009728
3.6	0.0009813
3.7	0.0010025
3.8	0.0010263
3.9	0.0010624
4.0	0.0010913*
4.1	0.0011232
4.2	0.0011577

CURVE 2

T	ρ
2.00	0.0009016
2.25	0.0009041
2.50	0.0009085
2.75	0.000917
3.00	0.00093
3.25	0.00095
3.50	0.00099
3.75	0.001042
4.00	0.001108
4.25	0.001194
4.50	0.001303
4.75	0.001436
[illegible]	0.001595
[illegible]	0.002
[illegible]	0.00255
[illegible]	0.00324
[illegible]	0.00408
7.50	0.00511
8.00	0.00632
8.50	0.00772
9.00	0.00933
9.50	0.00121
10.00	0.0132
11.00	0.0179
12.00	0.0236

CURVE 2 (cont.)

T	ρ
13.00	0.0302
14.00	0.0379
15.00	0.0467
16.00	0.0566
17.00	0.0676
18.00	0.0795
19.00	0.0925
20.00	0.1069
22.00	0.1369
24.00	0.1699

CURVE 3

T	ρ
273	6.0
291	6.7

CURVE 4

T	ρ
292	6.7*
328	8.4

CURVE 5

T	ρ
198	4.0
273	6.3
289	7.1

CURVE 6

T	ρ
86.0	1.96
194.8	4.70
273.0	7.01
323.1	8.65

CURVE 7

T	ρ
4.2	0.00341

CURVE 8

T	ρ
4.2	0.61

CURVE 9

T	ρ
2.85	0.00277
3.18	0.0027

CURVE 9 (cont.)

T	ρ
3.74	0.0028
4.04	0.00285
4.43	0.0031
5.08	0.0036
5.50	0.0041
6.47	0.0055
6.93	0.0068
7.67	0.0082
8.04	0.0100
8.45	0.0110
9.14	0.0135
9.48	0.0152
10.05	0.0183
10.94	0.0243
12.00	0.0320
12.94	0.040
13.80	0.050
14.89	0.059
15.74	0.072
16.98	0.085
18.03	0.100
18.49	0.117
19.68	0.135

CURVE 10

T	ρ
2.65	0.00218
2.78	0.00216
3.10	0.0022
3.40	0.00223
3.53	0.00227
4.12	0.0025
5.86	0.0048
6.71	0.0073
8.93	0.0155
10.45	0.0256
13.84	0.0664
15.07	0.0771
16.79	0.1078
18.28	0.1266

CURVE 11

T	ρ
2.56	0.0042
2.86	0.0042
3.17	0.0042
3.52	0.0042
3.88	0.0044

CURVE 11 (cont.)

T	ρ
4.18	0.0045*
4.44	0.0047
4.69	0.00495
4.98	0.00522
5.55	0.00582
6.05	0.00665
6.55	0.00776
7.11	0.00873
7.50	0.00966
8.05	0.01159
8.59	0.01374
8.85	0.01538*
9.44	0.01791
10.00	0.02065
11.09	0.02649
12.00	0.03412
12.82	0.04335
13.96	0.0537
14.93	0.0638
15.67	[illegible]
16.63	[illegible]
18.07	[illegible]
18.62	0.123
19.95	0.144

CURVE 12

T	ρ
3.02	0.0048
3.33	0.0049
4.14	0.0051
4.56	0.00538
4.59	0.00574
4.86	0.00597
5.33	0.0067
7.57	0.0116
9.40	0.0203
10.35	0.0264
11.05	0.0333
12.25	0.0415
14.22	0.062
16.07	0.090
17.02	0.101
18.03	0.116
19.10	0.130

CURVE 13

T	ρ
2.76	0.00437

CURVE[illegible] cont.)

T	ρ
2.8[illegible]	0.00438*
3.1[illegible]	0.0044
3.7[illegible]	0.00457
4.4[illegible]	0.0050
4.5[illegible]	0.0052
4.8[illegible]	0.00532
5.3[illegible]	0.00583
5.6[illegible]	0.00652
5.9[illegible]	0.00764
6.3[illegible]	0.00859
7.0[illegible]	0.00963
7.6[illegible]	0.0106
7.8[illegible]	0.0128
8.3[illegible]	0.0143
9.0[illegible]	0.0168
9.2[illegible]	0.0185
10.4[illegible]	0.0236
11.1[illegible]	0.0302
12.0[illegible]	0.0378
13.0[illegible]	0.0474
13.8[illegible]	0.0568
15.3[illegible]	0.0705
16.1[illegible]	0.0834

CU[illegible] 14

T	ρ
338	5.0
373	6.9
423	9.5
473	2.2*
523	5.1
573	8.2
623	1.5
673	5.1
723	8.7
773	2.6
823	6.6
873	0.9
923	5.5
973	0.5
1023	6.1
1073	2.2*
1123	9.0
1173	6.2*
1223	4.0
1273	2.3

CURVE 15

T	ρ
301	7.52
373	15.4
473	21.5
573	28.4*
673	35.8*
773	44.4
873	54.3
973	66.4
1033	74.2
1173	93.8
1273	110.0
1373	131.0
1423	145.0
1448	153.0

CURVE 16

T	ρ
373.2	15.0
398.0	16.3

CURVE 17

T	ρ
8	0.0103
10	0.0177
12	0.0284
14	0.0428
16	0.0618
18	0.0849
20	0.110
25	0.193
30	0.289
35	0.389
40	0.494
45	0.668
50	0.709
55	0.817
60	0.925
70	1.114
80	1.334
90	1.524
100	1.724
110	1.914
120	2.094
130	2.284
140	2.464
150	2.644
160	2.824
170	3.004

* Not shown in figure.

TABLE 19. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF POTASSIUM ependence) (continued)

CURVE 17 (cont.)

T	ρ
180	3.184
190	3.364
200	3.544
210	3.724
220	3.904
230	4.084
240	4.264
250	4.444
260	4.624
270	4.814
273.15	4.864
280	4.994
290	5.184
295.1	5.274

CURVE 18

T	ρ
8	0.0103*
10	0.0177*
12	0.0284*
14	0.0428*
16	0.0618*
18	0.0849*
20	0.110*
25	0.193*
30	0.289*
35	0.393
40	0.500
45	0.611
50	0.723
55	0.835
60	0.948
70	1.174
80	1.394
90	1.614
100	1.844
110	2.064
120	2.294
130	2.534
140	2.764
150	3.004
160	3.254
170	3.504
180	3.754
190	4.024
200	4.284
210	4.554
220	4.834
230	5.124

CURVE 18 (cont.)

T	ρ
240	5.424
250	5.724
260	6.034
270	6.344
273.15	6.454
280	6.674
290	7.014*
295.1	7.194

CURVE 19

T	ρ
383	17.3
423	19.4*
473	22.4

CURVE 20

T	ρ
278.0	6.492*
278.0	6.442
293.8	7.015
293.9	7.035*
294.1	6.980*
330.6	8.353*
331.0	8.338*

CURVE 21

T	ρ
296	7.02*
309	7.32
314	7.54
329	8.05
376	15.05
431	17.96
476	20.31
541	24.83
591	28.34
648	32.64
712	37.84
755	41.43
822	47.70
863	51.81
926	58.51
988	65.94
1031	71.44
1102	81.18
1144	87.82
1210	98.61
1253	106.63
1319	119.87
1365	130.61

CURVE 22

T	ρ
298.5	8.07
302.6	8.24
311.5	8.59
324.6	8.82
331.5	9.47
332.4	9.81
352.6	14.77
365.1	15.48
414.0	17.90
478.2	21.86
529.6	26.06
597.1	29.57
646.8	34.11
702.4	38.32
755.1	43.30
816.0	48.47
866.6	54.04
920.1	59.47
924.6	60.02
979.9	66.75
1037.4	74.30

CURVE 23

T	ρ
273.15	6.54
313.15	8.05
336.15	8.86
336.15	13.84
393.15	17.38
437.15	19.93

CURVE 24

T	ρ
273	6.88

CURVE 25

T	ρ
4.2	0.0022

CURVE 26

T	ρ
354	12.9
512	23.36
672	36.83
811	47.75
964	64.00
1081	78.23
1186	96.01
1287	115.8
1376	135.1

CURVE 27

T	ρ
373	15.49*
423	18.70
473	21.80
523	25.00*
573	28.20*
623	31.40*
337	13.16

CURVE 28

T	ρ
336.1	13.21*
353.2	14.33
363.3	15.03
372.7	15.59*
393.0	16.89

CURVE 29

T	ρ
342.8	13.39
350.6	13.65
363.5	14.05
374.2	14.34
384.5	14.63
393.4	14.97

CURVE 30

T	ρ
336.55	13.1
351.05	13.3
355.65	13.7
367.75	13.87
375.35	14.19
387.05	14.67
408.15	15.17
418.95	15.43
420.05	15.60
435.85	15.94
438.15	16.21
448.85	16.30
452.05	16.40
454.05	16.48*
456.05	16.46*
472.85	17.17
488.45	17.37
497.75	17.93
512.25	18.33
514.75	18.27*
522.85	18.49

31

ρ
13.78
16.30
22.35
28.75
36.15
44.1
51.15
62.1
72.7
86.4
101.0
117.0
137.0
160.0
186.0
217.0

32

ρ
0.35
1.6
4.0*
6.1*

33

ρ
15.67
16.43
17.19
18.16
19.13
20.03
20.88
22.04
23.07
23.85
25.01

34

ρ
0.0134
0.0137
0.0152
0.0179
0.0219
0.0284
0.0353
0.0408

CURVE 35

T	ρ
4.5	0.0149
6.8	0.0178
7.3	0.0190
9.2	0.0245
9.5	0.0265
10.7	0.0323
11.6	0.0382
13.7	0.0551
15.7	0.0745
20.4	0.1435
24.3	0.2199
30.7	0.3678
37.5	0.5583
56.4	1.0138

CURVE 36

T	ρ
3.6	0.0219
4.2	0.0221
6.4	0.0247
7.4	0.0261
7.9	0.0276
8.5	0.0312
9.6	0.0355
10.6	0.0424
12.0	0.0480
13.2	0.0588
14.8	0.0725
17.5	0.107

CURVE 37

T	ρ
2.01	0.00185
2.10	0.00185
2.18	0.00185*
2.30	0.00185
2.39	0.00186
2.49	0.00187
2.58	0.00187
2.71	0.00188
2.81	0.00188
2.89	0.00189
2.99	0.00190
3.03	0.00191*
3.09	0.00191
3.13	0.00192*
3.20	0.00192
3.30	0.00194
3.33	0.00195*

* Not shown in figure.

TABLE 19. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF POTASSI[illegible] Temperature Dependence) (continued)

CURVE 37 (cont.)

T	ρ
3.39	0.00195
3.45	0.00196*
3.49	0.00198
3.54	0.00198*
3.60	0.00199*
3.64	0.00201*
3.70	0.00202
3.73	0.00203*
3.74	0.00203*
3.80	0.00205
3.84	0.00206*
3.86	0.00208*
3.95	0.00211*
4.00	0.00212
4.04	0.00213*
4.07	0.00215*
4.11	0.00216
4.15	0.00219*
4.18	0.0022*

CURVE 38

T	ρ
1.22	1.182
3.44	1.182
4.21	1.202
20.42	1.409
77.60	3.653
87.81	4.075
273.16	12.75

CURVE 39*

T	ρ
293.15	7.118
373.15	15.275

CURVE 40

T	ρ
338.15	13.1*
408.15	16.8

CURVE 42

T	ρ
471	20.46
563	26.98
670	33.96
864	52.84
1064	78.88
1261	107.15
1466	153.81
1667	233.88
1865	388.15
2070	788.85
2122	1185.75*
2173	3104.60*

CURVE 43

T	ρ
670	33.8
869	51.4
1367	120.2
1466	144.5
1662	210.4
1862	311.1
2065	480.8
2126	563.6
2169	653.1
2222	772.6
2267	959.4
2327	1224.0*
2366	1496.0*

CURVE 44

T	ρ
475	19.50
578	25.47
669	32.28
867	48.86
969	59.98
1072	73.28
1157	86.30
1263	101.6

CURVE 45 (cont.)

T	ρ
755	43.8
811	49.1
866.5	54.9
922	61.1

CURVE 46

T	ρ
273	6.60*
298	7.71
303	8.82
348	14.43
373	15.80

CURVE 47

T	ρ
302	7.87
310	8.13
321	8.57*
331	9.03
335	9.22
336	9.55*
336	10.59
336	10.95
336	11.70
336	13.50
347	13.94
357	14.49
368	14.98
378	15.72
400	16.96
418	18.04*
443	19.51
464	20.69
479	21.64
491	22.35
512	23.67
534	25.11*
549	25.97
569	27.28

CURVE 48

T	ρ
1.61	0.004045
1.82	0.004045
2.02	0.004045
2.21	0.004044
2.40	0.004063
2.62	0.004077

CURVE 48 (co

T	ρ
2.80	0.00
3.00	0.00
3.19	0.00
3.40	0.00
3.59	0.00
3.81	0.00
4.00	0.00
4.21	0
4.31	0
4.43	0
4.49	0
4.57	0
4.66	0
4.71	0
4.82	0
4.90	0
4.97	0
5.04	0
5.10	0
5.18	0

CURVE [illegible]

T	ρ
1.62	0
2.00	0.[illegible]
2.21	0.00
2.42	0.00
2.63	0.00
2.79	0.00
3.00	0.00
3.20	0.00
3.37	0.00
3.58	0.00[illegible]
3.78	0.00719
4.00	0.00724
4.21	0.00733
4.35	0.00739
4.43	0.00742
4.51	0.00748
4.58	0.00752
4.67	0.00756
4.77	0.00760
4.83	0.00767
4.91	0.00773
4.97	0.00777
5.03	0.00782
5.11	0.00790
5.1	0796

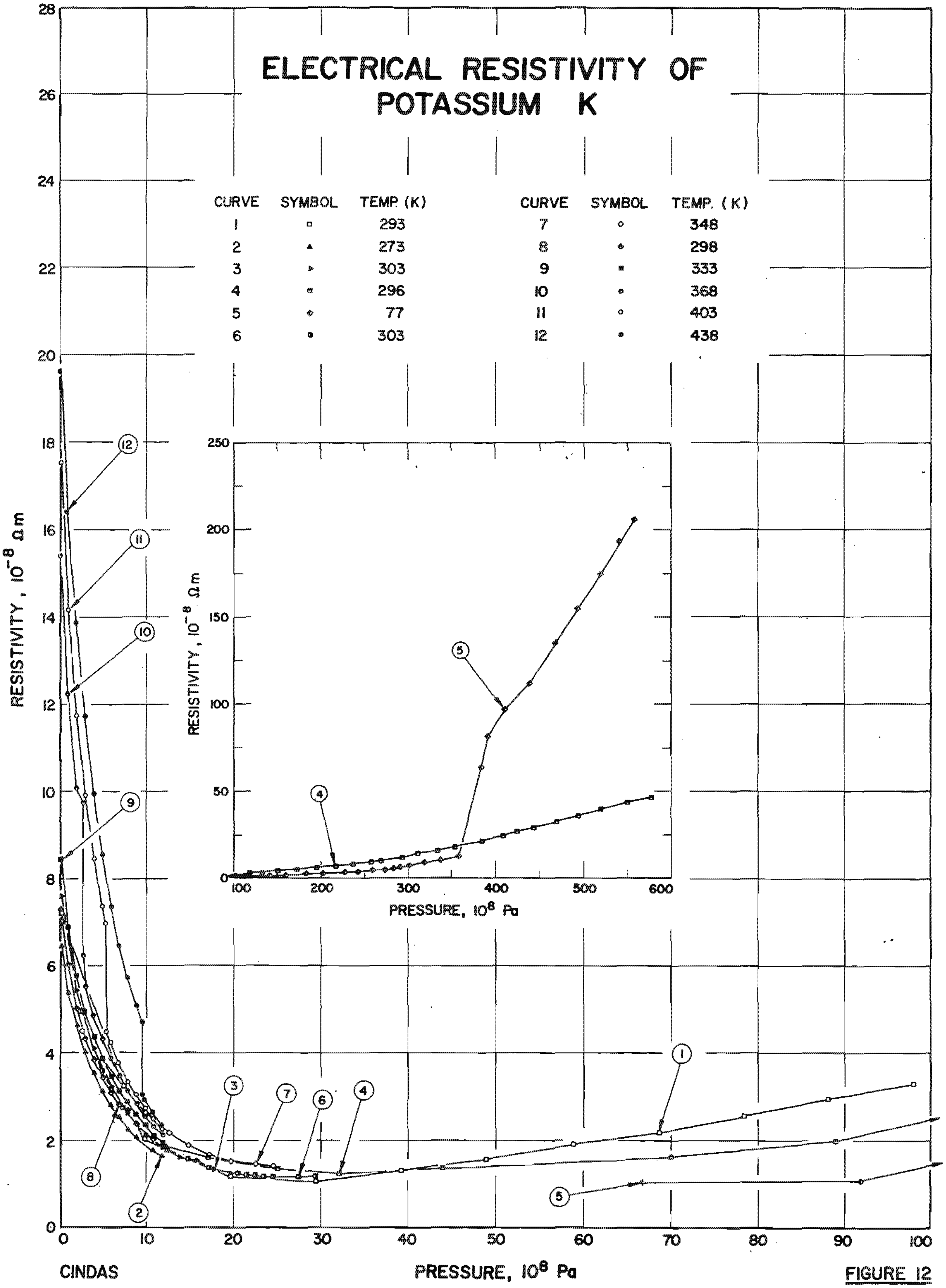

ELECTRICAL RESISTIVITY OF
POTASSIUM K
CURVE SYMBOL TEMP. (K)
1 293
2 273
3 303
4 296
5 77
6 303
7 348
8 298
9 333
10 368
11 403
12 438
RESISTIVITY, 10^{-8} Ω m
PRESSURE, 10^{8} Pa
CINDAS

FIGURE 12

TABLE 20. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF POTASSIUM ... ɘ Dependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Usec	Pressure R...	Temperature Range, K	Name and Specimen Designation	Composition	t), Specifications, and Remarks
1	30	Bridgman, P.W.	1952	A	ι	293		Pure; AgCl is the tance data wer obtained by usi at 293 K and or relative resist	ansmit pressure; the relative resis- electrical resistivity data were ended value of electrical resistivity ɘ, the compressibility data and the
2	86	›.W.	1925	A	0-11.76	273		Pure; solid, 1.5 r Nijol.	are wire sample was extruded under
3	72	Bridgman, P.W.	1930	A	0-19.60	303		Pure; solid, bare	
4	31	Stager, R.A. and Drickamer, H.G.	1963	A	12-578	296		Commercial purit was reported.	ɘ resistance as function of pressure
5	31	Stager, R.A. and Drickamer, H.G.	1963	A	67-558	77		Same as the above	
6	32	Bridgman, P.W.	1938		0-29.4	303		Pure; specimen w bare wire; the pressure data	m Kahlbaum; it was extruded to cal resistance as a function of
7	32	Bridgman, P.W.	1938		0-24.5	348		Same as the above	
8	33	Bridgman, P.W.	1921		0-11.76	298		Pure; specimen w resistance wer	a glass capillary; relative electrical
9	33	Bridgman, P.W.	1921		0-11.76	333		Same as the above	
10	33	Bridgman, P.W.	1921		0-11.76	368		Same as the above	
11	33	Bridgman, P.W.	1921		0-11.76	403		Same as the above	
12	33	Bridgman, P.W.	1921		0-11.76	438		Same as the above	

T... RESISTIVITY OF P... ure Dependence)

[Temperature, T, K; Pressure, P, 10^8 Pa; Resistivity,

P	ρ
CURVE 1 T = 293	
0.0	7.205
9.8	2.052
19.6	1.191
29.4	1.129
39.2	1.258
49.0	1.525
58.8	1.852
68.6	2.186
78.4	2.562
88.2	2.963
98.0	3.392
CURVE 2 T = 273	
0.00	6.453
0.98	5.392
1.96	4.634
2.94	4.031
3.92	3.538
4.90	3.133
5.88	2.800
6.86	2.520
7.84	2.285
8.82	2.078
9.80	2.020*
10.78	1.761
11.76	1.633
CURVE 3 T = 303	
0.00	7.600
1.96	5.495
3.92	4.115
5.88	3.239
7.84	2.619
9.80	2.184
11.76	1.860
13.72	1.626
15.68	1.581
17.64	1.334
19.60	1.250

P	ρ
CURVE 3 T = 303	
0.00	7.600
1.96	5.495
3.92	4.115
5.88	3.239
7.84	2.619
9.80	2.184
11.76	1.860
13.72	1.626
15.68	1.581
17.64	1.334
19.60	1.250
CURVE 4 T = 296	
12	1.850
17	1.602
25	1.366
32	1.249
44	1.343
70	1.627
89	1.985
119	2.543
133	2.930
151	3.337
173	4.137
195	5.125
218	6.160
237	7.173
257	8.499
269	9.437
294	11.48
313	13.11
335	15.45
355	17.89
385	20.95
409	24.00
425	26.24
443	28.57
469	32.00
494	35.75
520	39.65
550	43.16
578	46.33

P	ρ
CURVE 5 T = 77	
67	1.016
92	1.098
113	1.212
142	1.486
160	1.707
183	2.146
203	2.507
228	3.096
243	3.644
260	4.174
274	4.692
284	5.371
292	6.133
302	7.370
320	9.007
338	10.74
359	12.39
384	63.69
392	81.64
411	96.44
439	116.4
468	135.9
493	154.7
519	174.1
541	193.7
558	206.3
CURVE 6 T = 303	
0.00	7.600*
2.45	4.951
4.90	3.608
7.35	2.723
9.80	2.165*
12.25	1.788
14.70	1.535
17.15	1.370
19.60	1.257*
20.58	1.230
21.56	1.208
22.54	1.191
23.52	1.178
24.50	1.169
25.48	1.167*

P	ρ
CURVE 6 (cont.) T = 303	
26.46	1.169*
27.44	1.173
28.42	1.181*
29.40	1.192
CURVE 7 T = 348	
2.45	4.52
7.35	3.36
9.80	2.65
12.25	2.191
14.70	1.88
17.15	1.683
19.60	1.546
22.54	1.479
24.50	1.469
CU T = 298	
0.00	7.279
0.98	6.011
1.96	5.079
2.94	4.372
3.92	3.857
4.90	3.457
5.88	3.106
6.86	2.814
7.84	2.710
8.82	2.365
9.80	2.176*
1	2.016
1	1.876*
CURVE 9 T = 333	
0.00	8.434
0.98	6.893
1.96	5.791
2.94	4.966
3.92	4.366
4.90	3.888
5.88	3.477

ρ
E 9 (cont.) = 333
3.139
2.850
2.597
2.365
2.167
1.997
URVE 10 = 368
15.40
12.21
10.08
9.789
6.293
5.560
4.874
4.324
3.853
3.465
3.121
2.829
2.553
2.318
2.119
URVE 11 T = 403
17.58
14.19
11.71
9.90
8.442
7.382
6.966
4.498
4.230
3.797
3.385
3.055
2.735
2.464
2.233

P	ρ
CURVE 12 T = 438	
0.00	19.62
0.98	16.40
1.96	13.83
2.94	11.71
3.92	9.948
4.90	8.574
5.88	7.380
6.86	6.450
7.84	5.701
8.82	5.066
9.52	4.695
9.52	3.029
9.80	2.924
10.78	2.615
11.76	2.355

* Not shown in figure.

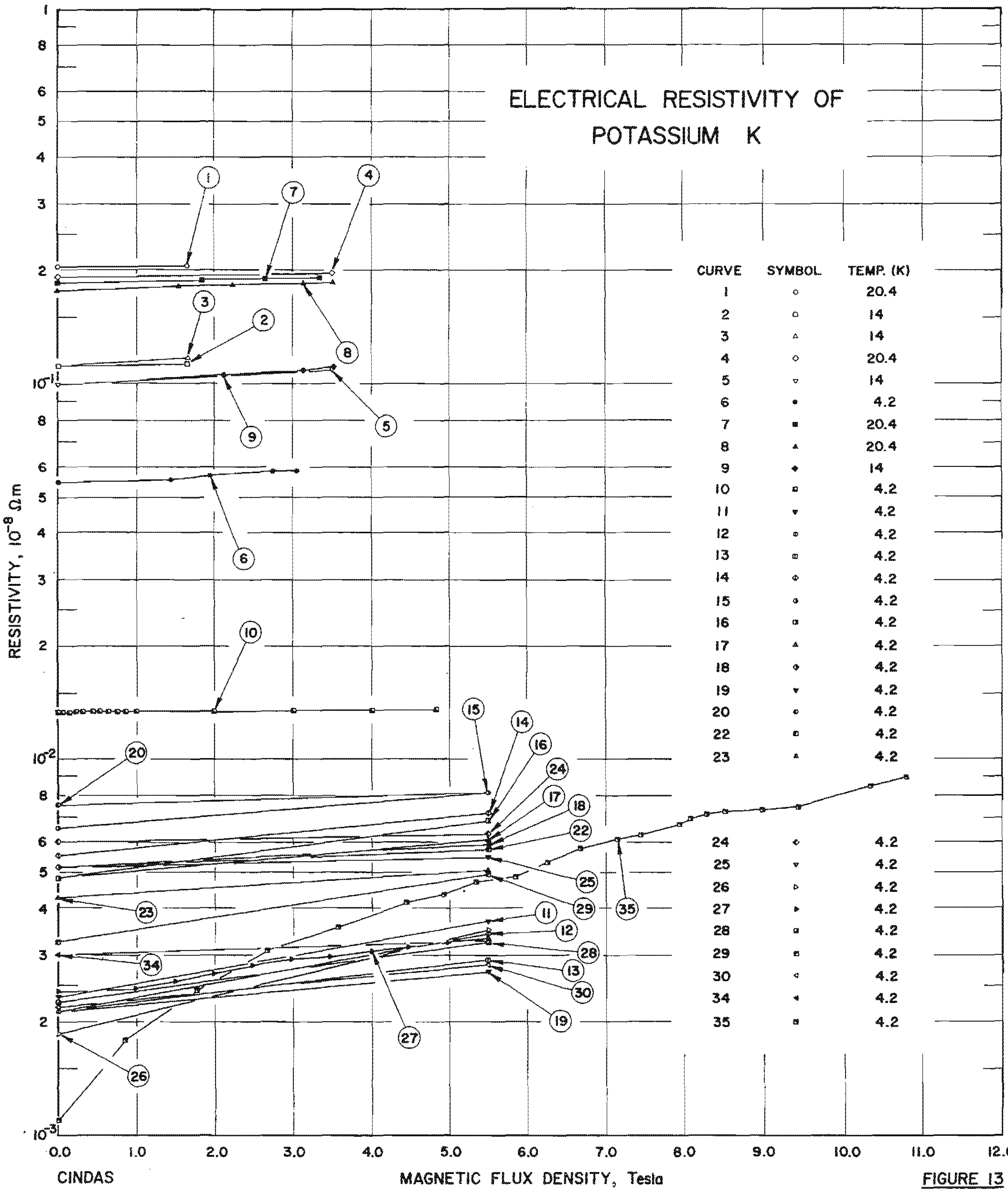


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FIGURE 13

TABLE 22. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF POTASSIUM K (Magn Density Dependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Magnetic Flux Density Range, Tesla	Temperature Range, K	Name and Specimen Designation	Composition (we	ent), Specifications, and Remarks
1	36	Justi, E.	1948	A	0, 1.65	20.4	K5	Pure; 1 mm width, measured in a	ng; $R_{20.4\ K}/R_{273.15\ K} = 0.02835$; magnetic field.
2	36	Justi, E.	1948	A	0, 1.65	14.0	K5	Same as the abov	$R_{14\ K}/R_{273.15\ K} = 0.0155$.
3	36	Justi, E.	1948	A	0, 1.65	14.0	K5	Same as the abov netic field.	except measured in a longitudinal mag-
4	36	Justi, E.	1948	A	0, 3.5	20.4	K6	Pure; $R_{20.4\ K}/R$ netic field.	).02673; measured in a transverse mag-
5	36	Justi, E.	1948	A	0, 3.5	14.0	K6	Same as the abov	$R_{14\ K}/R_{273.15\ K} = 0.0138$.
6	36	Justi, E.	1948	A	0-3.05	4.22	K6	Same as the abov	$R_{4.22\ K}/R_{273.15\ K} = 0.00756$.
7	36	Justi, E.	1948	A	0-3.33	20.4	K6	Same as the abov	$R_{20.4\ K}/R_{273.15\ K} = 0.02604$.
8	36	Justi, E.	1948	A	0-3.51	20.4	K11	Pure; $R_{20.4\ K}/R$ netic field.	).0247; measured in a transverse mag-
9	36	Justi, E.	1948	A	0-3.51	14.0	K11	Same as the abov	$R_{14.0\ K}/R_{273.15\ K} = 0.0138$.
10	74	Babiskin, J. and Siebenmann, P.G.	1969		0-5	4.2		Pure; 1 mm in di $R_{4.2\ K} = 560$; were extracte	1 mm long wire specimen; $R_{300\ K}/$ a transverse magnetic field; data mooth curve.
11	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	1	99.95 pure; singl surface with 4 from Mine Saf field was in [1 3.1×10^3; the resonance.	ecimen; 1 mm thickness and elliptical inor axes; the specimen was obtained e Co.; the disk normal and magnetic n; residual resistance ratio RRR = sistance was deduced from helicon
12	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	2	Similar to the ab	n and conditions except RRR = 3.4×10^3.
13	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	3	Similar to the ab	n and conditions.
14	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	4	Similar to the ab	n and conditions except RRR = 1.3×10^3.
15	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	5	Similar to the ab	n and conditions except RRR = 1.1×10^3.
16	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	6	Similar to the ab	n and conditions except RRR = 1.5×10^3.
17	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	7	Similar to the ab	n and conditions.
18	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	8	Similar to the ab	n and conditions except RRR = 1.4×10^3.
19	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	9	Similar to the ab and the magne direction.	n and conditions except RRR = 3.4×10^3 specimen normal was in the [110]
20	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	10	Similar to the ab	n and conditions except RRR = 0.9×10^3.

TABLE 22. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF POTASSIUM K (Magnetic Flu Dependence) (continued)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Magnetic Flux Density Range, Tesla	Temperature Range, K	Name and Specimen Designation	Composition (weig), Specifications, and Remarks
21*	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	11	Similar to the above sı .d conditions except RRR = 1.3 x 10^3.
22	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	12	lar to the above sr .d conditions except RRR = 1.4 x 10^3.
23	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	13	lar to the above sr .d conditions except RRR = 1.7 x 10^3.
24	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	14	Similar to the above sr .d conditions except RRR = 1.2 x 10^3.
25	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	15	Similar to the above sr .d conditions except RRR = 1.4 x 10^3.
26	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	16	Similar to the above sr .d conditions except RRR = 3.9 x 10^3 and the specimen nc the magnetic field was in [111] direction.
27	87	Penz, P.A. and Bowers, R.	1968	→	0-5.5	4.2	17	Similar to the above sr .d conditions except RRR = 3.0 x 10^3.
28	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	18	Similar to the above sr .d conditions except RRR = 3.2 x 10^3.
29	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	19	Similar to the above sr .d conditions except RRR = 2.2 x 10^3 and the specimen nc the magnetic field was in [123] direction.
30	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	20	Similar to the above sr d conditions except RRR = 3.3 x 10^3.
31*	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	21	Similar to the above sr d conditions except RRR = 3.9 x 10^3.
32*	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	22	Similar to the above sp d conditions except RRR = 1.4 x 10^3.
33*	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	23	Similar to the above sp d conditions except RRR = 1.2 x 10^3.
34*	87	Penz, P.A. and Bowers, R.	1968	→	0, 5.5	4.2	24	Similar to the above sp d conditions except RRR = 2.4 x 10^3.
35	87	Penz, P.A. and Bowers, R.	1968	→	0-11	4.2		99.95 pure; polycrysta men about 1 mm thick was used; the magnetic resist: ıeasured in a Bitter solenoid at the NML.

* Not shown in figure.

TABLE 23. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF POTASSIUM K (Magn [illegible] ensity Dependence)

[Temperature, T, K; Magnetic Flux Density, B, Tesla; Electrical Resistivity, ρ, 1

CURVE 1 T = 20.4

B	ρ
0.00	0.2040
1.65	0.2060

CURVE 2 T = 14.0

B	ρ
[illegible]	0.1117
[illegible]	0.1138

CURVE 3 T = 14.0

B	ρ
0.00	0.1117*
1.65	0.1167

CURVE 4 T = 22.4

B	ρ
0.00	0.1926
3.50	0.1977

CURVE 5 T = 14.0

B	ρ
0.00	0.09942
3.50	0.1089

CURVE 6 T = 4.22

B	ρ
0.00	0.05446
1.43	0.05589
1.93	0.05690
2.75	0.05830
3.05	0.05849

CURVE 7 T = 20.4

B	ρ
0.00	0.1876
1.83	0.1899
2.64	0.1904
3.33	0.1918

CURVE 8 T = 20.4

B	ρ
0.00	0.1779
1.545	0.1812
2.22	0.1831
3.13	0.1856
3.51	0.1869

CURVE 9 T = 14.0

B	ρ
0.00	0.09942*
2.10	0.1057
3.13	0.1089
3.51	0.1109

CURVE 10 T = 4.2

B	ρ
0.00	0.01336
0.05	0.01337
0.12	0.01339
0.21	0.01341
0.30	0.01343
0.43	0.01344
0.52	0.01345
0.64	0.01345
0.75	0.01346
0.86	0.01346
1.00	0.01347
2.00	0.01349
3.01	0.01352
4.01	0.01355
4.84	0.01358

CURVE 11 T = 4.2

B	ρ
0.0	0.00232
5.5	0.00370

CURVE 12 T = 4.2

B	ρ
0.0	0.00212
5.5	0.00343

CURVE 13 T = 4.2

B	ρ
0.0	0.00212*
5.5	0.00292

CURVE 14 T = 4.2

B	ρ
0.0	0.00554
5.5	0.00720

CURVE 15 T = 4.2

B	ρ
0.0	0.00655
5.5	0.00819

CURVE 16 T = 4.2

B	ρ
0.0	0.00480
5.5	0.00682

CURVE 17 T = 4.2

B	ρ
0.0	0.00480*
5.5	0.00610

CURVE 18 T = 4.2

B	ρ
0.0	0.00515
5.5	0.00592

CURVE 19 T = 4.2

B	ρ
0.0	0.00212*
5.5	0.00271

CURVE 20 T = 4.2

B	ρ
0.0	0.00753
5.5	0.00806*

CURVE 21* T = 4.2

B	ρ
0.0	0.00554
5.5	0.00610

CURVE 22 T = 4.2

B	ρ
0.0	0.00515*
5.5	0.00577

CURVE 23 T = 4.2

B	ρ
0.0	0.00424
5.5	0.00504

CURVE 24 T = 4.2

B	ρ
0.0	0.00600
5.5	0.00630

CURVE 25 T = 4.2

B	ρ
0.0	0.00515*
5.5	0.00545

CURVE 26 T = 4.2

B	ρ
0.0	0.00185
5.5	0.00351

CURVE 27 T = 4.2

B	ρ
0.00	0.00240
0.99	0.00243
1.48	0.00256
1.99	0.00269
2.49	0.00281
2.99	0.00293
3.47	0.00297
4.00	0.00308
4.47	0.00313

7 (cont.) 4.2

B	ρ
[illegible]	0.00324
[illegible]	0.00336

E 28 4.2

B	ρ
[illegible]	0.00225
[illegible]	0.00326

E 29 4.2

B	ρ
[illegible]	0.00327
[illegible]	0.00494

E 30 4.2

B	ρ
[illegible]	0.00218
[illegible]	0.00284

E 31* 4.2

B	ρ
[illegible]	0.00185
[illegible]	0.00327

E 32* 4.2

B	ρ
[illegible]	0.00515
[illegible]	0.00581

E 33* 4.2

B	ρ
[illegible]	0.0060
[illegible]	0.006305

E 34 4.2

B	ρ
[illegible]	0.00300
[illegible]	0.00330*

CURVE 35 T = 24.0

B	ρ
0.00	0.00109
0.85	0.00179
1.76	0.00242
2.67	0.00310
3.57	0.00358
4.46	0.00414
4.92	0.00436
5.33	0.00470
5.83	0.00484
6.27	0.00531
6.68	0.00579
7.17	0.00608
7.46	0.00627
7.93	0.00667
8.10	0.00694
8.30	0.00716
8.52	0.00723
8.99	0.00735
9.43	0.00743
10.32	0.00853
10.79	0.00893

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4.4. Rubidium

Rubidium, with atomic number 37, is a silvery-white soft alkali metal. It has a body-centered cubic crystalline structure with a density of 1.532 g cm^{-3} at 293 K. It melts at 312.64 K and boils at about 959 K. Its critical temperature has been determined to be 2106 K at a pressure of 408.2 atom and the density at the critical temperature was 0.1818 g cm^{-3}. Naturally-occurring rubidium is composed of one stable isotope, ^{85}Rb (72.15%), and one unstable isotope, ^{87}Rb (27.85%), which is radioactive and has a half-life of 5×10^{11} years. Ordinary rubidium is sufficiently radioactive to expose a photographic film in about one to two months. Fifteen other radioactive isotopes of rubidium are known to exist. Rubidium ranks 22nd in the order of abundance of elements in the continental crust of the earth (0.009% by weight).

a. Temperature Dependence

There are 33 sets of experimental data available for the temperature dependence on the electrical resistivity of rubidium. The information on specimen characterization and measurement conditions for each of the data sets is given in table 25. The data are tabulatzd in table 26 and shown in figures 14 and 15. Determination of the electrical resistivity of rubidium for the solid and liquid phase cover the continuous temperature range from 1.13 to 1866 K.

There are 15 sets of experimental data obtained below 100 K. Among these, 4 sets (curves 10, 12, 13, and 14) are at constant volume under various pressures and 2 sets are for thin films (curves 5 and 6). Aleksandrov, Lemonos, and Semenova [85] (curve 32) gave the lowest residual resistivity, $\rho_0 = 0.0134 \times 10^{-8}\Omega$ m. Four sets of the intrinsic electrical resistivity at zero pressure are obtained by subtraction of the residual resistivity ρ_0 from the measured resistivity. In deriving the smoothed most probable values of intrinsic resistivity from the available data, the following overlapping temperature ranges were considered: below 8 K; 5–20 K; 10–40 K; 20–80 K; 30–150 K; etc. Within each range, a least-mean-square fraction error fit of the semiempirical equation $\rho_i = aT^b$ was made to all available intrinsic resistivity data. The resulting values for adjacent ranges were intercompared and the values were corrected for thermal linear expansion. These preliminary values were then fitted with the equation (7) to generate the final recommended values. The coefficients of equation (7) obtained in the fitted are given in the following table:

Temperature range, K	a	b	c	d
1.97– 7.16	−3.322	3.325	1.973	−3.042
7.16– 10.72	−1.375	2.671	−3.140	10.75
10.72– 12.10	−0.945	2.561	2.514	−40.51
12.10– 14.46	−0.810	2.491	−3.851	10.85
14.46– 50.04	−0.635	2.089	−1.327	0.576
50.04–100	0.196	1.161	−0.396	0.562

There are 19 data sets in the temperature region from 100 K to the melting point, 312.64 K. Among these, 4 sets (curves 10, 12, 13, 14) are at constant volume under various pressures and 1 set (curve 1) is a single data point at 273 K. Messiner and Voigt [29] (curve 26) give the highest value, which is about 60% higher than all the other data; therefore, this data set and those sets measured at constant volume are excluded for the computer fitting. A least-mean-square fractional error fit to the totality of experimental data in this range was made with $\rho_i = aT^b$. The resulting values were corrected for thermal linear expansion, and then fitted with the cubic spline function equation (7) to obtain the final recommended values in this temperature range. The coefficients of equation (7) obtained are as follows:

Temperature range, K	a	b	c	d
50.04–312.64	0.196	1.161	−0.396	0.562

There are 11 data sets measured in the liquid state. Endo [40] (curve 22) and Lien and Silvertsen [41] (curve 2) have tabulated the electrical resistivity at constant volume up to 470 K. The rest of the data are apparently measured at the saturated vapor pressure. Solov'ev [52] (curve 3) gives the lowest values while Kapelner and Bratton [43] (curve 8) give the highest values. Grosse [5] derived electrical resistivity values (curve 34) from the melting point to his estimated critical temperature, 2106 K, by fitting the data of Kapelner and Bratton [43] (curve 8) to a hyperbola. Below 1000 K, all the experimental data except those measured at constant volume were fitted by a logarithmic third order polynomials. Above 1000 K, the electrical resistivity values are obtained by extrapolating the fitted values and following the experimental trend. The resulting values are fitted with the cubic spline function equation (7) to obtain the final recommended values. The coefficients of equation (7) obtained from fitting are as follows:

Temperature range, K	a	b	c	d
312.64– 611.74	1.353	1.051	0.485	−0.498
611.74–1087.7	1.689	1.207	0.049	4.138
1087.7 –2000	2.057	2.007	3.153	−0.531

At the melting point (312.64 K), the electrical resistivity of rubidium in the liquid state is about 63% higher than that of the solid state. Mott's formula (eq 5) gives the electrical resistivity about 75% higher than that of the solid state.

The recommended values for the total and intrinsic electrical resistivity are listed in table 24, and those for the total electrical resistivity are also shown in figures 14 and 15. The recommended values for the liquid state are for the saturated liquid. The recommended values of the total resistivities for the solid state are for a 99.99+% pure rubidium and those at temperatures below 50 K are only applicable for a specimen with residual resistivity $\rho_0 = 0.0131 \times 10^{-8}\Omega$ m. The recommended values from 1 K to 312.64 K are corrected for thermal linear expansion. The correction amounts to −1.77% at 1 K,

−0.9% at 160 K, and 0.2% at 312.64 K. The uncertainty of the recommended total electrical resistivity is believed to be within ±5% from 1 to 1500 K and within ±10% from 1500 K to 2000 K. Above 20 K the uncertainty of the intrinsic resistivity is about the same as that of the total electrical resistivity; below 20 K this uncertainty is higher than that of the total electrical resistivity.

b. Pressure Dependence

There are 10 sets of experimental data available for the electrical resistivity of rubidium as a function of pressure. The information on specimen characterization and measurement conditions for each of the data sets is given in table 27. The data are tabulated in table 28 and shown in figure 16.

The available data and information for the pressure dependence of electrical resistivity of rubidium are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only experimental data are presented here.

c. Magnetic Flux Density Dependence

There are three sets of experimental data available for the electrical resistivity of rubidium under the influence of magnetic field. The information on specimen characterization and measurement information for each of the data sets is given in table 29. The data are tabulated in table 30 and shown in figure 17.

The available data and information for the magnetic flux density dependence of electrical resistivity of rubidium are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only experimental data are presented here.

TABLE 24. RECOMMENDED ELECTRICAL RESISTIVITY OF RUBIDIUM
(Temperature Dependence)

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

Solid						Liquid	
T	ρ	ρ_i	T	ρ	ρ_i	T	ρ
1	0.0131		35	1.02	1.01	312.64	22.52
2	0.0136	0.00050*	40	1.21	1.20	350	25.42
3	0.0153	0.0022*	45	1.40	1.39	400	29.51
4	0.0194	0.0063*	50	1.58	1.57	500	38.27
5	0.0270	0.0139*	60	1.94	1.93	600	47.61
6	0.0384	0.0253*	70	2.29	2.28	700	57.48
7	0.0528	0.0397*	80	2.65	2.64	800	68.50
8	0.0691	0.0560*	90	3.00	2.99	900	81.50
9	0.0872	0.0741*	100	3.36	3.35	1000	97.26
10	0.109	0.0954*	150	5.27	5.26	1100	116.7
11	0.134	0.121*	200	7.49	7.48	1200	140.8
12	0.165	0.152*	250	10.14	10.13	1300	170.3
13	0.197	0.184*	273.15	11.54	11.53	1400	206.3
14	0.229	0.216*	293	12.84	12.83	1500	249.7
15	0.263	0.250*	300	13.32	13.31	1600	301.8*
16	0.298	0.285*	312.64	14.21	14.20	1700	364.1*
18	0.370	0.357*				1800	438.2*
20	0.444	0.431				1900	525.9*
25	0.636	0.623				2000	629.4*
30	0.830	0.817					

* Provisional values.

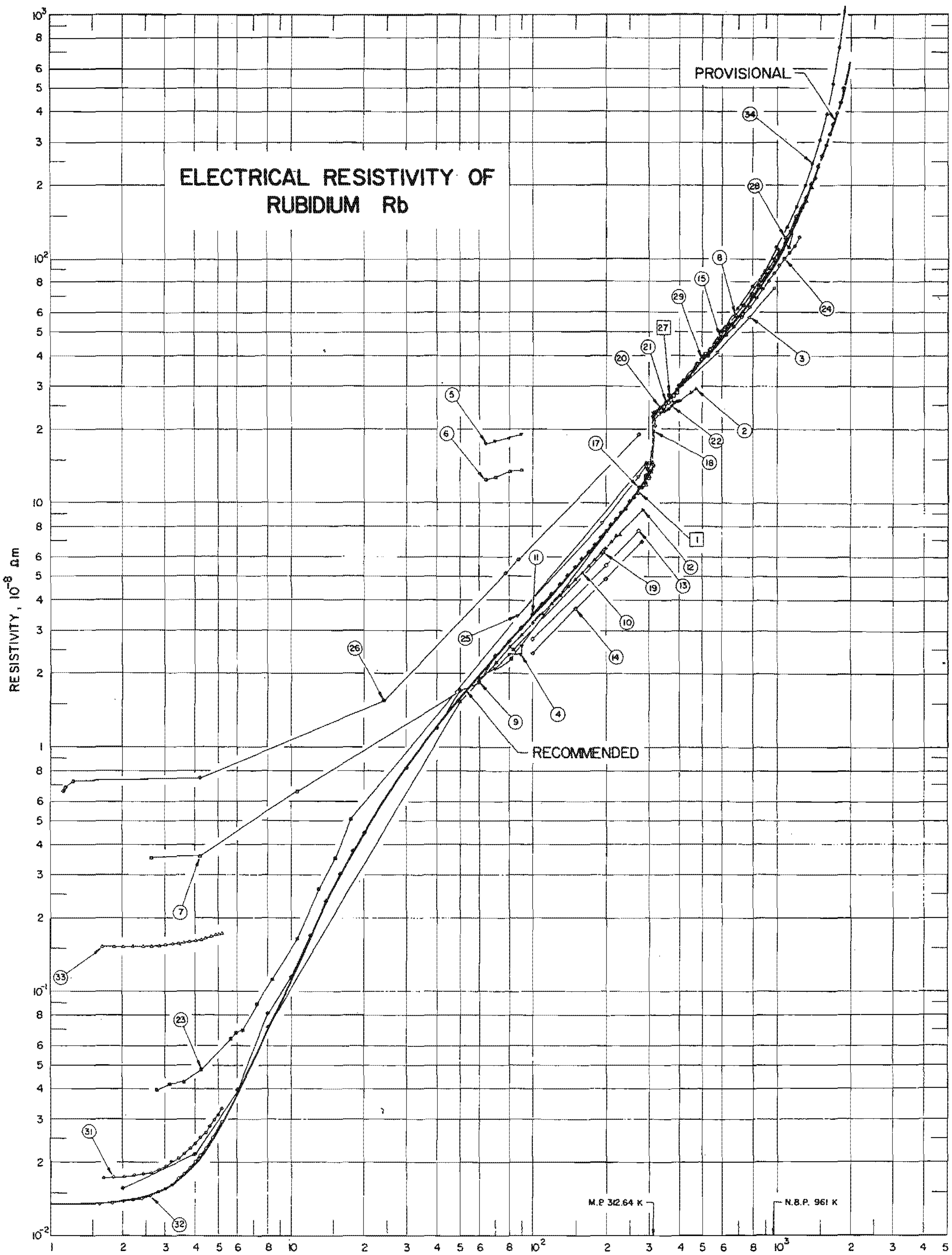
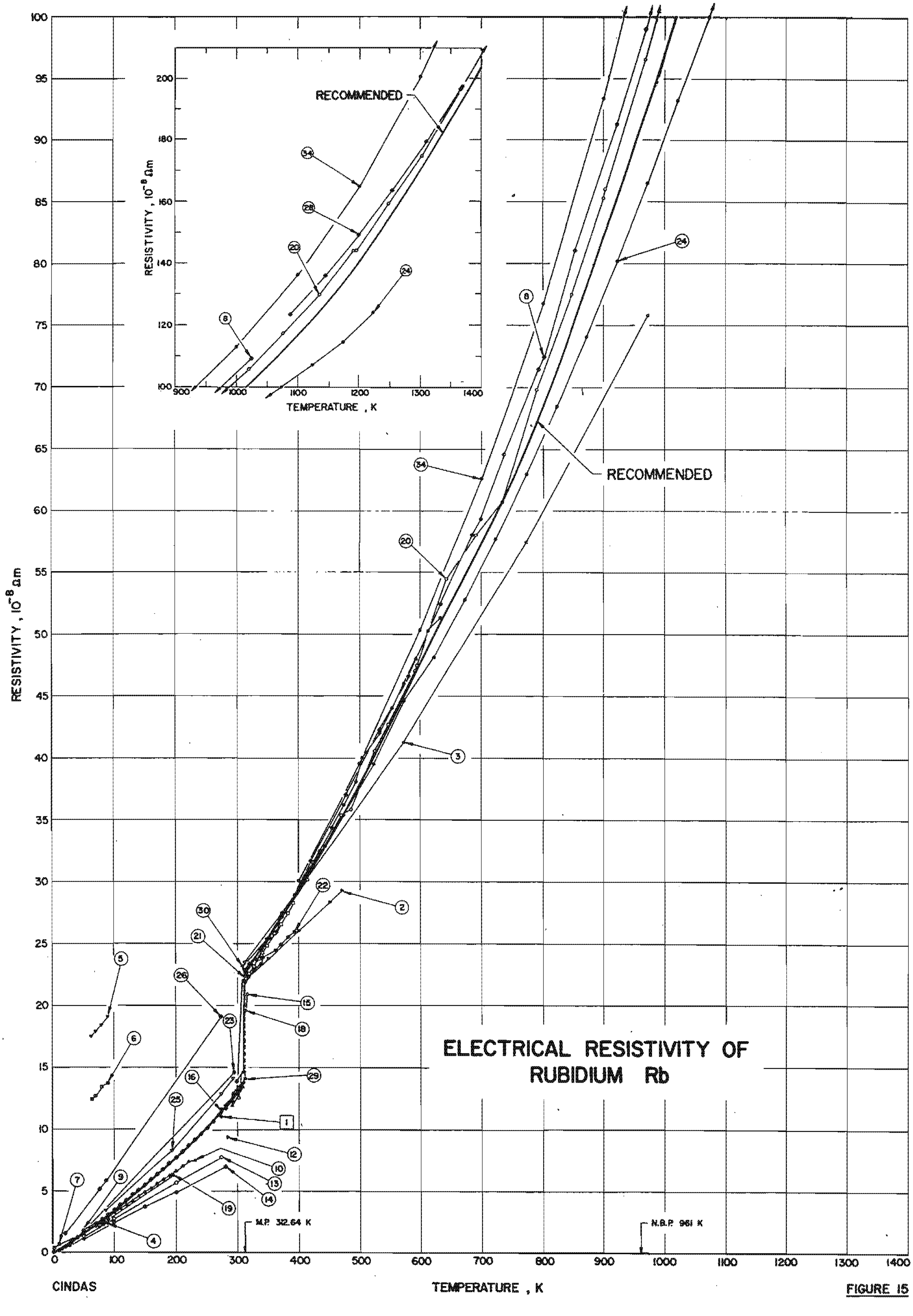

ELECTRICAL RESISTIVITY OF
RUBIDIUM Rb
PROVISIONAL
RECOMMENDED
RESISTIVITY, 10^{-8} Ωm
TEMPERATURE, K
M.P. 312.64 K
N.B.P. 961 K
CINDAS

FIGURE 14



ELECTRICAL RESISTIVITY OF RUBIDIUM Rb
RESISTIVITY, 10^{-8} Ωm
TEMPERATURE, K
RECOMMENDED
M.P. 312.64 K
N.B.P. 961 K
CINDAS

FIGURE 15

TABLE 25. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF RUBIDIUM Rb (Temper Dependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent),	ifications, and Remarks
1	22	Krautz, E.	1950	A	273		Pure.	
2	41	Lien, S.Y. and Silvertsen, J.M.	1969	A	312-470		99.9 pure rubidium was supplied by . were made from precision quart: current and potential leads were at constant volume; data represe $312 \leq T \leq 470$ K, ρ in units of 10'	Mackay Inc.; the specimen cells llaries open on one end; four tungsten d into the capillary; measurements y $\rho = 22.0 + (\partial\rho/\partial T)(T - 312)$, .
3	52, 88	Solov'ev, A.N.	1963, 1967		312-973		Pure; liquid state specimen; density 973 K.	5 g cm^{-3} at 312 K, 1.179 g cm^{-3} at
4	89	Lovell, A.C.B.	1936	A	60-90		0.03 Na, 0.8 K, 0.2 Cs, 0.2 B, tra by the reduction of rubidium chlc apparatus.	Ca, Si; the specimen was prepared with calcium metal in high vacuum
5	89	Lovell, A.C.B.	1936	A	60-90	Rb(Film)	The above specimen was deposited (1.55 cm long; film thickness 43.	:ex glass surface 1.35 cm width,
6	89	Lovell, A.C.B.	1936	A	60-90	Rb(Film)	Similar to the above specimen with	hickness 87.4 Å.
7	54	McLennan, J.C. and Niven, C.D.	1927	B	2.63-293		Pure; specimen was filled in a U-sh	capillary.
8	43	Kapelner, S.M. and Bratton, W.D.	1962	B	299-1025		99.5 pure; 0.32 Cs, 0.05 Na, and 0 American Potash and Chemical C type 307 stainless steel tube heat	; specimen was obtained from ; liquid specimen was loaded into a 550 C for 2 hr.
9	90	Dugdale, J.S. and Phillips, D.	1965	A	2-300	6,7,8	Pure; specimens were obtained fror about 2 mm in diameter were ext $R_{295}/R_{4.2} = 580$; electrical resist	Light and Co. Ltd.; wire specimens l under distilled paraffin oil; was measured under zero pressure.
10	90	Dugdale, J.S. and Phillips, D.	1965	A	2-230	6,7,8	Same as above specimen except the constant volume.	rical resistivity was obtained under
11	90	Dugdale, J.S. and Phillips, D.	1965	A	0-240		Similar to the above specimen; idea constant pressure ($p = 0$); data w	stivity as function of temperature at extracted from the smooth curve.
12	90	Dugdale, J.S. and Phillips. D.	1965	A	0-284		Similar to the above specimen; idea constant density as at 0 K at zerc smooth curve.	stivity as function of temperature at ssure; data were extracted from the
13	90	Dugdale, J.S. and Phil D.	1965	A	0-273		Similar to the above specimen; at cc	it density as at 0 K at 1000 atm.
14	90	Dugdale, J.S. and Phillips, D.	1965	A	0-280		Similar to the above specimen; at cc data above 150 K were interpolat based on Bridgman's data at ice		it density as at 0 K at 4,200 atm; etween present results and a point
15	56	Hackspill, L.	1910	A	291-316	1	Pure; specimen was filled in a U-sh	capillary.
16	56	Hackspill, L.	1910	A	273-293	2	Similar to the above specimen.	
17	56	Hackspill, L.	1910	A	273-291	3	Similar to the above specimen.	
18	56	Hackspill, L.	1910	A	293-313	4	Similar to the above specimen.	
19	56	Hackspill, L.	1910	A	83-313	5	Similar to the above specimen.	
	17, 91, 92	Tepper, F., Murchison, A., Zelenak, J., and Roehlich, F.	1963-1965	A	367-1370		99.5 pure; specimen was placed in a O.D., 0.065" wall, and 26" in le	ne-25 alloy cylindrical cell 0.5" in

TABLE 25. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF RUBIDIUM Rb (Temp ndence) (continued)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight p ifications, and Remarks
21	40	Eudo, H.	1963	A	313-393		Pure; specimen was supplie [ackay Ltd.; specimen was contained in a soft glass capillary 7 mm); electrical resistivity was measured at constant pr ion.
22	40	Eudo, H.	1963	A	313-393		Same as above specimen; e stivity was obtained at constant volume.
23	23	MacDonald, D.K.C., White, G.K., and Woods, S.B.	1955		2.5-293	Rb 1	Pure; specimen wa ers A. D. Mackay (New York); specimen was n into soft glass tubes with platinum leads sealed in; $\rho_0/\rho_{295} = 2.63 \times 10^{-3}$.
24	18	Semyachkin, B.E. and Solov'ev, A.N.	1964	A	313-1223		Pure; specimen wa 118-59; specimen was placed in a (0.8/0.5 mm) ng capillary.
25	19	Guntz, A. and Broniewski, W.	1909		86-292		Pure.
26	29	Meissner, W. and Voigt, B.	1930		1.13-273.16	Rb 1	Pure; specimen was distille ie; specimen diameter was 4.8 mm and 35 mm long.
27	68	Van der Lugt, W., Devlin, J.F., Hennephof, J., and Leenstra, M.R.	1972	B	373.15		Pure; data was extracted from
28	93	Hochman, J.M., Silver, I.L., and Bonilla, C.F.	1964	A	1088-1866		Commercial purity (99.7-99.9 cimen was provided by Penn Rare Metals; liquid phase specime rtially filled in a 90 Ta, 8 W, 2 Hf alloy capsule 1 in. O.D., 1/ ll, and 12 in. long; it was surrounded by a molybdenum wire heate umina core and radiation shields, all contained in a vessel pressu argon of extreme purity; temperature was obtained by W/W-26Re t ple; the electrical resistivity data were corrected for thermal ; critical point about 2111 K was determined by comparing the reduced" electrical resistivity with mercury and cesium.
29	94	Semyachkin, B.E. and Solov'ev, A.N.	1970	A	293-623		99.97 pure; the specimen was p stainless steel tube in a copper block; the temperature was r by a Pt-PtRh (10%) thermocouple; the measurements were carr ring both heating and cooling at ~0.01°/min. rate and with cu oth directions; $\rho_{liquid}/\rho_{solid} = 1.562$, $(1/\rho\ d\rho/dT)_{solid} = 45.5 \times 1($ $(1/\rho\ \partial\rho/\partial T)_{liquid} = 37.2 \times 10^{-4}$/K at melting point.
30	84	Kurnakow, N.S. and Nikitinsky, A.J.	1914	B	273-373		Pure; Thomson double bridge w r measurements; the specimen was filled in a glass tube and imr a Vaslin thermostat; mercury was filled in the tube for
31	85	Aleksandrov, B.N., Lomonos, O.I., and Semenova, E.D.	1973	A	1.6-5.2	Rb 1	99.99 purity specimen lass capillaries of diameter 0.5 mm and length 22 mm; ir led potential and current leads in the form of platinum or ; $R_0/R_{293} = 1.35 \times 10^{-3}$; relative electrical resistivity dat
32	85	Aleksandrov, B.N., et al.	1973	A	1.6-5.2	Rb 4	Similar to the above sp $R_{290} = 1.085 \times 10^{-3}$.
33	85	Aleksandrov, B.N., et al.	1973	A	1.6-5.2	Rb 5	Similar to the above sp $R_{290} = 1.21 \times 10^{-2}$.
34	5	Grosse, A.V.	1966		312.6-2100		Electrical resistivity d y fitting the data of Kaplener and Bratton to a hyperbo) $(T' + b) = a$ from 312.64 K to 2106 K; where σ' $= (T - T_{m.p.})/(T_{c.p.} - T_{m.p.})$; b = 0.185 and a = 0.

TABLE 26. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF RUBIDIUM Rb (Temperal Dependence)

[Temperature, T, K; Resistivity, ρ, 10^{-8} Ωm]

CURVE 1

T	ρ
273	11.0

CURVE 2

T	ρ
312	22.00
350	23.75
400	26.05
450	28.35
470	29.27

CURVE 3

T	ρ
312	23.5
373	27.5
573	41.3
773	57.5
973	75.8

CURVE 4

T	ρ
60.0	1.9
69.9	2.1
80.0	2.4
89.8	2.4

CURVE 5

T	ρ
63.9	17.5
69.8	17.9
79.9	18.4
89.8	19.1

CURVE 6

T	ρ
64.2	12.4
70.3	12.7
80.3	13.4
90.2	13.7

CURVE 7

T	ρ
2.63	0.353
4.2	0.357
10.6	0.658
82.0	2.30
293.0	12.6

CURVE 8

T	ρ
298.7	13.85
310.6	14.67
312.3	22.84
314.8	22.93*
319.5	23.35
364.8	25.96
419.8	31.62
477.3	37.06
583.4	42.30
581.4	46.59
582.5	46.61*
634.8	52.45
685.6	58.01
699.2	59.37
736.2	64.61
793.4	71.48
802.0	72.49
854.8	81.06
923.2	91.29
970.3	99.05
1024.8	109.31

CURVE 9

T	ρ
2	0.01572
4	0.02172
6	0.03966
8	0.08172
10	0.1155
12	0.1703
14	0.2352
16	0.3045
18	0.3762
20	0.4485
30	0.8219
40	1.2059
50	1.7195
60	1.867
70	2.338
80	2.715
90	3.095
100	3.476
110	3.865
120	4.261
130	4.661
150	5.481

CURVE 9 (cont.)

T	ρ
160	5.900
170	6.327
180	6.758
190	7.203
200	7.663
210	8.129
220	8.604
230	9.089
240	9.581
250	10.025
260	10.602
270	11.125
280	11.657
290	12.218
300	12.867

CURVE 10

T	ρ
2	0.01568*
4	0.02188*
6	0.03948*
8	0.07148
10	0.1155*
12	0.1703*
14	0.2353
16	0.3051*
18	0.3755*
20	0.4475*
30	0.8135*
40	1.1835*
50	1.542
60	1.867*
70	2.228
80	2.562
90	2.892
100	3.218
110	3.542
120	3.869
130	4.197
140	4.587
150	4.857
160	5.191
170	5.530
180	5.870
190	6.222
200	6.585

CURVE 10 (cont.)

T	ρ
210	6.953
220	7.334
230	7.376

CURVE 11

T	ρ
3	0.00
20	0.43
50	1.57
100	3.49
200	7.63
240	9.50

CURVE 12

T	ρ
3	0.00
20	0.43
50	1.57
100	3.23
200	6.55
284	9.33

CURVE 13

T	ρ
6	0.00
20	0.39
50	1.31
100	2.76
200	5.58
273	7.70

CURVE 14

T	ρ
9	0.00
20	0.28
50	1.13
100	2.42
150	3.70
200	4.89
280	6.96

CURVE 15

T	ρ
291	11.9
300	12.9
308	13.4
316	20.9

CU 16

T	ρ
273	11.6
290	11.9*

CU 17

T	ρ
273	11.6
291	12.1

CU 18

T	ρ
	12.3*
	13.1
	19.6

19

T	ρ
	2.5
	6.3
	11.6*
	12.0*
	12.8*

20

T	ρ
	12.51
	26.55
	30.12
	30.88
	32.82
	35.39
	35.90
	40.56
	42.70
	47.03
	47.48
	54.49
	58.01
	60.70
	69.82
	77.44
	85.30
	86.05
	96.59
	05.82
	17.59
	29.96

CURVE 20 (cont.)

T	ρ
1190.92	144.17
1195.37	144.27
1249.81	159.55
1303.70	174.96
1367.55	196.97
1369.81	197.36

CURVE 21

T	ρ
312.65	22.00*
314.95	22.15
319.35	22.54
327.55	23.16
336.35	23.74
341.85	24.22
349.25	24.84
361.65	25.74
372.35	26.58
383.25	27.43
392.95	28.24

CURVE 22

T	ρ
319.65	22.32
327.95	22.82
339.95	23.35
341.65	23.85
362.05	24.44
372.65	24.94
383.35	25.53
393.25	25.98

CURVE 23

T	ρ
2.76	0.0394
3.13	0.0409
3.60	0.0427
4.28	0.0474
5.69	0.0641
5.94	0.0678
6.34	0.0695
7.23	0.0887
8.36	0.113
10.52	0.169
13.06	0.261
15.17	0.353

* Not shown in figure.

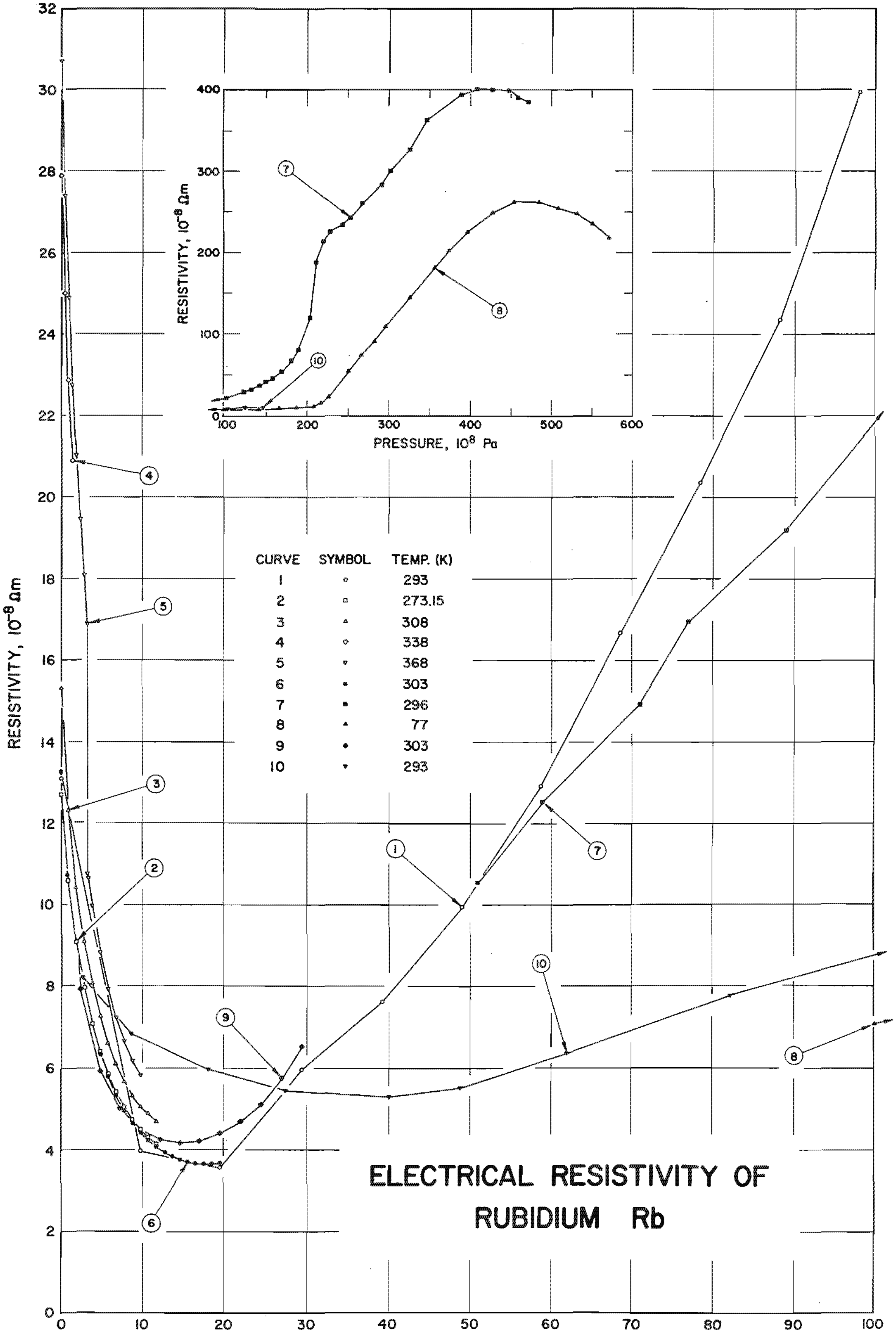
TABLE 26. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF RUBIDIU[illegible] Temperature Dependence) (continued)

T	ρ
CURVE 23 (cont.)	
18.79	0.5214
293.00	14.6
CURVE 24	
313	22.5
323	23.3
373	27.4*
423	31.4
473	35.4
523	39.5
573	44.6
623	48.1
673	52.8
723	57.7
773	63.0
823	68.5
873	74.1
923	80.2
973	86.5
1023	93.2
1073	100.0
1123	107.2
1173	114.5
1223	124.0
CURVE 25	
86.15	3.45
194.85	8.25
273.15	12.80
292.35	14.08
CURVE 26	
1.13	0.664
1.15	0.6893
1.25	0.7296
4.20	0.7507
20.42	1.569
77.60	5.186
[illegible]	[illegible]

T	ρ
CURVE 28	
1088.7	123.5
1144.3	130.0
1199.8	149.2
1255.4	163.6
1310.9	179.4
1366.5	196.6
1422.1	215.8
1477.6	239.1
1533.2	265.0
1588.7	294.0
1644.3	325.6
1699.8	359.6
1755.4	396.6
1810.9	439.8
1866.5	500.6
CURVE 29	
293.2	12.83
312	14.03
312	21.91
313.2	22.06*
333.2	23.72
353.2	25.42
373.2	27.14
393.2	28.89
413.2	30.67
433.2	32.48
453.2	34.32
473.2	36.20
493.2	38.10
513.2	40.04
533.2	42.01
553.2	44.01
573.2	46.05
593.2	48.13
613.2	50.24
633.2	51.32
CURVE 30	
[illegible]	[illegible]

T	ρ
CURVE 31	
1.66	0.01721
1.84	0.01741
2.03	0.01745
2.24	0.01767
2.43	0.01782
2.63	0.01824
2.82	0.01868
3.01	0.01920
3.20	0.02002
3.42	0.02076
3.62	0.02179
3.82	0.02275
4.00	0.02392
4.21	0.02526
4.34	0.02596
4.44	0.02649
4.52	0.02729*
4.60	0.02802
4.69	0.02863*
4.75	0.02918*
4.81	0.02985
4.90	0.03056*
5.00	0.03126
5.03	0.03187
5.10	0.03248
5.17	0.03311
CURVE 32	
1.6	0.01356
1.8	0.01368
2.0	0.01380
2.2	0.01405
2.4	0.01429
2.6	0.01466
2.8	0.01516
3.0	0.01565
3.2	0.01627
3.4	0.01713
3.6	0.01799
3.8	0.01898
[illegible]	0.02009
[illegible]	0.02144
[illegible]	0.02267
[illegible]	0.02403*
[illegible]	0.02526
[illegible]	0.02662*

T	ρ
CURVE 33	
1.64	0.[illegible]
1.84	0.[illegible]
2.00	0.[illegible]
2.20	0.[illegible]
2.42	0.[illegible]
2.61	0.[illegible]
2.81	0.[illegible]
3.00	0.[illegible]
3.21	0.[illegible]
3.40	0.[illegible]
3.58	0.[illegible]
3.78	0.[illegible]
4.00	0.[illegible]
4.21	0.[illegible]
4.34	0.[illegible]
4.40	0.[illegible]
4.50	0.[illegible]
4.58	0.[illegible]
4.67	0.[illegible]
4.74	0.[illegible]
4.81	0.[illegible]
4.87	0.[illegible]
4.94	0.[illegible]
5.00	0.[illegible]
5.10	0.[illegible]
5.14	0.17
CURVE 34	
400	30.06
500	39.56
600	50.31
700	62.60
800	76.78
900	93.31
1000	112.8
1100	136.2
1200	164.8
1300	200.5
1400	246.4
1500	307.4
1600	392.7
1700	520.2
1800	731.7
1900	1150*
2000	2376*
2100	67800*



CINDAS PRESSURE, 10^8 Pa FIGURE 16

TABLE 27. MEASUREMENT INFORMATION ON THE ELECTRICAL RESIS Dependence)

ıthor(s)	Year	Method Used	Pressure Range, 10^8 Pa	Temperature Range, K	), Specifications, and Remarks
ıan, P.W.	1952	A	0-98	~293	ɔecimen was squeezed flat to about d to transmit the pressure; relative ɔorted; the electrical resistivity e recommended value of electrical sibility data with the relative resis-
ıan, P.W.	1925	A	0-11.76	273	
ıan, P.W.	1925	A	0-11.76	308	
ıan, P.W.	1925	A	0-1.47	338	0.5 mm inside diameter, 4 or 5 cm
ıan, P.W.	1925	A	0-9.8	368	y, 0.5 mm inside diameter, 4 or
ıan, P.W.	1930	A	0-19.6	303	xtruded to a diameter about 1.6 mm ɔm on a side.
, R.A. and mer, H.G.	1963	A	50-472	296	ı resistance as function of pressure
, R.A. and ner, H.G.	1963	A	100-571	77	
ıan, P.W.	1938	A	0-29.4	303	a U shape glass envelope, the lower ameter and 2 cm long; the relative e reported.
F.P.	1959	A	2-150	293	cuum distilled; the specimen was glass capillary tube; the silver chlor- n core served as an approximate ɔe data were reported.

TABLE 28. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVIT JBIDIUM Rb (Pressure Dependence)

[Temperature, T, K; Pressure, P, 10^8 Pa; Resis), 10^{-8} Ωm]

P	ρ
CURVE 1	
T = 293	
0.0	13.10
9.8	3.97
19.6	3.57
29.4	5.96
39.2	7.62
49.0	9.96
58.8	12.92
68.6	16.68
78.4	20.38
88.2	24.35
98.0	29.95
CURVE 2	
T = 273.15	
0.00	12.71
0.98	10.60
1.96	9.10
2.94	7.97
3.92	7.10
4.90	6.41
5.88	5.87
6.86	5.42
7.84	5.05
8.82	4.75
9.80	4.50
10.78	4.31
11.76	4.15
CURVE 3	
T = 308	
0.00	15.32
0.98	12.32
1.96	10.42

P	ρ
CURVE 4	
T = 338	
0.00	27.90
0.49	25.01
0.98	22.88
1.47	20.91
CURVE 5	
T = 368	
0.00	30.72
0.49	27.41
0.98	24.90
1.47	22.76
1.96	21.03
2.45	19.48
2.94	18.10
3.36	16.90
3.36	10.76
3.43	10.65
3.92	9.98
4.90	8.84
5.88	7.94
6.86	7.24
7.84	8.66
8.82	6.19
9.80	5.81
CURVE 6	
T = 303	
0.00	13.28
0.98	10.74
1.96	9.10*
2.94	7.95*
3.92	7.06*
4.90	6.36

P	ρ
CURVE 6 (cont.)	
T = 303	
15.68	3.71
16.66	3.67
17.64	3.66
18.62	3.66
19.60	3.68
CURVE 7	
T = 296	
51	10.56
59	12.55
71	14.92
77	16.96
89	19.20
102	21.92
124	29.00
132	32.42
142	37.05
150	42.43
158	47.57
169	54.58
181	67.79
190	81.91
204	120.7
211	189.0
220	215.4
229	226.6
244	235.5
253	244.2
268	260.6
292	284.8
303	301.2
326	327.4
347	363.3
389	393.3

P	ρ
CURVE .)	
T	
142	1
166	0
186	2
208	5
217	4
227	9
251	7
268	8
283	7
296	[illegible]
326	[illegible]
356	[illegible]
373	[illegible]
396	[illegible]
427	[illegible]
455	[illegible]
485	[illegible]
508	[illegible]
531	[illegible]
550	[illegible]
571	[illegible]
CUI	
T =	
0.00	8*
0.45	4
4.90	4
7.35	3
9.80	1*
12.25	6
14	7
17	3
19	1
22	9
[illegible]	2
[illegible]	7
[illegible]	5
[illegible]	2
[illegible]	4
[illegible]	8

P	ρ
CURVE 10 (cont.)	
T = 293	
27.4	5.45
40.1	5.29
48.8	5.51
62.0	6.36
82.2	7.77
105.4	9.06
105.4	10.03*
126.7	10.21
147.0	10.20

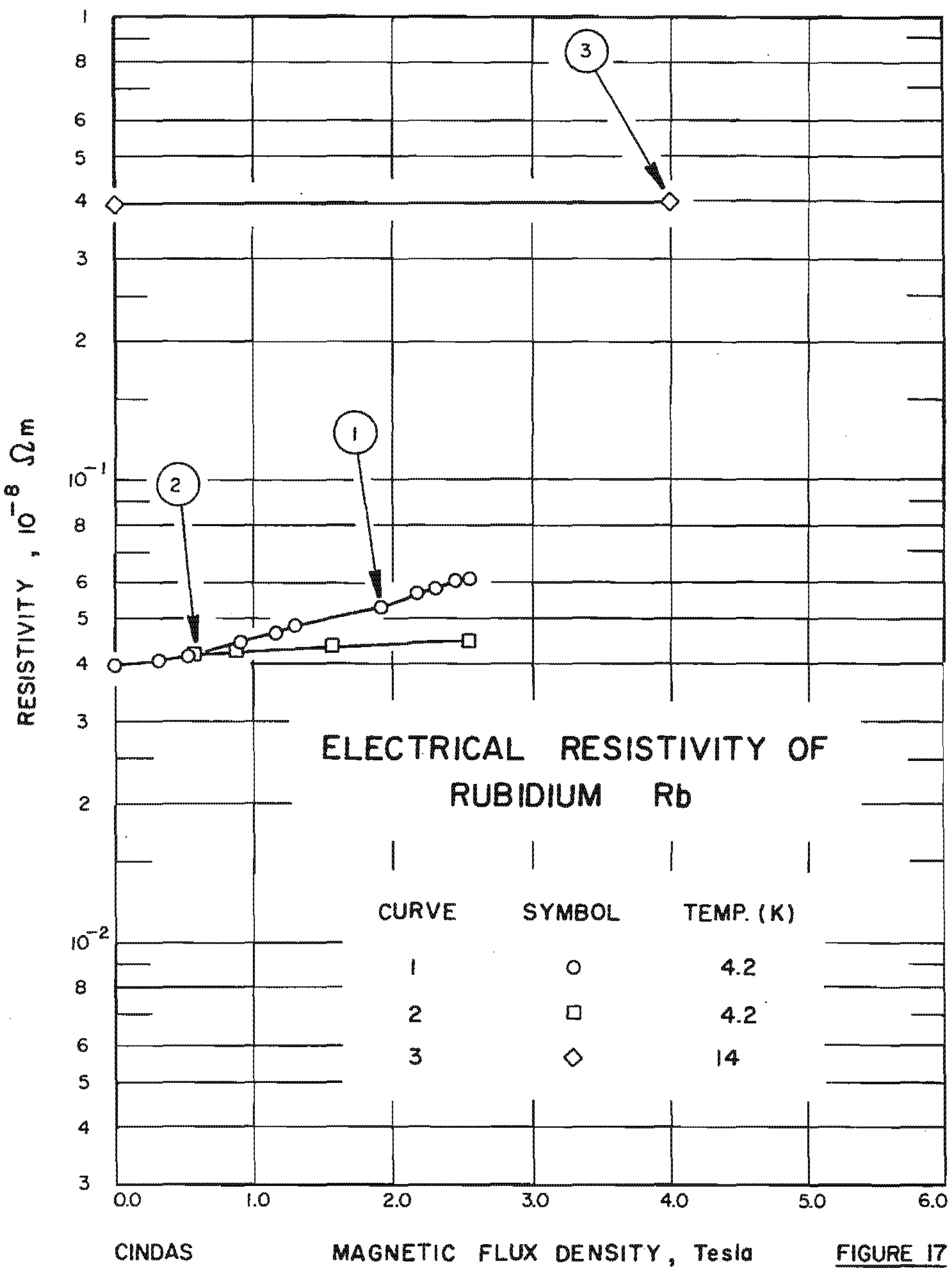

1
8
6
5
4
3
2
10^{-1}
8
6
5
4
3
2
10^{-2}
8
6
5
4
3
RESISTIVITY, 10^{-8} Ωm
0.0
1.0
2.0
3.0
4.0
5.0
6.0
MAGNETIC FLUX DENSITY, Tesla
ELECTRICAL RESISTIVITY OF RUBIDIUM Rb
CURVE SYMBOL TEMP. (K)
1 ○ 4.2
2 □ 4.2
3 ◇ 14
CINDAS

FIGURE 17

TABLE 29. MEASUR)RMATION ON THE ELE)ensity Dependence)

Cur. No.	Ref. No.	Author(s)	Ye	Magnetic Flux Density Range, Tesla	Temper Rang K	:ent), Specifications, and Rer.iarks
1	73	MacDonald, D.K.C.	1957	0-2.55	~4.2	6 mm thickness, 7 mm width, and ³294 K = 3.10⁻³; resistance was mea- cimen perpendicular to the magnetic
2	73	MacDonald, D.K.C.	1957	0-2.55	~4.2	the resistance was measured with the to the magnetic field.
3	36	Justi, E.	1948	0,4.0	14	.0339; it was measured in a transverse

TABLE 30. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF RUBIDIUM Rb (Mag ity Dependence)

[Temperature, T, K; Magnetic Flux Density, B, Tesla; Resistivity, ρ, 10^{-8}

B	ρ
CURVE 1	
T = 4.2	
0.00	0.0393
0.31	0.0407
0.54	0.0417
0.91	0.0446
1.17	0.0464
1.30	0.0487
1.91	0.0530
2.18	0.0566
2.31	0.0581
2.45	0.0601
2.48	0.0605*
2.55	0.0615
CURVE 2	
T = 4.2	
0.00	0.0393*
0.34	0.0405*

B	ρ
CURVE 2 (cont.)	
T = 4.2	
0.58	0.0418
0.88	0.0426
1.56	0.0433
2.55	0.0445
CURVE 3	
T = 14	
0.0	0.3922
4.0	0.3938

* Not shown in figure.

4.5. Cesium

Cesium, with atomic number 55, is a silvery-white, soft, ductile, alkali metal. It has a body-centered cubic crystalline structure with a density of 1.873 g cm^{-3} at 293 K. It melts at 301.55 K and boils at about 944 K. Its critical temperature has been measured to be 2051 ± 4 K. Cesium has only one stable isotope, ^{133}Cs, though twenty other radioactive isotopes are known to exist. It ranks 45th in the order of abundance of elements in the continental crust of the earth (0.003% by weight).

a. Temperature Dependence

There are 56 sets of experimental data available for the temperature dependence on the electrical resistivity of cesium. The information on specimen characterization and measurement conditions for each of the data sets is given in table 32. The data are tabulated in table 33 and shown in figures 17 and 18. Determinations of the electrical resistivity of cesium for the solid, liquid, and gas phases cover the temperature region from 1.5 to 8800 K.

There are 18 data sets obtained below 100 K. Among these, Aleksandrov, Lomonos, Ignatév, and Gromov [96] (curve 49) gave the lowest residual resistivity ρ_0 = 0.00236 × 10^{-8}Ω m for 99.995 pure specimen. Dugdale and Phillips [90] reported the electrical resistivities for several constant volumes (curves 10, 12, 13, and 14). Appleyard [97] tabulated the electrical resistivity of Cs thin film (495 Å) on pyrex glass (curve 24). McWhan and Stevens [98] tabulated the electrical resistivity data for several constant pressures (curves 50–52). Eight sets of intrinsic electrical resistivity are obtained by subtraction of residual resistivity ρ_0 from the measured resistivity. In deriving the smoothed most probable values of the intrinsic resistivity from the available data, the following overlapping temperatures were considered: below 10 K, 5–20 K, 10–40 K, 20–80 K, 30–150 K, etc. Within each range, a least-mean-square fraction error fit with the semiempirical equation $\rho_i = aT^b$ was made to all available intrinsic resistivity data. The resulting values for adjacent ranges were intercompared and the values were corrected for thermal linear expansion. The preliminary values were then fitted with the cubic spline function equation (7) to generate the final recommended values. The coefficients of equation (7) obtained in the fitting are given in the following table:

Temperature range, K	*a*	*b*	*c*	*d*
1 – 9.11	−3.551	2.829	1.293	−1.192
9.11– 11.10	−0.698	2.019	−2.137	20.63
11.10– 12.55	−0.529	2.105	3.149	−36.25
12.55– 22.14	−0.413	2.131	−2.670	2.793
22.14–100	−0.00765	1.323	−0.603	0.436

There are 17 data sets in the temperature region from 100 K to the melting point 301.55 K. Among these, four sets (curves 10, 12, 13, and 14) are for constant volume and three sets (curves 50–52) are for constant pressure. For the rest of the data, excluding curve 30, after subtracting the residual resistivity, they agree with one another within 5%. A least-mean-square fraction error fit of the totality of experimental data except those measured at constant volume in this range was made with $\rho_i = aT^b$. The resulting values were corrected for thermal linear expansion, and then fitted with the cubic spline function equation (7) to obtain the final recommended values in this temperature range. The coefficients of equation (7) obtained are as follows:

Temperature range, K	*a*	*b*	*c*	*d*
22.14–202.68	−0.00765	1.323	−0.603	0.436
202.68–301.55	1.095	1.373	0.655	−5.028

There are 32 data sets available for the liquid state. Endo [40] also tabulated the electrical resistivities at constant volume (curve 27). Pfeifer, Freyland, and Hensel [99] (curves 32–39), Renkert, Hensel, and Franck [100] (curves 40–45), Tamski, Ross, Cusak, and Endo [69] (curves 46 and 47), and Barol'skii, Ermokhin, Kulik, and Mel'mikov [101] (curve 53) have investigated the electrical resistivities at various constant pressure. The rest of the data are apparently measured at the saturated vapor pressure. Below 1000 K they agree with one another within 10% and somewhat higher above 1000 K. Below 1000 K, all the experimental data except those measured at constant volume and at constant pressure were fitted by a logarithm third order polynomial. Above 1000 K, the electrical resistivity values are obtained by extrapolating the fitted values and following the experimental trend. The resulting values are fitted with the cubic spline function equation (7) to obtain the final recommended values. The coefficients of equation (7) obtained from fitting are as follows:

Temperature range, K	*a*	*b*	*c*	*d*
301.55– 532.3	1.567	0.880	−0.030	0.739
532.3 – 652.4	1.794	1.000	0.516	−0.652
652.4 –2000	1.886	1.076	0.343	4.426

At the melting point (301.55 K), the electrical resistivity of cesium in the liquid is about 73% higher than that of solid state. Using Mott's formula (eq 5), it gives $(\rho_s/\rho_l)_{T_m}$ = 75%.

Borol'skii, Ermoklin, Kulik, and Mel'nikov [101] (curves 53–56) have investigated the electrical resistivity of dense nonideal plasma at various pressures up to 8800 K.

The recommended values for the total and intrinsic electrical resistivity are listed in table 31, and those for the total electrical resistivity are also shown in figures 17 and 18. The recommended values for the liquid state are for the saturated liquid. The recommended values of the total electrical resistivities for the solid state are for a 99.99$^+$% pure cesium and those at temperatures below 50 K are applicable only to a specimen with residual resistivity ρ_0 = 0.00232 × 10^{-8} ω m. The recommended values are corrected for thermal linear expansion from 1 K to 301.55 K. The correction amounts to −1.8% at 1 K,

−1.1% at 140 K, and 0.06% at 301.55 K. The uncertainty of the recommended values for the total electrical resistivity is believed to be within ±5% from 1 K to 1500 K and ± 10% from within 1500 K to 2000 K. Above 20 K the uncertainty of the intrinsic resistivity is about the same as that of the total electrical resistivity; below 20 K this uncertainty is higher than that of the total electrical resistivity.

b. Pressure Dependence

There are 17 sets of experimental data available for the electrical resistivity of cesium as a function of pressure. The information on specimen characterization and measurement conditions for each of the data sets is given in table 34. The data are tabulated in table 35 and shown in figure 20.

The available data and information for the pressure dependence of electrical resistivity of cesium are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only experimental data are presented here.

c. Magnetic Flux Density Dependence

There is only one set of experimental data available for the electrical resistivity of cesium under the influence of magnetic field. The information on specimen characterization and measurement information for each of the data sets is given in table 36. The data are tabulated in table 37 and shown in figure 21.

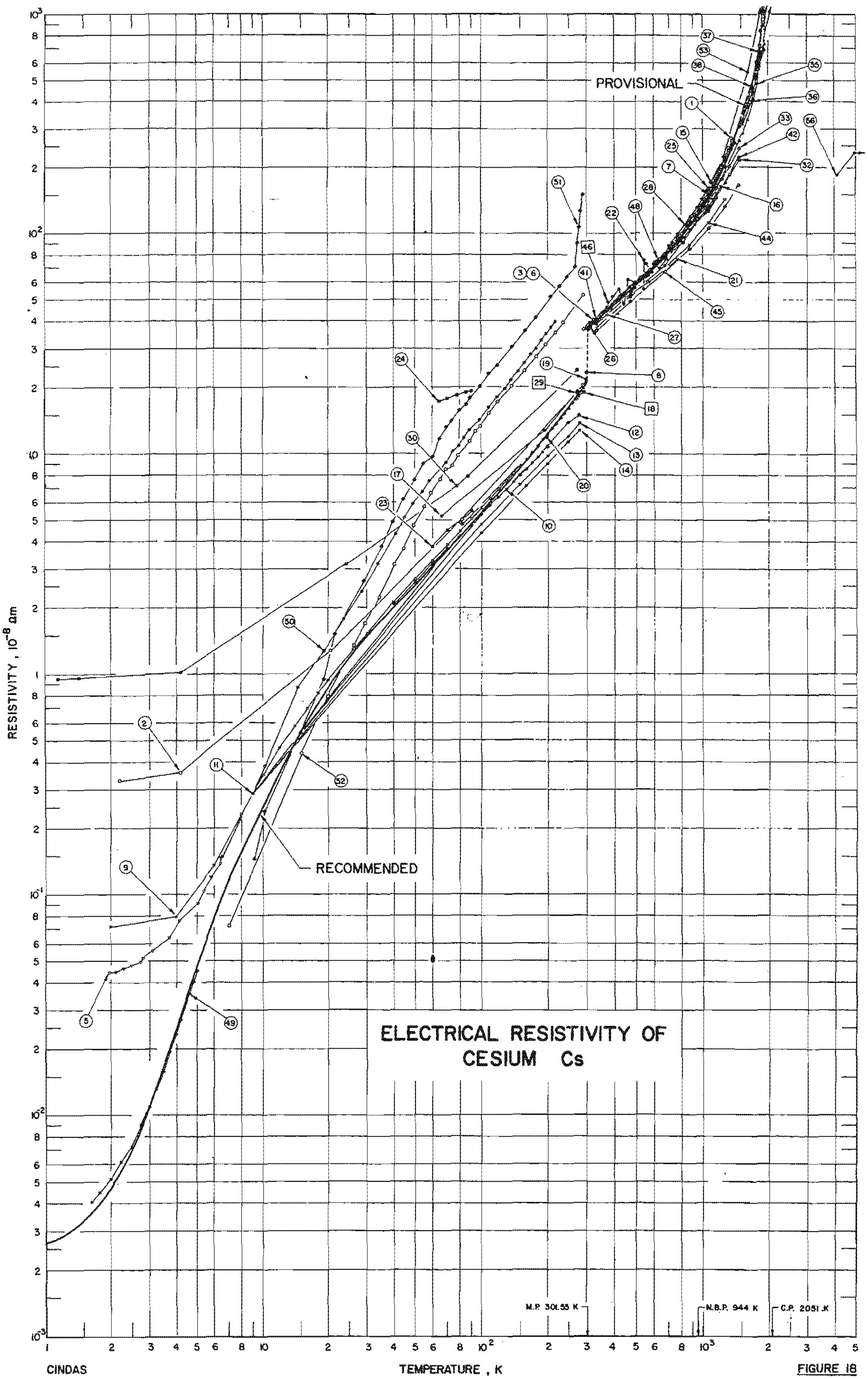
The available data and information for the magnetic flux density dependence of electrical resistivity of cesium are inadequate for performing detailed analysis and synthesis at this time. Consequently, no recommendations are made and only experimental data are presented here.

TABLE 31. RECOMMENDED ELECTRICAL RESISTIVITY OF CESIUM (Temperature Dependence)

[Temperature, T, K; Total Resistivity, ρ, 10^{-8} Ωm; Intrinsic Resistivity, ρ_i, 10^{-8} Ωm]

Solid						Liquid	
T	ρ	ρ_i	T	ρ	ρ_i	T	ρ
1	0.0026		35	1.72	1.72	301.55	36.93
2	0.0048	0.0024*	40	1.99	1.99	350	42.11
3	0.0118	0.0092*	45	2.27	2.27	400	47.45
4	0.0255	0.0229*	50	2.54	2.54	500	58.46
5	0.0474	0.0448*	60	3.07	3.07	600	70.30
6	0.0771	0.0745*	70	3.61	3.61	700	82.97
7	0.114	0.111*	80	4.16	4.16	800	96.97
8	0.155	0.152*	90	4.71	4.71	900	113.4
9	0.198	0.195*	100	5.28	5.28	1000	133.4
10	0.243	0.240*	150	8.43	8.43	1100	158.1
11	0.294	0.291*	200	12.22	12.22	1200	189.0
12	0.354	0.351*	250	16.66	16.66	1300	227.6
13	0.419	0.416*	273.15	18.75	18.75	1400	276.3
14	0.485	0.482*	293	20.46	20.46	1500	337.8
15	0.550	0.547*	300	21.04	21.04	1600	415.5*
16	0.614	0.611*	301.55	21.16	21.16	1700	513.9*
18	0.738	0.735*				1800	638.8*
20	0.859	0.856*				1900	797.6*
25	1.15	1.15				2000	1000.0*
30	1.44	1.44					

* Provisional values.


PROVISIONAL
RECOMMENDED
ELECTRICAL RESISTIVITY OF
CESIUM Cs
RESISTIVITY, 10^{-8} Ωm
TEMPERATURE, K
M.P. 301.55 K
N.B.P. 944 K
C.P. 2051 K
CINDAS
FIGURE 18

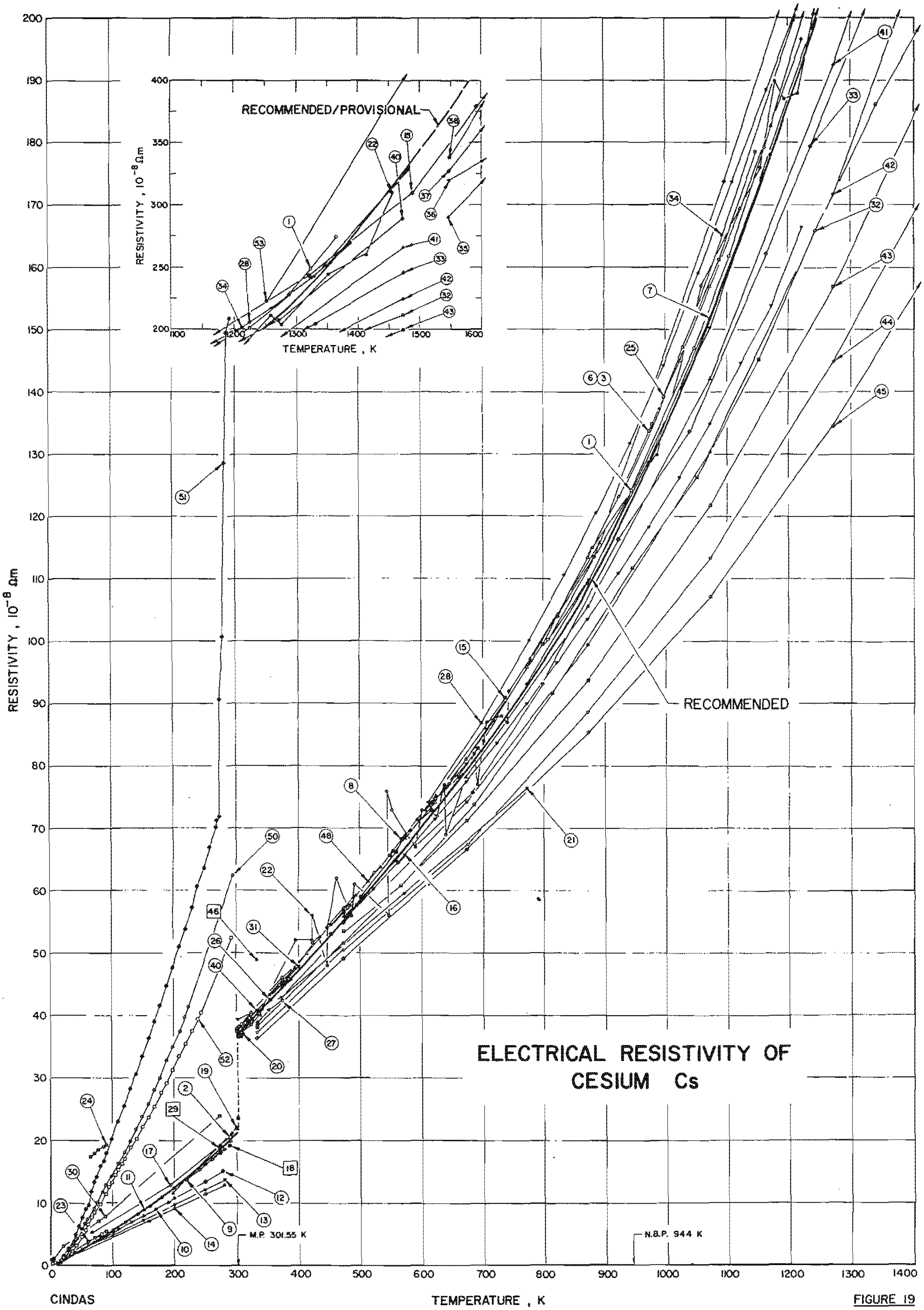

RECOMMENDED/PROVISIONAL
RESISTIVITY, 10^{-8} Ωm
TEMPERATURE, K
RECOMMENDED
M.P. 301.55 K
N.B.P. 944 K
RESISTIVITY, 10^{-8} Ωm
TEMPERATURE, K
ELECTRICAL RESISTIVITY OF CESIUM Cs
CINDAS
FIGURE 19

TABLE 32. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CESIUM Cs (Temper e Dependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent) ecifications, and Remarks
1	17, 91, 92	Tepper, F., Murchison, A., Zelenak, J., and Roehlich, F.	1963-1965	A	302-1360		Pure; specimen was placed in a 25 alloy cylindrical cell, 0.5 in. O.D. with wall thickness 0.065 ir .6 in. long.
2	102	McLennan, J.C., Niven, C.D., and Wilhelm, J.O.	1928		2.2-290		Pure; specimen was run into a f lary tube.
3	12	Shpil'rain, E'.E'., Soldatenko, Yu.A., Yakimovich, K.A., Fomin, V.A., Savchenko V.A., Belova, A.M., Kagan, D.N., and Krainova, J.F.	1965	A	300-1223	Cs (I)	Pure; 0.4 Rb, 0.05 K, and 0.04 cimen in liquid state; measured in insert gas atmosphere; the liquid s enclosed in a stainless steel tube; density = 1.853 - 5.71 3.15) g cm^{-3}; melting point = 300.45 K; boiling point = 963.15 presented by ρ = 34.88 + 11.233 x 10^{-2} (T-273.15) 10^{-8} Ωm (623 K), ρ = 49.66 + 2.318 x 10^{-2} (T-273.15) + 1.386 x 10^{-4} .5)^2 (from 623-1223 K), T in K units.
4*	12	Shpil'rain, E'.E'., et al.	1965	A	300-1223	Cs (II)	Pure; 0.003 Rb, 0.005 Na, and K; melting point = 301.25 K; other ns similar to th specimen; data were presented by -9.816 x 10^{-2} (T) + 0.383 x 10^{-4} (T-273.15)^2 (from 3 K), ρ = 63.98 x 10^{-2} (T-273.15) + 1.712 x 10^{-4} ^{2} (723-1223 K), in 10^{-8} Ωm, T in K units.
5	23, 103	MacDonald, D.K.C., White, G.K., and Woods, S.B.	1955, 1956	A	2-6.5	Cs 3	Pure; specimen was obtained fr ers A. D. Mackay (New York); specimen was melted in vac un into soft glass tube with platinum leads sealed in; sample dia 6 mm; ρ_0/ρ_{295} = 2.08 x 10^{-3}.
6	14	Shpil'rain, E'.E'. and Savchenko, V.A.	1968	A	303-1173	Cs 1	Pure; 0.4 Na, 0.05 K, and 0.03 cimen was obtained by reduction of CsCl and distillation of t t pressure of 1 x 10^{-3} torr and at temperature about 700 C was filled in a 1 Kh 18 NgT stainless steel test tube, 15 mm i and 50 cm long with a wall thickness 0.75 mm.
7	14	White, G.K., et al.	1968	A	303-1173	Cs 2	Pure; 0.005 Na, 0.00013 K, b; other specifications similar to the above specimen.
8	104	Hyman, J. Jr.	1961	A	302-692		Pure; specimen was placed in a ty stainless steel tube 0.125 in. in diameter, 0.012 in. wall, 3 i ; fitted with two copper current electrodes; two 30 guage electrod e spot welded along the tube with 1 in. separation.
9	90	Dugdale, J.S. and Phillips, D.	1965	A	1.5-300	Cs 4,5,6	Pure; specimens were obtained fr Light and Co. Ltd., Colnbrook, England; wire specimens were extrude r distilled paraffin; 3 mm diameter; $R_{295}/R_{4.2}$ = 250; the electrical ivity was measured under zero pressure.
10	90	Dugdale, J.S. and Phillips, D.	1965	A	2-200	Cs 4,5,6	Same as above specimen; electric stivity was measured at constant volume condition.
11	90	Dugdale, J.S. and Phillips, D.	1965	A	0-274		Similar to the above specimen; ide ctrical resistivity were reported as function of temperature at co pressure (p = 0); data were extracted from smooth curve.
12	90	Dugdale, J.S. and Phillips, D.	1965	A	0-277		Similar to the above specimen; ide ctrical resistivity were reported as function of temperature at co density as at 0 K at zero pressure; data were extracted from sm rve.
13	90	Dugdale, J.S. and Phillips, D.	1965	A	0-281		Similar to the above specimen; at nt density as at 0 K at 1000 atm.
14	90	Dugdale, J.S. and Phillips, D.	1965	A	0-280		Similar to the above specimen; at nt density as at 0 K at 42,000 atm; data above 150 K were interpo between present results and a point based on Bridgman's data at t.

* Not shown in figure.

TABLE 32. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CESIUM Cs (Temperature De| (continued)

ır. o.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight percent), !	ɔns, and Remarks
5	105, 106	Hochman, J.M. and Bonilla, C.F.	1965	A	589-1922		99.97 pure; 0.0154 O_2, 0.0145 Rb, 0 0.0016 B, 0.0006 K, 0.0003 each from Dow Chemical Co.; liquid sp capsule, 1 in. O.D., 1/10 in. wal	·.0023 Ca, 0.0018 Fe, 0.0013 S, ınd Ni; specimen was obtained ıs placed in a 90 Ta/10 W alloy in. long; thermal expansion corrected.
6	18	Semyachkin, B.E. and Solov'ev, A.N.	1964		303-1223		Pure; specimen was placed in a Hayr with wall thickness 0.065 in., anc	y cylindrical cell, 0.5 in. O.D., length.
7	19	Guntz, A. and Broniewski, W.	1909		86-293		Pure.	
8	56	Hackspill, L.	1910	A	289	1	Pure.	
9	56	Hackspill, L.	1910	A	198-307	2	Pure.	
0	56	Hackspill, L.	1910	A	83-310	3	Pure.	
1	52, 88	Solov'ev, A.N.	1963, 1967		302-773		Pure; liquid state specimen; density 373, 573, and 793 K.	·, 1.69, 1.58 g cm^{-3} at 302,
2	107	Lemmon, A.W. Jr., Deem, H.W., Eldridge, E.A., Hall, E.H., Matolich, J., and Walling, J.F.	1964		333-1456		Pure; 0.0002 each Al, Fe, 0.0001 ea 0.0005 Ni, 0.002 Na, Rb, and 0.0	·, 0.0003 Ca, 0.001 each Ca, Si,
3	97	Appleyard, E.T.S.	1937		60-90		Pure; bulk material.	
4	97	Appleyard, E.T.S.	1937		64.8-90	Cs (Film)	Pure; Cs film was deposited on Pyre	64 K; film thickness 49.5 Å.
5	43	Kapelner, S.M. and Bratton, W.D.	1962	B	301.5-1150		99.9 pure; 0.0001 each O_2, N_2, 0.00(obtained from MSA Research Corp type 347 stainless steel tube weld(for 2 hr prior to measurements.	0.0004 Rb; specimen was ;pecimen was loaded into a .ed and it was heated at 823 K
6	40	Endo, H.	1963	A	302-374		Pure; specimen was supplied by A. I an 0.7 mm I.D. soft glass capilla sured at constant pressure conditi	Ltd.; specimen was placed in ectrical resistivity was mea-
7	40	Endo, H.	1963	A	302-374		Same as above specimen; electrical ı volume.	was obtained at constant
8	108	Hoffman, H.W. and Robin, T.T. Jr.	1967		600-1388		Pure.	
9	22	Krautz, E.	1950		273		Pure.	
0	29	Meissner, W. and Voigt, B.	1930		1.15-273	Cs 1	Pure; specimen was distilled in a gla about 33 mm in length.	ımple diameter was 3 mm and
1	68	Van der Lugt, W., Devlin, J.F., Hennephof, J., and Leenstra, M.R.	1973	B	373.15-398.15		Pure; $d\rho/dT = 0.1005 \times 10^{-8}\ \Omega m/K$.	
2	99	Pfeifer, H.P., Freyland, W.F., and Hensel, F.	1973		473-1473		Pure; fluid cesium was placed in a m container, at the ends of the tube 26% Re) were fixed; electrical res to 500 bar; data were extracted fr	gsten-26% rhenium tube as ɔcouples (97% W, 3% Re-74% W, s measured at pressure equal ı curve.
	99	Pfeifer, H.P., et al.	1973		473-1473		Similar to the above specimen; elect: equal to 300 bar.	tivity was measured at pressure
	99	Pfeifer, H.P., et al.	1973		473-1482		Similar to the above specimen; elect: equal to 100 bar.	tivity was measured at pressure

TABLE 32. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CESIUM Cs (Temperat ence) (continued)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	Composition (weight per ifications, and Remarks
35	99	Pfeifer, H.P., Freyland, W.F., and Hensel, F.	1973		1546-2103		Similar to the above specimen resistivity was measured at pressure equal to 200 bar.
36	99	Pfeifer, H.P., et al.	1973		1547-2104		Similar to the above specimen resistivity was measured at pressure equal to 175 bar.
37	99	Pfeifer, H.P., et al.	1973		1547-2100		Similar to the above specimen resistivity was measured at pressure equal to 150 bar.
38	99	Pfeifer, H.P., et al.	1973		1548-2093		Similar to the above specimen resistivity was measured at pressure equal to 130 bar.
39*	99	Pfeifer, H.P., et al.	1973		1548-2007		Similar to the above specimen resistivity was measured at pressure equal to 115 bar.
40	100	Renkert, H., Hensel, F., and Franck, E.U.	1971		333-1473		Pure; liquid cesium was place l of pure molybdenum, the vessel was filled with purified argon a ı pressure balanced the cesium pressure inside the cell; critica = 2023 K and p_c = 110 bar; electrical resistivity was measured a ır.
41	100	Renkert, H., et al.	1971		333-1473		Similar to the above specimen resistivity was measured at p = 200 bar.
42	100	Renkert, H., et al.	1971		333-1473		Similar to the above specimen resistivity was measured at p = 400 bar.
43	100	Renkert, H., et al.	1971		333-1473		Similar to the above specimen resistivity was measured at p = 600 bar.
44	100	Renkert, H., et al.	1971		333-1473		Similar to the above specimen resistivity was measured at p = 800 bar.
45	100	Renkert, H., et al.	1971		333-1473		Similar to the above specimen resistivity was measured at p = 1000 bar.
46	69	Tamaki, S., Ross, R.G., Cusack, N.E., and Endo, H.	1973	A	373.15		Pure; liquid state; electrical r ıas measured at pressure 1 bar.
47*	69	Tamaki, S., et al.	1973	A	373.15		Pure; liquid state; electrical r ıas measured at pressure 4 kbar.
48	94	Semyachkin, B.E. and Solov'ev, A.N.	1970	A	293-623		99.97 pure; the specimen was stainless steel tube in a copper block; temperature was measured Rh(10%) thermocouple; the measurements were carried out dur ating and cooling at 0.01 C/min. rate and with current in both dir quid/ρ_{solid} = 1.704, $(1/\rho\ d\rho/dT)_{solid}$ = 49.2 x 10^{-4}/K, $(1/\rho\ d\rho/dT)$ .4 x 10^{-4}/K.
49	96	Aleksandrov, B.N., Lomonos, O.I., Ignat'ev, O.S., and Gromov, O.G.	1969	A	1.6-5		99.995 pure; 0.004 Rb, 0.002 K, and traces of Si, Ca, Mg, Fe, and Al; the resistance of cesiun ured in thick walled cylindrical glass capillaries; platinum wires as potential and current leads; relative resistivity ρ_0/ρ_{293} = 1.1 elative resistance data were reported.
50	98	McWhan, D.B. and Stevens, A.L.	1969		3-300		99.97 pure, $\rho_{298}/\rho_{4.2}$ = 450; ele istivity were measured at P = 30 Kbar.
51	98	McWhan, D.B. and Stevens, A.L.	1969		3-300		Same as the above specimen e› } Kbar.
52	98	McWhan, D.B. and Stevens, A.L.	1969		3-300		Same as the above specimen e›) Kbar.

* Not shown in figure.

TABLE 32. MEASURE ıdence) (continued)

Cur. No.	Ref. No.	Author(s)	cifications, and Remarks
53	101	Barol'skii, S.G., Ermokhin, N.V., Kulik, P.P., and Mel'nikov, V.M.	ary set up of the "ohmic oven" type at
54*	101	Barol'skii, S.G., et al.	et up with the plasma stabilized by a = 130 atm.
55*	101	Barol'skii, S.G., et al.	sured at p = 170 atm.
56*	101	Barol'skii, S.G., et al.	sured at p = 350 atm.

* Not shown in figure.

TABLE 33. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CESIUM

[Temperature, T, K; Resistivity, ρ, 10^{-8} Ωm]

CURVE 1

T	ρ
308.6	38.6
480.2	57.4
643.5	76.96
808.0	100.33
944.6	124.2
1048.5	147.06
1104.1	161.8
1162.4	174.32
1225.7	201.16
1290.2	229.1
1323.0	248.92
1365.8	274.57

CURVE 2

T	ρ
2.2	0.324
4.2	0.359
20.6	1.28
82.0	5.04
290.0	20.5

CURVE 3

T	ρ
300.3	37.94
323	40.49
373	46.11
423	51.72
473	57.34
523	62.96
573	68.57
623	74.19
623	74.75
673	81.11
723	88.15
773	95.90
823	104.33
873	113.46
923	133.28
973	133.80
1023	145.00
1073	156.90
1123	169.50
1173	182.78
1223	196.76

CURVE 4*

T	ρ
291.1	32.8
323	39.09
373	44.29
423	49.67
473	55.25
523	61.02
573	66.98
623	73.13
673	79.48
723	86.02
723	86.39
773	93.16
823	100.7
873	109.3
923	118.7
973	128.8
1023	139.8
1073	151.8
1123	164.6
1173	178.1
1223	192.6

CURVE 5

T	ρ
1.9635	0.0445
2.000	0.0448
2.070	0.0450
2.1088	0.0448
2.275	0.0462
2.478	0.0477
2.530	0.0467
2.716	0.0493
2.774	0.0506
3.076	0.0555
3.141	0.0550
3.707	0.0639
3.707	0.0661
4.12	0.0760
4.188	0.0747
5.105	0.0966
5.383	0.1093
5.875	0.1209
6.457	0.1388
6.457	0.1463

CURVE 6

T	ρ
303	38.25
323	40.50
373	46.12
473	57.35
573	68.58
673	81.12
773	95.92
873	113.5
973	133.8
1073	156.9
1173	182.8

CURVE 7

T	ρ
303	37.07
323	39.09*
373	44.29*
473	55.25*
573	66.98*
673	79.48*
773	93.16
873	109.3
973	128.8
1073	151.8
1173	178.1

CURVE 8

T	ρ
302	23.5
323	39.05*
387	45.8
452	53.1
494	57.6
503	59.0
560	66.3
568	68.4
617	73.0
617	74.2
661	78.3
692	82.9

CURVE 9

T	ρ
2	0.0719
4	0.0796
6	0.1365

CURVE 9 (cont.)

T	ρ
8	0.2335
10	0.350
12	0.465
14	0.578
16	0.693
18	0.812
20	0.937
30	1.535
40	2.121
50	2.709
60	3.298
70	3.883
80	4.478
90	5.082
100	5.691
110	6.308
120	6.928
130	7.555
140	8.190
150	8.834*
160	9.491
170	10.166
180	10.858
190	11.557
200	12.274
210	13.005
220	13.751
230	14.519
240	15.306
250	16.114*
260	16.939
270	17.774
280	18.650
290	19.551

CURVE 10

T	ρ
2	0.0559
4	0.0797*
6	0.137*
8	0.233*
10	0.349
12	0.464*
14	0.578*
16	0.693*
18	0.812*

pendence)

)

)33*
;20
)83
;35
l80
713
247
784
321*
362
399
327
160
389
534
)78
528
l89
748

29
70
37
35
l4
25

29*
38
)6
77
18
)8

29*
79
28
71
)8
75

CURVE 14

T	ρ
9	0.29*
100	4.42
159	7.18
200	9.07
250	11.41
280	12.85

CURVE 15

T	ρ
582	69.77
737	90.97
883	113.5
1097	173.8
1321	243.5
1488	309.1
1592	379.1
1706	445.6
1818	567.4
1911	690.7
1959	1000± 8000*

CURVE 16

T	ρ
303	37.9
323	39.9
373	44.9
423	49.8*
473	55.0*
523	60.3
573	65.8
623	71.5
673	77.5
723	83.7
773	90.0
823	96.6
873	103.6
923	110.9
973	118.5
1023	126.2
1073	134.9
1123	144.6
1173	153.8
1223	166.4

* Not shown in figure.

TABLE 33. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CESIUM Cs (Tempe dence) (continued)

T	ρ
CURVE 17	
66	5.25
194.7	12.81
273	19.3
292.4	21.1
CURVE 18	
289	19.2
CURVE 19	
198	11.5
273	18.0
290	19.9
300	22.1
307	36.6
CURVE 20	
83	4.8
198	12.0
273	18.2*
290	20.1*
300	22.3*
303	36.6
310	37.0
CURVE 21	
302	39.3
373	42.9
573	59.6
773	76.5
CURVE 22	
333	38
341	41
373	44*
395	52
421	52
421	56
446	48
446	54
462	62
486	56
492	61
544	76
547	56

T	ρ
CURVE 22 (cont.)	
553	73
590	67
601	73
626	72
637	77
640	69
686	82
691	77
701	84
706	87
731	88
740	87
743	92
824	104
880	115
987	130
1059	157
1156	176
1180	190
1195	187
1217	188
1259	211
1277	204
1353	244
1414	260
1456	310
CURVE 23	
60.0	3.8
70.1	4.5
80.0	4.9
90.0	5.5
CURVE 24	
64.8	17.4
70.1	17.9
77.9	18.5
85.2	19.1
90.0	19.3
CURVE 25	
301.3	37.42
308.8	38.32*
321.6	39.80*
374.4	45.77
483.8	57.71

T	ρ
CURVE 25 (cont.)	
549.9	65.74
643.6	77.28
717.2	87.35
800.2	99.68
923.0	123.63*
979.4	134.84
998.8	139.29
1029.9	147.20
1088.3	161.26
1149.7	178.63
CURVE 26	
302.1	36.74*
311.1	37.95
325.7	39.44
337.8	40.62
354.7	42.68
374.3	44.76*
CURVE 27	
306.2	37.22
323.1	38.52
338.6	40.04
351.6	40.95
373.2	42.42
CURVE 28	
611.1	74.2
698.4	86.9
777.3	100.2
835.0	110.7
886.1	120.6
942.8	131.9
997.8	144.3
1055.6	159.1
1110.0	173.8
1166.7	188.7
1222.3	205.9
1260.0	217.1
1288.9	227.9
1325.0	241.4
1357.8	254.4
1388.9	267.4
CURVE 29	
273	19.0

T	ρ
CURVE 30	
1.15	0.950
1.43	0.960
4.21	1.027
20.42	3.170
77.60	7.172
87.81	7.96
273.16	24.05
CURVE 31	
373.15	45.3
398.15	47.8
CURVE 32	
473	53.45
567	60.81
685	73.79
815	91.65
946	111.7
1052	125.3
1152	145.2
1244	165.9
1343	
1473	
CURVE 33	
473	54.95
561	64.56
683	75.64
799	93.32
822	116.4
1039	133.6
1164	162.2
1237	179.5
1331	204.1
1473	245.4
CURVE 34	
473	55.97
559	64.86
666	78.71
778	97.27
891	115.8
990	137.4
1094	165.2
1213	201.4
1327	242.1
1482	328.0

ρ
35
289.7
331.1
414.9
489.7
583.4
737.9
937.5
056*
253*
458*
36
319.1
337.3*
403.6
492.0*
602.5
701.4
851.1
081*
294*
520*
511*
37
326.6
378.4*
459.1
517.6
588.8*
688.6
893.5
066*
318*
729*
454*
855*
38
337.2
392.6
476.4
616.6
737.9
847.2
047*

T	ρ
CURVE 38 (cont.)	
1919	1458*
1958	2032*
1976	2666*
2002	3908*
2021	6426*
2042	9772*
2056	12820*
2068	17140*
2080	23330*
2093	34670*
CURVE 39*	
1548	337.2
1619	392.6
1678	474.2
1748	619.4
1794	731.1
1820	851.1
1852	1037
1886	1282
1915	1828
1935	2410
1950	3311
1968	4385
1980	6982
1990	11160
1997	21280
2006	35310
2007	47640
CURVE 40	
333	40.82
473	56.56
673	80.26
873	109.9
1073	150.15
1273	208.33
1473	289.85
CURVE 41	
333	40.16
473	55.31*
673	78.13
873	105.71
1073	142.04
1273	192.68
1473	265.96

TABLE 33. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF (Temperature Dependence) (continued)

CURVE 42

T	ρ
333	38.91
473	53.22
673	74.18
873	99.50
1073	130.04
1273	171.82
1473	224.20

CURVE 43

T	ρ
333	38.17
473	51.60
673	71.12
873	93.72
1073	121.80
1273	156.98
1473	199.20

CURVE 44

T	ρ
333	37.17
473	50.40
673	67.75
873	88.73
1073	113.38
1273	144.93
1473	183.48

CURVE 45

T	ρ
333	36.23
473	49.09
673	65.79
873	85.40
1073	107.07
1273	134.59
1473	168.92

CURVE 46

T	ρ
373.15	49.0

CURVE 47*

T	ρ
373.15	37.3

CURVE 48 (cont.)

T	ρ
301.5	37.24*
313.2	38.57
333.2	40.88
353.2	43.17
373.2	45.45*
393.2	47.72
413.2	49.99
433.2	52.26
453.2	54.55
473.2	56.86
493.2	59.20
513.2	61.58
533.2	63.99
553.2	66.46
573.2	68.90
593.2	71.46
613.2	73.98
623.2	75.25

CURVE 49

T	ρ
1.64	0.00406
1.78	0.00449
2.01	0.00516
2.24	0.00617
2.48	0.00718
2.75	0.00906
3.00	0.01091
3.23	0.01318
3.49	0.01597
3.74	0.01955
4.00	0.02342
4.22	0.02748
4.29	0.02934*
4.46	0.03317
4.64	0.03599
4.87	0.04037
5.04	0.04565

CURVE 50

T	ρ
6.6	0.149
10.3	0.383
14.7	0.867
19.1	1.285

CURVE 50 (cont.)

T	ρ
49.7	5.958
54.8	6.784
58.8	7.511
69.3	9.191
74.7	10.13
80.6	10.92
84.6	11.80
89.2	12.89
99.1	14.31
109.1	16.30
119.2	18.16
128.6	19.98
138.6	21.80
148.9	23.87
159.2	25.83
168.8	28.06
178.3	30.00
188.5	32.84
198.7	35.02
209.2	37.49
218.1	39.74
223.6	41.41
295.9	62.48

CURVE 51

T	ρ
9.2	0.145
10.3	0.239
15.1	0.542
19.3	0.950
21.5	1.527
29.1	2.662
35.2	3.845
39.9	4.911
44.7	6.257
50.0	7.693
55.4	9.018
60.1	9.780
65.5	11.83
70.2	13.38
74.4	14.18
80.9	15.98
86.1	16.75
89.8	18.00
99.5	20.24

CURVE 51

T	ρ
159.2	
169.1	
178.9	
188.9	
198.5	
209.2	
219.1	
229.3	
238.6	
248.7	
257.4	
268.1	
269.8	
273.2	
275.5	
280.8	
284.1	
287.8	
292.2	

CURVI

T	ρ
7.1	
15.2	
20.3	
26.3	
29.6	
34.3	
40.4	
44.8	
49.8	
55.3	
59.3	
65.4	
69.9	
74.3	
79.6	
89.5	
94.5	
99.6	
104.8	
109.6	
115.1	
119.7	
129.3	

CURVE 52 (cont.)

T	ρ
188.6	29.28
198.5	31.21
208.8	33.45
218.5	35.44
228.9	37.58
238.9	39.46
243.6	40.48
292.7	52.44

CURVE 53

T	ρ
1253	223
1623	549
1953	1348*
2353	1736*
2473	6896*

CURVE 54*

T	ρ
7050	512.8
7300	370.3
7750	308.6

CURVE 55*

T	ρ
7150	289.8
8050	250.0
8800	217.4

CURVE 56*

T	ρ
4150	185.2
4960	232.5
5780	232.5

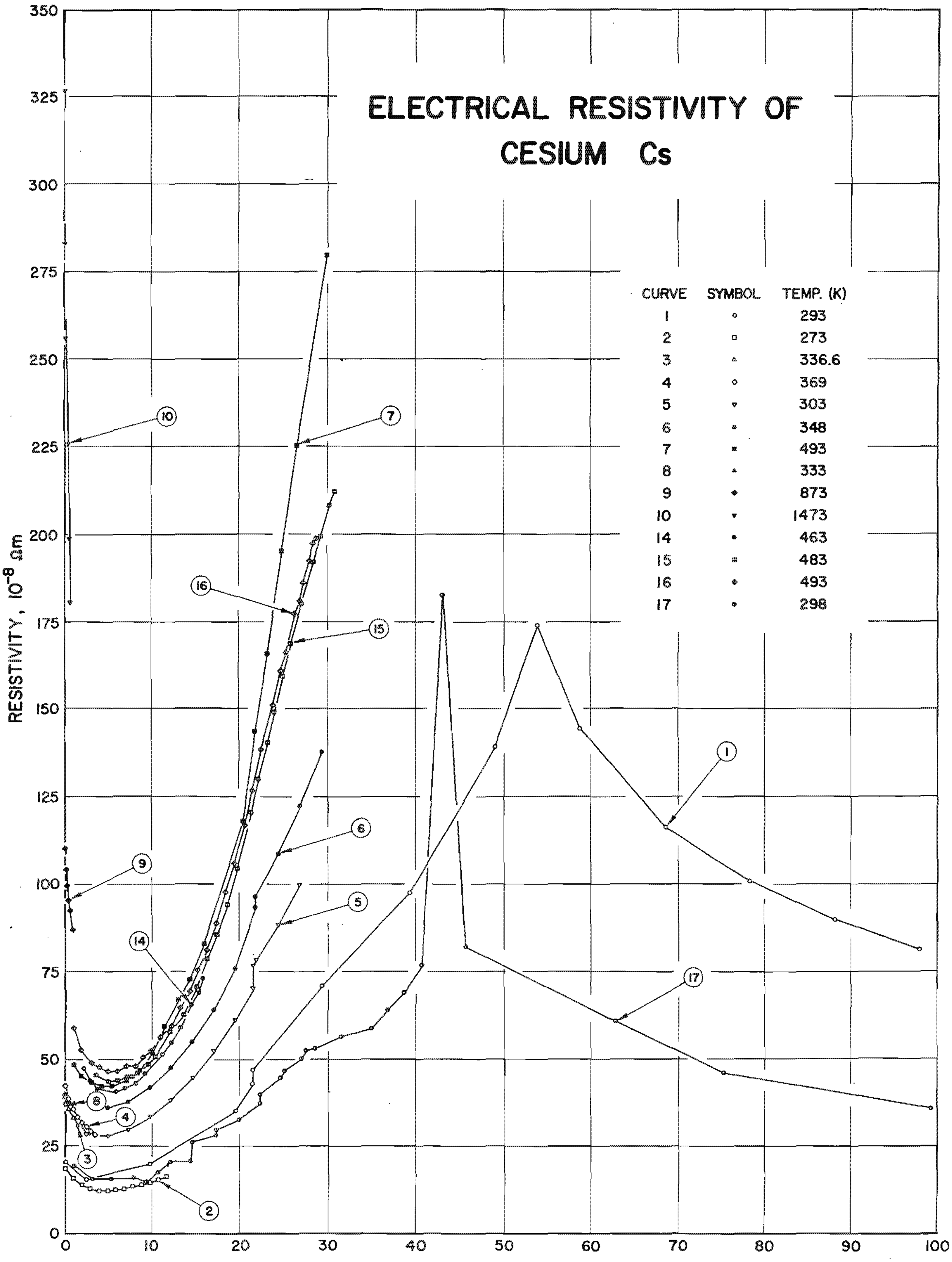

ELECTRICAL RESISTIVITY OF CESIUM Cs
CURVE SYMBOL TEMP. (K)
1 293
2 273
3 336.6
4 369
5 303
6 348
7 493
8 333
9 873
10 1473
14 463
15 483
16 493
17 298
RESISTIVITY, 10^{-8} Ωm
PRESSURE, 10^8 Pa
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
10
20
30
40
50
60
70
80
90
100
CINDAS

FIGURE 20

TABLE 34. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTI e Dependence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Pressure Range, 10^8 Pa	Temperature Range, K	Name and Specimen Designation	nt), Specifications, and Remarks
1	30	Bridgman, P.W.	1952		0-98	~298		; AgCl was used as the material for tive resistance data were reported; ımended value of electrical resistiv- ılity data, the electrical resistivity
2	86	Bridgman, P.W.	1925	A	0-11.76	273		
3	86	Bridgman, P.W.	1925	A	0-1.47	336.6		.
4	86	Bridgman, P.W.	1925	A	0-3.43	369		; R_{liquid}/R_{solid} = 1.695 at p = 3780
5	32	Bridgman, P.W.	1938		0-29.4	303		rom Mackay; provided sealed in glass; ıe as a function of pressure data were
6	32	Bridgman, P.W.	1938		0-29.4	348		
7	109	Oshima, R., Endo, H., Shimomura, O., and Minomura, S.	1974		0-30	493		ın was filled in a glass capillary with nd length of 12 mm; silicon oil was tted medium.
8	100	Renkert, H., Hensel, F., and Franck, E.U.	1971		0.025-1.0	333		ıed in the cell of pure molybdenum; ırified argon and the argon pressure re inside the cell; critical point ır.
9	100	Renkert, H., et al.	1971		0.025-1.0	873		
10	100	Renkert, H., et al.	1971		0.025-0.79	1473		Same as the above speci
11*	100	Renkert, H., et al.	1971		0.02-0.145	2073		Same as the above speci
12*	100	Renkert, H., et al.	1971		0.03-0.133	2173		Same as the above speci
13*	100	Renkert, H., et al.	1971		0.02-0.175	2273		Same as the above speci
14	110	Stishov, S.M. and Makarenko, I.N.	1968		2-16	463		Pure; liquid state; data xtracted from the figure.
15	110	Stishov, S.M. and Makarenko, I.N.	1968		3.6-30	483		Same as the above speci
16	110	Stishov, S.M. and Makarenko, I.N.	1968		1-29	493		Same as the above speci
17	98	McWhan, D.B. and Stevens, A.L.	1969		0-100	298		99.97 pure; $\rho_{298\ K}/\rho_{4.}$ 5°.

* Not shown in figure.

TABLE 35. EXPERIMENTAL DATA ON THE ELECTRICAL RESISTIVITY OF CESIUM Cs (Pressur dence)

[Temperature, T, K; Pressure, P, 10^8 Pa; Resistivity, ρ, 10^{-8} Ωm]

CURVE 1
T = 293

P	ρ
0.00	20.52
2.45	15.69
9.80	20.13
19.60	35.42
21.56	42.96
21.56	46.93
29.40	70.93
39.20	97.59
49.00	139.3
53.85	174.0
58.80	144.4
68.60	116.3
78.40	100.7
88.20	89.89
98.00	81.15

CURVE 2
T = 273

P	ρ
0.00	18.68
0.98	15.80
1.96	14.01
2.94	12.94
3.92	12.42
4.90	12.40
5.88	12.58
6.86	12.96
7.84	13.51
8.82	14.08
9.80	14.78
10.78	15.57
11.76	16.53

CURVE 3
T = 336.6

P	ρ
0.00	39.21
0.49	35.77
0.98	33.23
1.47	31.18

CURVE 4
T = 369

P	ρ
[illegible].00	42.59

CURVE 4 (cont.)
T = 369

P	ρ
0.49	38.72
0.98	35.79
1.47	33.54
1.96	31.84
2.45	30.73
2.94	29.48
3.43	28.59

CURVE 5
T = 303

P	ρ
0.00	37.10
2.45	28.62
4.90	28.05
7.35	29.94
9.80	33.56
12.25	38.51
14.70	44.92
17.15	52.48
19.60	61.38
21.63	70.13
21.63	76.64
22.05	78.12
24.50	88.17
26.95	99.74

CURVE 6
T = 348

P	ρ
4.90	36.13
7.35	37.84
9.80	42.07
12.25	47.77
14.70	55.01
17.15	64.11
19.60	75.85
21.95	93.33
21.95	96.03
22.05	96.18*
24.50	108.53
26.95	122.31
29.40	137.67

CURVE 7
T = 493

P	ρ
1.0	48.4
1.8	45.1
3.1	43.3
4.2	42.4
5.4	42.4
7.1	43.8
8.6	47.0
10.1	52.1
11.5	59.5
13.1	67.0
14.4	72.9
16.0	82.6
20.5	117.8
21.9	143.6
23.3	165.8
24.9	195.1
26.6	225.3
30.0	279.6

CURVE 8
T = 333

P	ρ
0.025	40.0
0.100	39.8*
0.200	38.0
0.410	38.0*
0.600	38.0*
0.775	37.32
1.007	37.32

CURVE 9
T = 873

P	ρ
0.025	110.2
0.100	104.2
0.200	99.5
0.400	95.5
0.600	92.5*
0.800	92.5
0.986	87.1

CURVE 10
T = 1473

P	ρ
0.025	326.6

CURVE 10 (cont.)
T = 1473

P	ρ
0.100	283.1
0.200	255.8
0.400	225.9
0.600	198.6
0.790	180.3

CURVE 11*
T = 2073

P	ρ
0.020	6.95 x 10^5
0.030	8.79 "
0.040	6.67 "
0.040	5.65 "
0.050	5.78 "
0.050	3.10 "
0.060	5.12 "
0.070	4.87 "
0.070	2.15 "
0.080	4.83 "
0.080	1.80 "
0.090	4.26 "
0.090	1.51 "
0.096	1.00 "
0.100	3.80 "
0.100	1.46 "
0.100	8.28 x 10^4
0.105	5.52 "
0.110	1.06 x 10^5
0.110	6.89 x 10^4
0.111	3.12 "
0.115	1.31 "
0.120	3.83 "
0.125	5.73 x 10^3
0.145	3.46 "

CURVE 12*
T = 2173

P	ρ
0.030	7.65 x 10^5
0.030	4.49 "
0.040	3.32 "
0.050	3.02 "
0.060	1.77 "
0.070	1.26 "
0.080	9.2 x 10^4

CURVE [illegible] (cont.)*
T = [illegible]

P	ρ
0.088	[illegible] x 10^4
0.095	[illegible] "
0.100	[illegible] x 10^5
0.100	[illegible] x 10^4
0.100	[illegible] "
0.105	[illegible] "
0.110	[illegible] "
0.110	[illegible]6 x 10^5
0.110	[illegible] x 10^4
0.114	[illegible] "
0.115	[illegible] "
0.118	[illegible] "
0.120	[illegible] "
0.124	[illegible] x 10^3
0.126	[illegible] x 10^4
0.130	[illegible] "
0.130	[illegible] x 10^3
0.133	[illegible] x 10^4

CU[illegible]*
T [illegible]

P	ρ
0.020	[illegible] x 10^5
0.030	[illegible] "
0.030	[illegible] "
0.040	[illegible] "
0.040	[illegible] "
0.050	[illegible] "
0.050	[illegible] "
0.060	[illegible] "
0.060	[illegible] "
0.070	[illegible] "
0.070	[illegible] "
0.080	[illegible] "
0.090	[illegible] "
0.090	[illegible] "
0.098	[illegible] "
0.099	[illegible] "
0.100	[illegible] "
0.105	[illegible] "
0.111	[illegible] "
0.116	[illegible] x 10^4
0.120	[illegible] "
0.120	[illegible] "
0.130	[illegible] "

CURVE 13 (cont.)*
T = 2273

P	ρ
0.135	3.36 x 10^4
0.140	2.51 "
0.155	2.69 "
0.175	1.26 "

CURVE 14
T = 463

P	ρ
2.1	47.5
2.8	44.0
3.6	41.7
5.8	40.9
6.9	41.7
8.1	43.1
9.2	46.0
11.2	51.5
12.3	54.9
13.3	59.1
14.5	65.6
15.4	69.0
15.9	73.1

CURVE 15
T = 483

P	ρ
3.6	45.6
5.0	43.9
6.1	44.0
7.1	45.1
7.7	45.1
8.4	46.3
9.6	48.7
10.4	50.8
12.1	58.0
13.7	62.8
15.2	70.9
16.4	78.7
17.5	85.6
18.7	94.1
19.8	104.4
21.4	120.4
22.2	130.0
23.3	140.5
24.1	149.3
25.0	159.5

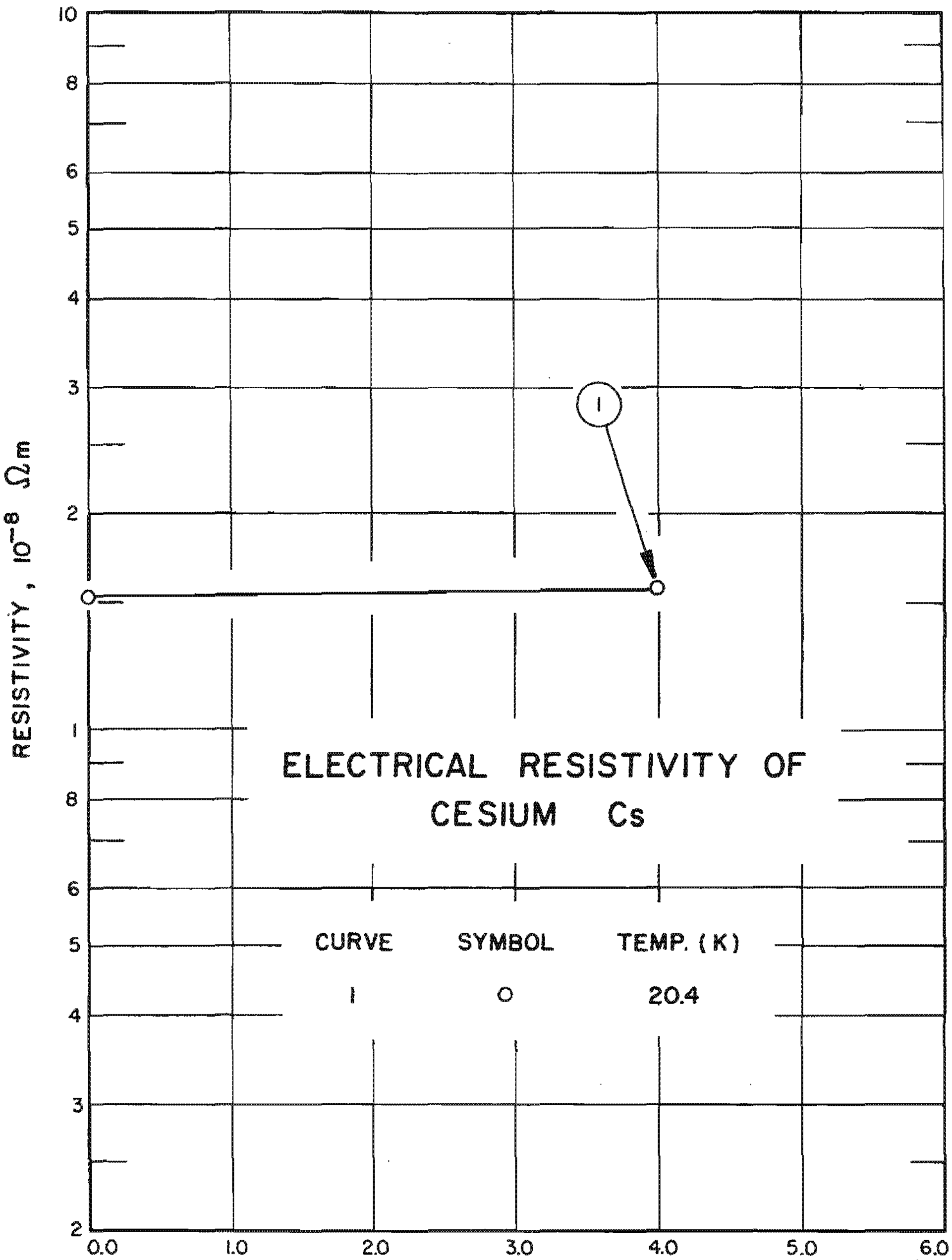
* Not shown in figure.

)ependence) (continued)

C

2
2
2
2
3
3

6.0	46.7	25.17	46.6
7.1	48.1	27.05	50.0
8.1	48.1	27.52	52.5
9.0	50.8	28.65	53.0
9.9	52.2	31.68	56.3
11.1	56.5	35.14	58.6
12.3	59.7	36.90	63.9
13.3	64.7	38.75	68.9
14.4	69.5	40.70	76.9
15.3	75.4	43.00	182.7
16.3	81.1	45.69	81.9
17.4	88.8	62.85	60.9
18.4	97.5	75.26	46.0
19.5	105.9	99.31	35.8
20.7	116.8		
21.6	126.7		
22.6	138.3		
23.9	151.0		
24.8	160.9		
25.3	166.1		
26.3	177.1		
26.9	181.0		
27.3	185.8		
28.0	192.1		
28.4	197.2		
28.8	198.6		



CINDAS MAGNETIC FLUX DENSITY, Tesla FIGURE 21

TABLE 36. MEASUREMENT INFORMATION ON THE ELECTRICAL RESISTIVITY OF CESI ... ›endence)

Cur. No.	Ref. No.	Author(s)	Year	Method Used	Magnetic Flux Density Range, Tesla	Temperature Range, K	Name and Specimen Designation	...ecifications, and Remarks
1	36	Justi, E.	1948	A	0,4.0	20.4	Cs 2	I ... t was measured in a transverse

L DATA ON THE ELECTRIC ... dence)

[Temperature, T, K; M gnetic Flux Density, B, Tesla; Resisti...

B	ρ
CURVE 1	
T = 20.4	
0.0	1.531
4.0	1.575

4.6. Francium

Francium, with atomic number 87, is the last member of the alkali metal series and is unstable and radioactive. Its chemical properties closely resemble those of cesium. It is a solid at room temperature having a melting point of 300.2 K and a boiling point of 950 K. Francium has no stable isotope, but twenty short-lived radioactive isotopes are known to exist, with half-lives ranging from far less than 1 millisecond (^{215}Fr) to 22 min. (^{223}Fr). The longest-lived isotope (^{233}Fr) exists in nature in uranium minerals, but the total amount of it in the crust of the earth at any time is probably less than an ounce.

a. Temperature Dependence

There is no experimental determination of electrical resistivity on francium. Solov'ev [52] calculated the electrical resistivity from 293.15 to 1273.15 K by assuming that the atomic electrical resistances of alkali metals are all the same.

On the basis of the expected similarities between francium and the other alkali metals, we have roughly estimated the electrical resistivity values from 100 K to 1500 K by extrapolation to the atomic number 87 of a curve drawn through the values for sodium, potassium, rubidium, and cesium in a graph of electrical resistivity versus atomic number with temperature as a parameter. The change of resistivity at the melting point was obtained by using Mott's formula, eq (5), with a latent heat of 0.4 K cal/mol, which was also obtained by extrapolating the data of latent heat versus atomic number of lithium, sodium, potassium, rubidium, and cesium to 87 (Fr).

The provisional values for the intrinsic electrical resistivity are smoothed by the cubic spline function eq (7). The four term coefficients for the function eq (7) are given in the following:

Temperature range, K	a	b	c	d
100–300.2	0.934	0.952	0.0137	1.286
300.2–881	1.74	0.907	−0.276	0.820
881–1500	2.19	1.186	0.874	1.522

These values are listed in table 38 and shown in figure 22 with the data of Solov'ev. The uncertainty of the provisional values is believed to be within ±50%.

TABLE 38. PROVISIONAL ELECTRICAL RESISTIVITY OF FRANCIUM
(Temperature Dependence)

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

Solid		Liquid	
T	ρ_i	T	ρ_i
100	8.6	300.2	55
150	12.9	400	71
200	18.0	500	86
250	25.0	600	102
273.15	28.9	700	119
293	32.6	800	138
300.2	34.0	900	158
		1000	181
		1100	211
		1200	251
		1300	307
		1400	385
		1500	497

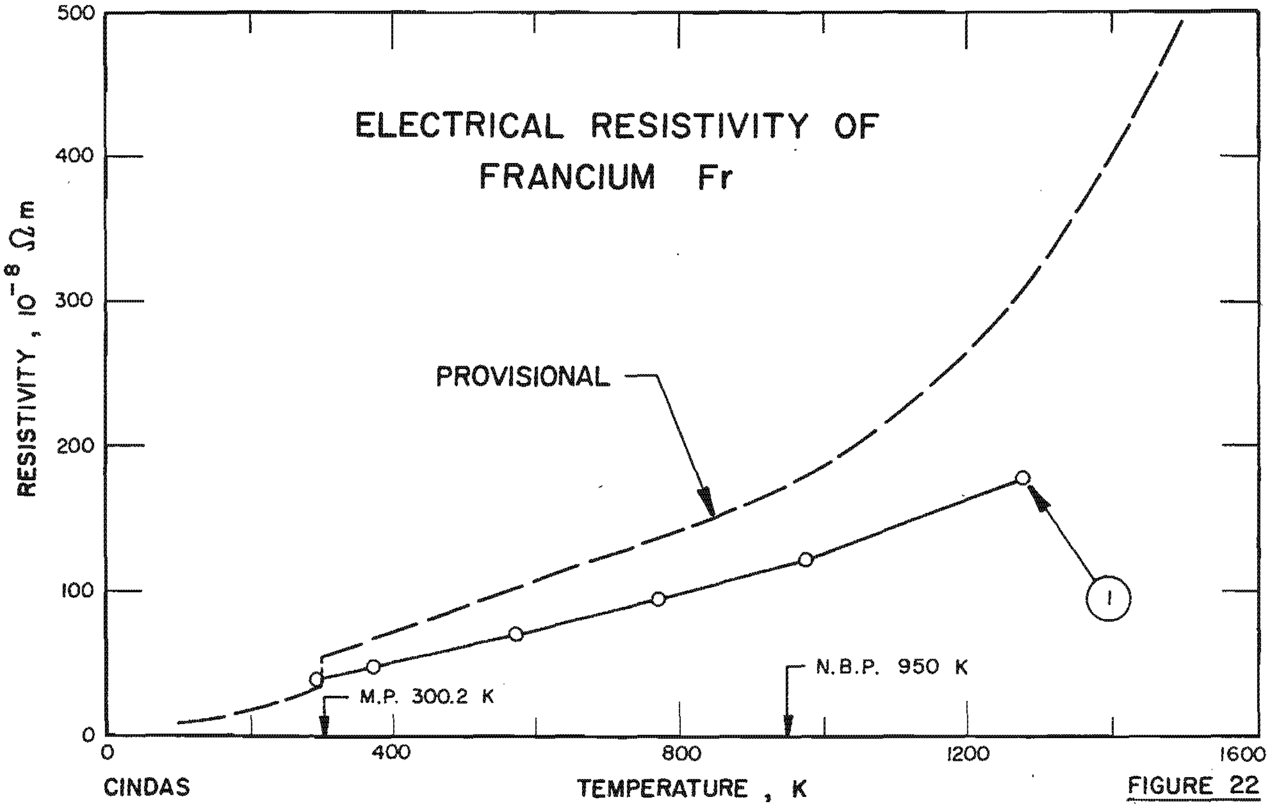

ELECTRICAL RESISTIVITY OF
FRANCIUM Fr
PROVISIONAL
1
M.P. 300.2 K
N.B.P. 950 K
RESISTIVITY , 10⁻⁸ Ω m
0
100
200
300
400
500
0
400
800
1200
1600
CINDAS
TEMPERATURE , K
FIGURE 22

TABLE 39. CALCULATED INF(:LECTRICAL RESIST:)ependence)

Author(s)	Year	Method Used	Temp. Range, K	Name and Specimen Designation	fications, and Remarks
lov'ev, A.N.	1963		293-1273		l by assuming the atomic electrical same; the data necessary for the l the density at T = 0 K and T = T_{melt}, ght lines for alkali metals in co- per.

TABLE 40. CALCULATED DATA ON THE ELECTRICAL F ıdence)

[Temperature, T, K; F

0
5
2
5
0
0

5. Summary and Conclusion

The electrical resistivities of the alkali elements have been surveyed and studied from time to time by a number of investigators, including Meaden [111], Kaye & Laby [112], Grosse [5], and Shpil'rain, et al. [113], to name just a few. Electrical resistivity data are compiled in a number of handbooks such as those sponsored by Landolt-Börnstein [114], AIP [115], CRC [116], and Liquid-Metals Handbook [117], etc. However, their main concern is to provide a general picture through only one or a few particular sets of data, and only a limited temperature range is covered. The purpose of the present work is quite different from that of the above mentioned works. There are two major aims: (1) to exhaustively search the open literature so that all the available experimental data are comprehensively compiled, and (2) to generate recommended reference values by critical evaluation, analysis, and synthesis of the existing experimental data.

The above aims are now achieved. The recommended values were obtained by least squares fitting of the selected experimental data, or by correlating the related properties, and by smoothing with a cubic spline function. The comparison of electrical resistivity data from the literature with the present recommended values are shown in table 41. The values from AIP [115] are taken from the book by Meaden [111] so that they are identical.

With a view to bring out any similarities or differences between the recommended values for the alkali elements, the recommended values of the intrinsic resistivities are plotted together from 2 to 2000 K and shown in figure 23.

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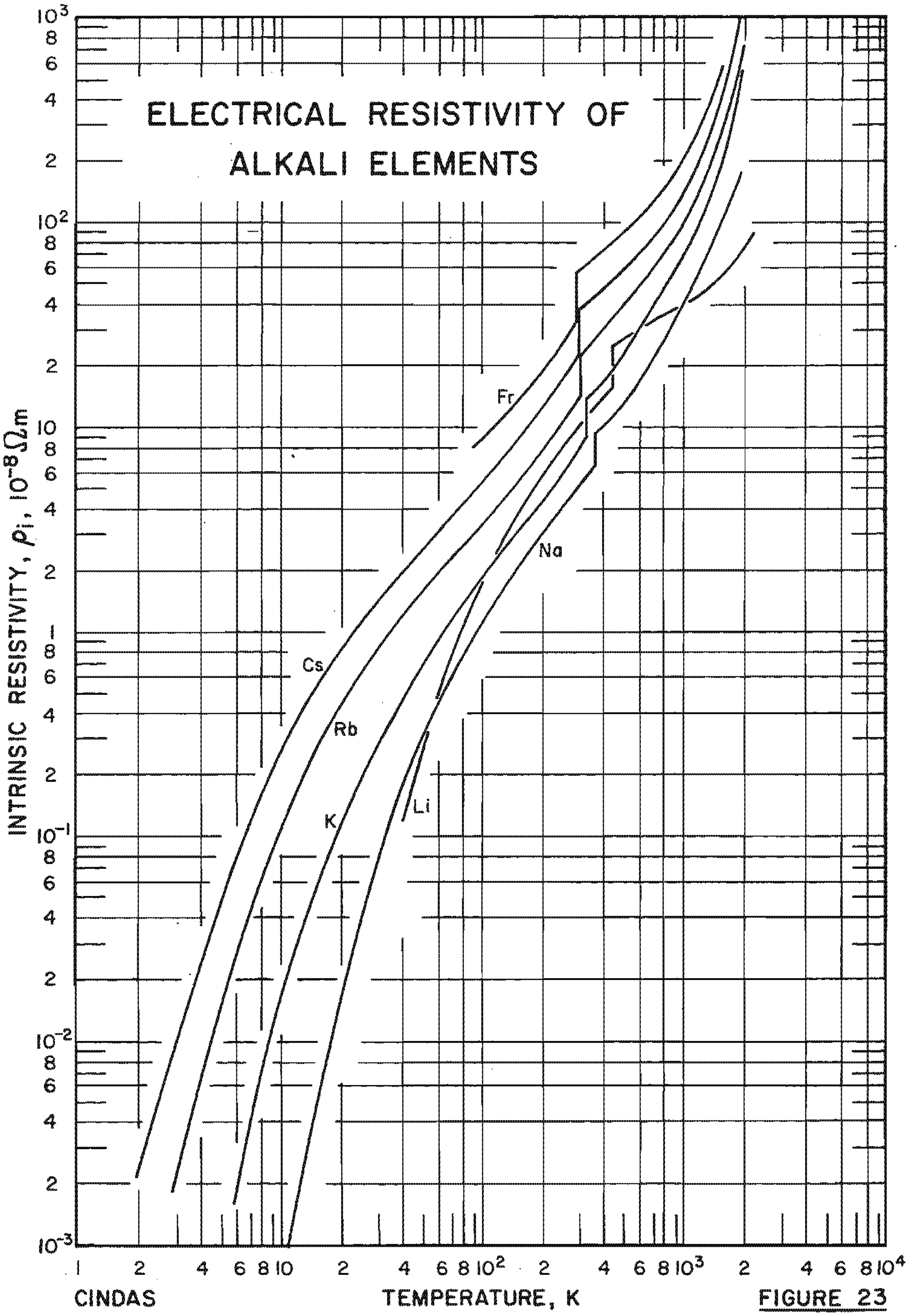
The author is grateful to H. M. James and C. Y. Ho of CINDAS's senior staff for their valuable guidance and suggestions.

TABLE 41. COMPARISON OF ELECTRICAL RESISTIVITY DATA FROM THE LITERATURE WITH THE PRESENT RECOMMENDED VALUES

Element	Temperature K	Total Resistivity, ρ, 10^{-8} Ω m								
		Present work (1976)	CRC (1974)	AIP (1972)	Shpil'rain, et al. (1970)	Grosse (1966)	Kaye & Laby (1966)	Meaden (1965)	Landolt & Börnstein (1960)	L. M. H. (1954)
Li	20	0.0129	-	-	-	-	-	0.035	-	-
	273.15	8.53	8.55	8.51	8.12	-	8.55	8.51	8.55, 8.9	-
	1000	39.69	-	-	39.00	41.83	-	-	-	45.25 (503K)
	2000	73.73	-	-	-	98.34	-	-	-	-
Na	20	0.0156	-	-	-	-	-	0.0175	-	-
	273.15	4.33	4.20	4.29	4.29	-	4.2	4.29	4.28-5.09	-
	1000	40.73	-	-	39.80	41.79	-	-	-	18.44 (623K)
	2000	184.4	-	-	-	207.4	-	-	-	-
K	20	0.117	-	-	-	-	-	0.112	-	-
	273.15	6.49	6.15	6.45	6.23	-	6.1	6.45	6.1-7.03	-
	1000	67.94	-	-	67.91	78.8	-	-	-	31.4 (623K)
	2000	575.3	-	-	-	746	-	-	-	-
Rb	20	0.431	-	-	-	-	-	0.443	-	-
	273.15	11.54	11.28	11.26	11.25	-	11.0	11.26	11.29-12.8	-
	1000	97.26	-	-	102.6	112.8	-	-	-	27.47 (373K)
	2000	629.4	-	-	-	2376	-	-	-	-
Cs	20	0.859	-	-	-	-	-	0.922	-	-
	273.15	18.75	20 (293K)	18.04	18.30	-	18.8	18.04	18.1-19.3	-
	1000	133.4	-	-	-	153.0	-	-	-	37.0 (310K)
	2000	1000	-	-	-	5731	-	-	-	-
Fr	100	8.6*	-	-	-	-	-	-	-	-
	273.15	28.9*	-	-	-	-	-	-	-	-
	1500	497*	-	-	-	-	-	-	-	-

* Intrinsic Resistivity, ρ_i.



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8. Appendix

8.1. Methods of Measuring Electrical Resistivity

A. Steady State Methods
  1. Voltmeter and ammeter direct reading (V) [118, p. 159; 119, pp. 244–5]
  2. dc Potentiometric Method (A) [111, pp. 151–8]
     a. 4-probe potentiometric method
  3. dc Bridge Method (B) [111, pp. 144–51]
     a. Kelvin Double Bridge
     b. Mueller Bridge
     c. Wheatstone Bridge
  4. van der Pauw Method (P), [120]
  5. Galvanometer Amplifier Method (G), [121, pp. 159–62]

B. Non-steady State Methods
  1. Periodic currents involved
     a. Direct connection to sample
        (1) ac Potentiometric Method (C) [111, pp. 161–2]
        (2) ac Bridge Method (D) [111, p. 162]
        (3) Q-Meter Method (Q)
     b. No connection to sample
        (1) Mutual Inductance Method (M) [122]
        (2) Self-inductance Method (S) [123]
        (3) Rotating Field Method (R) [124]
  2. Non-periodic currents involved
     a. Direct connection to sample
        (1) Transient (subsecond) technique (T) [125]
     b. No connection to sample
        (1) Eddy current decay method (E) [126; 111, p. 103]

C. General Comments
  1. Code "I" means Induction Method
     This is a combination of Items B.1.b. and B.2.b. above. Subsumed under I is M, R, S, or E. Used only if author indicates induction method used and does not report which specific one.
  2. The symbol "→" used if method described by the author is not sufficient to assign a specific code presently used. Example:
     a. If the author says an "ac Method" was used, the

following wording would be used under the item "Measuring conditions" in the column Composition, Specifications, and Remarks: "Experimental Method described as an ac Method." Note this "Method" corresponds to the heading B.1. above. In the column for Method Used on the Specification Table the following symbol would appear: →.

8.2. Conversion Tables for Units of Temperature, Pressure, and Magnetic Flux Density

TABLE 42. CONVERSION TABLES BETWEEN THE KELVIN, CELSIUS, FAHRENHEIT, AND RANKINE TEMPERATURE SCALES*

K	°C	°F	°R
0	-273.15	-459.67	0
50	-223.15	-369.67	90
100	-173.15	-279.67	180
150	-123.15	-189.67	270
200	-73.15	-99.67	360
250	-23.15	-9.67	450
273.15	0	32	491.67
293	19.85	67.73	527.4
300	26.85	80.33	540
350	76.85	170.33	630
400	126.85	260.33	720
450	176.85	350.33	810
500	226.85	440.33	900
1000	726.85	1340.33	1800
1500	1226.85	2240.33	2700
2000	1726.85	3140.33	3600
3000	2726.85	4940.33	5400
4000	3726.85	6740.33	7200

TABLE 43. CONVERSION FACTORS ON UNITS OF PRESSURE*

	atm	dyne/cm²	inch of water	cm Hg	PASCAL	lb/in.²	lb/ft²
1 atmosphere =	1	1.013×10^6	406.8	76	1.013×10^5	14.70	2116
1 dyne per cm² =	9.869×10^{-7}	1	4.015×10^{-4}	7.501×10^{-5}	0.1	1.450×10^{-5}	2.089×10^{-3}
1 inch of water at 4° C[a] =	2.458×10^{-3}	2491	1	0.1868	249.1	3.613×10^{-2}	5.202
1 centimeter of mercury at 0° C[a] =	1.316×10^{-2}	1.333×10^4	5.353	1	1333	0.1934	27.85
1 NEWTON per METER²=1 PASCAL=	9.869×10^{-6}	10	4.015×10^{-3}	7.501×10^{-4}	1	1.450×10^{-4}	2.089×10^{-2}
1 pound per in.² =	6.805×10^{-2}	6.895×10^4	27.68	5.171	6.895×10^3	1	144
1 pound per ft² =	4.725×10^{-4}	478.8	0.1922	3.591×10^{-2}	47.88	6.944×10^{-3}	1

[a] Where the accleration of gravity has the standard value 9.80665 meters/sec².

1 bar = 10^5 Pa 1 Kbar = 10^8 Pa

TABLE 44. CONVERSION FACTORS ON UNITS OF MAGNETIC FLUX DENSITY*

	gauss	kiloline/in²	TESLA	milli-gauss	gamma
1 gauss (line per cm²) =	1	6.452×10^{-3}	10^{-4}	1000	10^5
1 kiloline per in.² =	155.0	1	1.550×10^{-2}	1.550×10^5	1.550×10^7
1 WEBER per METER² = 1 TESLA =	10^4	64.52	1	10^7	10^9
1 milligauss =	0.001	6.452×10^{-6}	10^{-7}	1	100
1 gamma =	10^{-5}	6.452×10^{-8}	10^{-9}	0.01	1

* This table is based on the universal constants from "The International System of Units (SI)," NBS Special Publication 330, National Bureau of Standards, U.S. Department of Commerce.