

3.2. Temperature dependence of resistance

The results of the resistance measurements obtained with the low pressure apparatus are converted into resistivity values in the following way. We first derive the ideal resistance, R_i , by assuming Matthiessen's rule

$$R = R_i + R_0.$$

Here R is the total measured resistance at any temperature and R_0 the limiting low temperature value of the resistance. R_i is then assumed to be the resistance due to the lattice vibrations. Strictly this relationship should be applied only to measurements at constant density but the corrections to R_0 due to thermal expansion are small enough to be neglected. On the other hand, departures from Matthiessen's rule itself could be appreciable at low temperatures, perhaps 10% of R_0 at $\frac{1}{4}\theta$.

TABLE 3. ABSOLUTE RESISTIVITIES

metal	temperature (°K)	resistivity ($\mu\Omega$ cm)	observer
rubidium	295	12.6*	present work (average of three specimens)
	295	14.2	G. & B.
	295	12.6	H.
	295	14.6	M., W. & W.
caesium	275.6	18.2†	present work (average of two specimens)
	275.6	19.5	G. & B. (interpolated value)
	275.6	18.3	H. (interpolated value)
	282.3	19.9†	present work (specimen possibly oxidized)
	282.3	20.1	G. & B.
	282.3	18.8	H. (interpolated)

(For an estimate of accuracy, see text.)

G. & B.: Guntz & Broniewski (1909). H.: Hackspill (1910). M., W. & W.: MacDonald, White & Woods (1956).

* In deducing this value we took for the density of rubidium at 20 °C the value 1.53 g/cm³.

† In deducing these values we took for the density of caesium at 20 °C the value 1.87 g/cm³.

From the values of the ideal resistance we now wish to determine the resistivities. The first correction is for the change in dimensions of the specimen with temperature; since the thermal expansion data on rubidium and caesium are rather uncertain, this procedure can introduce a systematic error (up to $\frac{1}{2}\%$) into the values for the resistivity. However, the results can readily be corrected when more accurate volumetric data become available and, for this purpose, we give in table 6 the values for the changes in volume with temperature which we have assumed. The resistance data so corrected give *relative* resistivity values.

To find the *absolute* values we extrapolate our measured values of relative resistivity to the temperature region in which the absolute resistivities are known (above 0 °C). The relative resistivity values are then scaled to have the right magnitude; this process involves an extrapolation over a temperature interval of about 12 degC for rubidium and about 3 degC for caesium.

The resistivity values (effectively at zero pressure) obtained in this way are shown in tables 4 and 5. These values normalized to the ice point resistivity are compared with the results obtained by other observers in tables 7 and 8. This comparison shows that for the most part our values are systematically lower than those of previous workers. Take, for example, the data of Meissner & Voigt (1930); there is a systematic difference between our results and theirs which increases at

TABLE 4. THE IDEAL RESISTIVITY OF RUBIDIUM AT ZERO PRESSURE, ρ_i , AND AT CONSTANT VOLUME, ρ'_i

$T(^{\circ}\text{K})$	ρ_i/T^* ($10^{-8} \Omega \text{ cm/deg}$)	$\rho'_i/T^\dagger$ ($10^{-8} \Omega \text{ cm/deg}$)	$T(^{\circ}\text{K})$	ρ_i/T^* ($10^{-8} \Omega \text{ cm/deg}$)	$\rho'_i/T^\dagger$ ($10^{-8} \Omega \text{ cm/deg}$)
2	0.01 ₂	0.01	120	3.53 ₈	3.21 ₂
4	0.15 ₆	0.16	130	3.57 ₄	3.21 ₇
6	0.40 ₃	0.40	140	3.61 ₀	3.22 ₃
8	0.70 ₃	0.70	150	3.64 ₄	3.22 ₈
10	1.00 ₀	1.00	160	3.67 ₈	3.23 ₅
12	1.29 ₁	1.29	170	3.71 ₃	3.24 ₄
14	1.56 ₉	1.57	180	3.74 ₆	3.25 ₃
16	1.80 ₇	1.81	190	3.78 ₃	3.26 ₇
18	2.00 ₄	2.00	200	3.82 ₄	3.28 ₅
20	2.16 ₅	2.16	210	3.86 ₄	3.30 ₄
30	2.68 ₈	2.66	220	3.90 ₄	3.32 ₇
40	2.97 ₆	2.92	230	3.94 ₅	3.34 ₆
50	3.14 ₇	3.05 ₄	240	3.98 ₆	—
60	3.25 ₂	3.12 ₆	250	4.00 ₄	—
70	3.31 ₉	3.16 ₁	260	4.07 ₂	—
80	3.37 ₅	3.18 ₃	270	4.11 ₅	—
90	3.42 ₂	3.19 ₆	280	4.15 ₈	—
100	3.46 ₁	3.20 ₃	290	4.20 ₈	—
110	3.50 ₀	3.20 ₇	300	4.28 ₄	—

* Random error at all temperatures is ± 0.002 in the units used in the table. The systematic errors are estimated to be as follows: (a) $\pm 2\%$ due to uncertainty in the absolute value of ρ_i ; (b) $\pm \frac{1}{2}\%$ due to uncertainties in the equation of state of the metal; this decreases at higher temperatures; (c) $\pm 2\%$ at low temperatures (around 10°K) due to departures from Matthiessen's rule; this error should be appreciably smaller than the residual resistivity itself at all temperatures; (d) $\pm 1\%$ above *ca.* 140°K due to oxidation of the specimens (see text).

† The random errors are similar to those in ρ_i . The systematic errors in ρ'_i include those in ρ_i together with a high temperature error of about $\pm 1\%$ due to uncertainty in the equation of state.

lower temperatures. Some of this (down to 20.4°K in rubidium) could be due to capillary constraints in the specimens of Meissner & Voigt (cf. Dugdale & Guban 1963), but this alone could not account for the differences by factors of 2 or 3 that are observed at the lowest temperatures in both rubidium and caesium. This sort of difference might be due to cavitation. As we have already emphasized, there is a large volume contraction in cooling these two metals from room temperature to helium temperatures (nearly 10% in caesium) and in capillary specimens this can cause large, unreproducible changes in resistance (see figure 14 of MacDonald & Mendelssohn 1950). This sort of behaviour presumably comes about because if the stress in the specimen (due to the differential contraction between glass and metal)