

decreasing pressure we find that our estimate is consistent with Bridgman's findings. The change in pressure at the minimum is not very big and it is difficult to measure accurately but from the general agreement between our findings and Bridgman's it seems probable that the minimum occurs at the same *density* at all temperatures from about 40 °K up to near the melting point.

TABLE 10. THE PRESSURE DEPENDENCE OF THE ELECTRICAL RESISTANCE OF CAESIUM AT VARIOUS TEMPERATURES

The listed values give  $R_i(p)/R_i(p=0)$ .

pressure (atm)	3.2 °K {Cs 1, 3}	4.2 °K {Cs 1}	4.2 °K {Cs 3}	14.0 °K {Cs 1}	14.0 °K {Cs 3}	16.0 °K {Cs 1}	16.0 °K {Cs 3}
0	1.00	1.00	1.00	1.00 <sub>0</sub>	1.00 <sub>0</sub>	1.00 <sub>0</sub>	1.00 <sub>0</sub>
500	0.88	0.94	0.91	0.93 <sub>2</sub>	0.94 <sub>2</sub>	0.93 <sub>4</sub>	0.94 <sub>2</sub>
1000	0.84	0.88	0.85	0.87 <sub>1</sub>	0.88 <sub>5</sub>	0.87 <sub>9</sub>	0.88 <sub>9</sub>
1500	0.75	0.82	0.79	0.82 <sub>7</sub>	0.83 <sub>6</sub>	0.83 <sub>7</sub>	0.84 <sub>4</sub>
2000	0.72	0.75	0.75	0.79 <sub>2</sub>	0.79 <sub>7</sub>	0.80 <sub>0</sub>	0.80 <sub>6</sub>
	18.0 °K {Cs 1}	18.0 °K {Cs 3}	20.4 °K {Cs 1}	20.6 °K {Cs 3}	29.7 °K {Cs 1}	48.0 °K {Cs 1}	65.5 °K {Cs 1}
0	1.00 <sub>0</sub>	1.00 <sub>0</sub>	1.00 <sub>0</sub>	1.00 <sub>0</sub>	1.000 <sub>0</sub>	1.000 <sub>0</sub>	1.000 <sub>0</sub>
500	0.94 <sub>2</sub>	0.94 <sub>1</sub>	0.94 <sub>0</sub>	0.95 <sub>1</sub>	0.932 <sub>8</sub>	0.944 <sub>5</sub>	0.945 <sub>4</sub>
1000	0.89 <sub>0</sub>	0.89 <sub>0</sub>	0.88 <sub>7</sub>	0.88 <sub>6</sub>	0.879 <sub>8</sub>	0.897 <sub>9</sub>	0.921 <sub>9</sub>
1500	0.84 <sub>3</sub>	0.84 <sub>8</sub>	0.84 <sub>3</sub>	0.84 <sub>6</sub>	0.844 <sub>4</sub>	0.861 <sub>5</sub>	0.863 <sub>1</sub>
2000	0.80 <sub>4</sub>	0.81 <sub>0</sub>	0.80 <sub>9</sub>	0.81 <sub>0</sub>	0.815 <sub>3</sub>	0.832 <sub>4</sub>	0.833 <sub>8</sub>
2500	—	—	—	—	0.789 <sub>8</sub>	0.808 <sub>8</sub>	0.810 <sub>9</sub>
	78.3 °K {Cs 1}	79.3 °K {Cs 3}	89.8 °K {Cs 1}	159.3 °K {Cs 1}	195.2 °K {Cs 1}	259.4 °K {Cs 1}	273.2 °K {*}
0	1.000 <sub>0</sub>	1.000 <sub>0</sub>	1.000 <sub>0</sub>	1.00 <sub>0</sub>	1.00 <sub>0</sub>	1.00 <sub>0</sub>	1.00 <sub>0</sub>
500	0.944 <sub>3</sub>	0.944 <sub>1</sub>	0.943 <sub>6</sub>	0.94 <sub>3</sub>	0.93 <sub>4</sub>	0.91 <sub>7</sub>	0.92 <sub>7</sub>
1000	0.897 <sub>7</sub>	0.897 <sub>8</sub>	0.898 <sub>5</sub>	0.89 <sub>4</sub>	0.88 <sub>2</sub>	0.85 <sub>2</sub>	0.88 <sub>2</sub>
1500	0.861 <sub>7</sub>	0.860 <sub>9</sub>	0.862 <sub>4</sub>	0.85 <sub>8</sub>	0.84 <sub>4</sub>	0.79 <sub>9</sub>	0.81 <sub>5</sub>
2000	0.832 <sub>7</sub>	0.831 <sub>8</sub>	0.833 <sub>4</sub>	0.82 <sub>7</sub>	0.81 <sub>5</sub>	0.76 <sub>4</sub>	0.77 <sub>1</sub>
2500	0.808 <sub>3</sub>	0.809 <sub>5</sub>	0.810 <sub>5</sub>	0.80 <sub>5</sub>	0.79 <sub>5</sub>	0.73 <sub>6</sub>	0.75 <sub>1</sub>

\* P. W. Bridgman.

#### 4. DISCUSSION

##### 4.1. Theoretical calculations of $\rho_i$

There are three main elements to be considered in the calculation of  $\rho_i$ : (1) the perturbing potential; (2) the dispersion relations of the lattice waves (more briefly the phonon spectrum); and (3) the Fermi surface. Let us consider each of these briefly.

##### 4.1.1. The perturbing potential

Following the original work of Bloch (1928, 1930), the most important calculation from first principles of the ideal resistivity of the monovalent metals was that due to Bardeen (1937). In this the perturbing potential which scatters the conduction electrons was calculated by a self-consistent method. This potential is

considered as the sum of two terms, (1) the change in the potential due to the displacement of the ions, and (2) the change in the potential of the valence electrons which move so as to screen the ionic potential produced by (1). It turns out that, at least to the extent that electrons can be treated as effectively free, the effect of the screening of the conduction electrons can be written as a factor which simply

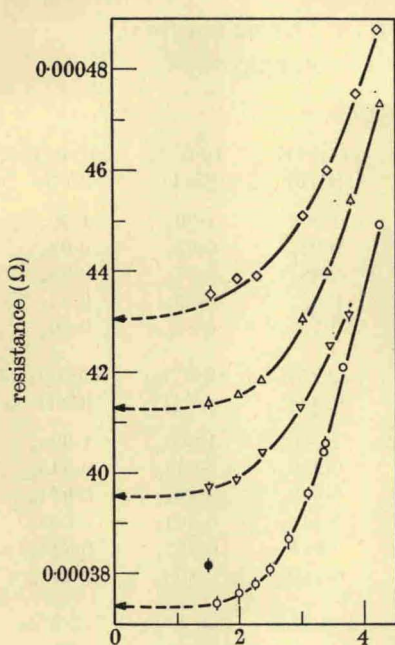


FIGURE 4

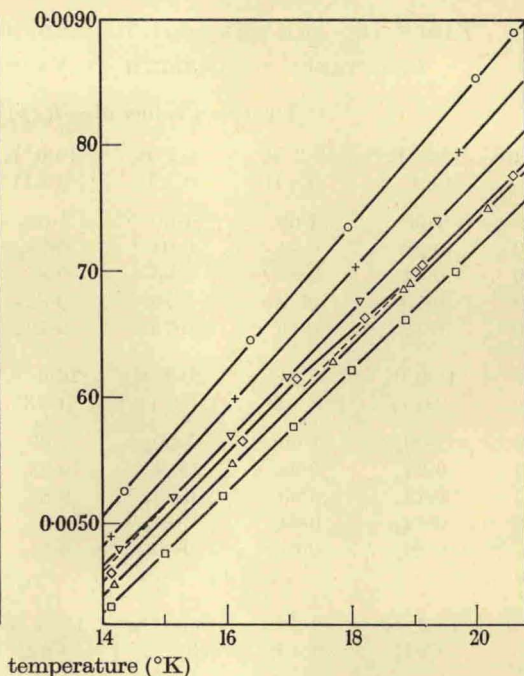


FIGURE 5

FIGURE 4. Resistance of rubidium specimen 4 at different pressures as a function of temperature below 4°K:  $\circ$ ,  $p = 0$  (initially);  $\bullet$ ,  $p = 0$  (finally);  $\nabla$ ,  $p = 640$  atm;  $\triangle$ ,  $p = 1360$  atm;  $\diamond$ ,  $p = 2080$  atm. The pressures were applied by means of solid helium.

FIGURE 5. Resistance of caesium specimen 1 at different pressures as a function of temperature in the hydrogen range of temperatures. The approximate pressures are as follows:  $\square$ , 2140 atm;  $\triangle$ , 1670 atm;  $\diamond$ , 1610 to 1240 atm;  $\nabla$ , 1120 to 990 atm;  $\times$ , 650 atm;  $\circ$ , 150 atm. The top two curves correspond to the fluid phase of helium and the bottom two to the solid phase only. In the middle two curves a change of phase takes place and this causes the slope of the curves to change.

multiplies the matrix elements associated with the unscreened ionic potential. In his calculations Bardeen used a Debye approximation for the phonon spectrum since at the time no other information was readily available; in addition, he considered only spherical Fermi surfaces. Nevertheless, his approach has remained the basis of nearly all the subsequent developments.

#### 4.1.2. *The phonon spectrum*

The recurring theme of much of the work since Bardeen has been the overriding importance of umklapp processes in the alkali metals (Ziman 1954; Bailyn & Brooks 1956; Bailyn 1960). An umklapp process tends to be more important than