14. J. A. Rayne, *Phys. Rev.* **118,** 1545 (1960).
15. C. W. Garland and J. Silverman, *Phys. Rev.* **119,** 1218 (1960); and **127,** 2287 (1962).
16. B. S. Chandrasekhar and J. A. Rayne, *Phys. Rev.* **124,** 1011 (1961).
17. B. S. Chandrasekhar and J. A. Rayne, *Phys. Rev.* **120,** 1658 (1960).
18. M. Blackman, *Phil. Mag.* **42**[7], 1441 (1951).
19. G. Masing, "Lehrbuch der Allgemeinen Metallkunde." Springer, Berlin, 1950.
20. E. J. Post, *Can. J. Phys.* **31,** 112 (1953).
21. K. A. Gschneidner, Jr., "Rare Earth Alloys," p. 38. Van Nostrand, Princeton, New Jersey, 1961.
22. F. F. Voronov, L. F. Vershchagin, and V. A. Goncharova, *Dokl. Akad. Nauk SSSR* **135,** 1104 (1960); *Soviet Phys. "Doklady" (English Transl.)* **5,** 1280 (1961).
23. H. L. Laquer, *in* "The Metal Plutonium" (A. S. Coffinberry and W. N. Miner, eds.), p. 157. Univ. of Chicago Press, Chicago, Illinois, 1961.

comparisons the θ_0^S value for each corresponding θ_0^E is listed in the second column of Table XVI. These θ_0^S values were taken from Table XV. Examination of θ_0^S and θ_0^E shows that $\theta_0^S = \theta_0^E$ within the experimental error given or within $\pm 5\%$, whichever is greater, for all of the elements except beryllium, vanadium, nickel, and white tin. The reason for the discrepancies for vanadium and nickel[105a] is not understood, but the discrepancies for beryllium and white tin may be due to an anisotropic contribution to the specific heat[106] (which has a T^5 dependence) which had not been taken into account when the low-temperature data were evaluated. Because of the sparsity of data, no plot of θ_0^E values is given here; but such a plot would be expected to be similar to Fig. 21 since $\theta_0^E \simeq \theta_0^S$.

There are many more data available for θ_{298}^E than for θ_0^E. The corresponding θ_{298}^S values are not included in Table XVI, but a comparison of θ_{298}^E to θ_{298}^S is found in Table XVIII along with several other comparisons of Debye temperatures. Close examination of the data for $\theta_{298}^E/\theta_{298}^S$ shows that only about 42% of the experimental values of θ_{298}^E lie within 10% of θ_{298}^S and 70% lie within 20% of θ_{298}^S. This suggests that $\theta_{298}^S = \theta_{298}^E$ is a rather poor approximation, as compared with $\theta_0^S = \theta_0^E$. Further analysis reveals that 27 of the 60 θ_{298}^E values are smaller than the corresponding θ_{298}^S values. This indicates that there is no systematic discrepancy between θ_{298}^S and θ_{298}^E; e.g., θ_{298}^E is generally not smaller than θ_{298}^S.

The Debye temperatures obtained from elastic constants, θ_{298}^E, for the rare earths are shown in Fig. 22b. The agreement of θ_{298}^E with θ_{298}^S is reasonable for the rare earths lanthanum through samarium, and also for terbium. The agreement becomes poorer as the atomic number increases.

Diamond, Aluminum, Iron, Copper, Silver, and Tungsten. The Debye temperatures, θ_{298}^E, given by Post[107] for diamond, aluminum, iron, copper, silver, and tungsten are not included in the average values listed in Table XVI because Post's values are significantly smaller than the other values given in the literature.

Zinc. The Debye temperature given by Masing[108] for zinc (303°K) is significantly larger than Post's value (231°K),[107] but since Post's value is in much better agreement with θ_{298}^S than Masing's value, the lower value was listed in Table XVI.

19. Debye Temperature from Electrical Resistivity

The Debye temperature may be calculated from the temperature dependence of the electrical resistivity.[109] The values obtained in this manner are given in Table XVII under the heading θ_m^R. The subscript m signifies that θ^R is an average value which fits the experimental data over a wide range of temperatures. In general these ranges are as large as ~20°K to 500° or 600°K, and thus the values should correspond closely to those obtained by other techniques at 298°K, e.g., θ_{298}^S and θ_{298}^E.

In general the θ_m^R values obtained from different sources agree with one another within about ±25°K, which indicates that θ_m^R values are probably not more accurate than that. Because of the lack of sufficient data, no plots were made for these Debye temperatures. The θ_m^R values range from a minimum of 37°K for mercury to a maximum of 495°K for chromium. A comparison of θ_m^R with θ_{298}^S is given in Table XVIII. Close examination reveals that only about one-third (34%) of the θ_m^R values lie within ±10% of the corresponding θ_{298}^S values and that about two-thirds (68%) lie within ±25% of θ_{298}^S. Hence the agreement between θ_m^R and θ_{298}^S is poorer than it is between θ_{298}^E and θ_{298}^S (Section 18). Furthermore, there is a tendency for θ_m^R to be larger than θ_{298}^S, i.e., 71% of the θ_m^R values are larger than the corresponding θ_{298}^S values. Thus we find that $\theta_m^R > \theta_{298}^S$ is probably a better approximation than $\theta_m^R = \theta_{298}^S$.

20. Debye Temperature from Thermal Expansion

The derivation of the Debye temperature from thermal expansion measurements is discussed by Blackman[93] and therefore no details will be given here. The values for the Debye temperatures as determined from thermal expansion (dilatometric) data, θ_m^D, are listed in Table XVII. The subscript m has the same significance as mentioned above for θ_m^R

[105a] *Note added in proof*: J. A. Morrison and L. S. Salter (*Phys. Letters* **9,** 110 (1964)) have shown that if higher order terms (such as T^5, T^7, etc.) are included in Eq. (13.1), then the resulting θ_0^S value for vanadium is in agreement with the θ_0^E value.
[106] C. W. Garland and J. Silverman, *J. Chem. Phys.* **34,** 781 (1961).
[107] E. J. Post, *Can. J. Phys.* **31,** 112 (1953).
[108] G. Masing, "Lehrbuch der Allgemeinen Metallkunde." Springer, Berlin, 1950.
[109] J. M. Ziman, "Electrons and Phonons." Oxford Univ. Press, London and New York, 1960.