this reason no further discussion is warranted here. The symbol $\theta_{298}{}^{I}$ is used herein to represent the Debye temperature determined from X-ray or neutron diffraction intensity data. The subscript refers to the temperature at which the experimental data were obtained. It should be noted that the experimentally measured θ^{Ie} value is not directly comparable with θ^{S}, because these two quantities are defined differently.[96,111] Zener and Bilinsky[111] showed that the ratio of θ^{Ie}/θ^{S} can be expressed as a function of Poisson's ratio; thus, from the known Poisson's ratio (Table III) of the material whose θ^{Ie} has been experimentally determined, one can calculate the θ^{I} value which should be compared with θ^{S}. All of the values given in Tables XVII and XVIII are θ^{I} values; that is, the experimental values θ^{Ie} have been converted to θ^{I} by the method of Zener and Bilinsky.

The $\theta_{298}{}^{I}$ values for 17 elements are listed in Table XVII and are compared with $\theta_{298}{}^{S}$ in Table XVIII. It is seen that the $\theta_{298}{}^{I}$ values range from a minimum of 67°K for lead to a maximum of 1730°K for diamond. Examination of the ratio of $\theta_{298}{}^{I}/\theta_{298}{}^{S}$ in Table XVIII indicates that only 47% of the $\theta_{298}{}^{I}$ values lie within ±10% of the corresponding $\theta_{298}{}^{S}$, and that about 70% lie within ±25%. Thus the agreement between $\theta_{298}{}^{I}$ and $\theta_{298}{}^{S}$ is poor. Furthermore, $\theta_{298}{}^{I}$ is less than $\theta_{298}{}^{S}$ for about 82% of the elements. Since, as noted earlier, $\theta_{298}{}^{E} \simeq \theta_{298}{}^{S}$ (i.e., approximately equal numbers of values of $\theta_{298}{}^{E}$ are larger and smaller than $\theta_{298}{}^{S}$) and since $\theta_{298}{}^{I} < \theta_{298}{}^{S}$, it is concluded that $\theta_{298}{}^{I}$ is generally less than $\theta_{298}{}^{E}$. This is in agreement with the observations of Blackman[93] and Herbstein.[96]

IX. Some Interrelationships and Derived Properties

22. Ratio of Young's Modulus to the Shear Modulus

The ratio of Young's modulus to the shear modulus, Y/μ, is essentially a constant for all materials. This is quite easily seen from Eq. (II.1) or (5.1), which show that Y/μ is related to Poisson's ratio. Since Poisson's ratio is practically a constant, equal to 0.301 (see Section 5), we find $Y/\mu = 2.604$ from Eq. (5.1). Furthermore, since Poisson's ratio can only have values between 0 and 0.5, the minimum value for Y/μ is 2.0 and the maximum is 3.0. Poisson's ratio is usually measured directly and not calculated from the two moduli; thus the interrelationships, as given by Eq. (II.1) or (5.1), among the three quantities serve as a check on the consistency of the three measured values.

Table XIX. Ratio of Young's Modulus to the Shear Modulus

Element	Y/μ	Element	Y/μ	Element	Y/μ
3 Li	2.72	38 Sr	(2.71)[a]	65 Tb	2.52
4 Be	2.08	39 Y	2.51	66 Dy	2.49
5 B	2.17	40 Zr	2.70	67 Ho	2.52
6 C(g)	2.56	41 Nb	2.80	68 Er	2.48
6 C(d)	2.50	42 Mo	2.83	69 Tm	(2.48)[a]
11 Na	2.61	43 Tc	(2.59)[a]	70 Yb	2.56
12 Mg	2.55	44 Ru	2.58	71 Lu	(2.50)[a]
13 Al	2.67	45 Rh	2.53	72 Hf	2.59
14 Si	2.59	46 Pd	2.42	73 Ta	2.64
15 P(w, r, b)	(2.67)[a]	47 Ag	2.82	74 W	2.60
16 S(r)	2.69	48 Cd	2.58	75 Re	2.58
19 K	2.78	49 In	2.82	76 Os	(2.57)[a]
20 Ca	2.67	50 Sn(g)	2.84	77 Ir	2.51
21 Sc	(2.54)[a]	50 Sn(w)	2.64	78 Pt	2.80
22 Ti	2.69	51 Sb	2.74	79 Au	2.83
23 V	2.83	52 Te	2.68	80 Hg	2.74
24 Cr	2.08	55 Cs	(2.71)[a]	81 Tl	2.89
25 Mn	2.59	56 Ba	2.58	82 Pb	2.91
26 Fe	2.58	57 La	2.55	83 Bi	2.66
27 Co	2.70	58 Ce(α)	2.31	84 Po	(2.68)[a]
28 Ni	2.58	58 Ce(γ)	2.51	87 Fr	(2.71)[a]
29 Cu	2.74	59 Pr	2.41	88 Ra	(2.61)[a]
30 Zn	2.48	60 Nd	2.62	89 Ac	(2.54)[a]
31 Ga	2.47	61 Pm	(2.53)[a]	90 Th	2.68
32 Ge	2.52	62 Sm	2.70	91 Pa	(2.56)[a]
33 As	(2.67)[a]	63 Eu	(2.58)[a]	92 U	2.53
34 Se	(2.68)[a]	64 Gd	2.52	93 Np	(2.51)[a]
37 Rb	(2.71)[a]			94 Pu	2.21

[a] Estimated value; see text for further discussion.

The Y/μ ratios, which are listed in Table XIX, were calculated from the values of Y and μ given in Tables I and II, respectively. The mean value for all of the experimental data is 2.60 ±0.17, which is identical to that calculated from the mean value of Poisson's ratio. The error, ±0.17, corresponds to a percentage error of ±6.5, which is misleadingly small. If Poisson's ratio and the corresponding error were to be calculated from the above numbers, it would be found that $\sigma = 0.300 \pm 0.080$. This error is equivalent to a percentage error of ±26.7. The ratio Y/μ varies from a minimum of 2.08 for beryllium and chromium to a maximum of 2.91 for lead, and lies within the minimum and maximum theoretical limits, 2.0 and 3.0.

---

[111] C. Zener and S. Bilinsky, *Phys. Rev.* **50**, 101 (1936).