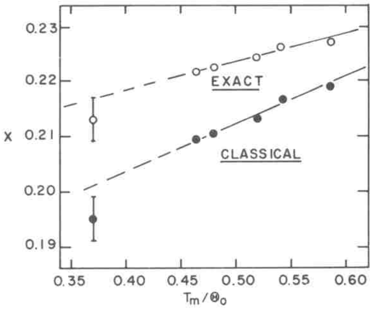

Fig. 9. A test of the Lindeman melting relation, with the reduced atomic vibration amplitude x plotted as a function of reduced melting temperature. See the text for details. "Classical" refers to the use of Eq. (9); "Exact" refers to the use of Eq. (10).

to emphasize the range of the reduced melting temperature for our data. A calculation for the triple point also is included which uses the extrapolation to the triple point volume which is described in the previous paragraphs. The value of x appears to be relatively constant over a wide range of temperature (24.6–53.5 K) and volume (14–12.4 cm^3/mole), and close to the values for other solids,[32] especially when the modified expression is used. The deviations are systematic, however, so extrapolations to higher temperatures are of doubtful validity.

5. RESULTS FOR ^{20}Ne AND ^{22}Ne

We initially had planned to repeat the V_0 (approximately 13.35 cm^3/mole) measurements with samples of pure ^{20}Ne and ^{22}Ne, and had purchased gas from the Mound Laboratories for this purpose. Measurements on ^{20}Ne, however, showed anomalies below 4 K and excessive warming rates, so extensive data were taken on this sample to outline the problems which were involved. The quantity of ^{20}Ne in the sample (0.2170 ± 0.0002 moles) gave a molar volume in the bomb at $T = 0$ of 13.38 ± 0.01 cm^3, which is to be compared with the $T = 0$, $P = 0$ molar volume of 13.397 given by Batchelder *et al.*[16] This suggests a minimum neon pressure of 20 bar. The low-temperature anomalies made it impossible to extrapolate the data directly to $T = 0$ to obtain a value for Θ_0 as was done for natural neon.

The ^{20}Ne was removed from the system and was replaced by ^{22}Ne. The quantity of this gas was inadequate to fill the bomb completely at $T = 0$, and because of experimental problems the number of moles (0.216 ± 0.001) in the sample had to be estimated from the observed melting temperature and the natural neon V_m-vs.-T_m relation. This introduces an additional uncertainty in the experiment which should not be greater than that quoted above. Low-temperature anomalies also were observed for this sample, which unfortunately were somewhat greater in magnitude than for ^{20}Ne. The experiment was terminated after only a few heat-capacity measurements were made when it was realized that the anomalous effects could be understood in terms of a hydrogen impurity of approximately 0.2% (well within the supplier's specifications). Normal hydrogen exhibits a very large low-temperature heat-capacity anomaly below 4 K, and considerable heat is generated due to the ortho–parahydrogen conversion.[34,35] Indeed, the anomaly and the heating both are consistent to within a factor of two or so with the postulate of a hydrogen impurity of this magnitude. Attempts to remove the hydrogen from the neon failed for various reasons, and the above experiments were not repeated.

One of the conclusions which follows from the experiments on natural neon is that the volume-dependent heat-capacity data scales very well with the reduced temperature T/Θ_0, especially for temperatures less than $0.08\Theta_0$ (Fig. 6). If this same type of scaling applies to the measurements on the isotopes, the natural neon data can be used to determine values of Θ_0 for the isotopes from the high-temperature data for which the impurity effects are small. The common relationship between Θ/Θ_0 and $T(\Theta_0$ for the natural neon is plotted as the solid curve in Fig. 10, where the $V = 13.39$ cm^3/mole

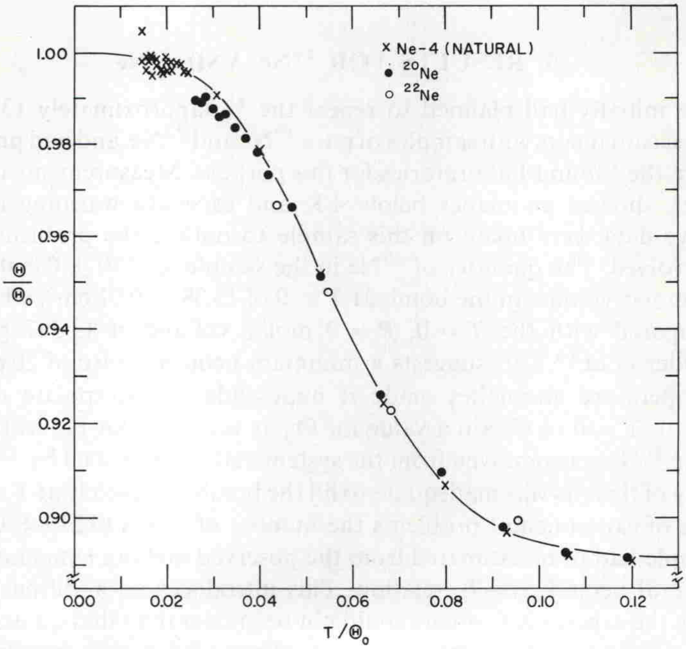

Fig. 10. The reduced equivalent Debye Θ plot (as derived from Fig. 6) which is used to determine Θ_0 for the neon isotopes. The symbols indicate the actual experimental data. See the text for details.