TWEEN 4·2 AND 12°K

K)	p (atm)
0	423
5	469
0	550
7	590
8	652
0	695
7	779

ROPIES AND VOLUMES

NE

e volumes are given to a higher
order to give ΔV correctly.)

solid	V_{fluid}
7·25	18·25
5·53	16·42
4·34	15·10
3·45	14·13
2·82	13·45
2·30	12·88
1·87	12·42
1·42	11·95
1·10	11·61
0·75	11·24
0·40	10·88
0·10	10·57
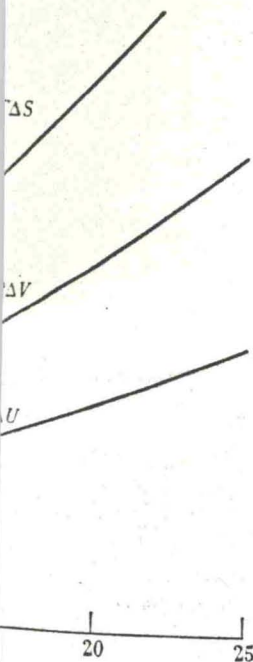
to determine the slope of the melting curve, the consistency of the ΔS and ΔV measurements was demonstrated.

As the experimental data have only been shown in the form of diagrams it may be useful to give smoothed numerical values for entropy and volume at a few temperatures along the melting line.

(iii) *Energy relations*

To concentrate attention more specifically on the change in properties on melting, the latent heat of melting $T\Delta S$, the change in internal energy ΔU, and the product $p\Delta V$ have been plotted as functions of temperature in figure 5. The values of ΔV used here were calculated from the Clausius-Clapeyron equation, since they are more accurate than the values derived directly from the volume measurements. Again, values below 4°K, taken from Swenson (1950), have been included for completeness. At the highest temperature to which measurements extended the latent heat of melting was almost 50 cal/mole, more than three times the latent heat of vaporization at absolute zero.

(b) *The thermodynamic properties of solid helium*

We shall now discuss the data on the molar heat at constant volume of solid helium which have been obtained as a function both of molar volume (from 17 to 10·6 ml.) and of temperature (from 5 to 26°K). Altogether measurements were made at twelve different densities, the whole temperature range was not covered at every density; as will be explained, certain temperature regions were examined more closely than others.

These data, together with one p, V, T relationship which covers the complete range of variation of temperature and volume, are then sufficient to determine all the thermodynamic properties of the solid in the region of the measurements. Such a p, V, T relationship was obtained from the melting curve (equation (2) above) together with the volume of the solid on melting.

(i) *The specific heats, entropy and internal energy*

In figure 6, the results of specific-heat measurements at four densities are shown, while in figure 7 the variation of Debye θ with temperature is shown for the same four densities. Although the molar heats follow only approximate Debye curves, all the results for different densities may be represented in a reduced form simply by a change of scale of the temperature axis. That is, the molar heats may be represented by

$$C_v = f(T/\phi),$$

where f is always the same function and ϕ is a parameter depending only on the volume. This is illustrated in figure 8 in which are shown the curves of figure 6 plotted as a function of T/ϕ. In this figure there have been included two Debye curves for comparison.

To avoid confusion the points in the figure are representative of only four densities, but by choosing suitable values of ϕ (see table 3) it is possible to reduce *all* our present results on to this curve. Hence in our range of measurement C_v

$T\Delta S$

$p\Delta V$

ΔU

20   25

on melting.