TABLE IIID-1 CHARACTERISTIC TEMPERATURES OF SOLIDS

Substance	Symbol	Θ_D(K)	Θ_F(K)
	Metals		
Aluminum	Al	396	$13.5 \cdot 10^4$
Copper	Cu	315	$8.16 \cdot 10^4$
Chrome	Cr	402	$12.7 \cdot 10^4$
Gold	Au	165	$6.41 \cdot 10^4$
Indium	In	109	$9.95 \cdot 10^4$
Iron	Fe	455	$13.0 \cdot 10^4$
Lead	Pb	86	$6.91 \cdot 10^4$
Mercury	Hg	90	$5.11 \cdot 10^4$
Nickel	Ni	456	$13.6 \cdot 10^4$
Potassium	K	100	$2.33 \cdot 10^4$
Platinum	Pt	220	$11.0 \cdot 10^4$
Silver	Ag	215	$6.35 \cdot 10^4$
	Non Metals		
Diamond	C	1860	
Germanium	Ge	366	
Silicon	Si	658	
Sodium Chloride	NaCl	281	
Tellurium	Te	89	

TABLE IIID-2 THE DEBYE FUNCTION

x_D	$D(x_D)$
0.0	1.0000
0.1	0.9630
0.2	0.9270
0.5	0.8250
1	0.6744
2	0.4411
3	0.2836
4	0.1817
5	0.1176
10	0.0193
20	0.0024
∞	0

$$D(x_D) \equiv \frac{3}{x_D^3}\int_0^{x_D} \frac{x^3 dx}{(e^x - 1)}$$

$$\lim_{x_D \to \infty} x_D^3 D(x_D) = 3\int_0^{\infty} \frac{x^3 dx}{(e^x - 1)} = 3 \cdot \left(\frac{\pi^4}{15}\right)$$

Ans. A1. The fact that the acoustical modes are fully excited, $T \gg \theta_{D,\ell}$, implies that $\bar{c}_{v,\ell} = 5\bar{R}$. The characteristic temperatures of the 4 optical modes are: 960.1 K (2), 2932 K, 3380 K. At −78°C = 195 K, their corresponding dimensionless temperatures are: $x_{v,(1,2)}$ = 960.1 K/195 K = 4.92, (2), $x_{v,3}$ = 9.91, $x_{v,4}$ = 17.3. Thus the optical mode specific heats are

$$\frac{\bar{c}_{v,v(1,2)}}{\bar{R}} = (x_{v(1,2)})^2 \frac{e^{x_{v,1,2}}}{e^{x_{v(1,2)}} - 1^{\,2}} = (4.92)^2 \frac{e^{4.92}}{(e^{4.92} - 1)^2} = 0.179$$

Similarly, $\bar{c}_{v,3}/\bar{R} = 4.88 \cdot 10^{-3}$, $\bar{c}_{v,4}/\bar{R} = 9.18 \cdot 10^{-6}$.

Thus the total specific heat is

$$\bar{c}_v = \bar{c}_{v,\ell} + \sum_{p=1}^{4} \bar{c}_{v,p} = (5 + 2 \cdot 0.179 + 4.88 \cdot 10^{-3} + 9.18 \cdot 10^{-6})\bar{R} = 5.36\ \bar{R} = 44.6\ \text{J/(g mol K)}$$