

Solutions

2.1 C $d = \lambda / (2 \sin \theta) = 0.154 / (2 \times 0.342) \approx 0.225 \text{ nm}$.

Compare the rejected options: 0.075 nm; 0.113 nm; 0.308 nm; 0.450 nm. Use the stated model and conditions.

2.2 B Only a T/T_F fraction of conduction electrons are excited, giving a linear- T electronic term; βT^3 is the Debye lattice term.

Compare the rejected options: lattice phonons; magnetic ordering; surface atoms; thermal expansion. Use the stated model and conditions.

2.3 0.2. $\sin \theta = \lambda / (2d) = 0.10 / 0.50 = 0.2$.

2.4 False. The sine doubles, not the angle; and no order exists once $\lambda / (2d)$ exceeds 1.

3.1 $\beta = (5.2 - 2.8) / (16 - 4) = 0.20 \text{ mJ} / (\text{mol K}^4)$. $\gamma = 2.8 - 0.20(4) = 2.0 \text{ mJ} / (\text{mol K}^2)$. Equality requires $\gamma T = \beta T^3$ for T positive, hence $T = \sqrt{\gamma / \beta} = \sqrt{10} \text{ K} = 3.16 \text{ K}$. Award transformed axes, slope, intercept, condition and temperature/units. Two constructed points cannot independently establish the model or experimental uncertainty.