Week 6 - Free Electron Model
Comprehension Check
Total points = 25 (scaled by a factor of 1/10 in the system)

Question 1 (8 points)
The energy of an electron in a potential well of length L is given by

$$\epsilon = \frac{\hbar^2}{2m}\left(\frac{n\pi}{L}\right)^2$$

(i) What is the ground state energy of the system (ε_o)?

$n = 1 \Rightarrow \epsilon_0 = \frac{\hbar^2}{2m}\frac{\pi^2}{L^2}$

(ii) If 7 electrons are to be placed in the potential well, what would be the energy of the top most filled level (ε_F) in terms of the ground state energy (ε_o)?

7 electrons $\Rightarrow$ $n = 4$

$\epsilon = 16\,\epsilon_0$

Question 2 (6 points)
What dependence does the electronic heat capacity exhibit at low temperatures? How does that compare to the phonon heat capacity at low temperatures?

$C_e \sim \gamma T$

$C_{ph} \sim AT^3$

Question 3 (8 points)
Explain why and how measurements of electrical conductivity can be used to evaluate purity of specimen. Be brief.

σ is limited by collision time τ at low T τ is dominated by scattering of electrons with defects/impurities, $\therefore$ σ at low T is measure of specimen purity

Question 4 (3 points)
What sort of important interactions are not accounted for in the free electron model?

- e-ph
- e-e
- e with lattice potential