PHYS1013 MIDTERM 22/23

Q1) • $\frac{1}{2}Mv^2 = \frac{3}{2}kT$ [ ]

$$v = \sqrt{\frac{3 \times 1.38 \times 10^{-23} \times 10^6}{1.66 \times 10^{-27}}}$$

$$= 1.6 \times 10^5 \text{ ms}^{-1} \quad [1]$$

• $\lambda = \frac{1}{\sqrt{2}\pi d^2 n}$ [ ]

$$= \frac{1}{\sqrt{2}\pi (10^{-15})^2 \, 2000/1.66\times10^{-27}} \quad [ ]$$

Σ equal number of e^- & p

$$= 0.2 \text{ m} \quad [ ]$$

In random walk travels net $\sqrt{N}\lambda = 7 \times 10^8 \text{ m}$ [1]

$$N = 1.2 \times 10^{19} \quad [1]$$

Total distance travelled is $N\lambda$ [ ]

Total time = $\frac{N\lambda}{v}$ [1]

$$= \frac{1.2 \times 10^{19} \times 0.2}{1.6 \times 10^5}$$

$$= 1.5 \times 10^{13} \text{ s} \quad [ ]$$

$$= 655000 \text{ year.}$$

Q2] In adiabatic process $PV^{\gamma} = \text{const}$ [1]

$$\gamma = \frac{C_p}{C_v} = \frac{C_v + R}{C_v} = 5/3 \quad [2]$$

$$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$$

$$V_2 = \left(\frac{P_1}{P_2}\right)^{1/\gamma} V_1 \quad [1]$$

$$= 0.5^{3/5}$$

$$= 0.66\ m^3 \quad [1]$$

Q3]

$$\delta U = C_v \delta T \quad [1]$$

$$= \beta T^3 dT \quad [1]$$

$$\Delta U = \beta \int_{T_i}^{T_f} T^3 dT \quad [1]$$

$$= \frac{\beta}{4} (T_f^4 - T_i^4) \quad [1]$$

$$= \frac{7.2 \times 10^{-6}}{4} (100^4 - 1)$$

$$= 180\,\text{J} \quad [1]$$