

① Volume of container: $V = \frac{nRT}{P} = \frac{(1.00 \text{ mole}) \left(8.31 \frac{\text{J}}{\text{mole K}} \right) (308 \text{ K})}{(1.22 \text{ atm}) (1.01 \times 10^5 \text{ Pa/atm})}$
 $T = 273 + 35 = 308 \text{ K}$
 $= 2.08 \times 10^{-2} \text{ m}^3$

Volume of one atom: $\frac{4}{3} \pi R^3 = \frac{4}{3} \pi (0.710 \times 10^{-10} \text{ m})^3 = 1.50 \times 10^{-30} \text{ m}^3$

Number of atoms = 6.02×10^{23}

Volume occupied by atoms = $(6.02 \times 10^{23}) (1.50 \times 10^{-30} \text{ m}^3/\text{atom})$
 $= 9.03 \times 10^{-7} \text{ m}^3$

Fraction = $\frac{9.03 \times 10^{-7} \text{ m}^3}{2.08 \times 10^{-2} \text{ m}^3} = 4.35 \times 10^{-5}$

② (a) $N = \frac{PV}{kT} = \frac{(108 \times 10^3 \text{ Pa}) (2.47 \text{ m}^3)}{(1.38 \times 10^{-23} \text{ J/K}) (273 + 12 \text{ K})} = 6.78 \times 10^{25}$

(b) $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow V_2 = V_1 \frac{T_2 P_1}{T_1 P_2}$

$V_2 = (2.47 \text{ m}^3) \left(\frac{273 + 31 \text{ K}}{273 + 12 \text{ K}} \right) \left(\frac{108 \text{ kPa}}{316 \text{ kPa}} \right) = 0.901 \text{ m}^3$

③ $N_1 = \frac{P_1 V_1}{kT_1} = \frac{(1.44 \text{ atm}) (1.01 \times 10^5 \text{ Pa/atm}) (1.22 \text{ L}) (10^{-3} \text{ m}^3/\text{L})}{(1.38 \times 10^{-23} \text{ J/K}) (273 + 16 \text{ K})}$
 $= 4.45 \times 10^{22}$

$N_2 = \frac{P_2 V_2}{kT_2} = \frac{(1.44 \text{ atm}) (1.01 \times 10^5 \text{ Pa/atm}) (3.18 \text{ L}) (10^{-3} \text{ m}^3/\text{L})}{(1.38 \times 10^{-23} \text{ J/K}) (273 + 16 \text{ K})}$
 $= 1.160 \times 10^{23}$

$$E_i = E_f$$

$$N_1 C T_{1i} + N_2 C T_{2i} = (N_1 + N_2) C T_f$$

$$\Rightarrow T_f = \frac{N_1 T_{1i} + N_2 T_{2i}}{N_1 + N_2} = \frac{(0.445)(289\text{K}) + (1.16)(381\text{K})}{1.605}$$

$$T_f = 355.5\text{K}$$

$$P_f V_f = (N_1 + N_2) k T_f$$

$$\Rightarrow P_f = \frac{(N_1 + N_2) k T_f}{(V_1 + V_2)}$$

$$= \frac{1.605 \times 10^{23} (1.38 \times 10^{-23} \text{ J/K}) 355.5\text{K}}{4.4 \text{ L } (10^{-3} \text{ m}^3/\text{L})}$$

$$P_f = 1.79 \times 10^5 \text{ Pa}$$

$$P_f = 1.77 \text{ atm}$$