

CHAPTER 5.

W1990 MT

$$a) \sqrt{c^2} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3(8.314 \frac{\text{kJ}}{\text{kmol K}})(293.15 \text{ K})(1000 \frac{\text{kg}}{\text{kmol}})}{44 \frac{\text{kg}}{\text{kmol}}}}$$

$$\sqrt{c^2} = \sqrt{166176 \frac{\text{m}^2}{\text{s}^2}}$$

$$\boxed{\sqrt{c^2} = 407.6 \frac{\text{m}}{\text{s}}}$$

$$b) E_k = \frac{1}{2} M c^2$$

$$= \frac{1}{2} \left(\frac{44 \text{ kg}}{\text{kmol}} \times \frac{1 \text{ kmol}}{1000 \text{ mol}} \right) \left(166176 \frac{\text{m}^2}{\text{s}^2} \right)$$

$$= 3656 \frac{\text{kg m}^2}{\text{s}^2}$$

$$= \boxed{3656 \text{ J}}$$

$$c) P = \frac{RT}{V_m} = \frac{\left(8.314 \frac{\text{KPa m}^3}{\text{kmol K}}\right) (293.15 \text{ K}) \left(\frac{1 \text{ kmol}}{1000 \text{ mol}}\right)}{\left(\frac{40 \text{ L} \times 0.001 \frac{\text{m}^3}{\text{L}}}{1 \text{ mol}}\right)}$$

$$P = \boxed{60.93 \text{ kPa}}$$

$$d) c_N = \frac{6.023 \times 10^{23} \text{ molecules}}{\text{mol}} \times \frac{40 \text{ L} \times 0.001 \frac{\text{m}^3}{\text{L}}}{1 \text{ mol}}$$

$$c_N = \boxed{1.506 \times 10^{25} \frac{\text{molecules}}{\text{m}^3}}$$

$$e) \delta = \left[\frac{kT}{P} \right]^{1/3}$$

$$= \left[\frac{1.3805 \times 10^{-23} \frac{\text{J}}{\text{K}} \times 293 \text{ K} \times \frac{\text{kg m}^2}{\text{s}^2 \text{ J}}}{60.93 \text{ kPa} \times 1000 \frac{\text{kg}}{\text{ms}^2 \text{ kPa}}} \right]^{1/3}$$

$$= 4.05 \times 10^{-9} \text{ m}$$

$$= \boxed{40.5 \text{ \AA}}$$