Fossum
Chem 1A

Answers - Diffusion/Effusion Questions

1. $N_{2(g)}$ 28.02 g/mol 20.8 cm
$Kr_{(g)}$ 83.80 g/mol ____ cm ← heavier. Won't travel as far.

d = distance

$$\frac{d_{Kr}}{d_{N_2}} = \sqrt{\frac{M}{M}} \qquad d_{Kr} = d_{N_2}\sqrt{\frac{M}{M}}$$

d_{Kr} should be < d_{N_2}, so put smaller M on top.

$$d_{Kr} = 20.8\text{ cm}\sqrt{\frac{28.02}{83.80}} = \boxed{12.0\text{ cm}}$$ makes sense

2. $He_{(g)}$ 4.003 g/mol 3.0 min
$Cl_{2(g)}$ 70.90 g/mol ____ min. Cl_2 is heavier. should take more time to travel the same distance.

$$\frac{t_{Cl_2}}{t_{He}} = \sqrt{\frac{M}{M}} \qquad t_{Cl_2} = t_{He}\sqrt{\frac{M}{M}}$$

$t_{Cl_2} > t_{He}$ so larger M on top.

$$t_{Cl_2} = 3.0\text{ min}\sqrt{\frac{70.90}{4.003}} = \boxed{13\text{ min}}$$ ✓ time for Cl_2

3. 3.2×10^{-3} mol O_2 32.00 g/mol
____ mol CH_4 16.042 g/mol ← lighter - so more will effuse in the same amt of time.

$$\frac{\text{mol } CH_4}{\text{mol } O_2} = \sqrt{\frac{M}{M}}$$

$$\text{mol}_{CH_4} = \text{mol } O_2\sqrt{\frac{M}{M}} = (3.2\times10^{-3}\text{ mol})\sqrt{\frac{32.00}{16.042}} = \boxed{4.5\times10^{-3}\text{ mol } CH_4}$$ will effuse

mol CH_4 > mol O_2
So larger M on top.

4. Ne 20.18 g/mol 2.18×10^{-2} mol/min
unk ____ 8.66×10^{-3} mol/min ← smaller rate.

unk gas is slower than Ne, so it must be heavier. $MM_{unk} > MM_{Ne}$

$$\sqrt{\frac{M_{unk}}{M_{Ne}}} = \frac{\text{rate}}{\text{rate}} = \frac{2.18 \times 10^{-2}\ \text{mol/min}}{8.66 \times 10^{-3}\ \text{mol/min}} = 2.5\bar{17}$$

$M_{unk} > M_{Ne}$ so put larger rate / smaller rate

$$\sqrt{\frac{M_{unk}}{20.18}} = 2.5\bar{17}$$ square both sides

$$\frac{M_{unk}}{20.18} = (2.5\bar{17})^2 = 6.3\bar{37}$$

$M_{unk} = 20.18 \times 6.3\bar{37}$ g/mol

$M_{UNK} = 128$ g/mol

5. $CO_{(g)}$ effuses in 3.8 min. MM = 28.01 g/mol
UNK effuses in 6.0 min MM = ?
unk takes longer to effuse, so unk must be heavier than CO.

$$\frac{\text{time}_{UNK}}{\text{time}_{CO}} = \sqrt{\frac{M}{M}}$$

time unk > time co so larger MM on top ⇒ M_{unk} to preserve equality

$$\frac{6.0\ \text{min}}{3.8\ \text{min}} = \sqrt{\frac{M_{unk}}{28.01}}$$

$$1.5\bar{79} = \sqrt{\frac{M}{28.01}}$$ square both sides $2.\bar{493} = \frac{M}{28.01}$

$M = 2.\bar{493}(28.01\ \text{g/mol}) = 69.8\ \text{g/mol} \Rightarrow 70.\ \text{g/mol}$

6.

$Ar_{(g)}$	39.95 g/mol	12.0 cm
Unk	____ ?	37.9 cm ← unk travels more distance in the same time, so it travels faster.

Unknown must be lighter.

$$\sqrt{\frac{M_{unk}}{M_{Ar}}} = \frac{12.0\,cm}{37.9\,cm} = 0.317 = \sqrt{\frac{M_{unk}}{39.95}}$$

$M_{unk} < M_{Ar}$ so put smaller # cm on top.

Square both sides

$$0.100 = \frac{M}{39.95} \qquad M = 0.100 \times 39.95 \text{ g/mol} = 4.00 \text{ g/mol}$$