

# Graham's Law of Effusion

(Honors Chemistry)

Using Graham's Law of Effusion, answer the following questions and show all work!

1. When gases are at STP, how many times faster will hydrogen effuse compared to nitrogen?

$$\frac{\text{rate H}_2}{\text{rate N}_2} = \sqrt{\frac{28.0 \text{ g/mol}}{2.0 \text{ g/mol}}} = \boxed{3.74}$$

H<sub>2</sub> effuses 3.74 times  
faster than N<sub>2</sub>

2. If the nitrogen in problem 1 takes 48 seconds to effuse, how long will the hydrogen take?

$$\frac{48 \text{ sec}}{3.74} = \boxed{12.83 \text{ seconds}}$$

3. When gases are at STP, how many times faster will neon effuse compared to carbon dioxide?

$$\frac{\text{rate Ne}}{\text{rate CO}_2} = \sqrt{\frac{44.0 \text{ g/mol}}{20.0 \text{ g/mol}}} = \boxed{1.48}$$

Ne effuses 1.48 times  
faster than CO<sub>2</sub>

4. If the carbon dioxide in problem 3 takes 27 seconds to effuse, how long will the neon take?

$$\frac{27 \text{ sec}}{1.48} = \boxed{18.24 \text{ seconds}}$$

5. What is the molar mass of a gas that diffuses at a rate of 6 times slower than neon?

$$\frac{\text{rate Ne}}{\text{rate X}} = 6 = \sqrt{\frac{X}{20.0 \text{ g/mol}}}$$

$$36 = \frac{X}{20}$$

$$\boxed{X = 720 \text{ g/mol}}$$

6. When gases are at STP, how many times faster will ammonia effuse compared to argon?

$\text{NH}_3$  effuses 1.53 times faster than Ar

$$\frac{\text{rate NH}_3}{\text{rate Ar}} = \sqrt{\frac{40.0 \text{ g/mol}}{17.0 \text{ g/mol}}} = 1.53$$

7. If the argon in problem 6 takes 32 seconds to effuse, how long will the ammonia take?

$$\frac{32 \text{ sec}}{1.53} = 20.92 \text{ sec}$$

8. A gas effuses 4 times faster than  $\text{N}_2\text{H}_4$  gas. What is the molar mass of the unknown gas?

$$\frac{\text{rate X}}{\text{rate N}_2\text{H}_4} = 4 = \sqrt{\frac{32.0 \text{ g/mol}}{X}}$$

$$16 = \frac{32}{X}$$

$$X = 2 \text{ g/mol}$$

9. Which noble gas effuses 3.16 times slower than helium?

$$\frac{\text{rate He}}{\text{rate X}} = 3.16 = \sqrt{\frac{X}{4.0 \text{ g/mol}}}$$

$$9.99 = \frac{X}{4}$$

$$X = 39.96 \text{ g/mol} = \text{Ar}$$

10. Which of the following gases ( $\text{CH}_4$ ,  $\text{N}_2$ ,  $\text{H}_2$ ,  $\text{O}_2$ , or  $\text{CO}_2$ ) effuses 2.16 times faster than Xenon gas?

$$\frac{\text{rate X}}{\text{rate Xe}} = 2.16 = \sqrt{\frac{131 \text{ g/mol}}{X}}$$

$$4.67 = \frac{131}{X}$$

$$X = 28 \text{ g/mol} = \text{N}_2$$

11. Which of the following gases ( $\text{SO}_2$ ,  $\text{NH}_3$ ,  $\text{O}_2$ ,  $\text{F}_2$ , or  $\text{CO}$ ) effuses 2.04 times faster than chlorine gas?

$$\frac{\text{rate X}}{\text{rate Cl}_2} = 2.04 = \sqrt{\frac{71.0 \text{ g/mol}}{X}}$$

$$4.16 = \frac{71}{X}$$

$$X = 17 \text{ g/mol} = \text{NH}_3$$