

Concentration of Reactants & Rate Law Practice Questions: Name: SOLUTIONS

1) Observe the following reaction: $2A_{(g)} + 3B_{(g)} \rightarrow 5C_{(g)} + 3D_{(g)}$

a) If 0.14 mol/L of substance B is used up in 120 sec, then what is the rate of substance B?

$$r_B = \frac{0.14 \text{ mol/L}}{120 \text{ sec}} = \boxed{r_B = 0.00117 \text{ mol/L}\cdot\text{s}}$$

b) What is the rate at which C is being produced?

$$\frac{1}{3} r_B = \frac{1}{5} r_C \quad \therefore \frac{1}{3} (0.00117)(5) = r_C$$

$$\boxed{r_C = 0.00195 \text{ mol/L}\cdot\text{s}}$$

c) What is the general reaction rate of the entire reaction?

$$r = \frac{1}{3} r_B \quad r = \frac{1}{3} (0.00117)$$

$$\boxed{r = 0.00039 \text{ mol/L}\cdot\text{s}}$$

2) Observe the following reaction: $X_{(g)} + 5Y_{(g)} \rightarrow Z_{(g)}$

a) How would the rate of this reaction change if the concentration of substance Y was tripled?

$$r_1 = k[X]^1 \cdot [Y]^5$$

$$r_2 = k[X]^1 [3Y]^5$$

$$\underline{r_1 = kXY^5}$$

$$r_2 = kX \cdot 243Y^5$$

$$\boxed{r_2 = 243 r_1}$$

$$\underline{r_2 = 243 kXY^5}$$

b) When the concentrations of X and Y are both 0.250 mol/L the rate of the reaction is 0.085 mol/L·s. What is the rate law constant?

$$r = k[X]^1 [Y]^5$$

$$0.085 = k(0.25)^1 \cdot (0.25)^5$$

$$0.085 = k(0.000244)$$

$$\boxed{k = 348}$$

c) What would be the rate of the reaction if 0.066 mol of X and 0.77 mol of Y were both placed in a 150 mL container?

$$[X]: C = \frac{n}{V} \quad \frac{0.066}{0.15} = 0.44 \text{ mol/L} \quad \textcircled{2}$$

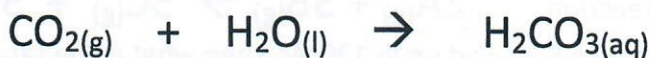
$$\textcircled{1} [Y]: C = \frac{n}{V} \quad \frac{0.77}{0.15} = 5.13 \text{ mol/L}$$

$$r = k[X]^1 [Y]^5$$

$$r = 348(0.44)(5.13)^5$$

$$\boxed{r = 544024 \text{ mol/L}\cdot\text{s}}$$

- 3) In blood, carbon dioxide (CO_2) gas combines with water to form carbonic acid (H_2CO_3) according to the following equation:



By dissociating into hydrogen ions (H^+) and bicarbonate ions (HCO_3^-), carbonic acid plays an important role as a buffer in blood. At body temperature, $k = 0.039$ for the above reaction. If in 5 L of blood, 0.014 g of CO_2 reacts, what will the rate of formation of the carbonic acid in $\text{mol/L}\cdot\text{s}$?

$$\textcircled{1} n = \frac{m}{M}$$

$$n = \frac{0.014}{44}$$

$$n = 0.000318 \text{ moles}$$

$$\textcircled{2} C = \frac{n}{V} = \frac{0.000318 \text{ moles}}{5}$$

$$C = 0.0000636 \text{ mol/L}$$

$$\textcircled{3} r = k [\text{CO}_2]^1$$

$$r = 0.039 (0.0000636)$$

$$r = 0.00000248 \text{ mol/L}\cdot\text{s}$$

$$\textcircled{4} r = \frac{1}{1} r_{\text{H}_2\text{CO}_3}$$

$$r_{\text{H}_2\text{CO}_3} = 2.48 \times 10^{-6} \text{ mol/L}\cdot\text{s}$$

- 4) Observe the following reaction:



If the rate of formation for CO_2 is $3.6 \times 10^{-5} \text{ mol/L}\cdot\text{s}$, and the concentrations of $\text{HgCl}_2 = 0.15 \text{ mol/L}$ & $\text{Na}_2\text{C}_2\text{O}_4 = 0.105 \text{ mol/L}$, what is the value of the rate constant (k)?

$$\textcircled{1} r = \frac{1}{2} r_{\text{CO}_2}$$

$$r = \frac{1}{2} (3.6 \times 10^{-5})$$

$$r = 0.000018 \text{ mol/L}\cdot\text{s}$$

$$\textcircled{2} r = k [\text{HgCl}_2]^2 [\text{Na}_2\text{C}_2\text{O}_4]^1$$

$$0.000018 = k (0.15)^2 (0.105)^1$$

$$k = 0.0076$$