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

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

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

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

$r_C = 0.00195\ mol/L \cdot s$

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

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

$r = 0.00039\ mol/L \cdot s$

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

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

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

$r_1 = KXY^5$

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

$r_2 = KX \cdot 243Y^5$

$r_2 = 243KXY^5$

$r_2 = 243 r_1$

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?

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

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

$0.085 = K(0.000244)$

$K = 348$

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

(1)

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

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

(2)

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

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

$r = 544024\ mol/L \cdot s$

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

$$CO_{2(g)} + H_2O_{(l)} \rightarrow H_2CO_{3(aq)}$$

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 mol/L•s ?

① $n = \frac{m}{M}$

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

$n = 0.000318 \text{ moles}$

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

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

③ $r = K[CO_2]^1$

$r = 0.039(0.0000636)$

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

④ $r = \frac{1}{1} r_{H_2CO_3}$

$r_{H_2CO_3} = 2.48 \times 10^{-6} \text{ mol/L}\cdot s$

4) Observe the following reaction:

$$2HgCl_{2(aq)} + Na_2C_2O_{4(aq)} \rightarrow 2NaCl_{(aq)} + 2CO_{2(g)} + Hg_2Cl_{2(aq)}$$

If the rate of formation for CO_2 is 3.6×10^{-5} mol/L•s, and the concentrations of $HgCl_2$ = 0.15mol/L & $Na_2C_2O_4$ = 0.105mol/L, what is the value of the rate constant (k) ?

① $r = \frac{1}{2} r_{CO_2}$

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

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

② $r = K[HgCl_2]^2 \cdot [Na_2C_2O_4]^1$

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

$K = 0.0076$