Chemical Kinetics

Name BETH "KEY"

Measuring Reaction Rates

1. A chemist wishes to determine the rate of reaction of zinc with hydrochloric acid. The equation for the reaction is:

$$Zn(s) + 2HCl(aq) \rightarrow H_2(g) + ZnCl_2(aq)$$

A piece of zinc is dropped into 1.00 L of 0.100 M HCl and the following data were obtained:

Time	Mass of Zinc
0 s	0.016 g
4 s	0.014 g
8 s	0.012 g
12 s	0.010 g
16 s	0.008 g
20 s	0.006 g

a) Calculate the rate of reaction in grams of Zn consumed per second.

$$RATE = -\frac{(0.006g - 0.016g)}{(20s - 0s)} = -\left(\frac{-0.010g}{20s}\right) = 5 \times 10^{-4} \frac{g}{s}$$

b) Calculate the rate of reaction in moles of Zn consumed per second.

$$\frac{5 \times 10^{-4} g\ Zn/s}{65.39 g/mol\ Zn} = 8 \times 10^{-6} mol\ Zn/s$$

c) What will happen to the [H+] as the reaction proceeds? decrease

d) What will happen to the [Cl-] as the reaction proceeds? stays the same

2. When magnesium is reacted with dilute hydrochloric acid (HCl), a reaction occurs in which hydrogen gas and magnesium chloride is formed.

a) Write a balanced equation for this reaction.

$$Mg + 2HCl \rightarrow H_2 + MgCl_2$$

b) If the rate of consumption of magnesium is 5.0 x 10^{-9} mol/s, find the rate of consumption of HCl in moles/s.

$$5.0 \times 10^{-9} \frac{mol\ Mg}{s} \times \frac{2 mol\ HCl}{1 mol\ Mg} = 1.0 \times 10^{-8} \frac{mol\ HCl}{s}$$

c) If the rate of consumption of magnesium is 5.0 x 10^{-9} mol/s, find the rate of production of H_2 in g/s.

MOLE RATIO $Mg : H_2$ = 1 to 1

RATE OF CONSUMPTION Mg = RATE OF PRODUCTION H_2 = $5.0 \times 10^{-9} \frac{mol}{s} \times 2.02 g/m$

1.0×10^{-8} g/s

d) If the rate of consumption of magnesium is 5.0 x 10-9 mol/s, find the rate of production of H_2 in L/s (at STP).

$$5.0 \times 10^{-9} \frac{mol\ H_2}{s} \times \frac{22.4 L}{mol\ H_2 \text{ at STP}} = 1.1 \times 10^{-7} L/s\ H_2$$

e) If the rate of consumption of magnesium is 5.0 x 10-9 mol/s, find the mass of Mg consumed in 5.0 minutes.

$$5.0 \times 10^{-9} \frac{mol\ Mg}{s} \times \frac{24.31 g\ Mg}{1 mol\ Mg} \times \frac{60 s}{1 min} \times 5.0 min = 3.6 \times 10^{-5} g$$

3. Butane, commonly found in lighters, easily combusts.

a) Write a balanced equation for this reaction.

$$2 C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

b) If butane is consumed at an average rate of 0.116 grams/s, determine the rate of production of CO_2 in g/s.

$$\frac{0.116 g\ C_4H_{10}}{s} \times \frac{1 mol\ C_4H_{10}}{58.14 g} \times \frac{8 mol\ CO_2}{2 mol\ C_4H_{10}} \times \frac{44.01 g\ CO_2}{1 mol\ CO_2} = \boxed{\frac{0.351 g}{s}}$$

6. The longer the *time of reaction*, the lower the *rate of reaction.*

7. Give some examples of situations where we might want to ***increase*** the rate of a particular reaction.

Production of gas in a car airbag.
Cooking food.
Neutralize stomach acid when you have an upset stomach.

8. Give some examples of situations where we might want to ***decrease*** the rate of a particular reaction.

Decrease rate of combustion when a building is on fire.
Decrease rate of rusting on a car.
Decrease rate of tarnishing on silver jewelry/etc.
Digestion of food. (Enzymes act as a catalyst.)

10. Give ***two*** reasons why *water* is effective at putting out fires. Use concepts learned in this unit so far.

- H_2O has a high heat capacity (ability to absorb energy) and will lower the rxn temperature decreasing the rate of rxn due to less energetic collisions.
- H_2O sprayed on the fire will vaporize. As it does the volume of the water vapor is much greater than liquid H_2O so it will displace O_2. ↓ O_2 ↓ # of collisions ↓ effective collisions and slows rate of combustion.

11. The following table relates the time and the mass of Zn during the reaction between Zn and 0.5M HNO_3 :

$$Zn(s) + 2HNO_3(aq) \rightarrow H_2(g) + Zn(NO_3)_2(aq)$$

Time	Mass of Zn (g)
0.0 s	36.2 g
60.0 s	29.6 g
120.0 s	25.0 g
180.0 s	22.0 g

a) Calculate the reaction rate, in g/s, from time 0 to 60 s.

$$RATE = -\frac{(29.6g - 36.2g)}{(60.0s - 0.0s)} = -\left(\frac{-6.6g}{60.0s}\right) = \boxed{0.11\frac{g}{s}}$$

b) Calculate the reaction rate, in g/s, from time 120s to 180 s.

$$RATE = -\frac{(22.0g - 25.0g)}{(180.0s - 120.0s)} = -\left(\frac{-3.0g}{60.0s}\right) = \boxed{0.050\frac{g}{s}}$$

c) Explain why the rate in calculation "b" is less than that of calculation "a".

Concentration impacts reaction rates. As the reaction proceeds, the concentration of HNO_3 will decrease slowing the rate of reaction. Fewer HNO_3 molecules means less collisions which results in fewer effective collisions.