Name _____ Block: _____ Date: _____

Chemistry 12

REACTION RATES

1. The following data were collected for the reaction: $Zn_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + ZnCl_{2(aq)}$

   in which zinc metal was reacted with 0.200 M $HCl_{(aq)}$:

Time (seconds)	Mass Zn (grams)
0.0	31.0
60.0	24.6
120.0	20.2
180.0	17.4

   a) Calculate the average reaction rate, in g/s, from time 0 to 60 s.
   b) Calculate the average reaction rate, in g/s, from time 120 to 180 s.
   c) Calculate the average reaction rate in g/s, from time 0 to 180 s.
   d) Explain why the average rate in (b) is less than in (a)

2. In each of the following pairs of reactions, which would have the faster reaction rate?

   a) $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$ **or** $Ag^{+}_{(aq)} + I^{-}_{(aq)} \rightarrow AgI_{(s)}$

   b) $Fe_{(s)} + 2H_2O_{(l)} \rightarrow Fe(OH)_{2(s)}$ **or** $CH_3COOH_{(aq)} + H_2O_{(l)} \rightarrow CH_3COO^{-}_{(aq)} + H_3O^{+}_{(aq)}$

   c) $Cu_{(s)} + S_{(s)} \rightarrow CuS_{(s)}$ **or** $CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2(s)}$

   d) $C_{(s,\ powder)} + O_{2(g)} \rightarrow CO_{2(g)}$ **or** $C_{(s,\ chunk)} + O_{2(g)} \rightarrow CO_{2(g)}$

   e) $HCl_{(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaCl_{(aq)}$ **or** $2H_2O_{(aq)} + 2H^{+}_{(aq)} \rightarrow 2H_3O^{+}_{(aq)} + O_{2(g)}$

3. Which of the reactions in #2 are HOMOGENEOUS reactions?

4. One piece of magnesium is reacted with 3.00M hydrochloric acid at 25°C. Another piece of magnesium of equal size and shape is reacted with 1.00 M hydrochloric acid at 25°C. Predict which reaction occurs at a faster rate. Explain using collision theory.

5. A chunk of zinc is reacted with 3.00 M hydrochloric acid at 25°C. An equal mass of powdered zinc is reacted with 3.00 M hydrochloric acid at 25°C. Compare the reaction rates.

6. State two ways that the number of effective collisions between reactants can be increased.

7. The following reaction occurs at constant temperature and constant volume in a closed system:

   $CaCO_{3(s)} + 2H^{+}_{(aq)} + 2Cl^{-}_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)} + Ca^{2+}_{(aq)} + 2Cl^{-}_{(aq)}$

   How could you experimentally measure the rate of this reaction?

1. Which of the following has the greatest reaction rate?
   a. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$
   b. $2H_2O_{2(l)} \rightarrow 2H_2O_{(l)} + O_{2(g)}$
   c. $2Al_{(s)} + 3CuCl_{2(aq)} \rightarrow 2AlCl_{3(aq)} + 3Cu_{(s)}$
   d. $NaCl_{(aq)} + AgNO_{3(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$

2. Which of the following has the lowest rate of reaction?
   a. $Pb_{(s)} + CuCl_{2(aq)} \rightarrow Cu_{(s)} + PbCl_{2(aq)}$
   b. $HCl_{(aq)} + NaOH_{(aq)} \rightarrow H_2O_{(l)} + NaCl_{(aq)}$
   c. $H_2SO_{4(aq)} + Ba(OH)_{2(aq)} \rightarrow 2H_2O_{(l)} + BSO_{4(s)}$
   d. $Pb(NO_3)_{2(aq)} + 2NaI_{(aq)} \rightarrow PbI_{2(s)} + 2NaNO_{3(aq)}$

3. Consider the following reaction: $N_2H_{4(l)} + 2H_2O_{2(l)} \rightarrow N_{2(g)} + 4H_2O_{(l)}$
   In 5.0 seconds, 0.015 mol of H_2O_2 is consumed. The rate of production of N_2 is:
   a. 1.5×10^{-3} mol/s
   b. 3.0×10^{-3} mol/s
   c. 6.0×10^{-3} mol/s
   d. 1.5×10^{-2} mol/s

4. At 25°C and considering only the nature of the reactants, which one of the following reactions most probably has the highest rate?
   a. $Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow CaCO_{3(s)}$
   b. $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$
   c. $H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$
   d. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

5. The following reaction occurs at constant temperature and constant volume in a closed system: $CaCO_{3(s)} + 2H^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)} + Ca^{2+}_{(aq)} + 2Cl^-_{(aq)}$

   Changes in which one of the following would be useful in experimentally measuring the rate of this reaction?
   a. The mass of the system
   b. The pressure of the system
   c. The concentration of water

6. Which one of the following reactions is most likely to have the highest reaction rate?
   a. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$
   b. $Mg^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mg(OH)_{2(s)}$
   c. $C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$
   d. $2MnO_4^-{}_{(aq)} + 16H^+_{(aq)} + 5C_2O_4^{2-}{}_{(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 10CO_{2(g)} + 8H_2O_{(g)}$

7. A 25.0 mL sample of hydrogen peroxide decomposes producing 50.0 mL of oxygen gas in 137 seconds. The rate of formation of O_2 in mL/min is
   a. 0.182 mL/min
   b. 0.365 mL/min
   c. 10.9 mL/min
   d. 21.9 mL/min

8. At 10°C, a small piece of Zn reacts with 2.0 M HCl to produce 15.0mL of H_2 gas in 25 seconds. What is the rate of this reaction?
   a. 0.060 mol Zn per second
   b. 0.4 C per second
   c. 0.60 mL H_2 per second
   d. 0.80 mol/L HCl per second

9. A sample of magnesium having a mass of 0.360 g is dropped into dilute hydrochloric acid. At the end of 4.00 minutes, the magnesium is removed and it is found to have a mass of 0.240 g. The average rate at which the reaction took place was:
   a. 0.003 mol/min
   b. 0.120 mol/min
   c. 2.06×10^{-5} mol/sec
   d. 8.33×10^{-5} mol/sec