

# AR Chemistry: Reaction Rates Problem Set

## 1: Effect of Concentration

a. Write Rates of Reaction Equations for the following reactions

- i.  $\text{H}_2 + \text{Cl}_2 \rightarrow 2 \text{HCl}$       Rate =  $k [\text{H}_2][\text{Cl}_2]$
- ii.  $\text{I}_2 + \text{H}_2 \rightarrow 2 \text{HI}$
- iii.  $\text{Ca} + \text{S} \rightarrow \text{CaS}$
- iv.  $\text{Mg} + \text{Cl}_2 \rightarrow \text{MgCl}_2$
- v.  $\text{NO} + \text{CO}_2 \rightarrow \text{NO}_2 + \text{CO}$
- vi.  $\text{Sc} + \text{P} \rightarrow \text{ScP}$
- vii.  $\text{Cu} + \text{S} \rightarrow \text{CuS}$

b. Solve the following Relative Rate Problems

- i. You run a reaction and then triple the concentration for the first reactant and double the concentration for the second reactant. What is the relative rate for the second reaction compared to the first?

$$\text{Let Rate}_1 = k [1] [1] = 1 k \quad \text{so} \quad \text{Rate}_2 = k [3] [2] = 6 k$$
$$R_2 / R_1 = 6 k / 1 k = \mathbf{6}$$

- ii. You run a reaction and then double the concentration for the first reactant and double the concentration for the second reactant. What is the relative rate for the second reaction compared to the first?
- iii. You run a reaction and then quadruple the concentration for the first reactant and halve the concentration for the second reactant. What is the relative rate for the second reaction compared to the first?
- iv. You run a reaction and then quadruple the concentration for the first reactant and triple the concentration for the second reactant. What is the relative rate for the second reaction compared to the first?
- v. You run a reaction and then halve the concentration for the first reactant and halve the concentration for the second reactant. What is the relative rate for the second reaction compared to the first?
- vi. You run a reaction and then triple the concentration for the first reactant and halve the concentration for the second reactant. What is the relative rate for the second reaction compared to the first?

## 2. Effect of Surface Area

- a. You triple the surface area of a reactant. What happens to the reaction rate?
- b. You quadruple the surface area of a reactant. What happens to the reaction rate?
- c. You increase the surface area of a reactant by 10,000 x. What happens to the reaction rate?
- d. You increase the surface area of a reactant by a factor of 'X'. What happens to the reaction rate?

## 3. Effect of Temperature

- a. What does temperature measure (in terms of molecular movement)?
- b. What is the 10 degree Celsius rule?
- c. What happens to the poisson distribution diagram as temperature rises?
- d. For each 10 degrees Celsius increase, what is the approximate change in speed of molecules?
- e. For each 10 degrees Celsius increase, what is the approximate number of molecules with enough energy to react?

f. Answer the following temperature questions

i) What happens to the rate of reaction if temperature is increased 30 C?

ii) What happens to the rate of reaction if temperature is decreased 40 C?

iii) What happens to the rate of reaction if temperature changes from 25 C to 75 C?

#### 4. Effect of Catalysts on Activation Energy

a. What is activation energy?

b. What is an activated complex?

c. What is a catalyst?

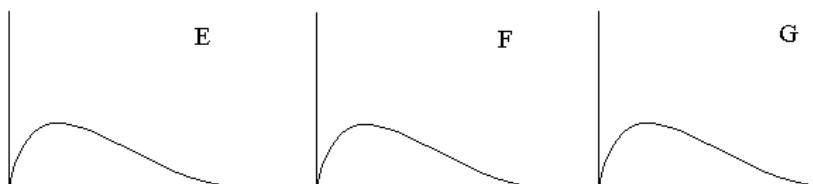
d. What does a catalyst do that enables it to do it's job (has to do with activation energy)

e. For diagram 'e', show i) the temperature line, ii) an  $E_a$  line, iii) the effect of a 10 C increase

Questions f and g are based on vaporization of liquids, not reaction rates (same diagrams)

f. For diagram 'f', show the  $E_a$  lines for material 'X' that has low IMA, material 'Y' that has a high IMA, and material 'Z' that has a very high IMA.

g. For diagram 'g', show the room temperature line and the  $E_a$  line for vaporization of Carbon Dioxide gas.



h. Draw Heat Content Diagrams for the following chemical reactions

i.  $E_a = +20$   $\Delta H = +10$

ii.  $E_a = +30$   $\Delta H = -10$

iii.  $E_a = +40$   $\Delta H = +30$

iv.  $E_a = +20$   $\Delta H = -20$

v.  $E_a = +30$   $\Delta H = +30$

vi.  $E_a = +40$   $\Delta H = -30$

vii.  $E_a = +20$   $\Delta H = -30$

viii.  $E_a = 0$   $\Delta H = -10$

