Score _____ / 100 pts.

Name ____________________________
Class _____ Date __________________

The rate of chemical reactions of atoms and molecules depends upon how often they encounter one another, which is a function of concentration, temperature, and pressure of the reacting materials. Catalysts can be used to change the rate of chemical reactions. Under proper conditions reactions may attain a state of equilibrium.

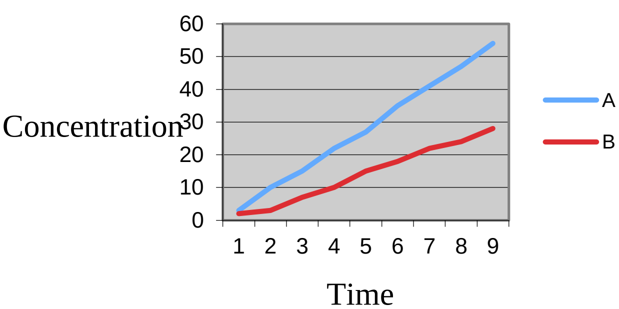
STANDARD V: Students will understand that many factors influence chemical reactions and some reactions can achieve a state of dynamic equilibrium.

Objective 1 Evaluate factors specific to collisions (e.g., temperature, particle size, concentration, and catalysts) that affect the rate of chemical reaction.

1. What is collision theory? Particles must collide in order to break bonds and form new bonds. What are the three requirements for an effective collision? Particles must collide. The collision must occur in the correct orientation. The collision must occur with sufficient energy.

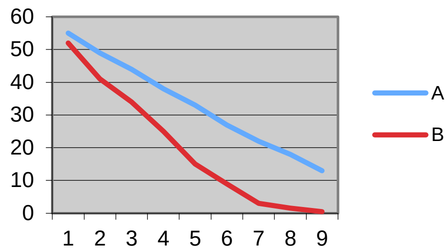
2. What are five things that can be done to increase the rate of a reaction (speed it up). Say WHY each one helps. (Use the terms “frequency of collisions” and “energy of collisions” in your explanations.) Increasing concentrations allow for more frequent collisions which increases reaction rates. Increasing surface area allows for more frequent collisions. Increasing temperature leads to more frequent and more energetic collisions. Decreasing volume of the reaction vessel with gaseous reactants leads to more frequent collisions. The use of a catalyst reduces the energy required for an effective collision.

3. The graph below is showing the concentration of the PRODUCTS of two different reactions. Which reaction is going faster? How do you know?



Reaction A is creating more product in the same amount of time. Reaction A has a faster reaction rate.

The graph below is showing the concentration of the REACTANTS of two different reactions. Which reaction is going faster? How do you know?



Reaction B is decreases reactant amount at a faster rate than reaction A. Reaction B has a faster rate.

4. How would you set up a reaction to measure the effect of different factors on reaction rates? Set up a reaction with a set concentration, at a set temperature, with a set amount of surface area, in a set volume and pressure and time the reaction. Then test the same reaction with all variables the same except the one you wish to test. Collect rate data involved with the changes for each individual independent variable.

5. What is a catalyst? How does it work? What does it do to a reaction rate? A catalyst is a substance that reactant particles interact with that facilitates the collisions required for a reaction. The activation energy for an effective collision is reduced and the rate of the reaction increases.

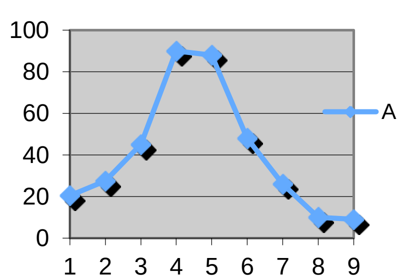
Objective 2 Recognize that certain reactions do not convert all reactants to products, but achieve a state of dynamic equilibrium that can be changed.

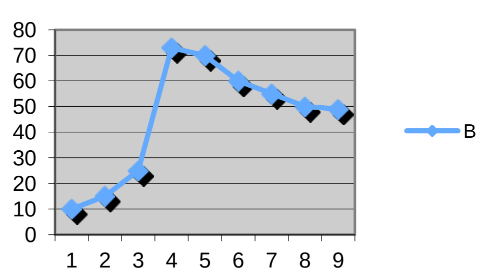
6. What is dynamic equilibrium? Dynamic equilibrium occurs when the rate at which reactants form products is equal to the rate at which products reform the reactants. How is it both "moving" and "staying the same" at the same time? The measured concentrations of both products and reactants remain constant, though the reaction continues changing products to reactants and reactants to products.

7. What does it mean to "react to completion"? React to completion refers to when all reactants have been formed into products. What does a one way arrow tell us? The reaction is not reversible and is moving toward completion. What does a two way arrow tell us? The two way arrow indicates that as product is formed it will react to make reactants again. The reaction is reversible.

8. Which of the following reactions is likely to occur the fastest? Why?

ENERGY





Reaction A requires an increase in energy from 20 units to 90 units: an activation energy of 70 units. Reaction B requires an increase in energy from 10 units to 75 units: an activation energy of 65 units. As reaction A requires more energy to form products, the rate of A will be less than the rate of reaction B.

9. Which of the above reactions is most likely to favor products at equilibrium? Why?
To reverse reaction A, product must increase energy from 10 units to 90 units, a reverse activation energy of 80 units. To reverse reaction B, product energy must increase from 50 units to 75 units, a reverse activation energy of 25 units. As it is much easier for reaction B to reverse and make reactants again, it will most likely favor the reactant concentrations. Reaction A has more difficulty reversing the reaction to make reactants, so it will favor product concentration.

10. The following reaction has reached equilibrium. $C + CO_2 \rightarrow 2CO$ + Heat
    a. If I increase the temperature (add heat), then which direction will equilibrium shift? Why? As temperature of the reaction is increases, it will be more difficult to produce additional heat as products form. The reaction slow in its product formation and shift to have higher concentrations of reactants.

    b. If I add carbon dioxide to the reaction vessel, then which direction will equilibrium shift? Why? As carbon dioxide concentrations increase, collisions leading to the formation of the products will be more frequent, increasing the rate of product formation. The reaction will shift toward higher concentrations of products.

11. The following reaction has reached equilibrium. $KCl + Na \rightarrow NaCl + K$ $\Delta H = +10$
    a. If I increase the temperature (add heat), then which direction will equilibrium shift? Why? The enthalpy change is a positive value, which indicates that heat is added to make products. If temperature increases, the additional heat will need to be absorbed by the reaction, and it is absorbed as reactants form more products. The reaction will shift to make more products.

    b. If I add sodium chloride to the reaction vessel, then which direction will equilibrium shift? Why? Increasing the concentration of sodium chloride will increase the concentration of products, increasing the rate of reactant formation. The equilibrium will shift to make more reactants.