Unit 11 Review - Kinetics and Equilibrium

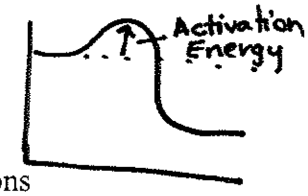
LT1: I can describe changes that would speed up the rate of a reaction.

1. What is collision theory?

particles must collide with sufficient energy and correct orientation to react.

2. What is activation energy?

the minimum energy required for reaction



3. List 5 factors that can affect the rate of a reaction and explain why (using collisions theory) each affects the reaction rate. See this video for assistance https://youtu.be/OttRV5ykP7A

- concentration - more particles increase the frequency of collisions
- surface area - more particles are exposed to the outside increasing the liklihood of collisions
- temperature - particles move faster, increases the energy of collisions
- volume - less space available so the particles collide more frequently
- catalyst - lowers the activation energy. More collisions will meet the required energy

LT2: I can calculate reaction rate given experimental data

4. What is the definition of the reaction rate of a chemical reaction?

Change in concentation of a chemical over time.

Use the data provided to answer the following questions.

a. Substance X has a molar mass of 36.46 g/mole.
b. Solution #1 is made by dissolving 150.0 grams of substance X in enough water to make 1500. mL.
c. Solution #2 is made by taking 500.0 mL of solution #1 and diluting it to a total volume of 2000.0 mL.
d. A catalyst is added to solution 2 which starts a chemical reaction in which substance X decomposes as follows: $X \rightarrow Y + Z$
e. The reaction is stopped after 180. seconds and the remaining concentration of X is measured and found to be 0.156 M.

5. Calculate the concentration of solution #1.

$150.0g \times \frac{1 mol}{36.46g} = 4.11 mol$ $M = \frac{mol}{L} = \frac{4.11 mol}{1.500 L} = 2.74 M$

6. Calculate the concentration of solution #2.

$M_1V_1 = M_2V_2$ $2.74M \times 500mL = M_2 \times 2000mL$ $M_2 = .686M$

7. Using the chemical reaction, $X \rightarrow Y + Z$, write the reaction rate expressions for the reaction in terms of the disappearance of X.

$rate = -\frac{\Delta[X]}{\Delta t}$

8. Using the data given above; the $[X]_0$ calculated in #6, and the [X] after 180. seconds, calculate the rate of the reaction over the 3 minutes in M/ s.

$rate = \frac{-(.156 - .686)}{180} = .00294 M/s$

LT3: I can define chemical equilibrium, how it relates to reversible reactions and explain how it is achieved

9. What is a reversible reaction? What is a completion reaction?

reversible - as the forward reaction takes place, the products can reform the reactants in the reverse reaction. completion is forward only.

10. What is meant by the term chemical equilibrium?

equilibrium - exact balancing of opposite processes.
chemical equilibrium - balance of forward and reverse reaction rates

11. When a reversible reaction reaches equilibrium, is it static, or dynamic?

Dynamic - both reactions keep going even though the concentrations stay constant

12. Indicate whether the statements are True or False. **CHANGE any false ones to make them true!**

F a) At equilibrium the ~~amount of products must equal the amount of reactants.~~ rate of the forward reaction equals the rate of the reverse reaction

T b) During equilibrium, the concentration of the products does not change.

F c) A collision between reactants is all that is needed to cause a reaction.
-must have sufficient energy and orientation

T d) At the beginning of a reaction the forward reaction is faster than the reverse reaction, but then the forward reaction slows down as the reverse reaction speeds up.

LT4: I can determine the equilibrium constant expression for a given reaction. (Keq = [products]/[reactants])

13. Write the equilibrium expression for the following reactions:

a. $P_4(s) + 6NO(g) \leftrightarrow P_4O_6(g) + 3 N_2(g)$
b. $KCl(l) + Na(l) \leftrightarrow NaCl (l) + K (g)$
c. $CH_4(g) + Cl_2 (g) \leftrightarrow CO(g) + 3H_2(g)$
d. $Fe (s) + CO_2 (g) \leftrightarrow FeO (s) + CO (g)$

a. $K = \frac{[P_4O_6][N_2]^3}{[NO]^6}$

b. $K = [K]$

c. $K = \frac{[CO][H_2]^3}{[CH_4][Cl_2]}$

d. $K = \frac{[CO]}{[CO_2]}$

LT5: I can analyze the extent of a reaction from its equilibrium constant

14. What are the meanings of different size K values?

large K means products are favored

small K means reactants are favored

LT6: I can calculate the equilibrium constant or the equilibrium concentration of a reactant or product by using the Equilibrium Constant expression

15. Calculate the K_{eq} of the following reaction $S_2 (g) + 2 H_2 (g) \leftrightarrow 2 H_2S (g)$ if the concentrations are $[H_2(g)] = 2.16$ M, $[S_2(g)] = 0.3$ M, $[H_2S(g)] = 0.5$ M

$$K = \frac{[H_2S]^2}{[S_2][H_2]^2} = \frac{(.5)^2}{(.3)(2.16)^2} = .179$$

$$= .2$$

16. Calculate the K_{eq} of this reaction, $NO(g) + O_3(g) \leftrightarrow O_2(g) + NO_2(g)$, if [NO]=0.02 M, $[NO_2]$=0.55M, $[O_2]$=1.5M, and $[O_3]$=0.75M

$$K = \frac{[O_2][NO_2]}{[NO][O_3]} = \frac{(1.5M)(.55M)}{(.02M)(.75M)} = 55$$

17. For the equilibrium system $PCl_{5(g)} \leftrightarrow PCl_{3(g)} + Cl_{2(g)}$, Keq = 15. If the concentrations of PCl_5 and PCl_3 are 0.045M and 0.35M respectively, what is the concentration of the Cl_2?

$$K = \frac{[PCl_3][Cl_2]}{[PCl_5]} \quad K = 15 = \frac{(.35M)(x)}{.045}$$

$$x = 1.93\ M$$

LT7: I can explain Le Chatelier's Principle

18. What is Le Châtelier's Principle?

If a system that is at equilibrium gets a stress applied to it, it will shift the equilibrium position to reduce the stress.

19. What is meant when we say a reaction "shifts"?

The forward or reverse reaction becomes favored until a new equilibrium position is reached.

LT8: I can describe how changes in energy, concentration, pressure, and temperature affect a reaction at equilibrium

20. For each of the following stresses, indicate how increasing or decreasing will affect the reaction:
    a. Concentration
    Increase [ ] : shifts away from the substance
    decrease[ ] : shifts towards the substance
    b. Pressure
    Increase pressure : shifts towards side with less gas
    decrease pressure : shifts towards side with more gas
    c. Volume
    Increase volume : decreases pressure : side with more gas
    decrease volume : increases pressure : side with less gas
    d. Temperature
    Increase temp : shifts away from heat
    decrease temp : shifts towards heat
    } changes K

21. For the reaction below, complete the table using Le Châtelier's Principle

heat + $A_{(g)}$ + $2B_{(g)}$ ↔ $C_{(s)}$ + $2D_{(g)}$

Stress	**Equilibrium Shift**	**[A]**	**[B]**	**[C]**	**[D]**	K_{eq}
Add A	R	——	↓	↑	↑	stays the same
Add D	L	↑	↑	↓	——	same
Remove C	R	↓	↓	——	↑	same
Remove B	L	↑	——	↓	↓	same
Increase Temperature	R	↓	↓	↑	↑	up
Decrease Temperature	L	↑	↑	↓	↓	down
Decrease Pressure	L	↑	↑	↓	↓	same