KEY

Chemistry Semester 2 Review

Unit 6 and 7: KMT and Gases, Thermochemistry

Vocab:

STP
Molar volume
Ideal gas law
Ideal gas constant
Kinetic-molecular theory
Pascal
Pressure
calorimeter
chemical potential energy
energy
enthalpy
enthalpy (heat) of combustion
enthalply (heat) of reaction
entropy
heat
Hess's law
Joule
Law of conservation of energy
Law of disorder
Molar enthalpy (heat) of fusion
Molar enthalpy (heat) of vaporization
Specific heat
Spontaneous process
Standard enthalpy (heat) of formation
Surroundings
System
Thermochemistry
Universe

1. Temperature is a measure of the average Kinetic energy of the molecules in a sample.
2. A gas exerts pressure on its container because the molecules collide with the walls.
3. What are the four variables that describe a gaseous system?
   1. pressure 2. volume 3. temp. 4. # of particles
4. Temperature must *always* be in Kelvin when calculating gas law problems.
5. Standard pressure = 1 atm
6. Standard temperature = 273 K = 0 degrees Celsius.
7. Answer the following questions with INVERSELY or DIRECTLY
   a) How are pressure and temperature related? directly
   b) Pressure and Volume? inversely
   c) Volume and Temperature? directly
8. What will happen to a balloon filled with helium gas when you take it from outside on a hot day to inside an air conditioned house? Temp ↓, Vol ↓
9. How many moles of a gas will occupy 2.50L at STP?
   P = 1atm, V = 2.50L, n = ? mol, R = 0.0821 L·atm/mol·K, T = 273K
   $1 \cdot 2.50 = n \cdot 0.0821 \cdot 273$
   $n = 0.112\ mol$
10. Calculate the volume that 3.60 grams of H_2 gas will occupy at STP.
    $3.60g\ H_2 \times \frac{1\ mol\ H_2}{2g\ H_2} = 1.8\ mol\ H_2$
    $1 \cdot V = 1.8 \cdot 0.0821 \cdot 273$
    $V = 40.3L$
11. Use the reaction shown to calculate the mass of iron that must be used to obtain .500L of hydrogen at 24.3 degrees Celsius and 100.0 kPa of pressure. $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
    $P = 100.0kPa \times \frac{1atm}{101.3kPa} = .987atm$, V = .500L, n = ? mol H_2, R = 0.0821, T = 24.3°C + 273 = 297.3K
    $.987 \cdot .500 = n \cdot 0.0821 \cdot 297.3$
    $n = .0202\ mol\ H_2$
    $.0202\ mol\ H_2 \times \frac{3\ mol\ Fe}{4\ mol\ H_2} \times \frac{56g}{1\ mol}$
    $= 0.849g\ Fe$
12. What does each of the symbols below represent?
    a) ΔH – enthalpy (heat)
    b) ΔS – entropy (disorder)
13. Define entropy and enthalpy.
    entropy – measure of disorder in a system
    enthalpy – measure of change in heat energy in a system
14. Describe an endothermic and exothermic reaction.
    endothermic – absorbs heat (energy)
    exothermic – releases heat (energy)

15. Determine if the letter below is supporting an exothermic or endothermic reaction:
    a) Products have more energy than the reactants — exothermic
    b) Reactants have more energy than the products — endothermic
    c) H_2O (l) → H_2O (g) — endothermic
    d) $+\Delta H$ — endothermic
    e) $-\Delta H$ — exothermic
    f) Water freezing — exothermic

18. In nature, do things tend to become more organized or more disordered? What law of thermodynamics is this?
    - more disordered
    - 2nd Law of Thermodynamics

19. Determine whether the change below supports an increase or decrease in disorder ($-\Delta S$ or $+\Delta S$)
    a) CH_3OH (l) → CH_3OH (g) — $+\Delta S$
    b) $2KClO_3$(s) → $2KCl$ (s) + $3Cl_2$ (g) — $+\Delta S$
    c) $2SO_2$ (g) + O_2 (g) → $2SO_3$(g) — $-\Delta S$

20. The enthalpy of the products is 255 kJ and the enthalpy of the reactants is 335 kJ. Calculate the change in enthalpy and determine if the reaction is exothermic or endothermic.
    products − reactants
    255KJ − 335KJ = −80KJ → exothermic ($-\Delta H$)

21. Predict the sign of ΔS_{system} for the following changes and explain your answer:
    a) ClF (g) + F_2 (g) → ClF_3 (g) — $-\Delta S$, less pieces
    b) $C_{10}H_8$ (l) → $C_{10}H_8$ (s) — $-\Delta S$, solids are more ordered than liquids

Unit 9: Rates and Equilibrium

Vocab:

Activated complex
Activation energy
Collision theory
Reaction rate
Transition state
Catalyst
Dissociation equations
reversible reaction
completion reaction
chemical equilibrium
homogeneous equilibrium
heterogeneous equilibrium
Le Chatelier's Principle
Ksp
Keq

22. List the factors that affect the RATE of a chemical reaction ***and*** tell HOW they affect the rate.

5 Factors that affect the reaction rate:	How the factors alter the rate:
Nature of Reactants	- some substances are naturally more reactive than others
Concentration of Reactants	- more reactants, means more collisions
Temperature	- ↑ temp means more collisions - ↑ temp means more energy
Surface Area	- more surface area more likely for correct orientation
Catalyst	- lowers the activation energy

23. What is a catalyst? How is an enzyme like a catalyst? How do catalysts work?
    - catalyst lowers the activation energy
    - enzymes are catalysts in the body
    - catalysts create an alternate pathway for the reaction

24. In order for a reaction to occur, the reactants must collide with enough energy and the correct orientation.

25. The amount of energy needed for an effective collision is called the activation energy.

26. What happens to the rate of a chemical reaction over time? slows down

27. In a chemical reaction that produces hydrogen 14.3 ml of gas was collected over a 20.0 second period. Calculate the rate of the reaction in ml/sec. $\frac{14.3\text{mL}}{20.0\text{s}} = 0.715\text{mL/s}$

28. A double arrow signifies a reversible reaction, while a single arrow signifies a completion reaction.

29. What causes a reaction to go to completion? The evolution of a gas or the formation of a precipitate. Describe chemical equilibrium. Give an example.
- forward & reverse reaction are going at equal rates at equilibrium

30. Write the equilibrium constant expression for $4HCl_{(g)} + O_{2(g)} \leftrightarrow 2Cl_{2(g)} + 2H_2O_{(g)}$

$K_{eq} = \frac{\text{products}}{\text{reactants}} = \frac{[Cl_2]^2[H_2O]^2}{[HCl]^4[O_2]}$

31. If you calculate a number less than 1 for the constant expression above, what does that tell you?
reactants are favored

32. At 773K, the reaction $2NO(g) + O_2(g) \leftrightarrow 2NO_2(g)$ produces the following concentrations: $[NO]=3.49 \times 10^{-4}$ M; $[O_2]=0.80$M; $[NO_2]=0.250$M. Write the equilibrium constant expression for the reaction, & calculate the value of the equilibrium constant.

$K_{eq} = \frac{[NO_2]^2}{[NO]^2[O_2]} = \frac{[.250]^2}{[3.49\times10^{-4}]^2[0.80]} = 641,415$ or 6.41×10^5

33. Le'Chatelier's Principle explains how an equilibrium system will respond to stress.

34. For the reaction given, complete the following table: **C (s) + H_2O (l) + heat ↔ CO (g) + H_2 (g)**

Stress applied	Shift left, shift right, or no change?	What happens to the concentration of CO?
Cooling	left	decrease
Adding water	right	increase
Adding a catalyst	no change	—
Removing H_2	right	increase
Decreasing volume	no change	—

35. For the reaction; **Heat + $H_{2(g)}$ + $I_{2(g)}$ ↔ $2HI_{(g)}$**

A. How will an increase in temperature change the concentration of Hydrogen gas? decrease

B. How will an increase in pressure affect the system? no change

C. Which direction will the addition of Iodine gas shift the system? right What does this do to the concentration of Hydrogen gas? decrease

36. For the reaction $N_2O_4(g)$ + heat ←→ 2 $NO_2(g)$

a. List 2 stresses that you could apply to the equilibrium system to increase the 2 $NO_2(g)$:

- add heat
- add reactant
- remove product
- ↓ pressure
- ↑ volume

b. List 2 stresses that you could apply to the equilibrium system to increase the $N_2O_4(g)$:

- remove heat
- remove reactant
- add product
- ↑ pressure
- ↓ volume

Unit 8: Solutions

Vocab:

Dissociation equations
chemical equilibrium
homogeneous equilibrium
heterogeneous equilibrium
Le Chatelier's Principle
Ksp
Keq
Concentration
Insoluble
Molarity
Saturated solution
Solubility
Soluble
Solution
Solvation
Solvent
Solute
Supersaturated solution
Unsaturated solution
Dilution

37. Describe solute and solvent.

solute - being dissolved
solvent - does the dissolving

38. List the factors that affect solubility.

- temp
- agitation
- surface area

39. In general, the solubility of most solid substances increases as temperature increases. The solubility of gases, however, decreases as temperature increases. Pressure only changes the solubility of gases.

a) Describe the rule "Likes dissolves Like".

polar substances dissolve other polar substances

b) What type(s) of compounds are soluble in water.

polar substances, ionic compounds

c) Circle the chemical(s) that are soluble in water. Cross out the one(s) that are not.

Fe (iron) $MgCl_2$ C_5H_{10} SiO_2

40. Describe the three types of solutions. Include how you could determine which solution is which.

Saturated: no more solute can be dissolved, add a crystal & it remains unchanged

Unsaturated: more crystals will dissolve, add a crystal & it will dissolve

Supersaturated: more crystals than normal are in solution, add a crystal & more will grow

41. When you add more solvent to a solution, the solution becomes more dilute.

42. What unit do chemists use most often to describe concentration? Molarity (M)

43. Calculate the molarity for each of the following solutions:

a. 3.4 moles of NaCl dissolved in 0.956 L of water $\frac{3.4 \text{ mol}}{.956 \text{ L}} = 3.56 \text{ M}$

b. 1.28 g of $CuSO_4$ dissolved in 150 mL of water

$1.28 \text{ g } CuSO_4 \times \frac{1 \text{ mol } CuSO_4}{160 \text{ g } CuSO_4} = .008 \text{ mol}$

$\frac{.008 \text{ mol}}{.150 \text{ L}} = 0.053 \text{ M}$

44. **How would you prepare** 500 mL of 1.5 M NaCl from solid NaCl? Show any calculations needed.

45. A .600 L sample of a 2.50 M solution of KI contains what mass of KI?

$2.50 \text{ M} = \frac{X \text{ mol}}{.600} = 1.5 \text{ mol KI}$

$1.5 \text{ mol KI} \times \frac{166 \text{ g KI}}{1 \text{ mol}} = 249 \text{ g KI}$

$1.5 \text{ M} = \frac{X \text{ mol}}{.500 \text{ L}} =$

$.75 \text{ mol NaCl} \times \frac{58 \text{ g}}{1 \text{ mol}} = 43.5 \text{ g NaCl}$

.75 mol NaCl

46. What is the volume of 0.1250 M solution of $AgNO_3$ that contains 1.75 moles of solute.

$\frac{0.1250M}{1} = \frac{1.75mol}{XL}$ $= 14L$

47. How many mL of 2.0 M KOH stock solution do you need to prepare 100 mL of 0.40 M KOH.

$M_1V_1 = M_2V_2$

$2.0 \cdot V_1 = 0.40M \cdot 100mL$ $V_1 = 20mL$

48. What would be the new molarity if you diluted 250 mL of 6.0 M HCl and up to 800 mL?

$M_1V_1 = M_2V_2$ $6.0M \cdot 250mL = XM \cdot 800mL$

$= 1.875M$

Unit 10: Acids and Bases

Vocab:

Arrhenius model	Conjugate acid-base pair	hydronium ion
Acid-base indicator	Conjugate base	neutralization reaction
Amphoteric (amphiprotic)	End point	pH
Bronsted-Lowry model	Equivalence point	pOH
Conjugate acid	K_w	titration

49. List 5 properties of acids and 5 properties of bases.

1) sour taste	1) bitter taste
2) pH < 7	2) slippery
3) not slippery	3) pH > 7
4) reacts w/ metals	4) doesn't react w/ metals
5) good conductors	5) good conductor

50. Describe the differences between an Arrhenius and a Bronsted-Lowry acid and base.

Arrhenius acid: H^+ as cation B-L acid: H^+ donor

Arrhenius base: OH^- as anion B-L base: H^+ acceptor

51. Identify the Bronsted-Lowry acid-base pairs in each of the following reactions. Label each substance (BB, BA, cb, ca).

a. NH_3 + H_2O <----> NH_4^+ + OH^- (BB, BA, CA, CB)

b. $HC_2H_3O_2$ + H_2O <----> $C_2H_3O_2^-$ + H_3O^+ (BA, BB, CA, CB)

52. Answer the following questions about electrolytes:

a) What is a strong electrolyte? strong acid/base that ionizes completely

b) What is a non-electrolyte? weak acid/base does not completely ionize

c) Give an example of each: strong electrolyte - HCl Non-Electrolyte - H_2S

53. Strong acids & bases dissociate (ionize) completely. weak acids & bases only slightly dissociate (ionize).

54. Circle the strong base and put a box around the strong acid.

HCl NH_3 CH_3COOH NaOH

55. What are the formulas for hydroxide OH^- and hydronium H_3O^+?

56. If the hydronium concentration of a solution is 2.34×10^{-3} M, what is the pH?

$pH = -\log(2.34 \times 10^{-3})$ $= 2.631$

57. If the concentration of $HClO_4$ is 0.00025 M, calculate the pH and pOH.

$-\log(.00025) = 3.6$ pH = 3.6

$14 - 3.6 = 10.4$ pOH = 10.4

58. What is the $[H^+]$ concentration of a solution with a pH of 2.687?

$[H^+] = 10^{-pH} = 10^{-2.687}$ $= 0.00206M$

59. Calculate the pH and the pOH for a 6.57×10^{-5} M solution of LiOH.

$-\log(6.57 \times 10^{-5}) = 4.18$ pOH = 4.18

$14 - 4.18 = 9.82$ pH = 9.82

60. An acid + a base yields a salt + H_2O. This type of reaction is called neutralization rxn.

61. The process used to find the concentration of an acid or a base is a titration.

62. What do we call it when the moles of acid = moles of base? equivalence point

63. What do we add to signal the end of the titration? indicator

64. For the following types of titrations, give the pH range for the equivalence point:

a) Weak acid-strong base pH > 7 b) Strong acid-strong base pH = 7 c) Strong acid- weak base pH < 7

65. Which indicator is best for a strong acid-strong base titration? Why?

one that changes just above or below pH = 7

66. If 25 mL of 0.20 KOH were used to titrate 15 mL of H_2SO_4, what is the molarity of the acid? You must first complete and balance the equation. Show your work for the calculation.

2 KOH + ____ H_2SO_4 → $K_2SO_4 + 2H_2O$

(25 mL, .20 M) (15 mL, x M)

$25\text{mL} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{.20\text{mol KOH}}{1\text{L}} \times \frac{1\text{mol } H_2SO_4}{2\text{mol KOH}} = \frac{.0025\text{mol } H_2SO_4}{.015\text{L}} = 0.167\text{M}$

67. 75.0 ml of .250M nitric acid, HNO_3, reacts with 25.5 ml of potassium hydroxide, KOH. What is the molarity of the base? Be sure to write a balanced chemical equation first.

$HNO_3 + KOH \rightarrow KNO_3 + H_2O$

(75.0 mL, .250 M) (25.5 mL, x M)

$75.0\text{mL} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{.250\text{mol } HNO_3}{1\text{L}} \times \frac{1\text{mol KOH}}{1\text{mol } HNO_3} = \frac{.01875\text{mol}}{.0255\text{L}} = 0.735\text{M}$

68. What is the molarity of $Ca(OH)_2$ solution if 30.5 ml of the solution is neutralized by 36.6 ml of .250 M HBr?

$Ca(OH)_2 + 2HBr \rightarrow 2H_2O + CaBr_2$

$Ca(OH)_2 + 2HBr \rightarrow CaBr_2 + 2H_2O$

(30.5 mL, x M) (36.6 mL, .250 M)

$36.6\text{mL} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{.250\text{mol HBr}}{1\text{L}} \times \frac{1\text{mol } Ca(OH)_2}{2\text{mol HBr}} = \frac{.00458\text{mol}}{.0305\text{L}}$

$= 0.15\text{M}$ $Ca(OH)_2$