

# Chemistry Semester 2 Review

KEY

## Unit 6 and 7: KMT and Gases, Thermochemistry

### Vocab:

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

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?

$$P = 1 \text{ atm} \quad R = 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$$

$$V = 2.50 \text{ L} \quad T = 273 \text{ K}$$

$$n = ? \text{ mol}$$

$$1 \cdot 2.50 = n \cdot 0.0821 \cdot 273$$

$$n = 0.112 \text{ mol}$$

10. Calculate the volume that 3.60 grams of H<sub>2</sub> gas will occupy at STP.

$$3.60 \text{ g H}_2 \times \frac{1 \text{ mol H}_2}{2 \text{ g H}_2} = 1.8 \text{ mol H}_2$$

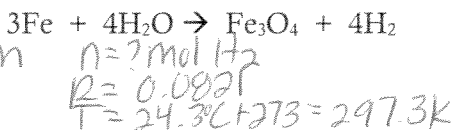
$$1 \cdot V = 1.8 \cdot 0.0821 \cdot 273$$

$$V = 40.3 \text{ L}$$

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.

$$P = 100.0 \text{ kPa} \times \frac{1 \text{ atm}}{101.3 \text{ kPa}} = .987 \text{ atm}$$

$$V = .500 \text{ L}$$



$$.987 \cdot .500 = n \cdot 0.0821 \cdot 297.3$$

$$n = .0202 \text{ mol H}_2$$

$$.0202 \text{ mol H}_2 \times \frac{3 \text{ mol Fe}}{4 \text{ mol H}_2} \times \frac{56 \text{ g Fe}}{1 \text{ mol}}$$

$$= 0.849 \text{ g Fe}$$

12. What does each of the symbols below represent?

- a)  $\Delta H$  - enthalpy (heat)  
b)  $\Delta S$  - 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
- b) Reactants have more energy than the products
- c)  $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$
- d)  $+\Delta\text{H}$
- e)  $-\Delta\text{H}$
- f) Water freezing

exothermic  
 endothermic  
 endothermic  
 endothermic  
 exothermic  
 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 ( $-\Delta\text{S}$  or  $+\Delta\text{S}$ )

- a)  $\text{CH}_3\text{OH}(\text{l}) \rightarrow \text{CH}_3\text{OH}(\text{g})$
- b)  $2\text{KClO}_3(\text{s}) \rightarrow 2\text{KCl}(\text{s}) + 3\text{Cl}_2(\text{g})$
- c)  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$

+ΔS  
+ΔS  
-ΔS

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  
 $255\text{kJ} - 335\text{kJ} = -80\text{kJ} \rightarrow$  exothermic ( $-\Delta\text{H}$ )

21. Predict the sign of  $\Delta\text{S}_{\text{system}}$  for the following changes and explain your answer:

a)  $\text{ClF}(\text{g}) + \text{F}_2(\text{g}) \rightarrow \text{ClF}_3(\text{g})$   $-\Delta\text{S}$ , less pieces

b)  $\text{C}_{10}\text{H}_8(\text{l}) \rightarrow \text{C}_{10}\text{H}_8(\text{s})$   $-\Delta\text{S}$ , 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  
 K<sub>sp</sub>  
 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  $4\text{HCl}_{(g)} + \text{O}_{2(g)} \leftrightarrow 2\text{Cl}_{2(g)} + 2\text{H}_2\text{O}_{(g)}$

$$K_{eq} = \frac{\text{products}}{\text{reactants}} = \frac{[\text{Cl}_2]^2 [\text{H}_2\text{O}]^2}{[\text{HCl}]^4 [\text{O}_2]}$$

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  $2\text{NO}(g) + \text{O}_2(g) \leftrightarrow 2\text{NO}_2(g)$  produces the following concentrations:  $[\text{NO}] = 3.49 \times 10^{-4} \text{ M}$ ;  $[\text{O}_2] = 0.80 \text{ M}$ ;  $[\text{NO}_2] = 0.250 \text{ M}$ . Write the equilibrium constant expression for the reaction, & calculate the value of the equilibrium constant.

$$K_{eq} = \frac{[\text{NO}_2]^2}{[\text{NO}]^2 [\text{O}_2]} = \frac{[0.250]^2}{[3.49 \times 10^{-4}]^2 [0.80]} = 641,415 \text{ or } 6.41 \times 10^5$$

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

34. For the reaction given, complete the following table:  $\text{C}(s) + \text{H}_2\text{O}(l) + \text{heat} \leftrightarrow \text{CO}(g) + \text{H}_2(g)$

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	no change
Removing H <sub>2</sub>	right	increase
Decreasing volume	no change	no change

35. For the reaction;  $\text{Heat} + \text{H}_{2(g)} + \text{I}_{2(g)} \leftrightarrow 2\text{HI}_{(g)}$

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  $\text{N}_2\text{O}_4(\text{g}) + \text{heat} \leftrightarrow 2 \text{NO}_2(\text{g})$

a. List 2 stresses that you could apply to the equilibrium system to increase the  $2 \text{NO}_2(\text{g})$ :

- add heat      - remove product      -  $\uparrow$  volume  
 - add reactant      -  $\downarrow$  pressure

b. List 2 stresses that you could apply to the equilibrium system to increase the  $\text{N}_2\text{O}_4(\text{g})$ :

- remove heat      - add product      -  $\downarrow$  volume  
 - remove reactant      -  $\uparrow$  pressure

### Unit 8: Solutions

#### Vocab:

Dissociation equations

chemical equilibrium

homogeneous equilibrium

heterogeneous equilibrium

Le Chatelier's Principle

$K_{sp}$

$K_{eq}$

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      - surface area  
 - agitation

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<sub>2</sub>

~~C<sub>5</sub>H<sub>10</sub>~~

SiO<sub>2</sub>

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

$$\frac{3.4 \text{ mol}}{0.956 \text{ L}} = 3.56 \text{ M}$$

b. 1.28 g of CuSO<sub>4</sub> dissolved in 150 mL of water

$$1.28 \text{ g CuSO}_4 \times \frac{1 \text{ mol CuSO}_4}{160 \text{ g CuSO}_4} = 0.008 \text{ mol}$$

$$\frac{0.008 \text{ mol}}{0.150 \text{ L}} = 0.053 \text{ M}$$

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?

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

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

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

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

$$.75 \text{ mol NaCl}$$

46. What is the volume of 0.1250 M solution of  $\text{AgNO}_3$  that contains 1.75 moles of solute.

$$\frac{0.1250 \text{ M}}{1} = \frac{1.75 \text{ mol}}{x \text{ L}} \quad \boxed{= 14 \text{ L}}$$

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

$$M_1 V_1 = M_2 V_2$$

$$2.0 \cdot V_1 = 0.40 \text{ M} \cdot 100 \text{ mL}$$

$$\boxed{V_1 = 20 \text{ mL}}$$

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

$$M_1 V_1 = M_2 V_2$$

$$6.0 \text{ M} \cdot 250 \text{ mL} = x \text{ M} \cdot 800 \text{ mL}$$

$$\boxed{= 1.875 \text{ M}}$$

### Unit 10: Acids and Bases

#### Vocab:

Arrhenius model

Acid-base indicator

Amphoteric (amphiprotic)

Bronsted-Lowry model

Conjugate acid

Conjugate acid-base pair

Conjugate base

End point

Equivalence point

$K_w$

hydronium ion

neutralization reaction

pH

pOH

titration

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

- 1) sour taste
- 2)  $\text{pH} < 7$
- 3) not slippery
- 4) reacts w/ metals
- 5) good conductors

- 1) bitter taste
- 2) slippery
- 3)  $\text{pH} > 7$
- 4) doesn't react w/ metals
- 5) good conductor

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

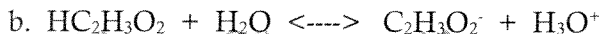
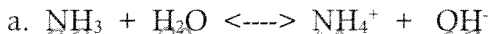
Arrhenius acid:  $\text{H}^+$  as cation

B-L acid:  $\text{H}^+$  donor

Arrhenius base:  $\text{OH}^-$  as anion

B-L base:  $\text{H}^+$  acceptor

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



52. Answer the following questions about electrolytes:

- What is a strong electrolyte? strong acid/base that ionizes completely
- What is a non-electrolyte? weak acid/base does not completely ionize
- Give an example of each: strong electrolyte - HCl Non-Electrolyte - H<sub>2</sub>S

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

$\text{NH}_3$

$\text{CH}_3\text{COOH}$

NaOH

55. What are the formulas for hydroxide  $\text{OH}^-$  and hydronium  $\text{H}_3\text{O}^+$ ?

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

$$\text{pH} = -\log(2.34 \times 10^{-3}) = \boxed{2.63}$$

57. If the concentration of  $\text{HClO}_4$  is 0.00025 M, calculate the pH and pOH.

$$-\log(0.00025) = 3.6$$

$$14 - 3.6 = 10.4$$

$$\boxed{\text{pH} = 3.6}$$

$$\boxed{\text{pOH} = 10.4}$$

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

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

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

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

$$14 - 4.18 = 9.82$$

$$\boxed{\begin{matrix} \text{pOH} = 4.18 \\ \text{pH} = 9.82 \end{matrix}}$$

60. An acid + a base yields a salt + H<sub>2</sub>O. 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

$$\text{pH} > 7$$

b) Strong acid-strong base

$$\text{pH} = 7$$

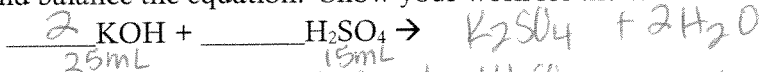
c) Strong acid-weak base

$$\text{pH} < 7$$

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

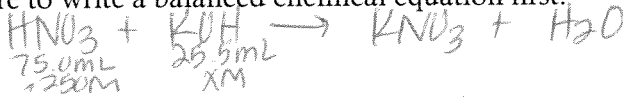
one that changes just above or below  $\text{pH} = 7$

66. If 25 mL of 0.20 KOH were used to titrate 15 mL of H<sub>2</sub>SO<sub>4</sub>, what is the molarity of the acid? You must first complete and balance the equation. Show your work for the calculation.



$$25 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.20 \text{ mol KOH}}{1 \text{ L}} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol KOH}} = \frac{0.0025 \text{ mol H}_2\text{SO}_4}{0.015 \text{ L}} = 0.167 \text{ M}$$

67. 75.0 ml of .250M nitric acid, HNO<sub>3</sub>, 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.



$$75.0 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.250 \text{ mol HNO}_3}{1 \text{ L}} \times \frac{1 \text{ mol KOH}}{1 \text{ mol HNO}_3} = \frac{0.01875 \text{ mol}}{0.0255 \text{ L}} = 0.735 \text{ M}$$

68. What is the molarity of Ca(OH)<sub>2</sub> solution if 30.5 ml of the solution is neutralized by 36.6 ml of .250 M HBr?  
Ca(OH)<sub>2</sub> + 2HBr → 2H<sub>2</sub>O + CaBr<sub>2</sub>



$$36.6 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.250 \text{ mol HBr}}{1 \text{ L}} \times \frac{1 \text{ mol Ca(OH)}_2}{2 \text{ mol HBr}} = \frac{0.00458 \text{ mol}}{0.0305 \text{ L}}$$

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