Accelerated Semester 2 Review   **Name:** _____ **Per.** ____

The performance task (22 points) will be taken in class on Tuesday, May 30th. The 62 multiple choice question test will be taken on Wednesday, May 31ˢᵗ for periods 4-7 and Thursday, June 1ˢᵗ for periods 1-3.

A. Unit 11-Acids and Bases

Vocabulary: Review the following vocabulary. Look up and write the definition for any words you do not know.

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

Unit Objectives:
- Distinguish between acids and bases as defined by Arrhenius and Bronsted-Lowry
- Distinguish between strong and weak acids and bases
- Explain the concept of neutralization & discuss how titrations can be used with acids and bases in neutralization reactions
- Explain and calculate pH and pOH (using H^+ and OH^- concentrations)
- Explain how buffers resist changes in pH

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

   1)   1)

   2)   2)

   3)   3)

   4)   4)

   5)   5)

2. _____ acids & bases dissociate (ionize) completely. _____ acids & bases only slightly dissociate (ionize).

3. On the periodic table, where are you most likely to find a strong acid? List the strong acids.

4. On the periodic table, where are you most likely to find a strong base? List the strong bases.

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

6. Identify the Bronsted-Lowry acid-base pairs in each of the following reactions. Label each substance.

   a. $NH_3 + H_2O \longleftrightarrow NH_4^+ + OH^-$ b. $HC_2H_3O_2 + H_2O \longleftrightarrow C_2H_3O_2^- + H_3O^+$

7. What are the formulas for hydroxide _____ and hydronium _____?

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

9. If the concentration of HNO_3 is .00025M calculate the pH and pOH.

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

11. Calculate the pH and the pOH for a 6.57×10^{-9} M solution of LiOH.

12. An acid + a base yields a _____ + _____. This type of reaction is called _____.

13. The process used to find the concentration of an acid or a base is a _____.

14. If 25 mL of 0.20 M 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. _____KOH + _____H_2SO_4 →

   a. Which substance is the titration standard? _____

   b. What must be added to signal the end of the titration? _____

   c. How do we choose an appropriate substance to signal the end of a titration? _____

   d. What do we call it when the moles of acid = moles of base? _____

15. Circle the strong base and put a box around the strong acid.
       ▪ HCl   NH3   CH3COOH   NaOH

16. For the following types of titrations, give the pH range for the equivalence point:
       ▪ Weak acid-strong base _____
       ▪ Strong acid-strong base _____
       ▪ Strong acid- weak base _____

17. 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.

18. 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?
$$Ca(OH)_2 + 2HBr → 2H_2O + CaBr_2$$

B.Unit 9-Solutions
Vocabulary: Review the following vocabulary. Look up and write the definition for any words you do not know.

Alloy	Insoluble	Solvation
Boiling point elevation	Miscible	Solvent
Colligative property	Molarity	Solute
Concentration	Saturated solution	Supersaturated solution
Dilution	Solubility	Suspension
Freezing Point depression	Soluble	Unsaturated solution
Immiscible	Solution	

Unit Objectives
- Discuss the factors affecting solubility and rate of dissolving one substance in another
- Use polarity of molecules to relate solubility of substances
- Describe the characteristics of a solution
- Calculate concentrations of solutions

19. Describe solute and solvent.

20. List the factors that affect solubility.

   1)

   2)

   3)

21. In general, the solubility of most solid substances _____ as temperature increases. The solubility of gases, however, _____ as temperature increases.

22. Describe the rule "Likes dissolves Like".

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

24. Describe the three types of solutions.
   Saturated:

   Unsaturated:

   Supersaturated:

25. When you add more solvent to a solution, the solution becomes more _____.

26. What unit do chemists use most often to describe concentration? _____

27. Calculate the molarity of 0.205 L of solution that contains 63.8 g of NaOH.

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

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

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

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

32. What is a colligative property?

33. What do colligative properties depend on?

3

34.   How is the boiling point of water affected when a solute is added? _____ How about the freezing point?_____

35. List in order which compound with equal concentrations has the greatest affect on raising the boiling point of a solution: NaCl, sugar ($C_{12}H_{22}O_{11}$), $CaCl_2$. **Why?**

36.   Explain why a solution has a lower freezing point than a pure solvent. Why does its boiling point also increase?

37.   What is an electrolyte? _____

38.   What is a nonelectrolyte?_____

39.   Give an example of each: Electrolyte- _____   Nonelectrolyte- _____

40.   Use the phase diagram to answer the following 4 questions:
        a.   Label the following on the phase diagram below: Solid phase, liquid phase, gas phase, triple point, critical point.
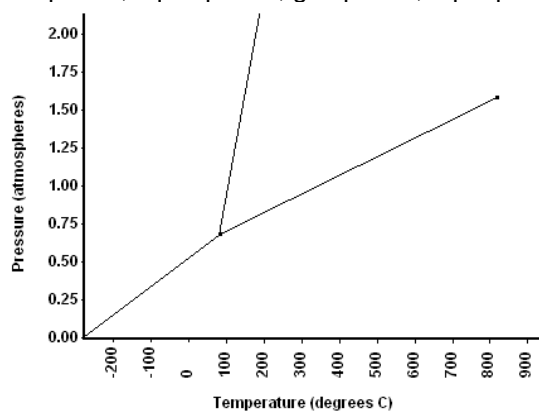
        b.   What is the normal melting point of this substance?

        c.   What is the normal boiling point of this substance?

        d.   What is the normal freezing point of this substance?

C. Unit 10-Equilibrium & Rates
Vocabulary: Review the following vocabulary. Look up and write the definition for any words you do not know.

Dissociation equations	chemical equilibrium	Le Chatelier's Principle
reversible reaction	homogeneous equilibrium	K_{sp}
completion reaction	heterogeneous equilibrium	K_{eq}

Unit Objectives
- Describe the characteristics of chemical equilibrium
- Use LeChatelier's principle to predict the direction of reversible reactions
- Calculate K_{sp} and K_{eq}

41.   Using the experimental data provided, determine the order of reaction with respect to each reactant, the rate law equation, and the overall order of reaction.
CO (g) + Cl_2 (g) → $COCl_2$ (g)
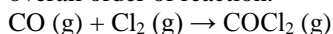
Experiment	Initial Concentration (mol/L)		Initial Rate (mol/L•s)
	CO	Cl	
1	0.12	0.20	0.121
2	0.24	0.20	0.241
3	0.12	0.40	0.483

4

42. A double arrow signifies a _____ reaction, while a single arrow signifies a _____ reaction.

43. What causes a reaction to go to completion? The evolution of a _____ or the formation of a _____.

44. _____ explains how an equilibrium system will respond to stress.

45. Describe chemical equilibrium. Give an example.

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

47. If you calculate a small number (less than 1) for the constant expression above, what does that tell you?

48. 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.

49. For the reaction given, complete the following table: $C(s) + H_2O(l) + heat \leftrightarrow CO(g) + H_2(g)$

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

50. For the reaction; **Heat + $H_{2(g)}$ + $I_{2(g)}$ $\leftrightarrow$ $2HI_{(g)}$**
   A. How will an increase in temperature change the concentration of Hydrogen gas? _____
   B. How will an increase in pressure affect the system? _____
   C. Which direction will the addition of Iodine gas shift the system? _____What does this do to the concentration of Hydrogen gas? _____

51. For the reaction **$N_2O_4(g) + heat \leftrightarrow 2NO_2(g)$**
      a. List 2 stresses that you could apply to the equilibrium system to increase the 2 NO_2 (g):

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

52. What is dissociation? Write and balance the equation for the dissociation of Na_3PO_4.

53. Write the K_{sp} expression for the dissociation of AgBr (s) and calculate the concentration of [Ag] if the K_{sp} value for AgBr is 5.4×10^{-13}. What does this K_{sp} value tell you about the reaction?

54. What is the K_{sp} for AgCl if the concentration of silver ions is 1.25×10^{-16} M?

D. Unit 10 – Reaction Rates

Vocabulary: Review the following vocabulary. Look up and write the definition for any words you do not know.

Activated complex

Activation energy

Collision theory

Reaction rate

Transition state

Catalyst

Unit Objectives
- Distinguish between exo- and endothermic reactions and determine heat of reactions
- Identify and describe factors that influence the rate of reaction

55. 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:

56. What is a catalyst? How is an enzyme like a catalyst? How do catalysts work?

57. In order for a reaction to occur, the reactants must _____ with enough _____ and the correct

_____. This will create an _____ _____ which can form product.

58. The amount of energy needed for an effective collision is called the _____ _____.

59. What happens to the rate of a chemical reaction over time? _____

60. 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.

E. Unit 8 – Energy and Chemical Changes

Vocabulary: Review the following vocabulary. Look up and write the definition for any words you do not know.

calorie

calorimeter

chemical potential energy

energy

enthalpy

enthalpy (heat) of combustion

enthalply (heat) of reaction

entropy

free energy

heat

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

Thermochemical equation

Thermochemistry

Universe

Unit Objectives
- Explain how changes in enthalpy, entropy, and free energy affect the spontaneity of chemical reactions and other processes.
- Write thermal equations and use them to calculate changes in enthalpy.
- Distinguish between exothermic and endothermic reactions
- Measure and calculate the energy involved in chemical changes.

61. Reactions that tend to be spontaneous have (negative, positive).
    a. ΔH _____
    b. ΔS _____
    c. ΔG _____

62. Define entropy, enthalpy and free energy.

63. Describe an endothermic and exothermic reaction.

64. In nature, do things tend to become more organized or more disordered? How is this related to entropy?

65. 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.

66. Predict the sign of ΔS_{system} for the following changes and explain your answer:
    a. ClF (g) + F_2 (g) → ClF_3 (g)

    b. $C_{10}H_8$ (l) → $C_{10}H_8$ (s)

67. Given ΔH_{system}, T, and ΔS_{system}, determine if the following process is spontaneous or non-spontaneous: ΔH_{system} = -75.9 kJ, T = 273 K, and ΔS_{system} = 138 J/K.

68. Is the following reaction spontaneous at 456 K? If not, is it spontaneous at some other temperature? Explain your answer.
    N_2 (g) + 2 O_2 (g) → 2 NO_2 (g) ΔH = 68 kJ and ΔS = -122 J/K

F. Unit 7-Gas Laws

Vocabulary: Review the following vocabulary. Look up and write the definition for any words you do not know.

Avogadro's Principle	Ideal gas constant	Pascal
STP	Barometer	Pressure
Combined gas law	Dalton's law	Dipole-dipole forces
Molar volume	Diffusion	Dispersion forces
Ideal gas law	Kinetic-molecular theory	Hydrogen bond

Unit Objectives
- Explain the concept of an ideal gas and perform calculations
- Use stoichiometry to convert between substances in chemical reactions
- Use the kinetic-molecular theory to describe the behavior of gases

69. What are the four variables that describe a gaseous system?

    1.   2.   3.   4.

70. Temperature must _always_ be in _____ when calculating gas law problems.

    a. 24°C = _____ Kelvin

    b. 392 K = _____ Celsius

71. Standard pressure = _____ atm = _____ kPa = _____ mmHg

72. Standard temperature = _____ K = _____ degrees Celsius.

73. When the amount of gas in a container increases the pressure _____ **because**....

74. When the temperature of a gas increases its volume will _____ if the pressure is kept constant **because**....

75. When you increase the volume on a sample of gas the pressure will _____ **because**...

76. Answer the following questions with INVERSELY or DIRECTLY.
    a. How are pressure and temperature related? _____
    b. Pressure and Volume? _____
    c. Volume and Temperature? _____

77. Write the formula for the combined gas law.

78. 150 mL of oxygen has a pressure of 752 mm Hg at 22°C. Calculate its volume at STP.

7

79. If 51.30 Liters of a gas is collected at a pressure of 59.0 kPa and 290 K, what volume will the same gas occupy at 101.3 kPa if the temperature drops to 274K?

80. If the volume of a gas is 26ml at 24.8 degrees Celsius and 1.3 atm, what will the temperature be in Celsius when the balloon is at 1.5 atm and 15 mL?

81. How many moles of a gas will occupy 2.50L at STP?

82. Calculate the volume that 3.60 grams of H_2 gas will occupy at STP.

83. If a 0.500 g sample of gas occupies 255 mL at 25°C and a pressure of 1.10 atm, what is the molar mass of the gas?

84. 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 + 4H₂O → Fe₃O₄ + 4H₂**

85. What is an intermolecular force?   How do they affect the melting point of different substances?

86. What kinds of molecules exhibit hydrogen bonding and how does it contribute to the relatively high boiling point for water?

87.	London Dispersion Forces	Dipole-Dipole	Hydrogen Bonds
Definition			
This type of force would be found between what type of molecules?			
Rank these three forces from strongest to weakest and **explain why.**			

88.   Circle the chemicals that are soluble in water. Cross out the ones that are not.

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

G. Multiple Choice Review Questions: Choose the best answer to complete each question.

1. Which of the following has the lowest freezing point?
   - a. KBr
   - b. CCl_4
   - c. H_2O
   - d. NCl_3

2. Which of the following reactions has a decrease in entropy?
   - a. H_2O (l) → H_2O (g)
   - b. $2 O_3$ (g) → $3 O_2$ (g)
   - c. $CaCO_3$ (s) → CaO (s) + CO_2 (g)
   - d. $3 H_2$ (g) + N_2 (g) → $2 NH_3$ (g)

3. Which of the following has the highest boiling point?
   - a. Ammonia (NH_3)
   - b. Water (H_2O)
   - c. Lithium fluoride (LiF)
   - d. Methane (CH_4)

4. Solid sodium hydroxide is added to water in a sealed container. Which of the following statements is true?
   - a. Entropy and the total energy remain constant.
   - b. Entropy increases, total energy is constant.
   - c. Entropy decreases, total energy is constant.

5. For this reaction, which of the following statements is false? $H_3O^+ + CO_3^{2-} \leftrightarrow HCO_3^- + H_2O$
   - a. The carbonate ion is a Bronsted base
   - b. The bicarbonate ion is a conjugate acid
   - c. The hydronium ion is a Bronsted acid
   - d. The water is the conjugate acid

6. Which mixture is used to prepare 500 mL of a 0.20 M solution of sodium sulfate?
   - a. 14.2 g of solute dissolved to make 500 mL of solution
   - b. 14.2 g of solute dissolved in 500 mL of water
   - c. 28.4 g of solute dissolved in 1 L of water
   - d. 14.2 g of solute dissolved in 500 g of water

7. Which of the following has the lowest pH?
   - a. 0.10 M HCl
   - b. 0.10 M CH_3COOH
   - c. 0.10 M H_2CO_3
   - d. They are all the same

8. A solution of a monoprotic strong acid has a pH of 2.10. What is the concentration of the acid?
   - a. 0.00794
   - b. 0.00931
   - c. 0.110
   - d. 0.0202

9. For a strong acid-weak base titration, which indicator would be most appropriate?
   - a. Crystal violet (color change pH 0.5-1.5)
   - b. Methyl red (color change pH 5.0-5.7)
   - c. Bromthymol blue (color change pH 6.0-7.3)
   - d. Alizarin yellow (color change pH 10.3-11.8)

10. Which of the following does NOT contain hydrogen bonds?
    - a. Water, H_2O
    - b. Ammonia, NH_3
    - c. Acetic acid, CH_3COOH
    - d. Dimethyl either, CH_3OCH_3

11. If the volume of a sample of gas in a piston is decreased to one-third of its original value at constant temperature, which of the following will increase proportionally?
    - a. Celsius temperature
    - b. Pressure
    - c. Velocity of the molecules
    - d. kinetic energy

12. A gas sample in a piston container has a volume of 2.0 liters at 1.0 atm and 27 °C. The temperature is changed such that the volume is decreased to 1.2 liters and the pressure is increased to 5.0 atm. What Kelvin temperature is needed to produce this change?
    - a. 15.0K
    - b. 273 K
    - c. 623 K
    - d. 900K

13. A 1.0 liter flask is filled with a mixture of two gases at 20 °C until a pressure of 14.43 atm is established. If 0.40 grams of the mixture is hydrogen, how many moles are there of the other gas?
    - a. 0.20 moles
    - b. 0.30 moles
    - c. 0.40 moles
    - d. 0.50 moles

14. A 1.5 g sample of a gaseous hydrocarbon has a volume of 820 mL when measured at 227 °C and 2.50 atm. Which of the following is the formula for the gas?
    - a. CH_4
    - b. C_2H_6
    - c. C_3H_8
    - d. C_4H_{10}

15. Which of the following water solutions has the lowest freezing point?
    - a. 0.3 m sucrose
    - b. 0.20 m $CaCl_2$
    - c. 0.20 m NaCl
    - d. 0.20 m NH_4Cl

16. Which applies to the colligative properties of solutions?
        I.   They depend on the specific kind of particles in the solute.
        II.   They affect the boiling point of a solution.
        III.   They affect the freezing point of a solution.
    a.   II only   c.   II and III only
    b.   III only   d.   I, II, and III

17. Which of the following will increase the molar solubility of an ionic salt in water?
    a.   Stir the solution   c.   Crush the solute
    b.   Add more solute   d.   Heat the solution

18. Which of the following affects the boiling point of a liquid?
    a.   The intermolecular forces   c.   The mass
    b.   The volume   d.   The size of the particles

19. For the exothermic reaction $C_3H_8 + 5O_2 \rightarrow 3 CO_2 + 4 H_2O$, which of the following is true at all temperatures?
        I. $\Delta G < 0$
        II. $\Delta S > 0$
        III. $\Delta H > 0$
a.   I only   c.   III only
b.   II only   d.   I and II only

20. In the following reaction ΔH_f is zero for _____. $Ni (s) + 2 CO (g) + 2 PF_3 (g) \rightarrow Ni(CO)_2(PF_3)_2 (l)$
    a.   Ni (s)   c. PF_3 (g)
    b.   CO (g)   d.   Both CO (g) and PF_3 (g)

21. The value of ΔH for the reaction below is -72 kJ. _____ kJ of heat are released when 80.9 grams of HBr is formed.
        $H_2 (g) + Br_2 (g) \rightarrow 2 HBr (g)$
    a.   144   c.   36
    b.   72   d.   -72

22. The value of ΔH for the following reaction is -3351 kJ: $2 Al (s) + 3 O_2 (g) \rightarrow 2 Al_2O_3 (s)$. The value of ΔH_f for Al_2O_3 (s) is _____ kJ.
    a.   -3351   c.   -32.86
    b.   -1676   d.   +3351

23. The enthalpy of formation of a compound is -184 kJ/mol, and the products of its combustion have a total enthalpy formation of -1356 kJ. What is the enthalpy of combustion of this compound?
    a.   -1172   c.   +1172
    b.   -150   d.   -1892

24. Which of the following should have the lowest boiling point?
    a. PH_3 c. SiH_4
    b. H_2S d. H_2O

25. Which of the following derivatives of ethane has the highest boiling point?
    a. C_2Br_6 c. C_2I_6
    b. C_2F_6 d. C_2Cl_6

26. Which of the following has dispersion forces as its only intermolecular force?
    a. CH_4 c. NaCl
    b. HCl   d. CH_3Cl

27. The predominant intermolecular force in $CaBr_2$ is _____.
    a.   London- dispersion forces   c.   Dipole-dipole forces
    b.   Ion-dipole forces   d.   Ionic bonding

28. Of the following, _____ is an exothermic process.
    a.   Melting   c.   Freezing
    b.   Subliming   d.   Boiling