Review Final-Chem 111

1. Which of the following compounds will produce an acidic solution when dissolved in water?
a. NO_2 b. $NaClO_4$ c. K_2SO_3 d. Na_2O e. NaCN

2. Which of the following compounds will produce a basic solution when dissolved in water?
a.) K_2O b. HNO_3 c. NH_4Cl d. HBr e. KBr

3. For the equilibrium given below, list the two pairs of base/conjugate acid:
$HSO_3^- + HF \rightleftharpoons H_2SO_3 + F^-$
Answer:
a.

b.

4. Consider a saturated solution of CaF_2 (s). Which of the following may take place upon the addition of $Ca(NO_3)_2$? Circle **all** correct answers.
a. More CaF_2 (s) dissolves. b. More CaF_2 will precipitate .
c. The concentration of the fluoride ions will decrease.
d. The concentration of Ca^{2+} ions will increase.
e. The concentration of NO_3^- will have no effect on the solubility of CaF_2 (s).
f. All of the above will happen g. None of (a) to (e) will happen.

5. The equilibrium concentration of HSO_3^- is much higher than the equilibrium conc. of SO_3^{2-} in the reaction:

$$HSO_3^- + H_2O \rightleftharpoons \_\ SO_3^{2-} + H_3O^+$$

List two conjugate acid /base pairs and label each species as stronger or weaker acid or base.
a.

b.

6. A. Write the equilibrium equation for the solubility of $CaCO_3$ (s).

B. Circle **all** correct answers:
The molar solubility of $CaCO_3$(s) in a saturated solution can be decreased by:
a. Adding Na_2CO_3 b. Adding a strong acid c. Adding $CaCl_2$
d. Adding more $CaCO_3$ (s).

7. Fill in the table given below:

Unit cell	**Simple cube**	**Body centered cube**	**Face-centered cube**	**Hexagonal unit cell**
Number of particles inside the unit cell				
The coordination number				
Relative packing efficiency				
Relative Density				

(next page)

8. a. What are the structural components that exist in a compound for hydrogen bonding to take place?
Ans: _____, _____, or_____.
b. The intermolecular forces that exist between nonpolar molecules are called _____.
c. The intermolecular forces that exist between polar molecules are called _____ and _____.

9. What are the forces of attraction between the lattice points of a crystalline solid made of:
a. $MgCl_2$ b. SO_2 (bent geometry) c. Copper d. NH_3(pyramidal)

e. KBr f. CO_2 (linear)

10) a. What is the mass of one mole of cobalt atoms in grams? Ans: _____
b. What is the mass of one cobalt atom in amu? Ans: _____
c. What is the mass of one cobalt atom in grams? Show the set-up:

Ans: _____

11. a. Define 'solution': _____.

b. Is air a compound, an element , or a solution? _____

c. If you combine sand and water, are you preparing a new element, a new compound, or a solution? _____. Explain your answer. _____

_____

12. Write the chemical formulas of the following compounds:

a. sodium nitride_____ b. cobaltous phosphide_____

c. nickel (II) bisulfide_____ d. Antimony (III) bisulfite_____

e. lead (II) thiocyanate_____ f. Aluminum thiosulfate _____

13. How many moles of C_6H_6O contain 7.03×10^4 carbon atoms?
setup:

Answer: _____

14. a. Explain how particles of a hydrophobic sol remain dispersed without precipitating.
_____.

b. Heating may cause a hydrophobic sol to coagulate. Why? _____

_____

15. List three methods for coagulating a hydrophobic colloid.
a. _____

b. _____

c. _____

16. a. What kind of particles (atoms , molecules, cations, anions, or cations and anions) may occupy the lattice points in each of the crystalline solids given below.
b.Give one or two examples of an element or a compound that may exhibit each type of crystalline solids.

Type of crystalline solid	**metallic crystal**	**ionic crystal**	**covalent network crystal**	**molecular crystal**
Kind of particles				
Give one or two examples of an element or a compound.				

17. Which of the 0.010 m solution given below :
K_3PO_4 , C_2H_6O(alcohol) , HCN , NaOH, $(NH_4)_2SO_4$

would have:
a. The highest boiling point _____

b. The lowest freezing point. _____

Explain your answer. _____

18. a) Define :
i. critical temperature:

ii. normal boiling point:
_____

b. Draw a typical vapor pressure-temperature phase diagram for water. Label the axes and the regions on the diagram where H_2O is expected to be in the solid, liquid, and gaseous state. Indicate on the diagram the normal boiling point, the normal freezing point, the triple point and the critical temperature.

19. What is the term used for a colloidal dispersion of :
a. solid dispersed in liquid _____ b. gas dispersed in liquid_____

c. liquid dispersed in liquid_____ d. solid dispersed in gas_____

e. liquid dispersed in gas _____ f. gas dispersed in solid _____

20. A. What is the approximate size range of colloidal particles in nm (nanometer)? _____
B. List <u>five</u> characteristic properties of colloids:
a.

b.

c.

d.

e.

21. **Circle** any solution that may be considered as a buffer. Justify your answer by listing all particles present in the solution after the reaction goes to completion, if any.

<u>Particles present after reaction</u>

a. One mole ammonium fluoride plus one mole of HBr. **a.** _____

b. One mole of formic acid, $HCHO_2$, plus 0.5 mole of KOH. **b.** _____

c. One mole of ammonia plus one mole of LiOH. **c.** _____

d. One mole of formic acid, $HCHO_2$, plus one mole of HCl. **d.** _____

22. a. Give the equation that shows the relationship between K_p and K_c. Define ' n ' given in your equation.
<u>Answer:</u>

b. The equilibrium reaction given below is **exothermic**.

$$A\ (g) + B\ (g) \rightleftharpoons C\ (g) + D\ (g)$$

Circle any factor given below that will cause the above equilibrium to shift to the right.
a. Removal of 'A'. b. The addition of 'D'
c. Removal of 'C'. d. Increasing the temperature
e. Increasing the volume of the container.

23. Which of the molecules given below is <u>nonpolar</u>?
a. CH_4 (tetrahedral) b. PF_3 (pyramidal) c. HBr d. H_2S (bent)

24 What is the solubility product expression, K_{sp}, for $Fe_3(PO_4)_2$?
<u>Answer:</u>

25. How many moles of chlorine atoms are needed to combine with 28.88 moles of oxygen atoms to produce Cl_2O_7 ?
Setup:

26. A. Define:
a. Electronegativity:

b. Electron affinity

c. ionization energy:

B. Give the general trend for the variation of the above properties by filling in the table given below:

	Electronega-tivity	**Electron affinity**	**Ionization energy**	**Metallic property**
From left to right across a period				
Down a group				

27. A. Give the definitions of acids, bases, and acid-base reactions by filling in the table below:

	An acid	**A base**	**An acid-base reaction**
According to Arrhenius			
According to Bronsted-Lowry			
According to Lewis			

B. i. What is the conjugate acid for NH_3. ____

ii. What is the conjugate base for NH_3 _____

iii. What is the conjugate acid for H_2O._____

iv. What is the conjugate base for H_2O. _____

28. a) When heat is added to a mixture of ice and water at 0 °C, the temperature remains unchanged for a while. Why? _____
_____.

b. When will the temperature of the water start to increase? _____
_____.

29. a. Is the pressure of the atmosphere higher on the mountain or in the valley? _____.

b. The higher the external pressure (atmospheric pressure), the _____ the boiling point
(higher , or lower)
of a liquid.
c. The higher the temperature, the _____ the vapor pressure of a liquid.
(higher, or lower)
d. The stronger the intermolecular forces, the _____ the normal boiling point.
(higher, or lower)

30. What factor changes the numerical value of the equilibrium constant, K, for a particular reaction? _____.

31. How are real gases different from ideal gases?
a. _____
b._____
c. _____

32. The behavior of a real gas may approach that of an ideal gas at a _____
temperature (high, or low)

and a _____pressure.
(high, or low)

33. Balance the following equations:

a. C_7H_{14} + O_2 → CO_2 + H_2O

b. $Ca(OH)_2$ + Na_3PO_4 → $Ca_3(PO_4)_2$ + NaOH

34. A. A n ion-exchange (double-displacement) reaction may go to completion due to the formation of any of the following three classes of compounds:
a. _____ b. _____ c. _____

B. In a double-displacement reaction, formation of which of the compounds listed below would **not** necessarily lead to a chemical change? (Hint: You must memorize the solubility rules and the list of strong acids and bases)
a. CO_2 b. NH_3 c. AgBr d. $HCHO_2$ e. H_2O f. $Co(OH)_3$
g. $PbCl_2$ h. Na_2CO_3

C. In a double-displacement reaction, formation of which of the compounds listed below would lead to a chemical change? (Hint: You must memorize the solubility rules and the list of strong acids and bases)

a. HNO_3 b. LiOH c. K_3PO_4 d. $(NH_4)_2SO_4$ e. $BaSO_4$

35. Name the following acids:
a. HIO_2 _____ b. HI _____
c. HBrO _____ d. HCN _____
e. HF _____ f. $HBrO_3$ _____

36. The molar solubility of $CaF_2(s)$ in a saturated solution can be <u>increased</u> by adding:
a. $CaCl_2$ b. NaF c. HBr d. none of these
(<u>Hint</u>: You need to write the equilibrium equation for the solubility of CaF_2 given above)

37. When barium chloride is added to a saturated solution of $BaSO_4(s)$, which of the following will result?(<u>Hint</u>: Write the equilibrium equation for the solubility of $BaSO_4$ (s).)

a. The concentration of SO_4^{2-} will increase.
b. The concentration of Ba^{2+} in solution will not change.
c. The added $BaCl_2$ will not dissolve and will settle to the bottom of the container.
d. More $BaSO_4$ (s) will precipitate.
e. All of the above will take place.

38. A mixture containing 25.53 g $CaCl_2$ and 19.38 g Na_2CO_3 is allowed to react according to the reaction given below:
(molar mass: $AlCl_3$= 133.5, Na_2CO_3 = 106, NaCl= 58.5 , $Al_2(CO_3)_3$ = 234)

$$2\ AlCl_3 + 3\ Na_2CO_3 \rightarrow 6\ NaCl + Al_2(CO_3)_3$$

a. How many grams of NaCl are produced?
Setup:

Answer: 21.4 g NaCl

b. Find the mass of any reacted $AlCl_3$ or Na_2CO_3 assuming 100 % yield.
Setup:

Answer: 9.23 g

39. How many grams of oxalic acids, $H_2C_2O_4$, are required to completely neutralize 35.0 ml of 0.670 M NaOH ? (molar mass: $H_2C_2O_4$ = 90.0, NaOH = 40.0, $Na_2C_2O_4$ =134.0, H_2O = 18.0)

$$H_2C_2O_4 + 2\ NaOH \rightarrow Na_2C_2O_4 + 2\ H_2O$$

Setup:

Answer: 1.06 g

40. What is the mole fraction of ethylene glycol, $C_2H_6O_2$, in 5.55 m ethylene glycol solution? (molar mass of ethylene glycol = 62.0, H_2O = 18.0)
Setup:

Answer: 0.091

41. The following equilibrium was achieved in a 3.00 liter container.

$NH_4HS\ (s) \rightleftharpoons NH_3\ (g) + H_2S\ (g)$

At equilibrium, there were 0.20 mole NH_4HS (s), 0.45 mole NH_3 (g) , and 2.11 mole H_2S (g) . Calculate K_c under these conditions.

Setup:

Answer: 0.11

42. The density of an unknown gas is 2.89 g/liter at 33 °C and 745 torr. Calculate the molar mass of the unknown gas. (R= 0.0821 L.atm/mol.K)

Setup:

Answer: 74.0 g/mole

43. For the equilibrium:

$CH_4\ (g) + H_2O\ (g) \rightleftharpoons CO\ (g) + 3\ H_2\ (g)$

at 1500 °C, K_c is 5.67. What is K_p for the equilibrium at 1500 °C?

Setup:

Answer: 825

44. For the equilibrium:

$CH_3OH\ (g) \rightleftharpoons CO\ (g) + 3\ H_2\ (g)$

at 275 °C , K_p is 1.14×10^3 . What is K_c for the equilibrium at 275 °C ?

Setup:

Answer: 0.0125

45. What is the molar solubility of MgF_2 in a 0.20 M NaF? (K_{sp} for $MgF_2 = 8.0 \times 10^{-8}$)

(Hint: Write the equilibrium equation for the solubility of MgF_2)

Setup:

Answer: 2.0×10^{-6} M

46. What is the pH of a 0.0030 M HNO_3 solution?

Setup:

Answer: 2.52

47. What is the $[H^+]$ of a solution which is 0.15 M HNO_2 and 0.75 M $NaNO_2$?
(K_a for $HNO_2 = 4.5 \times 10^{-4}$)
Setup:

Answer: 9.0×10^{-5}M

48. What is the $[OH^-]$ of a solution which is 0.080 M $(CH_3)_2NH$ and 0.32 M $(CH_3)_2NH_2Cl$?
[K_b for $(CH_3)_2NH$ is 7.4×10^{-4}]
Setup:

Answer: 1.9×10^{-4}M

49. What is the concentration of the H^+ ion in a 0.30 M HCN? (K_a for HCN = 4.0×10^{-10})
Setup:

Answer: 1.1×10^{-5}M

50. Draw the Lewis structure (electron-dot structure) for the following molecules and ions:
a. CO_2 b. PO_3^{3-} c. CO_3^{2-} d. H<u>C</u>N
(C is the central atom)

51. The addition of 8.83 g $C_{12}H_{22}O_{11}$ (a nonionizing compound) to a 125 ml of water at 23 °C resulted in 143 ml solution. (The density of water at 23 °C is 1.00g/ml; molar mass: $C_{12}H_{22}O_{11}$ =342.0, H_2O= 18.0)

a. Calculate the molarity of the solution.

Setup:

Answer: 0.181 M

b. Calculate the molality of the solution.

Setup:

Answer: 0. 206

c. Find the freezing point of the solution given above. (K_f for water = 1.86 °C.kg/mole)

Setup:

Answer: -0.384 °C

52. Consider the following equilibria:

$H_2CO_3 + H_2O \rightleftharpoons H_3O^+ + HCO_3^-$ $\quad K_{a1} = 4.2 \times 10^{-7}$

$HCO_3^- + H_2O \rightleftharpoons H_3O^+ + CO_3^{2-}$ $\quad K_{a2} = 4.2 \times 10^{-11}$

a. What is the hydrogen ion concentration, $[H^+]$, in a 0.300 M solution of H_2CO_3 ?

Setup:

Answer: 3.5×10^{-4} M

b. What the carbonate ion concentration, $[CO_3^{2-}]$, in the above 0.300 M H_2CO_3 ?

Answer: 4.2×10^{-11} M

53. The pH of a 0.20 M weak monoprotic acid, HX, is 4.60. Calculate the ionization constant, K_a, for this acid.

Setup:

Answer: 3.0×10^{-9}

54. What would be the ionization constant, K_a, of a weak monoprotic acid, HX, if it is 5.0 % ionized in a 0.18 M solution?
Setup:

Answer: 4.7×10^{-4}

55. A compound contains 1.55 g phosphorus and 1.20 g oxygen. Calculate the simplest formula of the compound.
Setup:

Answer: P_2O_3

56. Calculate the molarity of a solution made by diluting 8.00 ml of 15.00 M H_3PO_4 to a 0.500 L.
Setup:

Answer:0.240 M

57. What would be the H^+ concentration of a solution resulting from mixing 35.0 ml of 0.20 M HCl and 35.0 ml of 0.15 M NaOH ?
Setup:

Answer: 0.024 M

58. What is the mass of CO_2 (g) collected in a 580 ml flask at 50 °C and 1.50 atm ?
(R= 0.0821 L.atm/mol.K)
Setup:

Answer: 1.44 g

59. What is the density of NH_3 (g) at 100 °C and 1.35 atm? (R= 0.0821 L.atm/mol.K)
Setup:

Answer: 0.749 g

60. Consider the following reaction:

$$2\ C_2H_6\ (g) + 7\ O_2\ (g) \rightarrow 4\ CO_2\ (g) + 6\ H_2O\ (g)$$

a. What volume of oxygen gas is required for the complete combustion of 15.0 L of ethane, C_2H_6 (g), if all gases are measured at the same temperature and pressure?

Setup:

Answer: 52.5 L

b. What volume of oxygen gas is required for the complete combustion of 15.0 L of ethane, C_2H_6 (g), if all gases are measured at STP condition?

Setup:

Answer: 52.5 L

61. How many grams of Fe(s) are needed to produce 100. L of H_2 (g), measured at STP?

$$3\ Fe\ (s) + 4\ H_2O\ (g) \rightarrow Fe_3O_4\ (s) + 4\ H_2\ (g)$$

(molar mass: Fe = 55.8, = 231.4, H_2O = 18.0, H_2 = 2.00)

Setup:

Answer: 187 g Fe

62. 350 ml of Ar (g) at 30 °C and 1.50 atm are mixed with 540 ml of N_2 (g) at 50 °C and 0.80 atm. The two gases do not react. What would be the total pressure, if the two gases were transferred to a 2.50 L flask at 80°C. (R= 0.0821 L.atm/mol.K; molar mass:Ar = 39.95, N_2 = 28.0)

Setup:

Answer: 0.435 atm

63. A mixture of 40.0 g oxygen gas and 40.0 g helium gas exerts a total pressure of 0.900 atm . What is the partial pressure of the oxygen gas? (molar mass of O_2= 32.0 , He = 4.00)

Setup:

Answer: 0.100 atm