Name:_____ **August 6, 2007**
STEM Chemistry – Ms. Ally **City College – Mr. Marte**

FINAL EXAMINATION [100 points]

***SECTION 1:* [30 points] Directions: Select the best answer choice and fill in the corresponding oval on the answer sheet. You may use the Periodic Table provided.**

1. Which is the following statements about nuclear stability is correct?

   A. Heavier, more stable nuclei have somewhat larger numbers of protons of external energy.
   B. A stable nucleus cannot undergo a nuclear reaction, even with the addition of external energy.
   C. Unstable nuclei do not spontaneously change to stable nuclei.
   D. Lighter nuclei tend to have equal number of protons and neutrons.
   E. Heavier nuclei have significantly more neutrons than protons.

2. Which of the following compounds contain(s) no covalent bonds?
   KCl PH_3 O_2 B_2H_6 H_2SO_4

   A. KCl, PH_3, and B_2H_6 only
   B. KCl and H_2SO_4 only
   C. PH_3, O_2, and B_2H_6 only
   D. KCl only
   E. KCl and B_2H_6 only

3. Which of the following nuclear reactions is incorrect?

   A. $^{14}_{7}N + {}^{4}_{2}He \longrightarrow {}^{17}_{8}O + {}^{1}_{1}H$

   B. $^{9}_{4}Be + {}^{4}_{2}He \longrightarrow {}^{12}_{6}C + {}^{1}_{0}n$

   C. $^{30}_{15}P + {}^{-30}_{-14}Si \longrightarrow {}^{0}_{-1}b$

   D. $^{3}_{1}H + {}^{3}_{2}He \longrightarrow {}^{0}_{-1}b$

   E. None of the above.

4. Which statement about metals is incorrect?

   A. Metals exhibit higher electronegativities than non-metals.
   B. Metals are reducing agents.

C. Metals form basic hydroxides.
D. Metals exhibit low ionization potentials.
E. Metals generally have one of five electrons in their outermost shell.

5. Which of the following has the smallest ionic radius?

A. Li^+
B. Na^+
C. K^+
D. Rb^+
E. Cs^+

6. What is the molarity of a sulfuric acid solution if 50.0 mL completely neutralizes 1.00 L of a 0.10 M potassium hydroxide solution?

A. 1.0 M
B. 0.10 M
C. 2.0 M
D. 0.20 M
E. 10.0 M

7. What is the oxidation number of chlorine in $ClO4^-$?

A. +1
B. +3
C. +5
D. +7
E. +8

8. The emission of an alpha particle from $^{226}_{88}Rn$ will yield:

A. $^{223}_{86}Rn$
B. $^{222}_{86}Rn$
C. $^{223}_{87}Fr$
D. $^{222}_{87}Fr$
E. $^{222}_{88}Rn$

9. Rutherford's scattering experiments demonstrated:

A. the existence of X-rays.
B. the existence of a-particles.
C. the nature of blackbody radiation
D. the mass-to-charge ration of the electron.
E. the nuclear model of the atom.

10. Which of the alkali metals is most electronegative?

A. Li
B. Na
C. K
D. Rb
E. Cs

11. The primary weakness of the Bohr's model of the atom is that:

A. It only works for the hydrogen atom.
B. It treats the electron as a wave rather than a particle.
C. It doesn't consider the role of the neutron.
D. It neglects the radiation emitted by accelerating charged particles.
E. It only allows for certain energy levels.

12. Which of the following statements is not true for the reaction shown below:

$$Fe^{3+} + 1e^{-} \rightarrow Fe^{2+}$$

A. Fe^{3+} is being reduced.
B. The oxidation state of Fe has changed.
C. Fe^{3+} is the oxidizing agent in this reaction.
D. The reaction is similar to the reaction between magnesium metal and hydrogen gas.
E. Both Fe^{3+} and Fe^{2+} are anions.

13. Which of the following pairs of elements does not have approximately the same electronegativity?

A. C and S
B. Co and Ni
C. B and Al
D. U and Pu
E. Fe and Ni

14. During a redox reaction, the oxidizing agent:

A. Gains electrons.
B. Is oxidized.
C. Has an increase in oxidation state.
D. Is hydrolyzed.
E. Loses electrons.

15. Which of the following substances is an Arrhenius acid?

A. CCl_4
B. BF_3
C. I_2
D. NaH
E. H_2SO_4

16. A molecule that has an unpaired electron within its structure is this:

A. BF_3
B. C_2H_2
C. $CHCl_3$
D. XeF_4
E. NO_2

17. Which of the following compounds has the shortest carbon-halogen bond?

A. CH_3F
B. CH_3Cl
C. CH_3Br

D. CH_3I
E. They are all equal.

18. An electron probability density is the picture that emerges when we superimpose lots of instantaneous positions of electrons, revealing the atomic orbital shape as a cloud of points surrounding the nucleus. Why is this the most reliable image of an atomic orbital?

A. An electron is in all the positions in an orbital simultaneously.
B. The electron is moving a defined pathway in an orbital.
C. The electrons are frozen in positions in an orbital around the atom.
D. The film that is most often used for atoms takes multiple exposures.
E. The location of an electron is best described as the probability of finding an electron in a given region of space.

19. Which of the following statements is (are) true of isotopes of an element?

I. They are atoms of the same masses with different atomic numbers.
II. The only difference in composition between isotopes of an element is the number of neutrons.
III. The atomic weight of an element is an average of the weights of its isotopes, in the proportions in which they naturally occur in nature.

A. I only
B. II only
C. III only
D. II and III only
E. I, II, and III

20. Which atom has the same number of neutrons as ^{85}Rb?

A. ^{85}Sr
B. ^{86}Sr
C. ^{86}Kr
D. ^{85}Kr
E. ^{87}Rb

21. In the reaction $HCl + H_2O \rightarrow H_3O^+ + Cl^-$, the water acts as:

A. A Lewis acid.
B. A Bronsted acid.
C. A Bronsted base.
D. An oxidizing agent.
E. An inert substance.

22. Which of these substances has no covalent bonds?

A. H_2
B. Br_2
C. LiH
D. SiF_4
E. $Ca(OH)_2$

23. What is the percent of water of crystallization in $MgSO_4 - 7H_2O$?

A. 4.8%
B. 6.6%
C. 25.9%
D. 48.8%
E. 51.2%

24. Which statement about ionization energy is true?

A. It is represented by the equation $X + e^- \rightarrow X^- + \text{energy}$
B. It decreases as atomic number increases in a period of the Periodic Table.
C. It increases as atomic number increased in a group of the Periodic Table.
D. It is the energy needed to remove the most loosely bound electron from an atom in its ground state.
E. It is the energy released as an electron is added to a gaseous nonmetallic atom in its ground state.

25. What is the molarity of hydrogen ions in a 0.001 M solution of NaOH?

A. 0 M
B. 1×10^{-14} M
C. 1×10^{-11} M
D. 1×10^{-7} M
E. 1×10^{-3} M

26. How many moles of Al_2O_3 are formed when a mixture of 0.36 moles Al and 0.36 moles O_2 is ignited?

A. 0.12
B. 0.18
C. 0.28
D. 0..46
E. 0.72

27. Observations in his laboratory that some a-particles directed at a gold foil are scattered backwards at angles greater than 90° permitted Ernest Rutherford to conclude that>

A. All atoms are electrically neutral.
B. Electrons have a very small mass.
C. Negatively charged electrons are a part of all matter.
D. The positively charged part of atoms moves at extremely high velocity.
E. The positively charged part of atoms occupies an extremely small fraction of the volume of an atom.

28. What is a structural isomer of $CH_3CH_2CH_2CH_2OH$?

A. $CH_3CH_2OCH_3$
B. $CH_3CH_2CH_2OH$
C. $CH_3CH_2CH_2CH_3$
D. $CH_3CH_2CH_2CH_2Cl$
E. $CH_3CH(OH)CH_2CH_3$

29. Where does the reaction take place in a voltaic cell?

$$2\ H_2O \rightarrow O_2 + 4H^+ + 4e^-$$

A. Anode
B. Cathode
C. Salt bridge
D. Voltmeter
E. Wire

30. Fluorine-18 decays by positron emission. What is the product nuclide of this decay?

A. Fluorine-17
B. Neon-18
C. Nitrogen-14
D. Nitrogen-18
E. Oxygen-18

SECTION II: ***[70 points]***

1. Write the formulas to show the reactants and products for any FOUR of the laboratory situations described below: A reaction occurs in all cases. All solutions are aqueous unless otherwise indicated. You need not balance the equation.

A. Carbon dioxide gas is bubbled through distilled water. [1]

B. Solid lithium hydride is added to water. [1]

C. A strip of aluminum metal is dropped into a solution of 6 M hydrochloric acid. [1]

D. A solution of lead(II) nitrate is added to a solution of potassium iodide. [1]

E. Solid zinc nitrate is treated with excess sodium hydroxide solution. [1]

2. Use principles of atomic structure and/or chemical bonding to explain the following. In each part your answer should include references to both substances.

A. The atomic radius of Rb is larger than that of K. [1]

_____
_____
_____
_____

B. The carbon-to-carbon bond energy in CHCH is greater than it is in CH_3CH_3. [1]

_____
_____
_____
_____
_____

C. The 2nd ionization energy of Na is greater than the 2nd ionization energy of Mg. [1]

_____
_____

3. The questions refer to four 100 mL samples of aqueous solutions at 25 °C in stoppered flasks.

Flask 1: 0.10 M $CaCl_2$

Flask 2: 0.10 M KNO_2

Flask 3: 0.10 M CH_3COOH

Flask 4: 0.10 M CH_3COCH_3

A. Which solution has the lowest electrical conductivity? Explain. [2]

B. Which solution has the highest pH? Explain. [2]

4. An electrochemical cell is assembled using the components show in the representation.

Cd(s) / Cd+2 (aq) // Ag+ (aq) / Ag(s)

The salt bridge is filled with KNO_3(aq).

A. Identify the cathode of the cell and write the half-reaction that occurs there. [2]

B. Write the net ionic equation for the overall reaction that occurs as the cell operates. [2]

5. Determine which element is oxidized and which is reduced when lithium reacts with nitrogen to form lithium nitride. [2]

$$6\ Li(s) + N_2(g) \rightarrow 2\ Li_3N(s)$$

Oxidized = _____ Reduced = _____

6. Identify the oxidizing agent and the reducing agent in the following reaction. [2]

$$Ca(s) + H_2(g) \rightarrow CaH_2(g)$$

Oxidizing Agent = _____ Reducing Agent = _____

7. For each of the following compounds, predict whether you would expect it to be ionic or covalent. [4]

(a) chromium(III) oxide, Cr_2O_3 _____

(b) carbon tetrachloride, CCl_4 _____

(c) methanol, CH_3OH _____

(d) strontium fluoride, SrF_2 _____

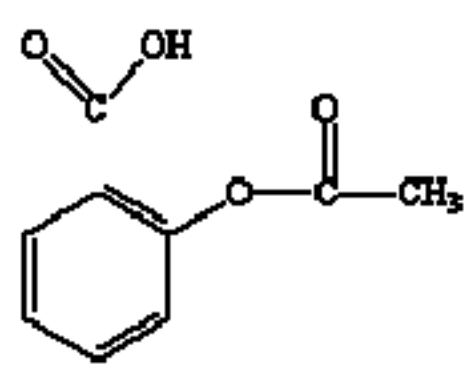
8. Which of the following compounds should conduct an electric current when dissolved in water, methanol or strontium fluoride? Explain. [2]

_____

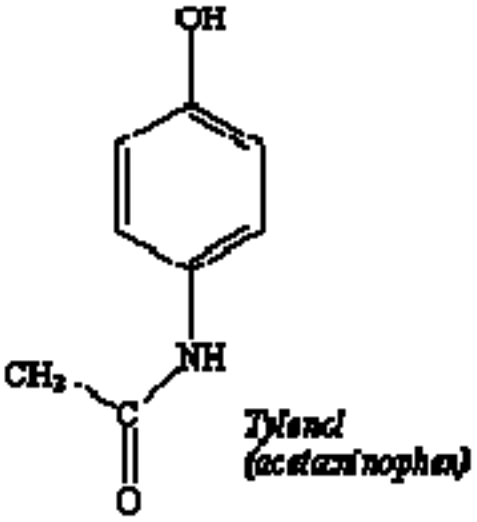
_____

_____

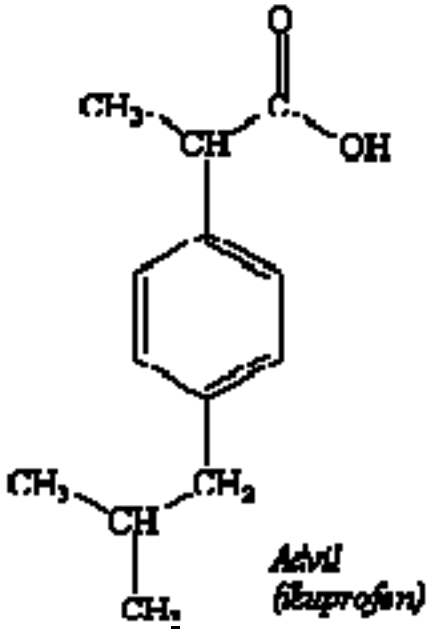
9. The following compounds are the active ingredients in over-the-counter drugs used as analgesics (to relieve pain without decreasing sensibility or consciousness), antipyretics (to reduce the body temperature when it is elevated), and/or anti-inflammatory agents (to counteract swelling or inflammation of the joints, skin, and eyes). Name and identify the functional groups in each molecule. [5]



Aspirin
(acetylsalicylic acid)



Tylenol
(acetaminophen)



Advil
(ibuprofen)

10. Predict which is larger in each of the following pairs of atoms or ions: [4]

(a) S^{2-} or O^{2-} _____

(b) Na or Al _____

(c) C^{4-} or F^{-} _____

(d) P^{3-} or P _____

11. Write a balanced equation for the following reaction and determine the sum of coefficients using the smallest whole-number ratio. [1]

$$Li(s) + O_2(s) \rightarrow$$

Sum:_____

12. Predict the electron configuration of the Fe^{3+} ion. [1]

13. Base your answers to the following questions below on the following information:

$$C_2H_4 + O_2 \rightarrow CO_2 + H_2O + \text{Heat}$$

a. What is the name of this reaction? [1]

Answer=_____

b. In order for the reaction to be balanced, what coefficient should the oxygen have? [1]

Answer=_____

c. What is the mole ratio of ethene to water? [1]

Answer=_____

d. How many moles of oxygen are needed if 2.5 moles of ethene reacts? [2]

Answer=_____

15. Base your answers to the following questions on the information below:

Uranium-238, a solid, is a naturally radioactive element found in the earth's crust. As it decays one of the products is radon-222 which is a gas and is very radioactive.

a. Write the equation for the decay of Rn-222. [2]

_____

b. The half-life of radon-222 is 3.82 days. How many grams of a 1.0 gram sample of Rn-222 would remain after 7.64 days? [2]

Answer: _____

16. If we started with 120 g of Protoactinium-234, and had 1.88 g after 7 minutes, work out a value for its half life. [4]

Answer: _____

17. Draw the Lewis electron-dot structure for a molecule of carbon tetrachloride in the box provided. [2]

18. When a student heated a 200.0 gram sample of **$FeCl_3 \cdot xH_2O$,** 43.72% of water was liberated and 56.28% of anhydrous salt remained. Find the empirical formula for the original hydrated sample. [4]

Answer=_____

19. Given the formula for glucose, $C_6H_{12}O_6$,

a. Calculate the number of formula units in 17.701 grams of glucose at STP conditions. [3]

Answer=_____

b. What is the percent composition of carbon in glucose? Express your final answer to three significant figures. [2]

Answer=_____

c. What is the empirical formula for glucose? [1]

Answer=_____

20. The following question relates to the equation given below:

$$Cu_{(s)} + AgNO_3 \rightarrow CuNO_3 + Ag_{(s)}$$

a. What is the name of this reaction when copper reacts with silver nitrate? [1]

Answer=_____

b. If 7.50 moles of $AgNO_3$ produces 12.81 moles of $Ag_{(s)}$, how many moles of $AgNO_3$ would it take to produce 17.00 moles of $Ag_{(s)}$? [2]

Answer=_____

21. The table below gives information about two isotopes of a newly discovered element Z.

Isotope	Mass	Relative Abundance
Z-10	10.01	19.9%
Z-11	11.013	80.10%

a. Calculate the average atomic mass of element Z. Be sure to show a correct numerical setup. Record your answer and express your answer to the correct number of significant figures. [3]

Answer=_____

b. Based on this information given in the data table, which element in the periodic table would be representative of element Z? [1]

Answer=_____

22. 1-butene reacts with bromine gas, Br_2. Use Markovnikov's rule to find the major product produced. Be sure to name this product that is produced. [2]

Name:_____ **August 6, 2007**

STEM Chemistry – Ms. Ally **City College – Mr. Marte**

EXTRA CREDIT:

A. A chemical experiment requires for a compound containing Lithium ion, but unfortunately this compound is not available. Nefretiris substitutes a compound that contains Potassium ion. Light uses a compound that contains Copper ion. From what you know about the periodic table, predict whether Nefretiris or Light will run a more successful experiment. [5]

_____

_____

_____

_____

_____

B. A student experimentally determines the density of titanium to be 4.25 g/cm^3. Calculate the student's percent error. [2]

Answer=_____