Names: _____

              _____

Team Name: _____

Team Number: _____

Division C: Chemistry Lab

Test and Lab Portions

DO NOT OPEN UNTIL INSTRUCTED

Please Provide Team Number on All Pages Submitted with the Test

Station 1 – Written : 25 minutes
Station 2 – Lab A/B : 10 minutes
Station 3 – Lab B/A : 10 minutes
You will be provided with a periodic table. You can go back to the written test at any time.

You may separate the sheets, but be certain to write your team number on each if you do so.

------------------------------DO NOT WRITE BELOW THIS LINE ------------------------------

Supervisor/Assistant Check off Each Item

Lab Coat / Apron to Knees	_____	Unsafe procedures noted at any station:
Pants or Skirts to Ankles	_____	1._____
Long Sleeved Shirt and		2._____
Apron or Coat	_____	3._____
Closed Toe Shoes	_____	4._____
Indirect Vent Goggles	_____	
Satisfactory Clean-up	_____	

1. **PERIODICITY** (2 points) - Arrange these atoms and ions in order of decreasing size: Mg^{2+}, Ca^{2+}, and Ca.

2. **PERIODICITY** (2 points) - Which of the following atoms and ions is largest: S^{2-}, S, O^{2-}?

3. **PERIODICITY** (2 points) - Arrange the following atoms in order of increasing size: P, S, As, Se.

4. **PERIODICITY** (2 points) - Arrange the ions K+, Cl^-, Ca^{2+}, and S^{2-} in order of decreasing size.

5. **PERIODICITY** (4 points) - Which of the following compounds are soluble? Check all that apply.

   Magnesium sulfide
   _____
   Ammonium sulfide
   _____
   Magnesium hydroxide
   _____
   Lithium hydroxide
   _____
   Silver chloride
   _____
   Sodium carbonate
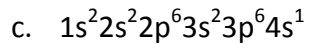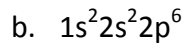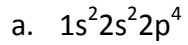   _____
   Barium carbonate
   _____
   Silver nitrate
   _____
   Barium nitrate
   _____

6. **PERIODICITY** (6 points) - Using the afbau principle, the following orbital configurations were identified. Predict the ionic charge for each configuration.
   a. $1s^2 2s^2 2p^4$

   b. $1s^2 2s^2 2p^6$

   c. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

7. **PERIODICITY** (8 points) - Locate and uniquely mark on the periodic table below where you would be able to find elements with outermost:
   a. 5d orbitals
   b. 3p orbitals
   c. 2s orbitals
   d. 4f orbitals

Blank Periodic Table of the Elements
http://chemistry.about.com
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8. **PERIODICITY** (8 points) - Indicate whether each statement is true (T) or false (F).

a. _____ The first ionization energies for Group 1A elements increase with increasing molecular weight.

b. _____ The first ionization energies for the Period 2 elements increase with increasing molecular weight.

c.

_____ The atomic radii increase with increasing molecular weight across a period.

d.

_____ The atomic radii decrease with increasing molecular weight down a group.

e.

_____ In general, the electronic affinity increases from left to right.

f. _____ Electronegativity increases from left to right on the periodic table (across Groups 1A to 8A) and top to bottom (from Periods 1 to 7).

g. _____ When two atoms bond, the greater the electronegativity difference the more ionic the bond.

h. _____ When two atoms of the same element bond, the electronegativity difference is zero and the bond can be identified as polar covalent.

9. **PERIODICITY** (2 points) - First ionization energy refers to (check all that apply):

_____ Removal of an electron from a gas atom.

_____ Energy to form the most probable ion.

_____ Trapping an ion in a lattice structure.

_____ Formation of a -1 anion.

10. **PERIODICITY** (2 points) - From the periodic table, predict the molecular formula of silicon (Si) oxide (O).

11. **PERIODICITY** (2 points) - The formula for potassium aluminum sulfate is (not including water of hydration):

12. **PERIODICITY** (2 points) - The name of $(NH_4)_2Cr_2O_7$ is:

13. **PERIODICITY** (2 points) - Two metals, both of which commonly form +1 and +2 ions in solution are:

_____ Cu and Hg

_____ Au and Ag

_____ Fe and Cu

_____ Zn and Cd

14. **PERIODICITY** (2 points) - Metals have: (check all that apply)

_____ Both high electrical and high thermal conductivity.

_____ High electrical but low thermal conductivity.

_____ Low cohesive strength and high luster.

_____ High luster and low ductility.

15. **PERIODICITY** (2 points) - Nonmetals are: (check all that apply)

    _____ Malleable but not ductile.

    _____ Very reactive with acids.

    _____ Good conductors of electricity.

    _____ Able to form halides which react with water to give an oxyacid.

16. **PERIODICITY** (2 points) - Halogens: (check all that apply)

    _____ Will not react with each other

    _____ Are strong electron donors

    _____ Form strong oxyacids of the formula HX_3O

    _____ Form strong covalent bond with Group 1A metals

17. **EQUILIBRIUM** (2 points) - When the same ion is produced by two different components, the common ion effect takes place. By adding salt containing a weak acid's conjugate base into solution, the dissociation of the weak acid will _____ and the pH will _____ according to Le Châtelier's Principle.
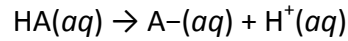
    _____ Increase, Increase

    _____ Decrease, Decrease

    _____ Increase, Decrease

    _____ Decrease, Increase

18. **EQUILIBRIUM** (2 points) - Buffers work by applying Le Châtelier's Principle to weak acid equilibrium. Buffer solutions contain significant amounts of the weak acid molecules, HA and its conjugate base A^{-1}. These molecules react with added acid or base to neutralize it:

$$HA(aq) \rightarrow A–(aq) + H^+(aq)$$

When adding a strong acid or a strong base to the buffer solution represented above,

_____ The added H^+ will decrease the conjugate weak base and increase the weak acid concentration.

_____ The added H^+ will increase the conjugate weak base and increase the weak acid concentration.
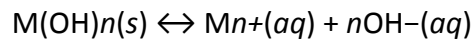
_____ The added OH^- will decrease the conjugate weak base and increase the weak acid concentration.

_____ The added OH^- will increase the conjugate weak acid and decrease the weak base concentration.

19. **EQUILIBRIUM** (2 points) - For insoluble ionic hydroxides (as shown in the equation below), the _____(lower, higher) the pH, the _____ (lower, higher) the solubility.

$$M(OH)n(s) \leftrightarrow Mn+(aq) + nOH−(aq)$$

20. **EQUILIBRIUM** (4 points) - The reaction for the dissociation of water results in the generation of hydronium ions and hydroxide ions. The equilibrium constant for this reaction at 25°C is 1.00×10^{-14}, and the enthalpy of the reaction is 55.81 kJ/mol. Estimate the activity of OH^- in a solution at 25°C and one at 4°C, if $\{H^+\}=10^{-7}$ in both solutions.

21. **EQUILIBRIUM** (4 points) If a solution contains 4.2×10^{-6} M silver ions, does a precipitate form? ($K_{sp}(AgCl) = 1.8 \times 10^{-10}$)

22. **EQUILIBRIUM** (10 points) - Phosphorus pentachloride (PCl_5) decomposes to phosphorus trichloride (PCl_3) and chlorine gas when heated. The equilibrium constant for this reaction is 0.030 at 250°C. The solution initially contains only PCl_5 with a solution density of 20.8 g/L.
    a. Write the equilibrium reaction.

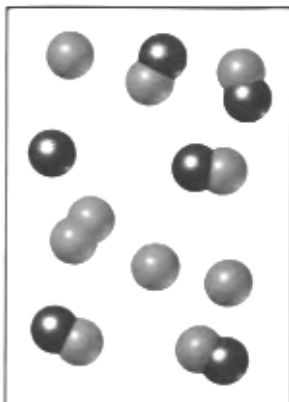   b. What is the initial molar concentration of the PCl_5 solution?

c. At equilibrium, what are the concentrations of:

    a) PCl_5

    b) PCl_3

    c) Cl_2

23. **EQUILIBRIUM** (6 points) - The diagrams below show mixtures containing A atoms (gray), B atoms (black), A_2 molecules and AB molecules at 300 K (diagram a) and 500 K (diagram b). Is the reaction exothermic or endothermic?
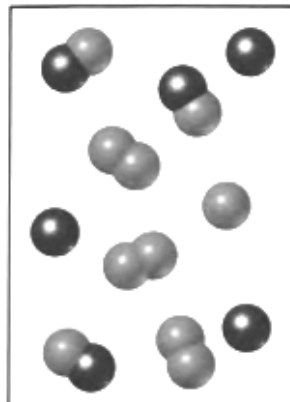
(Copyright by Prentice Hall)

(a)   (b)

24. **EQUILIBRIUM** (6 points) - When 1.0 mole of acetic acid is diluted to a volume of 1.0 L, the acid ionizes to form acetate ions and hydronium ions. At equilibrium, 0.42% of the acetic acid is ionized. What percentage of the acid ionizes when 2.0 moles of acetic acid is diluted to 1.0 L?

25. **EQUILIBRIUM** (4 points) - Given the following equilibrium constants, find pK_{eq} for the reaction.

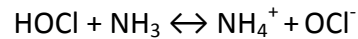$$HOCl + NH_3 \leftrightarrow NH_4^+ + OCl^-$$

Where,

$$HOCl + H_2O \leftrightarrow H_3O^+ + OCl^- \quad (K_{a,HOCl} = 10^{-7.6})$$

$$NH_4^+ + H_2O \leftrightarrow NH_3 + H_3O^+ \quad (K_{a,NH4+} = 10^{-9.25})$$
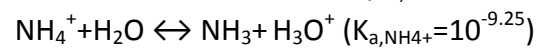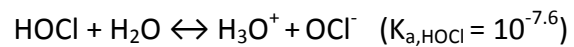
26. **EQUILIBRIUM** (6 points) - Bismuth sulfide (Bi_2S_3) was placed in contact with water and in the course of equilibrium reaction dissolves into bismuth and sulfide ions. Its measured solubility is 1.0×10^{-15} mol/L at 25°C. Calculate the solubility product.

27. **EQUILIBRIUM** (4 points) - Consider the following diagram. One curve illustrates a catalytic reaction and one illustrates a non-catalytic reaction.

Which of the following statements are true (check all that apply)?

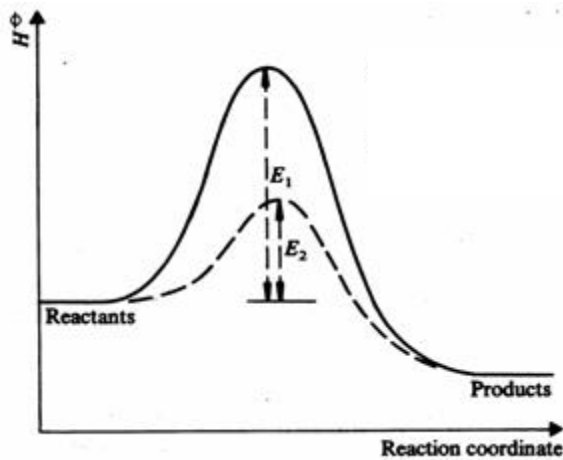_____ E_1 illustrates the energy required to progress a reaction without a catalyst and E_2 illustrates the energy required to progress a catalyzed reaction.

_____ E_1 illustrates the energy required to progress a catalyzed reaction and E_2 illustrates the energy required to progress a reaction without a catalyst.

_____ Progression of the reactions is endothermic.

_____ Progression of the reactions is exothermic.

_____ The reactions need more energy to proceed along the reaction coordinate (left to right).

_____ The reactions need more energy to proceed against the reaction coordinate (right to left).

END OF TEST PORTION

***CHECK LABELS ON CHEMICALS. ALWAYS TRANSFER FROM STOCK SUPPLY TO YOUR TEST TUBE TO PREVENT CROSS-CONTAMINATION. RINSE YOUR EQUIPMENT WHEN FINISHED.**

EQUILIBRIUM - Lab Portion A (Total 20 points)

Please read the whole lab before starting this lab. You may have to answer questions during certain steps in the procedures below.

Procedures:

1. Put 10 drops of copper(II) sulfate solution into test tubes A and B.
2. Add ammonia solution drop-by-drop to test tube B. Shake the tube gently from side to side after each drop (4-5 drops). (see Question 2)
3. Continue to add ammonia drop-by-drop into test tube B until the solution is clear blue (4-5 more drops). (see Question 3)
4. Pour half of the clear blue solution in test tube B into test tube C.
5. Add sulfuric acid drop-by-drop to test tube C until you noticed a marked change in the solution. Shake the tube gently from side to side after adding each drop. (see Question 4)

Questions:

1. Provide the reaction that is occurring in test tube B as ammonia is added to the copper sulfate solution.

2. What happens in the solution in Step 2 of the Procedures? Predict the products.

3. What predictions can you make about what is occurring as you continue to add ammonia to test tube B?

4. As you continue to add acid to test tube C, predict the end products as the reaction proceeds. Provide the reaction that occurs in Step 5.

***CHECK LABELS ON CHEMICALS. ALWAYS TRANSFER FROM STOCK SUPPLY TO YOUR TEST TUBE TO PREVENT CROSS-CONTAMINATION. RINSE YOUR EQUIPMENT WHEN FINISHED.**

PERIODICITY – Lab Portion B (Total 20 points)

Please read the whole lab before starting this lab. You may have to answer questions during certain steps in the procedures below.

Procedures:

1. Pour 10 mL of the unknown solution A in a test tube. (Question 1)
2. Add 5 drops of Phenolphthalein. (Question 2)
3. Place the thermometer in the test tube as you stir in the unknown solid 1. (Question 3)

Questions:

1. Record the following observations from Step 1:
    a. Color

    b. pH

    c. Temperature

2. What is the color of the solution when you added Phenolphthalein in Step 2? What conclusions can you make about unknown solution A?

3. Record the following observations after the solution has equalized in Step 3:
    a. Color

    b. pH

     c.   Temperature

     d.   Other noticeable changes

4. Based on your observations on the change in temperature of unknown solution A during the addition of unknown solid 1, would you say the reaction is endothermic or exothermic?

5. What type of chemical reaction occurred? Present the basis for your hypothesis using your observations in Questions 1-3.

END OF LAB PORTION