Exam 2: Name

1. **(5 points)** Capsaicin is the pungent component of various species of *Capsicum,* including red and green chili peppers, especially *c. annum* and is the active component of *paprika.* It has several actions in the body when ingested, such as stimulation of the formation of endorphins in the brain and increased salivation when eating spicy food. The formula of capsaicin is $C_{18}H_{27}O_3N$. A sample of capsaicin contains 6.79 $x10^{20}$ molecules of capsaicin.

a. How many moles of capsaicin does the sample contain?	
b. How many atoms of hydrogen does the sample contain?	
c. What is the molecular mass of capsaicin? Use the following values: C-12.011 amu; H-1.0079 amu; N-14.00672 amu; O-15.9994 amu	
d. What is the mass of this sample in grams?	

2. **(4 points**) Suppose you were marooned on a tropical island and had to make a primitive barometer using sea water (density = 1.10 g/mL). What height would the water reach in your sea water barometer when a mercury barometer would reach 77.5 cm? d (Hg) = 13.6g/mL.

3. **(7 points)** Cacodyl, a compound containing arsenic has an over powering, noxious, garlicy smell. It undergoes spontaneous combustion with dry air. It was reported in 1842 by the German chemist Robert Wilhelm Bunsen. To quote Bunsen, " the smell of this compound produces instantaneous tingling of the hands and feet, and even giddiness and insensibility." The composition of cacodyl is 22.88% C, 5.76 % H and 71.36 % As.
    a. Determine its empirical formula.
    b. A sample of 2.699×10^{-5} g of cacodyl represents 1.285×10^{-7} moles of cacodyl. What is the molecular formula of cacodyl

4. **(10 points)** Give the appropriate name or formula for the following.

a) mercury(II) hypobromite

b) $ZnCrO_4$

c) Xenon tetrafluoride

d) $CoCl_2$

e) $Hg_2(CN)_2$

f) Copper(I) cyanide

g) P_2S_5

h) zinc sulfite

i) $Mg(HSO_3)_2$

j) $AgMnO_4$

5. **(5 points)** A standard solution is prepared for the analysis of fluoxymesterone [FXM] ($C_{20}H_{29}FO_3$), an anabolic steroid. 25.00 g is dissolved in enough water to give a total volume of 500.00mL of solution. A 5.00mL sample of this stock solution is diluted to a final volume of 650. mL. What is the final solution in terms of molarity for the fluoxymesterone. The molar mass of fluoxymesterone is 336.43 g $C_{20}H_{29}FO_3$= 1 mole $C_{20}H_{29}FO_3$

6. **(6 points)** A sulfuric acid solution containing 571.6 g of H_2SO_4 per liter of solution has a density of 1.329 g/cm^3. [MW= 98.086 g/mol]Calculate the:

   (a) Mass percentage of this solution
   (b) The mole fraction of this solution
   (c) The molarity of H_2SO_4 of this solution

7. **(6 points)** Write the molecular, ionic and net ionic equations for the reaction of a strontium hydroxide solution mixing with propionic acid, $HC_3H_5O_2$. Propionic acid forms the propionate ion ($C_3H_5O_2^-$) upon reacting with a base. Ionic salts of propionate are very soluble. Clearly label states and charges if any.

Molecular

Ionic

Net ionic

8. **(5 points)** Acrylonitrile, C_3H_3N, is used to make acrylics. It can be made from propylene, C_3H_6, and nitric oxide, NO.

$$4\ C_3H_6 + 6\ NO \rightarrow 4\ C_3H_3N + 6\ H_2O + N_2$$

How many grams of acrylonitrile are obtained from 2.50 g of nitric oxide?

[NO = 30.01 amu; C_3H_3N = 53.064 amu]

9. **(4 points)** A child's balloon is filled with He to a volume of 5.00L at a temperature of 25.0°C. As the balloon rises in the atmosphere, lifting the child to new heights, the volume of the balloon increases by 20.5%. What is the temperature of the He gas in the balloon?

10. **(10 points)** A sample of an organic compound containing C, H, and O, which weights 1.213 g gives 3.06 g of CO_2 and 0.536 g of H_2O in combustion. Determine the empirical formula for this compound

11. **(6 points)** When 29.5 g of methane and 45.0 g of chlorine gas undergo a reaction that has a 85.0% yield, what mass of chloromethane (CH_3Cl) forms? (The second product is $HCl_{(g)}$)

12. **(6 points)** When iron metal is reacted with potassium permanganate in acid, the following reaction occurs.

$5\mathbf{Fe}_{(s)} + 3\ K\mathbf{Mn}O_{4(aq)} + 24\ HCl_{(aq)} \rightarrow 3\mathbf{Mn}Cl_{2(aq)} + 5\ \mathbf{Fe}Cl_{3(aq)} + 12\ H_2O_{(l)} + 3\ KCl_{(aq)}$

(a) **(4 points)** Oxidation number of the element in bold. Show your thought process, or work.

Fe	Mn in MnO_4	Mn in $MnCl_2$	Fe in $FeCl_3$

(b) **(0.5 point)** The reactant that contains the oxidized element and identity of that element:

(c) **(0.5point)** The reactant that contains the reduced element and identity of that element:

(d) **(0.5 point)** The compound that is the oxidizing agent

(e) **(0.5 point)** The compound that is the reducing agent

13. **(3 points)** You know that an unlabeled bottle contains one of the following: $Hg_2(NO_3)_2$, $BaCl_2$, or $MnSO_4$. A friend suggests that you test three portions of the bottle with 1) a sodium chloride solution, 2) a sodium sulfate solution, and 3) a sodium hydroxide solution.

    i. No reaction occurs when sodium chloride solution is added to a sample of the solution from the bottle
    ii. No reaction occurs when sodium sulfate solution is added to a sample of the solution from the bottle.
    iii. A precipitate formed when the sodium hydroxide solution is added to a sample of the solution from the bottle.

    What cation(s) are present in the bottle? Explain your choice(s) using solubility rules.

14. (**6 points)** Consider solutions in which 0.10 mol of each of the following compounds is dissolved in 1 L of water: $Ca(NO_3)_2$, $C_6H_{12}OH$, $NaC_2H_3O_2$, HF, $Al_2(SO_4)_3$. Rank the solutions in order of increasing electrical conductivity (which ones will be the worst conductors of electricity to the best conductors of electricity), based on the number of ions in solution. Explain your choices BRIEFLY.

15. **(8 points)** A sample of nitrogen gas is at STP. (STP is a pressure of 1 atm, 0°C) The volume of the container is **decreased** while keeping the temperature constant. Use kinetic-molecular theory to explain whether each of the following would increase, decrease, or remain constant and WHY. More importantly, explain the cause(s) for this change in **pressure** using concepts from the kinetic-molecular theory. Please answer clearly and thoroughly using complete sentences. No credit **without an explanation.**

    a) The average KE

    b) the average speed

    c) the frequency of the collisions

    d) the frequency of collisions per unit area

    e) The pressure of the gas

16. **(5 points)** You have 0.954 g of an unknown acid H_2A, which reacts with NaOH according to the reaction below.

$$H_2A_{(aq)} + 2\ NaOH_{(aq)} \rightarrow Na_2A_{(aq)} + H_2O_{(l)}$$

If 36.04 mL of 0.509 M NaOH is required to titrate the acid to the equivalence point, what is the molar mass of the acid?

17. (5 point) A student mixed 200.0 mL of 6.00 M Na_3PO_4, 300.0 mL of 1.00 M NaCl, 400.0mL of 0.500M Na_2CO_3 and enough water to make 2000.0 mL of solution. What is the molarity of the sodium ion (Na^+) in the final solution?

18. (6 points) Use the activity series to decide if an observable reaction can be expected when the follow actions are performed. If a reaction occurs, write out the balanced molecular equation showing the expected products with correct phases on all species. In one or two sentences describe why the reaction occurred. If a reaction does not occur, write NR. In one or two sentences describe why the reaction did not occur.

a) Copper wire is placed in hydrochloric acid.

b) Solid lead pellets are dropped into a solution of copper(II) sulfate.

c) Tin foil (a thin sheet of metal made of tin) is placed in a solution of iron(II)sulfate.

19. **(10 points)** A precipitate forms when aqueous sodium sulfide is mixed with aqueous copper(II) chloride.
    (a) Calculate the mass of the precipitate that forms when 75.0 mL of 1.50 M sodium sulfide is mixed with 100.0 mL 0.500 M copper(II) chloride.
    (b) Calculate the moles of all the dissolved ions at the end of the reaction (this includes spectator and excess ion(s))
    (c) What is the final volume of the solution?
    (d) Calculate the individual concentrations of all dissolved ions at the end of the reaction.