PART A: PRACTICE COMMON.
Choose the best answer. You may use a scientific calculator – no graphing calculators allowed. As you go, fill in the appropriate bubble on the bubble sheet attached (do NOT fill in the bubbles last). Double check your answers – make sure the exam and bubble sheet match.

1. _______ are chemically the simplest substances and hence cannot be broken down using chemical reactions.
   a. Compounds
   b. Molecules
   c. Protons
d. Elements

2. LiNO₃(aq) is an example of a _______.
   a. Compound
c. Molecule
   b. Element
   d. Mixture
   qₐ = aq ueous

3. N₂(g) is an example of a(n) _______.
   a. Compound
   c. Phase
   b. Element
d. Mixture
   lithium nitrate is dissolved in water and is a solution.

4. Which particle diagram(s) represent(s) a compound?
   a. A
c. B
   b. A and B
d. C

5. If a spoonful of NaF is mixed in a glass of water, what is the mixture called?
   a. solute
c. solvent
   b. solution
d. element

6. An element is _______.
   a. a mixture of atoms
c. a substance whose atoms all have the same number of protons
   b. a solution
d. a substance whose atoms all have the same number of neutrons

7. Identify the homogeneous mixture below:
   a. suspension of dirt and water
c. salt and sand
   b. steel
   d. soil
   steel is an alloy - homogeneous mix of iron, carbon, etc.
8. If you made 50 mL of Ba(NO₃)₂(aq), the solvent used to make this solution is:
   a. water
   b. Ba(NO₃)₂
   c. isopropanol
   d. benzene

9. What is the electron configuration of a neutral atom of Sulfur?
   a. [Ne]3s²3p⁶
   b. 1s²2s²2p⁶
   c. 1s²2s²2p⁴
   d. 1s²2s²2p⁶3s¹3p⁴

10. What is the electron configuration of a calcium ion?
    a. [Ne]3s²3p⁶
    b. [Ne]3s²2p⁶
    c. [Ne]3s²3p⁶4s¹
    d. [Ne]3s²3p⁶4s²

11. What is the electron configuration of a Silicon cation?
    a. 1s²2s²2p⁶
    b. 1s²2s²2p⁶3s²3p⁶
    c. 1s²2s²3s²2p²
    d. [Ar]

12. Which element has two unpaired electrons in the 2p sublevel?
    a. F
    b. Cl
    c. O
    d. P

13. Which atom/ion has the electron configuration 1s²2s²2p⁶?
    a. N
    b. Cl⁻
    c. P³⁺
    d. Al³⁺

14. How many valence electrons are present in an atom with the following electron configuration:
    1s²2s²2p⁶3s²3p⁶?
    a. 1
    b. 2
    c. 3
    d. 4

15. A neutral element with the electron configuration 1s²2s²2p⁴3s²3p¹ would most likely form which ion?
    a. 1⁺
    b. 2⁺
    c. 3⁺
    d. 5⁻

16. Select the list of atoms that are arranged in order of increasing atomic radius.
    a. C, N, O, F
    b. S, As, Sn, Tl
    c. As, P, S, G
    d. Sb, Bi, N, As

17. Select the list of atoms that are arranged in order of increasing ionization energy.
    a. Cl, F, I, Br
    b. Na, Mg, Sr, Li
    c. Po, Te, Se, S
    d. Mg, Al, Cl, S

18. Choose the correct relationship concerning ionic/atomic radius.
    a. Br > Br⁻
    b. Mn < Mn³⁺
    c. Ga > Ga³⁺
    d. Se > Se²⁻

19. What is the correct chemical formula for manganese (VI) phosphate?
    a. Mn₆PO₄
    b. Mn₃(PO₄)₄
    c. Mn(PO₄)₂
    d. Mn(PO₄)₃
20. What is the correct chemical formula for gold (II) periodate?
   a. Au(IO₃)₂  
   b. Au₂IO₄  
   c. Au₃O₄  
   d. Au₂IO₅

21. NH₄NO₂ is ______
   a. ammonium nitrate  
   b. ammonium (I) nitrite  
   c. ammonium nitrite  
   d. denitrogen tetrahydrodride dioxide

22. Tin (IV) oxide is ______
   a. Sn₂O  
   b. Sn₂O₃  
   c. SnO₂  
   d. Sn(OH)₄

23. If RaSO₄ is radium sulfate, what is the chemical formula for beryllium sulfate?
   a. BeSO₄  
   b. Be₂SO₄  
   c. BeSO₃  
   d. BaSO₄

24. In the formula X₂(SO₄)₃, the X represents a metal. This metal could be located on the Periodic Table in
   a. Group 1  
   b. Group 13  
   c. Group 2  
   d. Group 14

25. Which formula correctly represents the composition of iron (III) oxide?
   a. Fe₂O₃  
   b. Fe₃O  
   c. Fe₂O₁  
   d. Fe₃O₂

26. Given the balanced equation representing a reaction:
   \( \text{K}_2\text{CO}_3(\text{aq}) + \text{BaCl}_2(\text{aq}) \rightarrow 2\text{KCl(\text{aq}) + BaCO}_3(\text{s}) \)

   What kind of reaction is represented by this equation?
   a. synthesis  
   b. neutralization  
   c. decomposition  
   d. double replacement

27. Which change results in the formation of different substances?
   a. burning of propane  
   b. melting of NaCl (s)  
   c. deposition of CO₂(g)  
   d. solidification of water

28. Given the word equation:
   sodium chlorate → sodium chloride + oxygen

   Which type of chemical reaction is represented by this equation?
   a. double replacement  
   b. single replacement  
   c. decomposition  
   d. synthesis
29. In which type of chemical reaction do two or more reactants combine to form one product, only?  
   a. synthesis  
   b. decomposition  
   c. precipitation  
   d. double replacement

30. Given the reaction between aluminum and copper (II) sulfate to produce aluminum sulfate and copper, what is the correct coefficient of aluminum?
   a. 2.  
   b. 3.  
   c. 4.  
   d. 5.

   \[ 2\text{Al} + 3\text{CuSO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{Cu} \]

31. Given the unbalanced equation \( \underline{1} \text{Mg(ClO}_3\text{)}_2 \text{(s)} \rightarrow \underline{1} \text{MgCl}_2 \text{(s)} + \underline{3} \text{O}_2 \text{(g)} \)

   When the equation is balanced using the smallest whole-number coefficients, what is the coefficient of \( \text{O}_2 \)?
   a. 1  
   b. 2  
   c. 3  
   d. 4

32. What is the proper Lewis structure of hydrogen cyanide, HCN?
   a. \( \text{H} \equiv \text{N} \equiv \text{C} \)  
   b. \( \text{H} \equiv \text{C} \equiv \text{N} \)  
   c. \( \text{H} \equiv \text{C} \equiv \text{N} \)  
   d. \( \text{H} \equiv \text{C} \equiv \text{N} \)

33. How many electrons does Carbon have in its outer shell in \( \text{CCl}_3 \)?
   a. 4  
   b. 6  
   c. 8  
   d. 10

34. In the Lewis structure for phosphorous trichloride, the central atom has ___.
   a. two double bonds and one lone pair  
   b. four single bonds and no lone pairs  
   c. three single bonds and one lone pair  
   d. two double bonds and no lone pairs

   \( :\text{Cl} \equiv \text{P} \equiv \text{Cl} : \)
13. What determines if a bond is polar? (2pts) If the electronegativities of the atoms sharing the electrons are very different, the electrons will be unequally distributed, and the bond will be polar.

14. Write out a complete ionic equation for the precipitation reaction between iron (II) sulfate and magnesium nitrate. Label the spectator ions. (10pts) $\text{FeSO}_4 + \text{Mg(NO}_3)_2 \rightarrow \text{Fe(NO}_3)_2 + \text{MgSO}_4$

$$\text{Fe}^{2+}(aq) + \text{SO}_4^{2-}(aq) + \text{Mg}^{2+}(aq) + 2\text{NO}_3^-(aq) \rightarrow \text{Fe}^{2+}(aq) + 2\text{NO}_3^-(aq) + \text{MgSO}_4(s)$$

15. Draw a complete electron box diagram for a neutral atom of silicon. (6pts)

Part Three: Calculations. Show all work including setup and formulas, units, unrounded answers, and rounded final answers. Final answers must have correct significant digits, units, and be circled or boxed.

16. 175.2 mL of 3.5 M copper sulfate was added to a 500. mL volumetric flask. Distilled water was then added to the calibration mark. What is the concentration of this final dilute solution? (5pts)

$$M_1V_1 = M_2V_2$$

$$3.5M \times 0.1752L = M_2 \times 0.500L$$

$$M_2 = 1.2264 \quad 1.2M$$

17. 300. g of Pb(NO$_3$)$_2$ are combined with 500. g of KI according to the following equation:

$$\text{Pb(NO}_3)_2 + 2\text{KI} \rightarrow \text{PbI}_2 + 2\text{KNO}_3$$

The excess reactant is potassium iodide and 199 grams remain in the mixture after the reaction. (5pts)

$$\frac{300. \text{ g Pb(NO}_3)_2}{1} \times \frac{1 \text{ mol Pb(NO}_3)_2}{331.2 \text{ g Pb(NO}_3)_2} = 0.9058 \text{ mol} / L \quad \text{LR}$$

$$\frac{500. \text{ g KI}}{1} \times \frac{1 \text{ mol KI}}{166.1 \text{ g KI}} = 3.012 \text{ mol} / 2 \quad 1.506$$

$$\frac{300 \text{ g Pb(NO}_3)_2}{1} \times \frac{1 \text{ mol Pb(NO}_3)_2}{331.2 \text{ g Pb(NO}_3)_2} \times \frac{2 \text{ mol KI}}{1 \text{ mol Pb(NO}_3)_2} \times \frac{166.1 \text{ g KI}}{1 \text{ mol KI}} = 301.9 \text{ g KI}$$
35. From the balanced equation below, how many moles of hydrogen gas will be produced if 0.27 moles of hydrochloric acid is completely reacted?

\[ 2\text{HCl(aq)} + \text{Fe(s)} \rightarrow \text{FeCl}_2(\text{aq}) + \text{H}_2(\text{g}) \]

\[ \frac{0.27 \text{ mol HCl}}{1} \times \frac{1 \text{ mol H}_2}{2 \text{ mol HCl}} = \frac{0.14 \text{ mol H}_2}{1} \]

a. 0.14 mol H₂   
b. 0.27 mol H₂   

c. 0.54 mol H₂   

d. 0.28 g H₂

36. Determine the number of moles of Sn(l) produced when 4.0 moles of H₂(g) is completely consumed in excess of SnO₂.

\[ \text{SnO}_2(\text{s}) + 2\text{H}_2(\text{g}) \rightarrow \text{Sn}(\text{l}) + 2\text{H}_2\text{O}(\text{g}) \]

\[ \frac{4.0 \text{ mol H}_2}{1} \times \frac{1 \text{ mol Sn}}{2 \text{ mol H}_2} = \frac{2.0 \text{ mol Sn}}{1} \]

a. 1.0 mol Sn(l)   

c. 4.0 mol Sn(l)   

b. 2.0 mol Sn(l)   

d. 6.0 mol Sn(l)

37. Given the balanced equation below:

\[ \text{Ba}_3\text{N}_2 + 6 \text{H}_2\text{O} \rightarrow 3 \text{Ba(OH)}_2 + 2 \text{NH}_3 \]

If 79.4 g of water is reacted in excess Ba₃N₂, what is the theoretical yield of ammonia (NH₃)?

\[ \frac{79.4 \text{ g H}_2\text{O}}{1} \times \frac{1 \text{ mol H}_2\text{O}}{18.016 \text{ g H}_2\text{O}} \times \frac{2 \text{ mol NH}_3}{6 \text{ mol H}_2\text{O}} \times \frac{17.0349 \text{ g NH}_3}{1 \text{ mol NH}_3} = 25.024 \text{ g NH}_3 \]

a. 17.024 g NH₃   

c. 225 g NH₃   

b. 25.0 g NH₃   

d. 239 NH₃

38. Given the balanced equation below:

\[ 2 \text{As} + 6 \text{NaOH} \rightarrow 2 \text{Na}_3\text{AsO}_3 + 3 \text{H}_2 \]

If 1.35 mol of sodium hydroxide is reacted, how many grams of hydrogen will be produced?

\[ \frac{1.35 \text{ mol NaOH}}{1} \times \frac{3 \text{ mol H}_2}{6 \text{ mol NaOH}} \times \frac{2.016 \text{ g H}_2}{1 \text{ mol H}_2} = 1.3608 \text{ g H}_2 \]

a. 1.36 g H₂   

c. 0.675 g H₂   

b. 0.680 g H₂   

d. 2.70 g H₂
PART B: PRACTICE NATIVE EXAM

Part One: Multiple Choice. Choose the best answer and write the capital letter of your answer in the box. (2pts each)

1. The concentration of hydronium ions is $5.25 \times 10^{-9}$ M in a solution. pH = -log[H_3O^+]
   A. Solution has a pH of 5.25 and is acidic.  
   B. Solution has a pH of 8.27 and is acidic.  
   C. Solution has a pH of 4.6 and is basic.  
   D. Solution has a pH of 8.27 and is basic.

2. Experimental yield is determined by
   A. calculations starting with the limiting reactant.  
   B. the percentage yield.  
   C. performing experiments.  
   D. stoichiometry.

3. How many grams of sodium sulfate are needed to prepare 1.00 L of a 1.00 M solution?
   A. 1.00 g  
   B. 103.05 g  
   C. 119.05 g  
   D. 142.04 g

4. The reaction stops when the
   A. limiting reactant runs out.  
   B. excess reactant runs out.  
   C. a combination of an s and a p orbital  
   D. too much product is made.

5. A covalent bond in which there is an unequal attraction for the shared pair of electrons is
   A. nonpolar  
   B. polar  
   C. ionic  
   D. dipolar

6. A clover-shaped electron cloud surrounding an atomic nucleus would represent
   A. an s orbital  
   B. a p orbital  
   C. a d orbital  
   D. a combination of an s and a p orbital

7. The experimental yield of a chemical reaction is generally
   A. less than the theoretical yield  
   B. greater than the percentage yield.  
   C. greater than the theoretical yield  
   D. equal to the percentage yield

Part Two: Short Answer

8. Listed below are the successive ionization energies in kJ/mol for an element. Which element in Period 2 do you expect this data to match? (2pts)
   
   \[
   \begin{array}{cccc}
   \text{IE}_1 & = & 1,402 & \text{IE}_2 = 2,856 \text{ IE}_3 = 4,578 \text{ IE}_4 = 7,475 \text{ IE}_5 = 9,445 \text{ IE}_6 = 53,266
   \end{array}
   \]
   Answer: nitrogen

9. Compare the radius of an anion to the radius of its neutral atom. (2pts) Anions are larger, have a larger radius, than their neutral atoms.

10. Define endothermic (2pts). A change that requires the absorption or input of heat.

11. Define precipitate (2pts). An insoluble solid that is formed upon the reaction of two solutions.

12. A chemical reaction is described in the equation below.
   \[
   \text{Reactants} + \text{Heat} \rightarrow \text{Products}
   \]
   Is this chemical change endothermic or exothermic? (2pts) endothermic

Practice Chemistry Comp 21 | 6