Chemistry 11 - Review

Part A - True or False.

Indicate whether each of the following statements is true or false. **Correct the false statements.**

____ 1. The mass of an electron is equal to the mass of a proton.
____ 2. The mass of a proton is approximately equal to the mass of a neutron.
____ 3. The atomic number represents the number of protons in a nucleus.
____ 4. The proton has a mass of approximately 1 u.
____ 5. The difference in mass of isotopes of the same element is due to the different number of protons in the nucleus.
____ 6. The isotope carbon-12 is used as the relative mass standard for the atomic mass scale.
____ 7. The mass of the most common isotope of each element is listed on the periodic table.

Part B - Multiple Choice

____ 1. A(n) __ is used to represent a compound.
a) symbol b) equation c) subscript d) formula

____ 2. ___ atoms or groups of atoms are called ions.
a) charged b) diatomic c) neutral d) monatomic

____ 3. For the formula of a compound to be correct, the algebraic addition of the charges on the atoms or ions in the compound must add up to __.
a) zero b) one c) two d) four

____ 4. Potassium bromide is an example of a(n) __ compound.
a) molecular b) organic c) polyatomic d) ionic

____ 5. The only common polyatomic ion that has a positive charge is the __ ion.
a) phosphate b) ammonium c) sulfate d) nitrate

____ 6. In the formula H_2SO_4, the number 4 would be called a(n) __.
a) subscript b) oxidation number c) coefficient d) charge

____ 7. Which subatomic particle contributes the least to the mass of an atom?
a) nucleon b) electron c) proton d) neutron

____ 8. In the free, or uncombined, state the number of protons in the nucleus of an element must equal the __.
a) mass number c) mass number - atomic number
b) number of neutrons in the nucleus d) number of electrons present

____ 9. Which of the following ideas of the Bohr model is not retained in the modern theory of atomic structure?
a) Electrons can absorb or emit energy only in whole numbers of photons.
b) Atoms have a central positively charged nucleus.
c) Electrons move around the nucleus as planets orbit the sun.
d) Most of the volume of an atom is empty space.

____ 10. Which of the following orbitals is spherical in shape?
a) 3p b) 2s c) 4d d) 5f

____ 11. The third energy level of an atom may have __ electrons.
a) 2 b) 18 c) 8 d) 32

____ 12. How many sublevels are possible at the fourth energy level?
a) 2 b) 3 c) 4 d) 18

____ 13. Lustrous, malleable, ductile elements that are good conductors of electricity and heat are classified as __.
a) metals b) nonmetals c) metalloids d) noble gases

____ 14. The electron configuration of a certain element ends with $3p^5$. Which of the following describes its position in the periodic table?
a) period 5, group 13 b) period 3, group 15 c) period 3, group 17 d) period 5, group 15

____ 15. Which of the following is an example of a metalloid?
a) iodine b) boron c) bromine d) indium

____ 16. The periodicity of the elements is basically a function of their __.
a) nuclear stability b) atomic numbers c) mass numbers d) none of these

____ 17. An element with seven electrons in the outer level would be a __.
a) metal b) metalloid c) noble gas d) nonmetal

____ 18. As the atomic number in a period increases, the degree of nonmetallic character __.
a) increases b) decreases c) increases then decreases d) remains the same

____ 19. Elements in a group have similar chemical properties because of their similar __.
a) nuclear configurations c) mass numbers
b) outer electron configurations d) names

____ 20. The period number in the periodic table designates the __ for the row.
a) total nuclear charge c) maximum number of outer electrons
b) maximum number of nucleons d) highest energy level

____ 21. Compared to the stability of the original atom, the stability of its ion that resembles a noble gas configuration would be
a) identical b) sometimes less c) less d) greater

____ 22. The formation of bonds between atoms depends on __.
a) the electron configurations of the atoms involved c) both of the preceding factors
b) the attraction the atoms have for electrons d) neither of the preceding factors

____ 23. The particle that results when two or more atoms form covalent bonds is a __.
a) single charged atom b) molecule c) polyatomic ion d) b or c

____ 24. The most active __ have the highest electronegativities.
a) nonmetals b) metalloids c) metals d) noble gases

____ 25. __ compounds have high melting points, conduct electricity in the molten phase, and tend to be soluble in water.
a) hydrogen b) metallic c) covalent d) ionic

____ 26. The element in the following group that has the lowest electronegativity is __.
a) potassium b) arsenic c) bromine d) chromium

____ 27. If there are only two electron pairs in the outer energy level of an atom in a molecule, they will be found __.
a) at 90° to one another c) at 120° to one another
b) on the same side of the nucleus d) on opposite side of the nucleus

____ 28. The __ molecule has two bonding pairs and two unshared pairs of electrons.
a) CH_4 b) H_2O c) NH_3 d) HF

____ 29. A certain atom contains 34 protons, 34 electrons, and 45 neutrons. This atom has a mass number of __.
a) 34 b) 45 c) 68 d) 79

____ 30. An example of a compound is
a) oxygen b) mercury c) salt d) diamond

____ 31. Carbon is classed as an element rather than as a compound because it
a) cannot be chemically decomposed into two or more substances
b) has been known for many centuries
c) is formed when wood is heated out of contact with air
d) combines with oxygen to form a gas

____ 32. The positively charged particles in the nucleus of an atom are called
a) protons b) neutrons c) electrons d) ions

____ 33. The charged particles that are found outside the nucleus of an atom are called
a) protons b) ions c) electrons d) mesons

____ 34. A nonmetallic atom generally becomes a negative ion by
a) losing protons b) losing electrons c) gaining protons d) gaining electrons

____ 35. Which of the following subatomic particles has the smallest mass?
a) electron b) neutron c) proton d) nucleus

____ 36. Which of the following symbols represents an atom that contains the largest number of neutrons?
a) $^{235}{}_{92}U$ b) $^{239}{}_{92}U$ c) $^{239}{}_{93}Np$ d) $^{239}{}_{94}Pu$

____ 37. The nuclide symbol $^{16}{}_{8}O$ represents an oxygen atom with
a) a mass of 8 u b) an atomic number of 16 c) a mass of 16 u d) 16 neutrons

____ 38. If Z represents the atomic number of an element and A represents the mass number, then the number of neutrons in one atom is
a) A b) A + Z c) A - Z d) Z - A

____ 39. Which of the following statements about the elemental species $^{24}{}_{11}X$ and $^{25}{}_{12}Z$ is correct?
a) They are isotopes of the same element. c) They are members of the same chemical family.
b) They are nonmetals. d) They have the same number of neutrons per atom.

____ 40. An element X has a mass number of 32 and an atomic number of 16. The most common ion of element X is represented by
a) X^+ b) X^{2-} c) X^- d) X^{2+}

Part C - Short Answer

1. What is the maximum number of electrons that may occupy one orbital?
2. The Lewis electron dot diagram is used to represent only which electrons in the atom?
3. What is the diagonal rule used to predict?
4. How many sublevels are possible at the third energy level?
5. How many orbitals are there in the ***f*** sublevel?
6. What is the maximum number of electrons that can occupy a ***d*** sublevel?
7. Which sublevel may contain a maximum of three pairs of electrons?
8. What must be true about the spins of two electrons occupying the same orbital?
9. Write the electron configuration for each of the following elements:
   a) lithium b) radium c) sodium d) mercury
10. Draw the energy level diagram for each of the following elements:
   a) tin b) krypton c) gold d) potassium

11. Write the energy level population for each of the following elements:
    a) calcium b) sulfur c) scandium d) tungsten
12. Element X has the following configuration: $1s^2 2s^2 2p^6 3s^2 2p^6 4s^2 3d^{10} 4p^6 5s^1$
    a) What period is this element located in?
    b) What group is this element in?
    c) Identify the element.
    d) Is the element a metal, nonmetal, or metalloid?
13. List five properties of metals and five properties of nonmetals.
14. Would an element with two outer electrons be a metal or a nonmetal?
15. For the transition elements, as the atomic number increases, to which sublevel are the electrons being added?
16. According to the octet rule, how many pairs of outer electrons do the most stable atoms have?
17. In the lanthanide series, as the atomic number increases, to which sublevel are electrons being added?
18. Give examples of molecules with the following shapes:
    a) linear b) trigonal planer c) bent
    c) trigonal pyramidal e) tetrahedral
19. Draw Lewis Structures, sketch and name the shape of the molecule, predict the bond polarity, and molecule polarity for the following molecules:
    a) PH_3 c) H_2O e) CH_4
    b) CO_2 d) HCN f) BCl_3
20. Use electron dot formulas to show the complete balanced bonding reactions between the following elements. Indicate the type of bond expected.
    a) sodium & oxygen c) zirconium & sulfur
    b) nitrogen & hydrogen d) magnesium & chlorine
21. Explain the process of fractional distillation and describe the variety of substances obtained from crude oil.
22. Explain the difference between saturated and unsaturated compounds and how this relates to fats and oil. Describe a laboratory technique that can be used to distinguish between saturated and unsaturated compounds.

*23. Compare the boiling points of methane, ethane, propane, and butane. Use Intermolecular bonding to explain why they are different.

*24. Compare the boiling points of propanoic acid, 1-butanol, diethyl ether, butanal, and pentane. Use Intermolecular bonding to explain why they are different.

25. Write the correct names for the following chemical compounds.

a) HCl(aq)	e) $Al_2(SO_4)_3$	i) NH_4NO_3	m) SO_3	q) SbF_3	u) $NiSeO_4$
b) KOH	f) N_2O_5	j) $NaHCO_3$	n) $NaC_2H_3O_2$	r) $Pd(CN)_2$	v) $H_2SO_3(aq)$
c) HgOH	g) HF	k) $Zn(NO_2)_2$	o) $HFO_2(aq)$	s) $Ca(MnO_3)_2$	w) $Ba(OH)_2$
d) $FeCl_3$	h) $Pb(OH)_2$	l) $H_3PO_4(aq)$	p) $Al(BrO_4)_3$	t) $Be(NO_4)_2$	x) PbS

26. Write the correct chemical formula for each compound and balance the equation.
    a) sodium carbonate + calcium hydroxide → sodium hydroxide + calcium carbonate
    b) carbon dioxide + water → carbonic acid
    c) phosphorus + oxygen → phosphorus pentoxide
    d) sodium + water → sodium hydroxide + hydrogen
    e) zinc + sulfuric acid → zinc sulfate + hydrogen
    f) aluminum sulfate + calcium hydroxide → aluminum hydroxide + calcium sulfate
    g) calcium oxide + water → calcium hydroxide
    h) iron + copper(I) nitrate → iron(II) nitrate + copper
    i) iron(II) sulfide + hydrochloric acid → hydrogen sulfide + iron(II) chloride
    j) potassium oxide + water → potassium hydroxide
    k) carbon + ferric oxide → iron + carbon dioxide
    l) sulfur tetrafluoride + water → sulfur dioxide + hydrofluoric acid
    m) calcium hydroxide + phosphoric acid → calcium phosphate + water
    n) ethane + oxygen → carbon dioxide + water
    o) aluminum sulfate + ammonia + water → aluminum hydroxide + ammonium sulfate
27. Identify the type of reaction. Write the correct chemical formulas of the compounds, complete and balance the equations and name the products formed.
    a) calcium carbonate + hydrochloric acid →
    b) iron + sodium bromide →
    c) ammonium acetate + iron(II)chloride →
    d) silver bromide + ammonium sulfate →
    e) zinc + sulfuric acid →
    f) neon + potassium →
    g) lead(II)hydroxide + hydrochloric acid →
    h) iron + sulfur →
    i) potassium chlorate (heated) →
    j) calcium oxide + water →
    k) dinitrogen pentoxide + water →
    l) carbon dioxide + water →
    m) chlorine + chromium(III) bromide →
    n) sulfur + oxygen →
    o) zinc + hydrochloric acid →
    p) sodium + water →
    q) magnesium + water →
    r) copper + stannic nitrate →
    s) aluminum + cupric sulfate →

Part D – Calculations

1. Calculate the average atomic mass of the following elements:
   a) Mg-24 mass = 23.985 u 78.70%
      Mg-25 mass = 24.986 u 10.13%
      Mg-26 mass = 25.983 u 11.17%
   b) Ir-191 mass = 191.0 u 37.58%
      Ir-193 mass = 193.0 u 62.42%
2. Calculate the average atomic mass for titanium based on the following data: ${}_{22}^{46}Ti$ = 8.0%, ${}_{22}^{47}Ti$ = 7.5%, ${}_{22}^{48}Ti$ = 73.7%, ${}^{49}_{22}Ti$ = 5.5%, and ${}_{22}^{50}Ti$ = 5.3%
3. Calculate the percentage of each of the isotopes of silver if silver-107 has a mass of 106.905 u and silver-109 has a mass of 108.905 u and the average atomic mass of silver is 107.869 u
4. Calculate the average atomic mass of selenium, which consists of the following naturally occurring isotopes: ${}_{34}^{74}Se$ 0.90%, mass = 73.9225 amu; ${}^{76}{}_{34}Se$ 9.0%, mass = 75.9192 amu; ${}^{77}{}_{34}Se$ 7.6%, mass = 76.9199 amu; ${}^{78}{}_{34}Se$ 23.5%, mass = 77.9173 amu; ${}^{80}{}_{34}Se$ 49.8%, mass = 79.9165 amu; and ${}^{82}{}_{34}Se$ 9.2%, mass = 81.9167 amu.

*5. Naturally, occurring silicon consists of three isotopes, ${}^{28}Si$, ${}^{29}Si$, and ${}^{30}Si$, whose atomic masses are 27.9769, 28.9765, and 29.9738, respectively. The most abundant isotope is ${}^{28}Si$, which accounts for 92.23 percent of naturally occurring silicon. Given that the observed atomic mass of silicon is 28.0855, calculate the percentages of ${}^{29}Si$ and ${}^{30}Si$ in nature.

6. Complete the chart below:

Element	Atomic #	Mass #	# Protons	# Neutrons	# Electrons
calcium–43					
lead-211					
plutonium–242					
chromium-50					
${}^{65}Cu^{2+}$					
${}^{34}S^{2-}$					
		128	53		54
	82			126	78

7. Convert each of the following to moles.
   a. 8.8 g of potassium carbonate
   b. 0.257 g of arsenic pentachloride
   c. 12.5 L of carbon dioxide at STP
   d. 5.00×10^{13} atoms of iron
   e. 8.63×10^{28} molecules of water
   f. 450.0 mL helium at STP
   g. 236.0 g of ammonium phosphate
   h. 15.0 g of butanoic acid
8. Calculate the mass of each of the following.
   a. 2.60 mol of sodium carbonate
   b. five million atom of gold
   c. 25.0 mL of carbon dioxide at STP
   d. 4.50×10^{21} molecules of decanoic acid
9. Determine the percentage composition of each element in gallium nitrate.
10. Aspirin tablets contain Acetylsalicylic acid (ASA), which has the chemical formula $C_9H_8O_4$. Calculate the mass of carbon contained in a 250.0 mg sample of ASA.
11. Calculate the molarity of 825 mL of solution, which contains 30.0 g of acetic acid.
12. What volume of solution can be made from 80.0 g of sodium hydroxide if a 2.00 M solution is required?
13. What mass of calcium chloride is required to produce 750.0 mL of a 0.500 M solution?
14. What volume of 14.0 M nitric acid is required to produce 750.0 mL of a 0.250 M solution?
15. What concentration results when 250.0 mL of a 0.125 M solution of hydrochloric acid is mixed with 125.0 mL of a 1.00 M solution?

*16. What volume of 0.225 M sulfuric acid must be mixed with 500.0 mL of a 0.750 M solution in order to obtain a 0.500 M solution?

17. Determine the empirical formula for each compound listed below:
    a. 80.0% carbon; 20.0% hydrogen
    b. 35.0% nitrogen; 5.0% hydrogen; 60.0% oxygen
    c. 83.7% carbon; 16.3% hydrogen
    d. 26.6% potassium; 35.4% chromium; 38.0% oxygen
    e. Chemical analysis of a 10.000 g sample of oil of wintergreen shows that it consists of 6.320 g of carbon, 0.530 g of hydrogen, and 3.16 g of oxygen. What is the simplest formula for oil of wintergreen?

*18. Calculate the molecular formula for the following compounds.
   a) Analysis of a compound shows that it consists of 24.3% carbon, 4.1% hydrogen, and 71.6% chlorine. The molecular mass of the compound is determined to be 99.8 g/mol. What molecular formula corresponds to these data?
   b) Chemical analysis of a gaseous compound show its composition to be 36.4% carbon, 57.5% fluorine, and 6.1% hydrogen. A sample of 1.00 L of this gas has a mass of 2,96 g. What molecular formula do these data suggest for this compound?
   c) Analysis of an organic compound indicates that it has a percentage composition as follows: 40.7% carbon; 5.0% hydrogen; 54.3% oxygen. When this compound is vapourized, 35.0 mL of the vapour has a mass of 0.184 g. Determine the molecular formula for this compound.
   d) A gaseous compound is found to have the following composition: 30,5% nitrogen and 69.5% oxygen. The molar mass of the gas if found to be 91.8 g/mol. What is the molecular formula of this gas?

E. STOICHIOMETRY - Begin each problem by writing a balanced chemical equation.

1. Sulfur dioxide may be catalytically oxidized to sulfur trioxide. How many grams of sulfur dioxide could be converted by this process if 100.0 g of oxygen are available for the oxidation?
2. Phosphoric acid is produced in the reaction between calcium phosphate and sulfuric acid. What mass of phosphoric acid would be produced from 55.0 g of the calcium phosphate?
3. How much magnesium sulfate is needed to completely react with 145 g of sodium chloride? How much sodium sulfate could be produced by this reaction?
4. Gold will dissolve in the acid mixture known as aqua regia according to the following reaction:

$$Au + HNO_3 + 3\ HCl \rightarrow AuCl_3 + NO + 2\ H_2O$$

   How much gold(III)chloride will be produced in this reaction when one starts with 5.0 mg of gold? How much hydrochloric acid must be added initially to dissolve the all this gold?
5. How many grams of sulfuric acid will react with 400.0 g of aluminum metal?
6. An unknown amount of potassium chlorate was heated until no more oxygen was evolved. 15.824 g of potassium chloride remained in the test tube. What mass of potassium chlorate had originally been placed in the tube? What volume of oxygen gas was evolved in the process?
7. How many grams of carbon can be completely burned in 15.0 L of oxygen? How many litres of carbon dioxide gas are produced in this reaction?
8. How many grams of magnesium metal are required to liberate 250.0 mL of hydrogen gas from hydrochloric acid? Exactly how much acid would be used up in this reaction?
9. Will 30.0 L of fluorine gas completely react with 50.0 L of hydrogen gas? Which gas is in excess and by how much? What volume of hydrogen fluoride is formed in this reaction?
10. A mixture containing 100.0 g of H_2 and 100.0 g of O_2 is sparked so that water is formed. How much water is formed?
11. When copper is heated with sulfur, Cu_2S is formed. How many grams of Cu_2S could be produced if 100.0 g of copper is heated with 50.0 g of sulfur?
12. What volume (at STP) of carbon monoxide is required to produce 100.0 g of iron according to the equation:

$$Fe_2O_3 + CO \rightarrow Fe + CO_2 \quad \text{(not balanced)}$$

13. What is the molarity of a NaOH solution if 25.00 cm^3 is required to completely neutralize 40.00 cm^3 of a 1.50 M solution of H_2SO_4?
14. Calculate the volume of a 0.600 M solution of HNO_3 necessary to neutralize 28.55 cm^3 of a 0.450 M solution of KOH.
15. A titration of 15.00 cm^3 of household ammonia, $NH_4OH(aq)$, required 38.57 cm^3 of 0.780 M HCl. Calculate the molarity of the ammonia.
16. What volume of 0.250 M H_3PO_4 is required to neutralize 30.00 cm^3 of a 0.0500 M $Ba(OH)_2$ solution?
17. What mass of $Ca(OH)_2$ would be required to completely neutralize 50.0 cm^3 of 0.125 M HCl?
18. What mass of $Mg(OH)_2$ would be required to completely neutralize 70.0 cm^3 of 0.175 M HNO_3?

*19. Hydrazine is a nitrogen-hydrogen compound having the formula N_2H_4. It is an oily, colourless liquid that freezes at 1.5°C and boils at 113.5°C. The principal use of hydrazine and certain compounds derived from it is a rocket fuels, but it is also used in fuel cells, in the treatment of water in boilers to removed dissolved oxygen gas, and in the plastics industry. One widely used method for the manufacture of hydrazine is the Raschig process. The Raschig process involves three reaction steps. In the first step, sodium hydroxide is reacted with chlorine to produce sodium hypochlorite, sodium chloride and water. The sodium hypochlorite produced in the first step is reacted with ammonia in the second step to produce chloramine (NH_2Cl) and sodium hydroxide. The chloramine and sodium hydroxide produced in the second step is reacted with ammonia in the third step to produce hydrazine, sodium chloride and water. A chemical plane using the Raschig process obtains 0.299 kg of 98.0% hydrazine for every 1.00 kg of chlorine. What are the theoretical, actual, and percent yields of ***pure*** hydrazine?

*20. The characteristic odour of pineapple is due to ethyl butyrate, a compound containing carbon, hydrogen, and oxygen. Combustion of 2.78 mg of ethyl butyrate produces 6.32 mg of carbon dioxide and 2.58 mg of water. What is the empirical formula of the compound?

*21. Nicotine, a component of tobacco, is composed of carbon, hydrogen, and nitrogen. A 5.250 mg sample of nicotine was combusted, producing 14.242 mg of carbon dioxide and 4.083 mg of water. What is the empirical formula for nicotine?