SCH 3U Exam Review Name: _____

DATE: _____

You need: a calculator, pencils, eraser, your textbook!

Key Terms:

- Proton
- Neutron
- Electron
- Valence electron
- Atomic mass
- Atomic number
- Ion
- Isotope
- Metal
- Nonmetal
- Energy level
- Nuclear charge
- Atomic radius
- Ionization energy
- Electronegativity
- Electron affinity
- Molecular compound
- Ionic compound
- Covalent bond
- Polar covalent bond
- Ionic bond
- Intramolecular forces
- Intermolecular forces
- Electrolyte
- Single displacement reaction
- Double displacement reaction
- Combustion reaction
- Synthesis
- Decomposititon
- Activity series
- Percent composition
- Mole
- Avogadro's number
- Avogadro's principle
- Molar mass
- Empirical formula
- Molecular formula
- Molar ratio
- Stoichiometry
- Excess reagent
- Limiting reagent
- Actual yield
- Theoretical yield
- Percentage yield
- Nuclear equation
- Solubility
- Nonpolar
- Polar
- Dilution
- Ionic equation
- Net ionic equation
- Precipitate
- Spectator ion
- Strong/weak acid
- Strong/weak base
- pH
- pH scale
- Neutralization reaction
- Indicator
- Titration
- Boyle's law
- Charles's law
- Gay-Lussac's law
- Combined gas law
- Gas constant
- Ideal gas law
- Dalton's law of partial pressures
- Molar volume
- Partial pressure

Be able to:

- explain periodic trends such as atomic radius, ionic radius, ionization energy, electron affinity, electronegativity
- explain how different elements combine to form covalent and ionic bonds, explain properties of compounds
- write the IUPAC name, write the formula and draw the Lewis structures of compounds
- predict the products and use balanced chemical equations to represent chemical reactions
- classify chemical reactions as synthesis, decomposition, combustion, single displacement or double displacement
- predict the producst of, and use balanced chemical equations to represent chemical reactions.
- compare the reactivity of metals
- explain how different elements combine to form covalent and ionic bonds, using the octet rule.
- Predict the ionic character or polarity of a given bond using electronegativity values, and represent the formation of ionic and covalent bonds using diagrams.
- Draw Lewis structures, construct molecular models, and give the structural formulas for compounds containing single and multiple bonds.
- solve problems involving quantity in moles, number of particles and mass
- determine the percent composition of a compound
- determine empirical formulas and molecular formulas
- calculate, for any given reactant or product in a chemical equation, the corresponding mass of any other reactant or product
- solve problems involving limiting reagents and percentage yield
- explain the formation of solutions involving various solutes in water and nonpolar solutes in nonpolar solvents
- solve solution concentration problem
- describe how to prepare solutions of required concentrations
- describe the dependence on temperature of the solubility of solids, liquids and gases in water
- predict the products of combinations of aqueous solutions that produce precipitates and represent these using net ionic equations
- solve solution stoichiometric problems
- demonstrate an understanding of the Arrhenius and Bronsted-Lowry theories of acids and bases
- write balanced equations for reactions involving acids and bases
- use titration to determine the concentration of an acid or base in solution

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- ❖ solve quantitative problems involving Charles's law, Boyle's law, Gay-Lussac's law, combined gas law, ideal gas law
- ❖ explain Dalton's law of partial pressures
- ❖ perform stoichiometric calculations involving moles, mass and volume of substances in a balanced chemical equation

Unit 1 – Matter, Chemical Trends and Chemical Bonding

1. How many electrons, protons, and neutrons are in each of the following particles?

a) $^{81}_{35}Br^-$ **c)** $^{63}_{29}Cu^{2+}$

b) $^{58}_{26}Fe^{3+}$ **d)** $^{87}_{37}Rb^+$

2. Write the symbols of the isotopes that contain the following.
   - **a)** An isotope of iodine whose atoms have 78 neutrons.
   - **b)** An isotope of strontium whose atoms have 52 neutrons.
   - **c)** An isotope of cesium whose atoms have 82 neutrons.
   - **d)** An isotope of fluorine whose atoms have 9 neutrons.

3. Give the numbers of neutrons, protons, and electrons in the atoms of each of the following isotopes.

a) radium-226 **c)** $^{206}_{82}Pb$

b) carbon-14 **d)** $^{23}_{11}Na$

4. To which group of the periodic table does the element with the following successive ionization energies likely belong? Explain. (ANS: Alkaline earth metal)

First Ionization Energy = 0.65 MJ/mol
Second Ionization Energy = 2.00 MJ/mol
Third Ionization Energy = 14.00 MJ/mol
Fourth Ionization Energy = 25.38 MJ/mol
Fifth Ionization Energy = 38.55 MJ/mol

5. Describe and explain the trends in ionization energy as one moves up a group in the periodic table.

6. Describe and explain the trends in ionization energy as one moves from left to right across a period in the periodic table.

7. What factors affect ionization energy? (ANS: radius/size and atomic number)

8. If an element has a low ionization energy and a low electron affinity is it more likely to form a positive or negative ion? Explain. (ANS: positive ion)

9. Explain how the trend in electronegativity is related to
   a) the trend in atomic radius
   b) the trend in ionization energy
   c) the trend in electron affinity

10. Draw Lewis structures for each of the following: N_2, HCN, H_2O, O_2, SO_2, CO_3^{2-}

11. Why do covalent molecules have low melting and boiling temperatures?

12. Discuss the bonding continuum and explain how electronegativity can be used to predict the location of a bond on the continuum.

13. Write the name of each of the following compounds;

$PbCl_2$		H_3PO_4	
KNO_3		N_2S_3	
FeO		Be_3N_2	
LiOH		$Ca(ClO_2)_2$	
HNO_3		Na_2CO_3	
SnO_2		Cu_3P	
HCl(aq)		CI_4	
$BaSO_4$		$HBrO_2$(aq)	
Cl_2		H_2S	
HgSe		$Cu_3(PO_3)_2$	

14. Write the chemical formula for each of the following:

	Beryllium fluoride		Nickel(III) carbonate
	Diphosphorous pentoxide		Sulfurous acid
	Lead(IV) acetate		Gallium oxide
	Sulfur tribromide		Lithium hydrogen sulfite
	Hydroiodic acid		Barium chloride dihydrate
	Nitrogen gas		Sulfur hexafluoride
	Aluminuium hypochorite		Nitric acid
	Barium chloride		Cupric sulfide
	Nitrogen monoxide		Ferrous carbonate
	Lithium acetate		Sodium chloride

Unit 2 – Chemical Reactions

15. Balance each of the following chemical equations;
    a) $Ca_3P_2 + H_2O \rightarrow PH_3 + Ca(OH)_2$
    b) $C_3H_7OH + O_2 \rightarrow CO_2 + H_2O$
    c) $Cu + H_2SO_4 \rightarrow CuSO_4 + H_2O + SO_2$

16. According to the activity series, which of the following reactions will take place:
    a) $Ag(s) + NaNO_3(aq) \rightarrow AgNO_3(aq) + Na(s)$
    b) $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$
    c) $Cu(s) + 2HCl\ (aq) \rightarrow CuCl_2(aq) + H_2(g)$

17. Indicate which of the following reactions will occur and balance the equations:
    a) $Au(s) + FeSO_4(aq) \rightarrow$
    b) $Al(s) + ZnSO_4(aq) \rightarrow$
    c) $Sn(s) + AgNO_3(aq) \rightarrow$

18. For each of the following reactions, indicate whether a precipitate will be formed and name it.
    a) $CaCl_2(aq) + K_2CO_3(aq) \rightarrow CaCO_3(?) + 2KCl(?)$
    b) $3Ba(OH)_2(aq) + Fe_2(SO_4)_3 \rightarrow 2Fe(OH)_3(?) + 3BaSO_4(?)$
    c) $3NH_4Cl(aq) + Na_3PO_4(aq) \rightarrow (NH_4)_3PO_4(?) + 3NaCl(?)$

19. Which of the following salts are not soluble:
    a) ammonium carbonate
    b) lead(II) sulfate
    c) barium hydroxide
    d) silver iodide
    e) mercury(II) nitrate
    f) lead(IV) sulfate
    g) copper(II) bromide
    h) aluminum phosphate

20. Complete and balance the following equations:
    a) $(NH_4)_2SO_4(aq) + Ba(OH)_2(aq) \rightarrow$
    b) $AgNO_3(aq) + Na_2S(aq) \rightarrow$
    c) $Al(OH)_3 + HCl(aq) \rightarrow$
    d) $MgCl_2(aq) + NaOH(aq) \rightarrow$

21. Classify each of the following as a synthesis, decomposition, single or double displacement reaction.
    a) $KOH(aq) + HNO_3(aq) \rightarrow KNO_3(aq) + H_2O(l)$
    b) $Ni(s) + CuSO_4(aq) \rightarrow NiSO_4(aq) + Cu(s)$
    c) $2NaNO_3(s) \rightarrow 2NaNO_2(s) + O_2(g)$
    d) $Al(NO_3)_3(aq) + 3LiOH(aq) \rightarrow 3LiNO_3(aq) + Al(OH)_3(s)$
    e) $2Zn(s) + O_2(g) \rightarrow 2ZnO(s)$

Unit 3 – Stoichiometry

22. What is the total number of atoms in 1 mol of $Al_2(SO_4)_3$? (ANS: 1.02×10^{25} atoms)

23. Calculate the number of atoms in 30.0 g of Li. (ANS: 2.61×10^{24} atoms)

24. Calculate the actual number of atoms contained in 4.4×10^{-2} g of carbon dioxide. (1.80×10^{21} atoms)

25. Determine the mass represented by 3.01×10^{20} atoms of sulphur. (ANS: 0.0160 g)

26. Determine the mass of 1.204×10^{22} atoms of potassium. (ANS: 0.782 g)

27. What is the mass of 1.8×10^{21} molecules of O_2? (ANS: 0.0957 g)

28. Calculate the mass represented by a single molecule of carbon monoxide gas.(ANS: 4.65×10^{-23}g)

29. Calculate the mass in grams of a single atom of hydrogen. (ANS: 1.66×10^{-24}g)

30. Calculate the mass represented by 10.0 mol of calcium hydroxide. (ANS: 741 g)

31. Determine the mass represented by 10.0 mol of magnesium nitrate. (ANS: 1.48×10^3 g)

32. What is the mass of 0.782 mol of barium? (ANS: 107 g)

33. Calculate the number of moles of Li in 15.0 g of Li. (ANS: 2.16 mol)

34. Calculate the number of moles of molecules contained in 4.6×10^{-2} g of ethanol. (1.0×10^{-3} mol)

35. Calculate the percentage of nitrogen in ammonia, NH_3, and urea, $CO(NH_2)_2$. (These are two major nitrogen fertilizers used in agriculture worldwide.)

36. One compound of mercury with a molar mass of 519 g/mol contains 77.26% Hg, 9.25% C, and 1.17% H (with the balance being O). Calculate the empirical and molecular formulas, arranging the symbols in the order HgCHO.

37. Zinc and sulfur react to form zinc sulfide according to the equation.

$$Zn + S \rightarrow ZnS$$

38. In an experiment, 30.0 g of zinc and 36.0 g of sulfur are mixed.
    (a) Which chemical is the limiting reactant?
    (b) How many grams of ZnS can form?
    (c) How many grams of the excess reactant will be left over after the reaction?

39. Aluminum sulfate can be made be the following reaction.

$$2AlCl_3(aq) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 6HCl(aq)$$

It is quite soluble in water, so to isolate it the solution has to be evaporated to dryness. This drives off the volatile HCl, but the residual solid has to be heated to a little over 200°C to drive off all of the water. In one experiment, 25.00 g of $AlCl_3$ was used.

(a) How many grams of H_2SO_4 are needed?

(b) There was eventually isolated 28.36 g of pure $Al_2(SO_4)_3$. Calculate the percentage yield.

40. Read p. 189 to p. 193 in your textbook.

Unit 4 – Solutions and Solubility

41. a) What is the molar mass of calcium fluoride? (1 mark) (ANS: 78.08 g/mol)
b) Determine the concentration of the solution produced by dissolving 1.0 g of calcium fluoride in enough water to make 100 mL of solution (3 marks) (ANS: 0.13 mol/L)
c) What would be the resulting concentration if 50 mL of water is added to the solution from "b"? (3 marks) (ANS: 0.087 mol/L)

42. What mass of calcium carbonate would be required to produce 1.0 L of 0.001 mol/L solution? (3 marks) (ANS: 0.10 g)

43. A student added 250 g of H_2SO_4 to 4.50 L of water.
a) Calculate the molar concentration of the sulfuric acid solution. (ANS: 0.567 mol/L)
b) How many mL of 0.5 mol/L NaOH are required to neutralize 50.0 mL of acid in part a). (ANS: 112 mL)

44. Calculate the number of grams of $Hg(IO_3)_2$ dissolved in 57.5 mL of a 0.250 mol/L solution. (7.93 g)

45. Calculate the molar concentration of a solution made by dissolving 22.9 g of $PCl_3(s)$ in water to make 285 mL of solution. (0.586 mol/L)

46. A water solution of sodium hydroxide contains 2.00 g NaOH in 50.0 mL of solution.
a) the number of moles of NaOH present equals: (ANS: 0.0500 moles)
b) the molar concentration of the solution is: (ANS: 1.00 mol/L)
c) how many moles of NaCl would be formed if 50.0 mL of 1.0 mol/L HCl solution were added to the 50.0 mL of NaOH solution? (ANS: 0.050 moles)

47. Hydrochloric acid reacts with magnesium hydroxide to produce magnesium chloride and water. What volume of 1.50 mol/L magnesium hydroxide would be required to neutralize 50.0 mL of 3.10 mol/L hydrochloric acid? (ANS 51.6 mL)

48. A solution of copper(II) sulfate is prepared by placing 5.80g in a flask and adding enough water to prepare 125 mL of solution. A 25.0 ml sample of this solution is added to 125 mL of sodium hydroxide (0.125 mol/L) and a double displacement reaction occurs.
a) determine the limiting reagent
b) determine the mass of copper(II) hydroxide produced

49. Write ionic and net ionic equations for these reactions.

(a) $(NH_4)_2CO_3(aq) + MgCl_2(aq) \rightarrow 2NH_4Cl(aq) + MgCO_3(s)$

(b) $CuCl_2(aq) + 2NaOH(aq) \rightarrow Cu(OH)_2(s) + 2NaCl(aq)$

(c) $3FeSO_4(aq) + 2Na_3PO_4(aq) \rightarrow Fe_3(PO_4)_2(s) + 3Na_2SO_4(aq)$

(d) $2AgC_2H_3O_2(aq) + NiCl_2(aq) \rightarrow 2AgCl(s) + Ni(C_2H_3O_2)_2(aq)$

50. Use the solubility rules to decide which of the following compounds are insoluble in water.

(a) AgCl

(b) $Cr_2(SO_4)_3$

(c) $(NH_4)_2CO_3$

(d) $Ca_3(PO_4)_2$

(e) $Al(C_2H_3O_2)_3$

(f) ZnO

51. Calculate the molarity of a solution prepared by dissolving.

(a) 4.00 g of NaOH in 100.0 mL of solution.

(b) 16.0 g of $CaCl_2$ in 250.0 mL of solution.

(c) 14.0 g of KOH in 75.0 mL of solution.

(d) 6.75 g of $H_2C_2O_4$ in 500 mL of solution.

52. p. 316 #1-2 (Questions on the solubility curves)

Unit 5 – Gases and Atmospheric Chemistry

52. A gas at 200°C and 101.3 kPa has a volume of 5.0 L. Calculate the pressure if the temperature is changed to 100°C and the volume to 7.0 L. (ANS: 57.1 kPa)

53. A sample of oxygen gas is trapped in a plastic syringe with a moveable piston. The original sample had a volume of 45.0 mL measured at 99.5 kPa and 21.0°C. Several days later the temperature was 25.5°C and the pressure was 97.8 kPa. What volume would the gas occupy under the new conditions? (ANS: 46.5 mL)

54. Acetylene gas $C_2H_{2(g)}$, burns in oxygen to form carbon dioxide gas and water vapour.
    a) Write the balanced chemical equation for this reaction.
    b) What volume of oxygen is required to burn completely with 8.0 L of acetylene, if all the gases are measured at the same temperature and pressure? (20.0 L)

55. A weather balloon, filled with 132.0 L of helium in a lab at a temperature of 20°C and standard pressure, is allowed to rise into the atmosphere. Just before the balloon bursts, the transmitter attached to it registers a temperature of –50°C and an atmospheric pressure of 27.7 kPa. Calculate the maximum volume of the balloon just before it bursts. (367L)

56. Given the reaction

$$C_7H_{16(g)} + 11O_{2(g)} \rightarrow 7CO_{2(g)} + 8H_2O_{(g)}$$

    a) If 5.0 L of C_7H_{16} are burned, what volume of oxygen gas is required? (measured under the same conditions) (ANS: 55.0L)
    b) If 500 g of CO_2 are formed, what weight of C_7H_{16} was burned? (ANS: 163.4 g)

SCH 3U
Final Exam Review

Exam Review Answers

Unit 1 – Matter, Chemical Trends and Chemical Bonding

1.

	# of electrons	# of protons	# of neutrons
a)	36	35	46
b)	23	26	32
c)	27	29	34
d)	36	37	50

2. a) ${}^{131}_{53}I$ b) ${}^{90}_{38}Sr$ c) ${}^{137}_{55}Cs$ d) ${}^{18}_{9}F$

3.

	# of electrons	# of protons	# of neutrons
a)	88	88	138
b)	6	6	8
c)	82	82	124
d)	11	11	12

4. This element belongs to Group #2 – Alkaline Earth Metals. Alkaline Earth metals have 2 electrons in the outer shell which will be removed more easily than electrons from the inner shells. The 1st and 2nd ionization energies are much smaller than the 3rd, 4th, and 5th indicating the first 2 electrons are easier to remove.

5. The ionization energy increases up a group. This is because there are less shells at the top and the electrons are closer to the nucleus. There is a stronger attraction between the electrons and the nucleus and therefore it requires more energy to pull the electrons away.

6. The ionization energy increases left to right across a period. This is because the elements have more protons as you move left to right. There is a stronger attraction between the nucleus and the electrons if there are more protons and so more energy is required to remove an electron.

7. Ionization energy is affected by a) radius/size: the bigger the radius, the lower the ionization energy and b) atomic number: the higher the atomic number (# of protons), the higher the ionization energy.

8. Low ionization energy means an electron is easily removed. Low atomic number means the higher the atom does not readily accept more electrons. Therefore, it will form a positive ion (lose electrons).

9. a) EN decreases as AT increases, since the farther electrons are from the nucleus, the less of a pull the atom has on the electrons.
b) EN increases as IE increases, the more energy it takes to remove and electron, the more attraction the atom has on the electron and the higher the EN.
c) EN increases as EA increases, the higher an atom's attraction to its electrons, the higher the EN

10. answers will be posted in class.

11. Covalent molecules have weaker intermolecular forces. A small amount of heat will cause a molecular compound to change state.

12. The absolute value of the difference in electronegativities of 2 bonded atoms gives the polarity of the bond. If the difference is 0, the bond is covalent, greater than 1.7, ionic and in between, polar covalent bond.

13.

Lead (II) chloride	Aqueous hydrogen phosphate (phosphoric acid)
Potassium nitrate	Dinitrogen trisulfide
Iron (II) oxide	Beryllium nitride
Lithium hydroxide	Calcium chlorite
Aqueous hydrogen nitrate (nitric acid)	Sodium carbonate
Tin (IV) oxide	Copper (I) phosphide
Aqueous hydrogen chloride (hydrochloric acid)	Carbon tetraiodide
Barium sulfate	Aqueous hydrogen bromite (bromous acid)
Chlorine gas	Dihydrogen monosulfie
Mercury (II) selenide	Copper (II) phsophite

14.

BeF_2	$Ni_2(CO_3)_3$
P_2O_5	H_2SO_3
$Pb(C_2H_3O_2)_4$	Ga_2O_3
SBr_3	$LiHSO_3$
HI(aq)	$BaCl_2 \cdot 2H_2O$
N_2	SF_6
$Al(ClO)_3$	HNO_3
$BaCl_2$	CuS
NO	$FeCO_3$
$LiC_2H_3O_2$	NaCl

Unit 2 – Chemical Reactions

15. a) 1 6 2 3
b) 2 9 6 8
c) 1 2 1 2 1

16. a) NR
b) This reaction will take place.
c) NR

17. a) NR
b) $2Al + 3ZnSO_4 \rightarrow Al_2(SO_4)_3 + 3Zn$
c) $Sn + 2AgNO_3 \rightarrow Sn(NO_3)_2 + 2Ag$

18.

a)	$CaCO_3(s)$	Calcium carbonate
b)	$Fe(OH)_3(s)$	iron (III) hydroxide
c)	$BaSO_4(s)$	barium sulfate

19.

a)	(aq)	b)	(s)
c)	(aq)	d)	(s)
e)	(aq)	f)	(s)
g)	(aq)	h)	(s)

20.
a) $(NH_4)_2SO_4(aq) + Ba(OH)_2(aq) \rightarrow BaSO_4(s) + 2NH_4OH(aq)$
b) $2AgNO_3(aq) + Na_2S(aq) \rightarrow Ag_2S(s) + 2NaNO_3(aq)$
c) $Al(OH)_3(aq) + 3HCl(aq) \rightarrow 3H_2O(l) + AlCl_3(aq)$
d) $MgCl_2(aq) + 2NaOH(aq) \rightarrow 2NaCl(aq) + Mg(OH)_2(s)$

21. a) DD b) SD c) Decomposition d) DD e) synthesis

Unit 3 – Stoichiometry

22.
$$atoms = 1\,\text{mol}\,Al_2(SO_4)_3 \times \frac{6.02\text{x}10^{23}\ \text{molecules}}{\text{mol}} \times \frac{17\ \text{atoms}}{\text{molecule}}$$
$$= 1.02\times10^{25}\ \text{atoms}$$

23.
$$atoms = 30.0\ \text{g Li} \times \frac{1\,\text{mol}}{6.94\ \text{g Li}} \times \frac{6.02\times10^{23}\ \text{atoms}}{\text{mol}}$$
$$= 2.60\times10^{24}\ \text{atoms}$$

24.
$$atoms = 4.4\times10^{-2}\ \text{g}\ CO_2 \times \frac{1\,\text{mol}}{44.01\ \text{g}\,CO_2} \times \frac{6.02\times10^{23}\ \text{atoms}}{\text{mol}} \times \frac{3\ \text{atoms}}{\text{molecule}}$$
$$= 1.8\times10^{21}\ \text{atoms}$$

25.
$$mass = 3.01\times10^{20}\ \text{atoms} \times \frac{1\,\text{mol}}{6.02\times10^{23}\ \text{atoms}} \times \frac{32.06\ \text{g}}{\text{mol}}$$
$$= 0.0160\ \text{g S}$$

26.
$$mass = 1.204\times10^{22}\ \text{atoms} \times \frac{1\,\text{mol}}{6.02\times10^{23}\ \text{atoms}} \times \frac{39.10\ \text{g}}{\text{mol}}$$
$$= 0.782\ \text{g}$$

27.
$$mass = 1.8\times10^{21}\ \text{molecules} \times \frac{1\,\text{mol}}{6.02\times10^{23}\ \text{atoms}} \times \frac{32.00\ \text{g}}{\text{mol}}$$
$$= 0.0957\ \text{g}$$

28. $mass = 1\,\text{molecule} \times \frac{1\,\text{mol}}{6.02\times10^{23}\,\text{atoms}} \times \frac{28.01\,\text{g}}{\text{mol}}$
$= 4.65\times10^{-23}\,g$

29. $mass = 1\,\text{atom} \times \frac{1\,\text{mol}}{6.02\times10^{23}\,\text{atoms}} \times \frac{1.01\,\text{g}}{\text{mol}}$
$= 1.68\times10^{-24}\,g$

30. $mass = 10.0\,\text{mol} \times \frac{74.10\,\text{g}}{\text{mol}}$
$= 741\,g$

31. $mass = 10.0\,\text{mol} \times \frac{148.33\,\text{g}}{\text{mol}}$
$= 1.48\times10^{3}\,g$

32. $mass = 0.782\,\text{mol} \times \frac{137.33\,\text{g}}{\text{mol}}$
$= 107\,g$

33. $moles = 15.0\,\text{g} \times \frac{1\,\text{mol}}{6.94\,\text{g}}$
$= 2.16\,mol$

34. $\text{molecules ethanol} = 4.6\times10^{-2}\,\text{g} \times \frac{1\,\text{mol}}{46.10\,\text{g}}$
$= 1.0\times10^{-3}\,mol$

35. $\%\,\text{N in } NH_3 = \frac{14.01\,\text{g}}{17.04\,\text{g}} \times 100\%$
$= 82.22\%$

$\%\,\text{N in } CO(NH_2)_2 = \frac{28.02\,\text{g}}{60.07\,\text{g}} \times 100\%$
$= 46.65\%$

36.

	Mass(g)	Moles (mol)	Ratio	Whole # ratio
Hg	77.26	0.3851	1	1
C	9.25	0.770	1.99	2
H	1.17	1.16	3.01	3
O	12.32	0.7700	1.99	2

The empirical formula is $HgC_2H_3O_2$. Empirical molar mass = 259.64 g/mol
Molecular molar mass = 519 g/mol

$$\frac{\text{molecular}}{\text{empirical}} = \frac{519\,\text{g/mol}}{259.64\,\text{g/mol}}$$
$$= 1.99$$
$$= 2$$

Therefore the molecular formula is $Hg_2C_4H_6O_4$

37. a)

From Zn

$$n_{ZnS} = 30.0\ g \times \frac{1\ mol}{65.38\ g} \times \frac{1\ mol\ ZnS}{1\ mol\ Zn}$$
$$= 0.456\ mol\ ZnS$$

From S

$$n_{ZnS} = 36.0\ g \times \frac{1\ mol}{32.06\ g} \times \frac{1\ mol\ ZnS}{1\ mol\ S}$$
$$= 1.12\ mol\ ZnS$$

Therefore Zn is the limiting reagent

b)
$$m_{ZnS} = 0.459\ mol \times \frac{97.44\ g\ ZnS}{1\ mol\ ZnS}$$
$$= 44.7\ g\ ZnS$$

c)
$$n_S\ (\text{reacted}) = 0.459\ mol \times \frac{1\ mol\ S}{1\ mol\ Zn}$$
$$= 0.459\ mol\ S$$
$$n\ (\text{remaining}) = n_{used} - n_{reacted}$$
$$= 1.12\ mol - 0.459\ mol$$
$$= 0.661\ mol$$
$$m_s = 0.661\ mol \times \frac{32.06\ g}{1\ mol}$$
$$= 21.2\ g\ S\ \text{remaining}$$

38. see #37

39. a)
$$m_{H_2SO_4} = 25.00\ g \times \frac{1\ mol}{133.33\ g} \times \frac{3\ mol\ H_2SO_4}{2\ mol\ AlCl_3} \times \frac{98.08\ g}{1\ mol\ H_2SO_4}$$
$$= 27.59 g$$

b)
$$m_{Al_2(SO_4)_3} = 25.00\ g \times \frac{1\ mol}{133.33\ g} \times \frac{1\ mol\ Al_2(SO_4)_3}{2\ mol\ AlCl_3} \times \frac{342.14\ g}{1\ mol\ H_2SO_4}$$
$$= 32.08 g$$
$$\%\ \text{yield} = \frac{28.36\ g}{32.08\ g} \times 100\%$$
$$= 88.40\%$$

40. Read p. 189 to p. 193 in your textbook.

<u>Unit 4 – Solutions and Solubility</u>

41. a) $M_{CaF2} = 40.08\ g/mol + 2(19.00\ g/mol) = 78.08\ g/mol$

b)
$$n_{CaF_2} = 1.0\ g \times \frac{1\ mol}{78.08\ g}$$
$$= 0.013\ mol$$
$$C_{CaF_2} = \frac{0.013\ mol}{0.100\ L}$$
$$= 0.13\ mol/L$$

Therefore, the concentration is 0.13 mol/L.

c)
$$C_1V_1 = C_2V_2$$
$$C_2 = \frac{C_1V_1}{V_2}$$
$$= \frac{(0.13\ mol/L)\quad (100\ mL)}{150\ mL}$$
$$= 0.087\ mol/L$$

The concentration would be 0.087 mol/L

42.
$$m_{CaCO_3} = 1.0\ L \times \frac{0.001 mol}{1\ L} \times \frac{100.09\ g}{1\ mol}$$
$$= 0.10g$$

43. a)
$$n_{H_2SO_4} = 2.50\ g \times \frac{1\ mol}{98.08\ g}$$
$$= 2.55\ mol$$

$$C_{H_2SO_4} = \frac{n}{V}$$
$$= \frac{2.55\ mol}{4.50\ L}$$
$$= 0.567\ mol/L$$

b) $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

$$V_{NaOH} = 0.050\ L \times \frac{0.567\ mol}{1L} \times \frac{2\ mol\ NaOH}{1\ mol\ H_2SO_4} \times \frac{1L}{0.5\ mol}$$
$$= 0.112\ L$$

44.
$$m = 0.0575\ L \times \frac{0.250\ mol}{1L} \times \frac{550.39\ g}{1\ mol}$$
$$= 7.93g$$

45.
$$n = 22.9g \times \frac{1\ mol}{137.32\ g}$$
$$= 0.167\ mol$$

$$C = \frac{n}{V}$$
$$= \frac{0.167\ mol}{0.285L}$$
$$= 0.586\ mol/L$$

46. a) $$n = 2.00\,g \times \frac{1\,mol}{40.00\,g}$$
$$= 0.0500\,mol$$

b) $$C = \frac{n}{V}$$
$$= \frac{0.0500\,mol}{0.0500\,L}$$
$$= 1.00\,mol/L$$

c) From NaOH
$$n_{NaCl} = 0.050\,L \times \frac{1.0\,mol}{1L} \times \frac{1\,mol\,NaCl}{1\,mol\,NaOH}$$
$$= 0.050\,mol$$

From HCl
$$n_{NaCl} = 0.050\,L \times \frac{1.0\ mol}{1L} \times \frac{1\,mol\,NaCl}{1\,mol\,HCl}$$
$$= 0.050\,mol\,NaCl$$

Therefore, the number of moles of NaCl would be 0.050 mol.

47. $2HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2H_2O$

$$V_{NaOH} = 0.050\,L \times \frac{3.10\ mol}{1L} \times \frac{1\ mol\ Mg(OH)_2}{2\,mol\,HCl} \times \frac{1L}{1.50\,mol}$$
$$= 0.0516\,L$$

48. a) $$n_{CuSO_4} = 5.80\,g \times \frac{1\,mol}{159.61g}$$
$$= 0.0363\,mol$$

$$C_{CuSO_4} = \frac{n}{V}$$
$$= \frac{0.0363\,mol}{0.125L}$$
$$= 0.290\,mol/L$$

$CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

From $CuSO_4$
$$n_{Cu(OH)_2} = 0.0250\ L \times \frac{0.290\,mol}{1L} \times \frac{1\,mol\,Cu(OH)_2}{1\,mol\,CuSO_4}$$
$$= 0.00725\,mol$$

From NaOH
$$n_{Cu(OH)_2} = 0.125\,L \times \frac{0.125\,mol}{1L} \times \frac{1\,mol\,Cu(OH)_2}{2\,mol\,NaOH}$$
$$= 0.00780\,mol$$

Therefore the limiting is $CuSO_4$.

b) $m_{Cu(OH)_2} = 0.00725\ mol \times \frac{97.57\ g}{1\ mol}$
$= 0.707\ gl$

49. a) $2NH_4^+(aq) + CO_3^{2-}(aq) + Mg^{2+}(aq) + 2Cl^-(aq) \rightarrow 2NH_4^+(aq) + 2Cl^-(aq) + MgCO_3(s)$
$CO_3^{2-}(aq) + Mg^{2+}(aq) \rightarrow MgCO_3(s)$

b) $Cu^{2+}(aq) + 2Cl^-(aq) + 2Na^+(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s) + 2Na^+(aq) + 2Cl^-(aq)$
$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$

c) $3Fe^{2+}(aq) + 3SO_4^{2-}(aq) + 6Na^+(aq) + 2PO_4^{3-}(aq) \rightarrow Fe_3(PO_4)_2(s) + 6Na^+(aq) + 3SO_4^{2-}(aq)$
$3Fe^{2+}(aq) + 2PO_4^{3-}(aq) \rightarrow Fe_3(PO_4)_2(s)$

d) $2Ag^+(aq) + 2C_2H_3O_2^-(aq) + Ni^{2+}(aq) + 2Cl^-(aq) \rightarrow 2AgCl(s) + Ni^{2+}(aq) + 2C_2H_3O_2^-(aq)$
$2Ag^+(aq)\ 2Cl^-(aq) \rightarrow 2AgCl(s)$

50. a) insoluble b) soluble c) soluble
d) insoluble e) soluble f) soluble

51. a) $n_{NaOH} = 4.00\ g \times \frac{1\ mol}{40.00g}$
$= 0.100\ mol$

$C_{NaOH} = \frac{n}{V}$
$= \frac{0.100\ mol}{0.100L}$
$= 1.00\ mol/L$

b) $n_{CaCl_2} = 16.0\ g \times \frac{1\ mol}{110.98g}$
$= 0.144\ mol$

$C_{CaCl_2} = \frac{n}{V}$
$= \frac{0.144\ mol}{0.250L}$
$= 0.577\ mol/L$

c) $n_{KOH} = 14.0\ g \times \frac{1\ mol}{56.11g}$
$= 0.250\ mol$

$C_{KOH} = \frac{n}{V}$
$= \frac{0.250\ mol}{0.0750L}$
$= 3.33\ mol/L$

d) $n = 6.75\ g \times \frac{1\ mol}{90.04g}$
$= 0.0750\ mol$

$C = \frac{n}{V}$
$= \frac{0.0750\ mol}{0.500L}$
$= 0.150\ mol/L$

52.
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$
$$P_2 = \frac{P_1V_1T_2}{V_2T_1}$$
$$= \frac{(101.3)(5.0)(373)}{(473)(7.0)}$$
$$= 57.1\,\text{kPa}$$

53.
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$
$$V_2 = \frac{P_1V_1T_2}{P_2T_1}$$
$$= \frac{(99.5)(0.045)(298.5)}{(294)(97.8)}$$
$$= 0.0465\,\text{L}$$

54. a) $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$

b)
$$V_{O_2} = 8.0\,\text{L} \times \frac{5\ \text{mol}\ O_2}{2\,\text{mol}\ C_2H_2}$$
$$= 20.0\,\text{L}$$

55.
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$
$$V_2 = \frac{P_1V_1T_2}{P_2T_1}$$
$$= \frac{(101.3)(132.0)(223)}{(27.2)(293)}$$
$$= 367\,\text{L}$$

56. a)
$$V_{O_2} = 5.0\,\text{L} \times \frac{11\,\text{mol}\ O_2}{1\,\text{mol}\ C_2H_2}$$
$$= 55.0\,\text{L}$$

b)
$$m_{C_7H_{16}} = 500\,\text{g} \times \frac{1\ \text{mol}}{44.01\,\text{g}} \times \frac{1\,\text{mol}\ C_7H_{16}}{7\,\text{mol}\ CO_2} \times \frac{100.23\,\text{g}}{\text{mol}}$$
$$= 163g$$