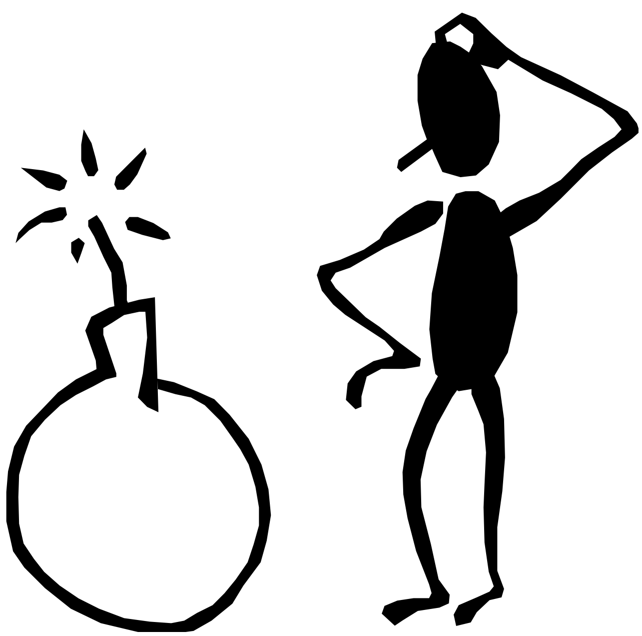
Name: ____________________

Chemistry 20

Worksheets



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Worksheet 1.1: Atomic Structure

1. Complete the following table. Using symbols, provide an example of each category using the element provided. For the average atom assume that the mass number is the atomic mass rounded off. The first one is done. (8 marks) (1/2 mark off for each mistake in each row).

	Average Atom	**Monoatomic Polyatomic or diatomic element**	**Most common simple Ion**	**Complex or polyatomic Ion**	**Isotope of the average**	**Ionic compound**	**Molecular compound**	**Acid compound**
chromium	^{52}Cr	Cr	Cr^{3+}	CrO_4^{2-}	^{53}Cr	Cr_2O_3	NONE	NONE
sulfur								
nitrogen								

2. Complete the following table. Note that the mass number can change for isotopes. If there is not a noble gas with the same # of electrons, than put NONE. The first one is done.(6 marks) (1/2 mark off for each mistake in each row)

Atom or Ion name	**Atom or ion symbol**	**Atomic number**	**Mass number**	**Protons**	**Electrons**	**Neutrons**	**Noble Gas with same # of electrons**
sodium ion	$^{23}Na^{+}$	11	23	11	10	12	neon
aluminum atom			28				
			34	17	18		

Worksheet 1.2: Compounds

1. Complete the following table (Assume water is used with ionic compounds): (16 marks)

I, M, A	chemical formula(add states)	chemical name
	$K_2SO_{3(\ )}$	
		sulfuric acid
	$Na_2S_2O_3\bullet H_2O_{(\ )}$	
		ethanol
	$Pb(SO_4)_{2\,(\ )}$	
	$P_5O_{10\,(\ )}$	
		sucrose
		sodium silicate
		ammonia

	$H_2O_{2\,(\quad)}$	
	$SO_{3\,(\quad)}$	
		ammonium phosphate
		copper (II) sulfate pentahydrate
		propane
		ethanoic acid
	$O_{3\,(\quad)}$	
	$HOH_{(\quad)}$	

Worksheet 1.3: Reactions

Complete the following reactions, identify the reaction type and balance the equation.(3 marks each; 15 marks total)

1) mercury (II) oxide is broken down into its elements by heating.

2) a nickel strip is placed in a gold (III) sulfate solution

3) phosphoric acid reacts with iron (III) oxide.

4) decane is burned in air

5) sulfur combines with oxygen to from sulfur trioxide

Worksheet 1.4: Mole Problems

1. What is the molar mass of hydrogen peroxide?

2. What is the molar mass of lead (II) nitrate?

3. How many moles in 30.6 g of copper?

4. How many moles in 6.55×10^{19} atoms of zinc?

5. Determine the number of moles in 33.6 L of methane at STP?

6. How many formula units in 3.99 mol of potassium carbonate?

7. What volume of gas would be present in 0.955 mol at SATP?

8. What is the mass of 2.3 mol of carbon dioxide at STP?

9. How many moles in 100 mL of carbon dioxide at SATP?

10. What volume of nitrogen monoxide would be present in 2.7 mol if the temperature is 25C and the pressure is 100 kPa?

Worksheet 1.5: More difficult mole problems

1. How many molecules in 2.00 mol of sulphur dioxide?

2. How many molecules in 7.5 mol of chlorine?

3. How many atoms of **copper** are in 0.088 mol of copper (I) oxide?

4. How many mol of **magnesium ions** are in 1.00 x 10^{20} formula units of magnesium nitride?

5. What is the mass of 14.6 L of carbon monoxide at STP?

6. How many atoms of xenon are in 15 L at SATP?

7. How many moles of **carbon and oxygen** are in 6.02×10^{23} molecules of carbon dioxide?

8. When studying reactions what unit are most quantities converted into? (HINT: What do the coefficients in front of a balanced equation represent?)

9. What are the temperature, pressure and molar volume of a gas at STP?

10. What are the temperature, pressure and molar volume of a gas at SATP?

Worksheet 2.1: Mole to Mole Stoichiometry

Directions: Write balanced equations with states. Solve the problem. Assume water is available.

1. Liquid water decomposes into its elements. How many moles of hydrogen gas are produced if 0.500 mol of water is used?

2. Sulphur reacts with barium oxide. How many moles of sulphur are needed if 2.00 mol of barium oxide is used?

3. Methane gas burns. How many moles of oxygen gas are needed to completely burn 3.00 mol of methane?

4. Sodium and phosphorus react. How many moles of phosphorus are needed if 0.600 mol of sodium metal is used?

5. Magnesium phosphate reacts with lithium carbonate. How many moles of lithium carbonate are needed when 1.50 mol of magnesium phosphate is used?

6. Sulphur dioxide decomposes. How many moles of sulphur dioxide are needed to produce 0.30 mol of sulphur?

7. Magnesium chloride reacts with sodium. How many moles of sodium are needed to react with 0.0250 mol of magnesium chloride?

8. Iron (II) phosphate reacts with tin (IV) nitride. How many moles of tin (IV) nitride are needed to produce 0.500 mol of iron (II) nitride?

9. Gasoline ($C_8H_{18(l)}$) is burned. How many moles of carbon dioxide are produced when 3.00 mol of gasoline is reacted?

10. Chlorine reacts with potassium bromide. How many moles of chlorine would be needed to completely use up 25 mol of potassium bromide?

Worksheet 2.2: Mole to Quantity Stoichiometry

Directions: Solve the following hypothetical stoichiometry problems. Assume water is available.

1. When 6.5 mol of solid potassium chlorate breaks into solid potassium chloride and oxygen gas, what mass of solid potassium chloride is produced?

2. When 5.00 mol of methane burns, what volume of carbon dioxide at STP, will be produced?

3. How many particles of hydrochloric acid is needed to neutralize 2.50 mol of calcium hydroxide?

4. When 5.25 mol of butane ($C_4H_{10(l)}$) burns, what volume of water vapour will be produced at SATP?

5. When excess silver reacts with 3.45 mol of zinc phosphate, what mass of silver phosphate would be produced?

6. When 3.00 mol of iron (II) hydroxide reacts with cobalt (II) phosphate, what mass of cobalt (II) phosphate is needed?

7. In a neutralization reaction, 4.56 mol of sodium hydroxide neutralizes the sulphuric acid. What mass of water is produced?

8. Hydrogen and 2.5 mol of Nitrogen react to form ammonia. How many moles of ammonia will be produced at STP? SATP?

Worksheet 2.3: Quantity to Mole Stoichiometry

Directions: Solve the following hypothetical stoichiometry problems. Assume water is available.

1. How many moles of iron (III) oxide is produced when 5.6 g of iron burns with oxygen gas?

2. When 4.00×10^{23} particles of methanol is burned, how many moles of water vapour are produced?

3. If 122.6 g of solid potassium chlorate is heated, the crystals melt and decompose into solid potassium chloride and oxygen gas. How many moles of potassium chloride are formed?

4. Black iron(III) oxide solid can be converted into water and iron metal when the iron (III) oxide is reacted with hydrogen gas. If 125 g of iron (III) oxide is reacted, how many moles of water are formed?

5. How many moles of zinc can react with hydrochloric acid to form 44.8 L of hydrogen gas at STP?

6. Solutions of copper (II) sulphate and potassium phosphate are mixed. If 8.5 g of copper (II) phosphate form, how many moles of copper (II) sulphate react?

7. In the manufacturing of nitric acid, nitrogen dioxide gas reacts with water to from nitric acid and nitrogen monoxide gas. How many moles of nitrogen dioxide gas reacts if 120.6 L of nitrogen monoxide gas is formed at SATP?

8. The thermite reaction is used in welding iron and steel. Aluminium and iron (III) oxide are ignited at high temperatures to produce aluminium oxide and iron. If 15.0 g of aluminium is used in this reaction, how many moles of aluminium oxide will be produced?

Worksheet 2.4: Quantity to Quantity Stoichiometry

Directions: Solve the following hypothetical stoichiometry problems. Assume water is available.

1. How many particles of aluminium oxide must be decomposed to produce 80.0 g of oxygen gas at STP?

2. Natural gas is mainly made up of methane. What mass of methane must be burned to produce 56.0 L of carbon dioxide at STP?

3. Aluminium metal is refined from bauxite ore. In the refining process, aluminium oxide decomposes to aluminium and oxygen gas. What mass of aluminium can be produced from **2.04 kg** of aluminium oxide?

4. Sodium hydrogen carbonate can be used to neutralize acids. If sodium hydrogen carbonate reacts with hydrochloric acid, what volume of carbon dioxide gas at STP can be produced by 16.8 g of sodium hydrogen carbonate? NOTE: Sodium chloride and water vapour is also produced.

5. Photography film is coated with silver chloride, which is produced when silver nitrate reacts with sodium chloride. What mass of silver chloride can be made from 11.7 g of sodium chloride?

6. Ammonia reacts with hydrochloric acid to produce ammonium chloride. What volume of ammonia at SATP is needed to produce 36.1 g of ammonium chloride?

7. If sulphuric acid reacts with 29.4 g of potassium hydroxide, what mass of potassium sulphate is produced?

8. If sodium iodide reacts with lead (II) nitrate, what mass of lead (II) nitrate will be required to produce 150 g of precipitate?

Worksheet 2.5: Limiting & Excess Reagents

Directions: For each of the following, write a balanced equation and determine the limiting reagent & the excess reagent (if they are present).

1. 5.0 mol of gasoline ($C_8H_{18(l)}$) burns 47.0 mol of oxygen at STP. How many moles of carbon dioxide are produced?

2. 18.0 g of water breaks up into 6.0 g of oxygen. What is the mass of hydrogen produced?

3. 22.4 mL of methane reacts with 22.4 mL of oxygen at SATP. How many moles of water vapor are theoretically produced?

4. 26 g of magnesium react with 1.00 mol of hydrochloric acid.

    a. What volume of hydrogen gas is produced at STP?

    b. How much excess reagent is left over

5. 3.02×10^{23} formula units of sodium react with 12 L of chlorine gas at STP. How much excess reagent is left over if the limiting is all used up?

6. Describe what a limiting reagent and an excess reagent are and what they are used for.

Worksheet 2.6: Percent yield and Percent error

Directions: For each of the following write a balanced equation and determine the theoretical yield, actual yield, percent yield & the percent error.

1. 8.0 mol of sulfur dioxide decomposes and actually produces 7.0 mol of oxygen gas.

2. 26.0 g of aluminum reacts with a solution of calcium nitrate and produces 3.00 moles of calcium.

3. 6.50 mol of potassium chlorate solid is heated and breaks down into potassium chloride solid and 223 L of oxygen gas at SATP.

4. 33.6 L of methane burns and produces 2.00 mol of carbon dioxide gas at STP.

5. Sulfuric acid reacts with 29.4 g of potassium hydroxide and produces 40.5 g of potassium sulfate

6. Describe percent yield and percent error.

Worksheet 2.7: Limiting Reagents and Percent Yield

1. Methane gas burns at STP.

   a. If 0.500 mol of methane is burned in 2.50 mol of oxygen, what is the limiting reagent?

   b. What is the theoretical yield, in moles, of water?

   c. How much of the excess is left over?

2. Sodium and chlorine are mixed together.

   a. What is the limiting reagent if there is 10.0 g of sodium and 20.0 g of chlorine?

   b. How many grams of the product are produced?

3. In the synthesis of sulfuric acid, one step involves the mixing of sulfur dioxide with oxygen to produce sulfur trioxide. If 175 L of sulfur dioxide was mixed with 85 L of oxygen at SATP, how many litres of sulfur dioxide is produced?

4. Adipic acid ($C_6H_{10}O_{4(s)}$), a raw material for nylon, is made by the oxidation (reacting with oxygen) of cyclohexane ($C_6H_{12(s)}$). Water is a by-product.

   a. How many moles of oxygen gas would be needed to make 40.0 mol of adipic acid?

   b. If 2 mol of oxygen is reacted with 164 g of cyclohexane, what is the theoretical yield of adipic acid in grams?

   c. If 285 g of acid was produced in b) what is the percent yield?

5. A chemist, new to the behavior of chlorine toward hydrocarbon compounds, tried to make dichloromethane ($CH_2Cl_{2(g)}$), by mixing 5500 mL of chloromethane ($CH_3Cl_{(g)}$) and 5500 mL of chlorine at STP. Hydrogen chloride gas was a by-product. After the reaction was complete, some chloromethane remained unchanged and 12.8 g of dichloromethane was obtained.

    a. Which reactant is excess?

    b. How much dichloromethane can theoretically be produced?

    c. What is the percent yield?

    d. What is the percent error?

Worksheet 2.8: Stoichiometry Review

1. A 34.5 g sample of sodium hydroxide solution is reacted with excess phosphoric acid. What is the mass of sodium phosphate that will form?

2. A 75.0 g sample of lithium carbonate reacts with 120 g of aluminium nitrate. What mass of precipitate will form?

3. A 45.0 g sample of ethanol burns in the presence of 105 L of oxygen gas. (assume STP). What is the percent yield if 50.0 g of carbon dioxide is formed?

4. When 5.6×10^{24} particles of magnesium sulfide reacts with potassium hydroxide, then 500 g of precipitate forms. What is the percent error?

5. When 36.9 L of chlorine gas (SATP) reacts with 36.8 g of magnesium oxide, 38.9 g of magnesium chloride formed. What mass of magnesium chloride did you expect?

6. When 24.5 g of iron(II) chloride reacts with 35.0 g of zinc, 7.2 g of iron was formed. What is the percent yield and percent error is this experiment?

Worksheet 3.1: Introduction to Gases & Dalton's Gas Law

1. What are three physical properties of all gases?

2. What three variables affect gases?

3. What instrument measures pressure?

4. What is the SI unit for pressure?

5. What unit expresses the average kinetic energy of a gas?

6. A 1.00 L bottle of gas contains oxygen at 10.0 kPa, nitrogen at 12.1 kPa & hydrogen at 97.5 kPa
    a. What is the total pressure?

    b. What percent of each gas is present? (HINT % = P_{gas}/P_{total} x 100)

    c. What is the volume of each gas?

7. Four gases (A, B, C and D) make up a mixture with a pressure of 150 kPa. What is the partial pressure of gas A, if gas B has a pressure of 58.0 kPa, gas C has a pressure of 23.8 kPa and gas D has a pressure of 15.9 kPa.

8. Three gases make up a mixture. At a particular pressure, the partial pressures are measured: Gas A = 67.00 kPa, Gas B, 6.70 kPa, and Gas C = 0.67 kPa. What is the pressure conditions under which this measurement is taken?

Worksheet 3.2: Boyles' Gas Law

1. What is the pressure when: (temperature is constant)

    a. 130 mL of a gas at 740 mmHg is changed to 150 mL?

    b. 25 mL of gas at 65 atm is changed to 30.0 mL?

    c. 1.0 L of gas at 70 kPa is changed to 1.2 L?

2. What is the volume when: (temperature is constant)

    a. 75 mL of gas at 4.1 atm is changed to 7.0 atm?

    b. 60.0 mL of gas at 760 mmHg is changed to 10 mmHg?

    c. 400.0 mL of gas at 760 kPa is changed to 300 kPa?

Worksheet 3.3: Charles' Gas Law

1. What is the volume when: (pressure is constant)

    a. 125 mL of gas at 25^{o} C is cooled to Standard temperature?

    b. 300.0 mL of gas at $0.0^{o}C$ is heated to $30.0^{o}C$?

    c. 220.0 mL of gas at $10.0^{o}C$ is heated to $100.0^{o}C$?

2. What is the temperature when: (pressure is constant)

    a. 30.0 mL of gas at 14°C is compressed to 22 mL?

    b. 16.4 mL of gas at 28°C is expanded to 20.0 mL?

    c. 39 mL of gas at 0.0°C is compressed to 35 mL?

Worksheet 3.4: Lusac's Gas Law

1. What is the pressure when: (volume is constant)

   a. A gas at 130 C and 740 mmHg is changed to 150 C?

   b. A gas at 25 C and 65 atm is changed to 30.0 C?

   c. A gas at 1.0 K and 70 kPa is changed to 1.2 K?

2. What is the temperature in degrees Celsius when: (volume is constant)

    a. A gas at 75.0 C and 4.10 atm is changed to 7.00 atm?

    b. A gas at 60.0 C and 760 mmHg is changed to 10.0 mmHg?

    c. A gas at 113 K and 760 kPa is changed to 300 kPa?

Worksheet 3.5: Combined Gas Law

1. If 120 mL of oxygen is collected at 27^{o}C and 740 mmHg, what will the volume of the dry gas be at STP?

2. If 500.0 mL of hydrogen is collected at 293.15 K and 95.0 kPa, what will the volume of the gas by at SATP?

3. 113 mL of oxygen is collected at 22^{o}C and 98.0 kPa and left over night. The next day, the volume was 109 mL and the temperature was 21^{o}C. What was the pressure?

4. 36 mL of nitrogen was collected at 25°C, but the barometer was broken so the pressure could not be read. Three days later, the new barometer arrived. The new volume was 32 mL, the temperature was 21°C and the pressure reading was 739 mmHg. What was the original pressure?

5. If 250 mL of helium was collected at STP, what will the temperature be if the volume is reduced to 200 mL and the pressure increased to 110 kPa?

6. A certain 1.0L sample of gas has a temperature of 23°C and a pressure of 0.96 atm. The sample was left overnight and the next day had a pressure of 1.00 atm and a volume of 1.1 L. What is the temperature on the second day?

Worksheet 3.6: Ideal Gas Law

1. What pressure (kPa) is exerted by 1.0 mol (of an ideal gas contained in a 1.0 L vessel at 0.0^{o}C?

2. What volume will 5.0 mol of an ideal gas occupy at 25.0^{o}C and 1.5 atm of pressure?

3. Calculate the molar mass of gas if 4.5 L of the gas is at 785 mmHg, 23.5^{o}C and the gas has a mass of 13.5 g.

4. 0.453 mol of a gas confined to a 15.0 L container exerts a pressure of 1.24 atm on the walls of the container. What is the temperature of the gas?

5. 5.4 g of carbon dioxide gas is confined to a 20.0 L container at a temperature of 315.5 K. What pressure (kPa) does the gas exert?

6. 2.125 g of a gas in a 1.25 L container exerts a pressure of 86.0 kPa at 40.0^{o}C. What is the molar mass of the gas?

7. To what temperature must 10.0 g of ammonia gas have to be heated in a 15.0 L container in order for it to exert a pressure of 3.50 atm?

8. 2.0 x 10^{-5}g of hydrogen gas at 327 K exerts a pressure of 50.5 kPa on the walls of a small tube. What is the volume of the tube?

Worksheet 3.7: Gas Stoichiometry

1. What mass of propane from a tank can be burned using 50 L of oxygen at STP?

2. Hydrogen gas is burned in pollution-free vehicles to produce water vapor. What volume of hydrogen at $40^{o}C$ and 150 kPa can be burned using 300 L of oxygen gas measured at the same conditions?

3. A Down's Cell is used in the industrial production of sodium from the decomposition of molten sodium chloride. What is the temperature of 250 L of chlorine gas produced at 100.1 kPa if 100 g of sodium is also produced?

4. A typical home is heated with natural gas and consumes 2.00 ML of natural gas during the month of December. What volume of oxygen at STP is required to burn 2.00 ML of methane measured at 0.00°C and 120 kPa?

5. Methane reacts with steam to produce hydrogen gas and carbon dioxide gas. What volume of hydrogen gas, measured at 25°C and 120 kPa, can be produced from 1.0 t of steam?

6. Hydrogen gas can be produced from the electrolytic decomposition of water. What volume of hydrogen gas is produced, along with 52 kL of oxygen gas, at 25°C and 120kPa?

Worksheet 3.8: Review of Gases

1. A volume of 20.0 L of oxygen is warmed from -30.0 C to 85.0 C. What is the new volume, if the pressure is kept constant?

2. A mass of air occupies a volume of 5.7 L at a pressure of 0.52 atm. What is the new pressure if the same mass of air at the same temperature is transferred to a 2.0 L container?

3. Determine the total pressure of a gas mixture that contains CO, Ne and He if the partial pressures of the gases are P_{CO} = 1.53 atm, P_{Ne} = 0.82 atm, and P_{He} = 0.34 atm.

4. What is the volume of a sample of oxygen gas that has a mass of 50.0 g and is under a pressure of 1.20 atm at 27.0 C?

5. What is the volume at STP of a sample of carbon dioxide gas that has a volume of 75.0 mL at 30.0 C and 680 mmHg?

6. A rigid container holds a gas at a pressure of 0.55 atm at a temperature of -100 C. What will the pressure be when the temperature is increased to 200 C?

7. Explain why real gases deviate from the gas laws.

Worksheet 4.1 – Solution Terminology and Theory

1. Illustrate (with a drawing) the difference between:
   a) solute vs. solvent

   b) homogenous mixture vs. heterogenous mixture

   c) electrolyte vs. non-electrolyte

2. Illustrate two factors that affect the rate of solubility.

3. Illustrate with a drawing how the following solids dissolve in water
   a) Glucose

   b) copper (II) sulfate

   c) hydrochloric acid

4. Many reactions only occur when the reactants are dissolved in water. Why?

Worksheet 4.2: Concentration Problems

1. What is the molar concentration of an electroplating solution in which 1.50 mol of copper (II) sulfate are dissolved in 2.00 L of water?

2. What is the molar concentration of a solution in which 0.240 mol of washing soda, sodium carbonate decahydrate, is dissolved in 480 mL of water to make soft water solution?

3. What is the molar concentration of 500 mL of a solution that contains 12.7 g of swimming pool chlorinator, $Ca(OCl)_2$?

4. A given sample of household ammonia contains 156 g of ammonia dissolved in water to form a 2.00L solution. What is the molar concentration of the ammonia solution?

5. Find the number of moles of sodium phosphate in 2.00L of a 0.100 mol/L sodium phosphate cleaning solution.

6. How many moles of potassium sulfate are there in 500 mL of a 0.242 mol/L solution used to remove rust stains?

7. What mass of sodium bicarbonate must be added to a 2.50 L bowl to obtain a necessary 0.150 mol/L solution?

8. What volume of a 0.075 mol/L solution would contain the necessary 1.10 mol of sodium phosphate used to remove radiator scales?

9. What mass of sodium silicate is necessary to prepare 10.0 L of a 0.00500 mol/L water softening solution?

10. How many litres of 0.800 mol/L solution would contain 119.2 g of NaOCl?

Worksheet 4.3: Making solutions and dilutions

1. A scientist has a container with solid sodium hydroxide and a container of 5.00 mol/L sodium hydroxide.
   a) What are the two ways that the scientists can use to make a solution with a specific volume and concentration?

   b) What are two ways that the scientist can dilute the 5.00 mol/L solution?

2. Describe the steps you would take to make 100 mL of a 0.200 mol/L sodium chloride solution from salt crystals. Include the equipment and calculations you would make. Remember this is not a reaction.

3. Describe the steps you would take to make 250 mL of a 0.453 mol/L solution of copper (II) sulfate from solid copper (II) sulfate pentahydrate. Include equipment and calculations.

4. Describe the steps you would take to make 100 mL of a 0.50 mol/L sucrose solution from a container of 2.10 mol/L sucrose solution. Include equipment and calculations.

5. Describe the steps you would take to make 500 mL of a 0.900 mol/L sulfuric acid from a 1.50 L container of 6.00 mol/L sulfuric acid solution. Include equipment and calculations.

6. What is the final concentration of a cleaner if 10 L of concentrated sodium hydroxide (19.1 mol/L) is diluted to 400 L?

7. What is the mass of baking soda (sodium hydrogen carbonate) needed to make 2.5 L of a 1.00mol/L solution?

8. If 2.0 L of water is added to 1.0 L of a 0.250 mol/L solution of potassium hydroxide what is the final concentration. (Be Careful)

9. CHALLENGE: If 1.50 L of a 12.4 mol/L solution of hydrochloric acid was mixed with 300 mL of a 6.10 mol/L solution of hydrochloric acid, then what would be the final concentration?

10. CHALLENGE: How much water is added to 50.0 mL of a 0.500 mol/L solution to make a 0.100 mol/L solution?

Worksheet 4.4: Dissociation and ionization reactions

1. What type of compounds dissociate? What type of compounds ionize?

2. Write dissociation or ionization reactions for the following chemicals after they are mixed with water. Show the physical states of all species involved. Use modified ionization reactions when necessary.
   a) Solid hydrochloric acid

   b) Solid strontium hydroxide

   c) Solid copper (II) sulfate pentahydrate

   d) Solid sodium bicarbonate

   e) ammonia gas

3. For each of the following write dissociation or ionization equations and find the concentration of each ion.
   a) 0.90 mol/L solution of sodium phosphate

   b) 0.143 mol/L solution of nitric acid

   c) 0.0135 mol/L solution of calcium hydroxide

   d) 0.150 mol of hydrogen fluoride gas bubbled into 1.00 L of water

4. What is the concentration of chloride ions in a solution prepared by dissolving 800 g of zinc chloride in 4.50 L of water?

5. What is the mass of calcium chloride required to prepare 2.000 L of 0.120 mol/L chloride ions?

6. What is the final concentration if 2.0 L of water is added to 4.50 L of a 0.89 mol/L solution of sodium chloride?

Worksheet 4.5: Net Ionic Equations

For the following reactions, write the nonionic equation, the total ionic equation and the net ionic equation.

1. Aqueous solutions of sodium sulfate and barium bromide are mixed.

2. A lead (II) nitrate solution reacts with sodium sulfide solution

3. Sulfuric acid is neutralized by a potassium hydroxide solution

4. Hydrochloric acid is added to a solution of barium hydroxide

5. Magnesium metal is added to an aqueous solution of hydrogen bromide

6. Zinc reacts with copper (II) sulfate solution

7. Zinc reacts with acetic acid (vinegar)

8. Bromine is added to a magnesium iodide solution

Worksheet 4.6: Solution Stoichiometry

1. A 200 mL solution of potassium phosphate reacts with 100 mL of 0.150 mol/L iron (III) sulphate solution. What is the concentration of the potassium phosphate solution?

2. If 230 mL of a 1.00 mol/L solution of aluminium chlorate is reacted with sufficient lithium hydroxide solution, what mass of precipitate is formed?

3. Predict the mass of magnesium metal that will be required to react with 44.0 ml of 0.200 mol/L hydrochloric acid.

4. What volume of 1.00 mol/L $HNO_{3(aq)}$ is required to react completely with 1.20g of $LiOH_{(aq)}$?

5. A 100 ml sample of sodium sulphide solution is completely reacted with 50.0 ml of 0.250 mol/L lead (II) nitrate solution. Predict the concentration of the $Na_2S_{(aq)}$?

6. 500 ml of 0.150 mol/L cobalt (II) nitrate solution is reacted with 500 ml of 0.250 mol/L of sodium hydroxide solution producing 4.77 g of precipitate. Find the % yield for this reaction.

7. CHALLENGE: Predict the final mass of a 500 g bar of lead that is allowed to react completely with 2.00 L of 2.00 mol/L HCl.

8. A 75.0 mL sample of 0.25 mol/L silver chlorate solution reacts with 19.0 mL of 0.50 mol/L copper (II) sulphate solution. What is the concentration of the solution produced? (NOTE: Find out what the **total** volume of the solution produced.)

Worksheet 4.7: Review of Solutions

1. Answer the following questions
   a) How do solutions differ from heterogeneous mixtures?

   b) How do the number of molecules of $C_{12}H_{22}O_{11}$ in 250 mL of a 1.5 mol/L solution of $C_{12}H_{22}O_{11}$ compare to the number of molecules of $C_6H_{12}O_6$ in 250 mL of a 1.5 mol/L $C_6H_{12}O_6$?

   c) What is the term used to describe two liquids which will **NOT** mix with each other?

   d) What are two factors that affect the amount of solute that dissolves and two factors that affect the rate of dissolving?

2. Write the equation for each of the following dissolving in water. Use modified Arrhenius theory.
   a) Hydrogen chloride gas

   b) Solid aluminium nitrate

   c) Solid sucrose

   d) Aqueous nitric acid

3. Determine the concentration of each of the following solutes in the solution described.
   a) 0.725 mol of cobalt (II) nitrate in 1.35 L of solution.

   b) 15.0 g of barium sulphate in 125 mL of solution.

   c) 1.85×10^{22} molecules of ammonia gas in 400 mL of solution.

4. Write the dissociation equation and calculate the concentration of each of the ions produced in 1.25 mol/L solution of barium chloride.

5. Write the dissociation equation and determine the concentration of the solution if 1.26 mol/L of $[Na^+]$ is found in a sodium phosphate solution.

6. CHALLENGE: What is the [Cl^-] in a solution made by mixing 200 mL of 0.300 mol/L sodium chloride solution with 350 mL of 0.250 mol/L calcium chloride solution?

7. Write net ionic equations for the following reactions. (3 marks)
   a) lead nitrate solution is mixed with sodium hydroxide

   b) barium nitrate reacts with potassium sulfide

   c) nitric acid reacts with barium hydroxide

8. Draw a diagram describing how methanol is dissolved in water. (1 mark)

9. Predict whether the following solutes are electrolytes or nonelectrolytes:
   a) nitrogen monoxide
   b) hydrofluoric acid
   c) magnesium hydroxide
   d) potassium hydrogen carbonate

10. A scientist wants to make 100 mL of a 0.150 mol/L sodium hydroxide solution. He has 100 g of solid sodium hydroxide and he has 1.00 L of a 2.25 mol/L sodium hydroxide solution. Describe step by step the two ways that he could make his 0.150 mol/L solution. Include the sample calculations and equipment.

11. A 20.0 g sample of lead (II) nitrate is mixed in 1.00 L of water. The lead (II) nitrate solution then reacts with a 1.00 L of a 0.100 mol/L solution of rubidium iodide. If 20.0 g of precipitate forms, what is the percent yield?

Worksheet 4.8: Introduction to Acids & Bases

1. Safety is very important when working with acids. Describe what the student should do in the following situations.
   a) A student drops a 100 mL beaker with 50 mL of hydrochloric acid and spills the acid onto the floor.

   b) A student drips a couple of drops of sodium hydroxide solution onto his hand.

   c) A beaker with $Ba(OH)_2$ tips over onto the lab bench.

   d) A student would like to dilute an acid and would like to know if he should add the acid to the water or the water to the acid

2. WHMIS symbols help communicate dangers.
   a) WHMIS stands for ____
   b) The symbol that would be associated with a beaker of base that corrodes metal is

   c) Acids and bases can cause immediate and serious damage to a person's skin. The WHMIS symbol related to this is

   d) Some acids react with oxygen. The WHMIS symbol found on a bottle of this acid would be

3. A person would like to make 100 mL 1.00 mol/L solution of NaOH. Describe the steps the student would use. Include the calculations.

4. A person would like to dilute a 12.1 mol/L solution of HCl and make a 250 mL 3.00 mol/L solution. Describe the steps the student would use. Include the calculations.

5. Indicators change color to indicate whether you have an acid or base. Litmus paper and bromothymol blue are two common indicators. Complete the following table for these indicators.

PH	**Litmus Paper color**	**Bromothymol Blue color**
3		
7		
10		

6. What is one property that is similar between acids and bases?

7. What is one property that is different between acids and bases?

8. Complete the following acid or base reactions.
   a) sulfuric acid is neutralized by potassium hydroxide. Identify the "salt" in the reaction.

   b) hydrochloric acid reacts with magnesium

   c) self ionization of water

<u>Worksheet 4.9: Acid & Base Calculations</u>

1. A 1.00 L solution of 1.50 mol/L perchloric acid is diluted by adding 500 mL of water. What is the hydronium concentration of the diluted solution?

2. A 250mL solution of 3.56 mol/L barium hydroxide is sitting on the counter in the lab. Help a chemistry 20 student determine the hydronium concentration of the solution.

3. A 1.00 mol/L solution of nitric acid ionizes. What is the hydroxide ion concentration?

4. A student takes 11.6 grams of strontium hydroxide and adds it to 3.00 litres of water. What is the hydronium concentration?

5. A solution contains 1.67×10^{-14} mol/L of hydronium ions. Determine the mass of barium hydroxide that was added to 1.00 L of water to make this solution.

6. What is the concentration of hydroxide ions found in a 1.00 L solution of 2.00 mol/L potassium hydroxide?

7. What is the hydroxide concentration of a 1.00 L solution of 2.50 mol/L hydrobromic acid?

8. What is the hydronium concentration when 1.00 mol/L of barium hydroxide dissociates

9. 6.02×10^{22} particles of sulfuric acid ionize into hydrogen sulfate ions in 1.00 L of water. What is the hydroxide concentration of the solution?

10. A solution contains 3.45×10^{-12} mol/L of hydroxide ions. What is the concentration of the hydrochloric acid solution that contain these hydroxide ions?

Worksheet 4.10: Acid & Base Review

1. The concentration of hydroiodic acid is 1.73×10^{-3} mol/L. What is the pH and the pOH?

2. What is the hydronium concentration and hydroxide concentration of a 2.47×10^{-2} mol/L solution of thallium hydroxide?

3. Complete the following table (Significant digits are important):

pH	$[H^+]$	$[OH^-]$	pOH	A/B/N
			4.56	
		1.23×10^{-5}		
	3.56×10^{-8}			
12.8				
3.52				
		5.74×10^{-1}		
			7.45	
	3.99×10^{-3}			
			1.23	
		8.9×10^{-9}		

4. What color would the indicator be given the following data?

	ORANGE IV	METHLY RED	PHENOL RED	METHYL ORANGE	INDIGO CARMINE
pOH=9.00					
pH=8.3					
$[H+]=9.5 \times 10^{-4}$					
$[OH-]=5.6 \times 10^{-3}$					
$[H_3O+] = 1.0 \times 10^{-7}$					

WORKSHEET 5.1: BONDING INTRODUCTION

NAME: ____________________ DATE: ______________________

1. Which groups of elements in the periodic table of elements will form
   a. network covalent compounds

   b. metallic compounds

   c. ionic compounds

   d. molecular compounds

2. Predict whether the bonding between the atoms in the following substances will be *network, metallic, ionic or covalent*.

a.	$KCl_{(s)}$	b.	$Mg_{(s)}$	c.	$CaO_{(s)}$
d.	$O_{2(g)}$	e.	$NO_{2(g)}$	f.	$Ag_{(s)}$
g.	$BaCl_{2(s)}$	h.	$S_{8(s)}$	i.	$SO_{2(g)}$
j.	$CsF_{(s)}$	k.	$C_{4(s)}$	l.	$SiC_{(s)}$

3. Define and give one characteristic for each of the following:
   a. A chemical bond:

   b. A covalent bond

   c. An ionic bond:

   d. An metallic bond:

   e. A network bond:

<u>WORKSHEET 5.2: BASICS OF BONDING</u>

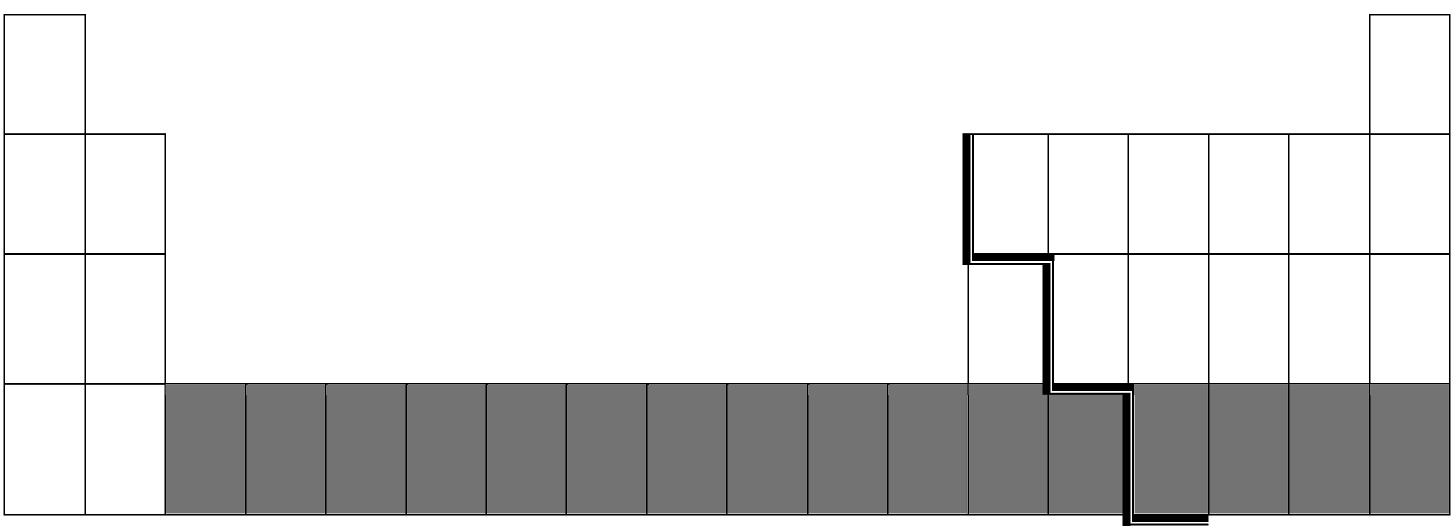
1. Draw energy level diagrams for:
   a) ${}_{11}Na^{23}$ and Na^+

   b) ${}_{8}O^{15}$ and O^{2-}

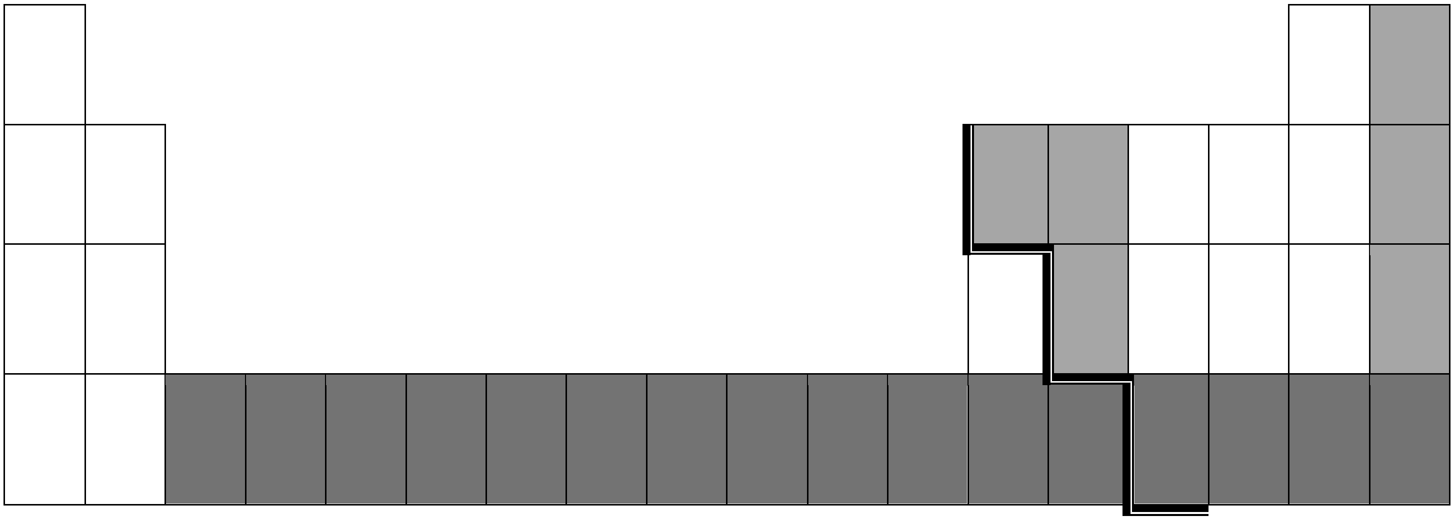
2. Predict and fill in the rest of the *valence shell* representations for the first 36 elements

$1s^1$																	$1s^2$
$2s^1$	$2s^2$											$2s^2$ $2p^1$	$2s^2$ $2p^2$				
														$3s^2$ $3p^3$			
		$3d^1$ $4s^2$										$3d^{10}$ $4s^2$ $4p^1$					

3. Draw the electron dot diagrams for the first 20 elements.



4. Draw the electron dot diagrams for the first 14 ions. Hydrogen has two ions.



5. Complete the following table.

	Group #	**Gain/Lose e^-**	**Name of Ion**	**Ion formula**	**Nobel Gas Most Like**
sodium					
magnesium					
sulfur					
chlorine					

6. Name and draw the Lewis dot diagrams for 4 ionic compounds that could form from the table above.

7. Does carbon gain or lose electrons to achieve a stable electron configuration. HINT look at your periodic table.

7. What observable evidence is there that the electron structure in Noble Gases is stable?

8. Define & give an example of

   a. bonding electrons

   b. lone pair

   c. ionic bond

   d. network covalent bond

   e. metallic bond

9. Based on electronegativity describe what type of bond would form between:
   a. Br_2
   b. CO
   c. Hydrogen phosphide
   d. Lithium nuclei
   e. Argon nuclei
   f. Potassium sulfide

WORKSHEET 5.3: IONIC COMPOUNDS

1. Silver sulfide tarnish:
   a) Write a balanced simple composition reaction. Identify the type of reaction. Identify the element that is undergoing reduction and the element that is undergoing oxidation.

   BONUS: Write the reduction and oxidation reactions below.

   b) Write out the formula unit for silver sulfide using dot diagrams.

   c) Write any evidences of a reaction.

   d) How could the silver sulfide tarnish removed?

2. Fertilizers are made of ammonium dihydrogen phosphate, ammonium nitrate and ammonium sulfate.

   a) Write the formula unit for each compound. Verify the formula unit by showing that the net charge is zero. Identify the cation and anion.

   b) Identify three physical properties that each of these compounds may have.

3. Sodium chloride, found in the Lotsberg formation below Fort Saskatchewan is in a solid crystal form. The formation is too deep to be mined.

   a) Write out a reaction for the formation of sodium chloride from its elements.

   b) What evidence is there that a reaction occurred?

   c) What are the solubility, color and approximate melting point of sodium chloride?

   d) Knowing that salt is very soluble in warm water, how could sodium chloride be removed from the ground?

   e) Why is iron (III) oxide not recovered the same way as sodium chloride. (Hint: Is iron (III) oxide soluble in water)

WORKSHEET 3.4: LEWIS DOT DIAGRAMS FOR ELEMENTS

1. Fill in the Table Below. The first one is done for you.

NAME & SYMBOL	TOTAL # OF VALENCE ELECTRONS	Electron Dot Diagram	TOTAL # OF LONE PAIRS	# OF BONDING ELECTRONS IN ONE ATOM	Bonding Capacity or Shared Pairs	Electron Configuration of one atom
F **FLUORINE**	**7**	• • : F : •	**3**	**1**	**1**	$2s^22p^5$
H						
He						
Be						
Al						
C						
N_2						
O_2						

Cl_2						
S_8						

2. What is a covalent bond?

3. What elements form covalent bonds?

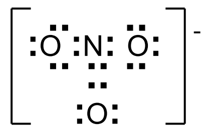
4. Using electronegativity, how do I know if I have a covalent bond?

5. What determines the bond distance?

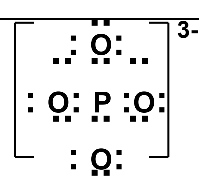
6. What are two differences between ionic and covalent bonds?

WORKSHEET 3.5: LEWIS DOT DIAGRAMS FOR COMPOUNDS

NAME	FORMULA	TOTAL # OF VALENCE ELECTRONS	ELECTRON DOT DIAGRAM	TOTAL # OF LONE PAIRS	# & TYPES OF BONDS (SINGLE, DOUBLE, TRIPLE, COORDINATE)
Ammonia					
Bromine					
			$:\ddot{O}::\ddot{O}:$		
			H:C:::N:		
			H H $:\ddot{\underset{\cdot\cdot}{C}}:$ H H		
Dinitrogen tetrahydride					
	N_2				
Carbon dioxide					
	C_2H_6				
	H_3O^+				

Acetylene					
Water					
	CH_3OH				
					
Phosphate ion					

WORKSHEET 3.6: VSEPR DIAGRAMS

NAME	FORMULA	TOTAL VALENCE ELECTRONS	ELECTRON DOT DIAGRAM	VSEPR DIAGRAM & SHAPE(S)
Hydrogen cyanide	***$HCN_{(l)}$***	***10***	***H:C:::N:***	***H-C-N or H-C=N/ linear***
Iodine				
			O ::C:: O	
	CO_3^{2-}			
Hydronium ion				
Carbon Monoxide				
Ethyne (acetylene)			H:C:::C:H	
ethanol				
	C_2H_6			
Ethanoic acid				
			H: S:H	
Water				
	CH_3OH			
Nitrite Ion				
				

WORKSHEET 3.7: POLARITY

1. Water exposed to a positive glass rod bends towards the glass rod. Draw a water molecule turned in the right position towards the positive glass rod below.
2. Draw the bond dipole using both delta notation & vector notation for the bonds below. Indicate which has the strongest bond dipole.
   a) S – O b) F – F c) C – H d) N – Br

3. Circle the following molecules that are polar. What characteristics helped you determine if they where polar?
   hydrogen chloride, hydrogen sulfide, ammonia, methane, hydrogen peroxide

4. Fill in the Table Below. The first one is done for you.

NAME & FORMULA	LEWIS DOT DIAGRAM	STRUCTURAL DIAGRAM WITH ELECTRONEGATIVITY	VSEPR DIAGRAM & SHAPE(S) WITH OVERALL BOND DIPOLES IF POLAR (ANY NOTATION)	POLAR OR NONPOLAR MOLECULE
Hydrogen cyanide $HCN_{(l)}$	***H:C:::N:***	***2.1 2.5 3.0 H – C ≡ N***	***∂^{+} ∂^{-} H – C – N linear***	***Polar***
Nitrogen				
Phosphorus trihydride				
Dibromethane				
Hydronium ion				
Carbon Monoxide				
	H:C:::C:H			
Ethanol				
C_2H_4				
Water				

Worksheet 3.8: Bonding Review

1. Complete the following table. (* 1 is strong and 4 is weak)

Chemical Formula & name	**Polarity & number of e-**	**Melting Point**	**Boiling Point**	**VSEPR Diagram With bond dipoles if polar**	**Types of Intermolecular Forces**	**Rank Inter-molecular strength***
$F_{2(g)}$		-220	-188			
$I_{2(s)}$		114	184			
$Cl_{2(g)}$		-101	-35			
$Br_{2(l)}$		-7	59			
$ICl_{(g)}$		14	97			
$BrF_{(g)}$		-33	-20			
$ClF_{(g)}$		-154	-101			
$BrCl_{(g)}$		-66	5			
$CH_3OH_{(l)}$		-100	65			
$CH_3I_{(l)}$		-66	43			
$CH_3Br_{(g)}$		-94	4			
$CH_3Cl_{(g)}$		-98	-24			
$C_2H_5Br_{(l)}$		-119	38			
$C_2H_5I_{(l)}$		-108	72			
$C_2H_5OH_{(l)}$		-117	78			
$C_2H_5F_{(g)}$		-143	-38			

2. Rank the following in order of increasing melting point. Give reasons to support your answer.

RANK(1 is low; 8 is high)REASONS(bond type, intermolecular forces, # of e-)

___ Sodium chloride:
___ Water:
___ Methane:
___ Hydrogen chloride:
___ Hydrogen gas:
___ Methanol:
___ Silicon carbide:
___ Iron metal:

3. Use the observations about five solids below to fill in the table that follows.

SOLID	COLOR	ODOR	HARDNESS	OTHER
A	Yellow	Slight	Moderate	Melts over flame
B	White	None	Hard	Dissolves in water & conducts electricity
C	White	Strong	Soft	Melts over a flame
D	Grey	None	Very hard	None
E	Silver	None	Hard	None

Letter, Name & Formula	**Type of Intra-& Interbonds /forces**	**Explain how you identified the substances**
sodium chloride Formula:____ Letter:____		
silicon carbide Formula: ____ Letter:____		
iron Formula: ____ Letter: ____		
Sulfur Formula:_____ Letter: ____		
dichlorobenzene Formula:$C_6H_4Cl_{2(s)}$ Letter: _____		

4. A person is analyzing the five compounds below. Answer the questions that follow.
CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4

- Draw the Lewis diagrams
- List the five compounds in order of increasing boiling points.
- List the five compounds from the most non-polar to the most polar compounds

5. Complete the following table

Formula & Name	**Lewis Diagram**	**VSEPR Shape**	Polarity	**Type of Bonds/Forces**
ammonia				
CBr_4 tetrabromomethane				
H_2S				
PCl_3				
BCl_3				
ammonium ion				
hydrogen bromide				
CO_2				
NI_3				
SO_4^{2-}				
SBr_2				
GeH_4				
H_2Te				
nitrogen trifluoride				
H_2Se				
$SnBr_4$				
SO_3^{2-}				