

Chem 1311 Exam4/Final Test Prep

Chapters 1-3:

Notes/Formulas

$$1 \text{ kg} = 1000 \text{ g} \quad d = \frac{m}{V}$$

$$1 \text{ L} = 1000 \text{ mL}$$

1) Define a **physical change** and provide at least 2 examples.

changes state of matter (melting ice)

2) Define a **chemical change** and provide at least 2 examples.

changes the chemical properties (burning wood)

3) How many **significant figures** are in each number?

10.310 5

0.0010030 5

1.030×10^3 4

130300 4

4) Solve the following using correct significant figure rules.

$$245.30 + 13.617 = \underline{258.92}$$

$$32.0 - 15.34 = \underline{16.7}$$

$$14.8 \times 23 = \underline{340}$$

$$6780 / 14.50 = \underline{468}$$

5) Complete the **basic unit conversions** using appropriate significant figures.

$$1400 \text{ mL} \rightarrow \underline{1.4} \text{ L}$$

$$23.5 \text{ C} \rightarrow \underline{296.7} \text{ K}$$

$$6.05 \text{ kg} \rightarrow \underline{6050} \text{ g}$$

$$55.2 \text{ km/h} \rightarrow \underline{15.3} \text{ m/s}$$

$$\frac{55.2 \text{ km}}{1 \text{ hr}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ hr}}{3600 \text{ s}} = 15.3 \text{ m/s}$$

6) A 250mL container is filled with gas and weighs 2.30g. Calculate the **density** of the gas in the container.

$$d = \frac{m}{V} = \frac{2.30 \text{ g}}{250 \text{ mL}} = \boxed{0.0092 \text{ g/mL}}$$

7) An experiment requires 205g of phosphoric acid. Is a 150mL Erlenmeyer flask large enough to hold the acid which has a **density** of 1.83g/mL?

$$V = \frac{m}{d} = \frac{205 \text{ g}}{1.83 \text{ g/mL}} = 112 \text{ mL} \quad \underline{\text{Yes, it fits!}}$$

Who did what?

d J. Thomson

b E. Rutherford

c J. Dalton

a N. Bohr

- a) Constructed a model that showed electrons orbiting a nucleus on fixed energy levels
- b) Conducted the gold foil experiment where he discovered a positively charged nucleus
- c) Created the atomic theory to explain the behavior of atoms
- d) Made the "plum pudding" model that showed scattered electrons about a positive cloud

8) List the 5 postulates of Dalton's Atomic Theory:

- 1) Law of conservation of mass
- 2) Law of multiple coefficient
- 3) All matter are made of atoms
- 4) Each element has a specific type of atom
- 5) They can combine/rearrange to form compounds.

9) Identify the correct series of numbers to match the order of the following characteristics for Mg^{2+} .
What is this ion's atomic number, mass number, # of neutrons, and # of electrons?

10, 24, 14, 10

$A = P = E$ $M - A = N$

10) If an isotope of bromine has a mass number of 81.0 amu, how many neutrons does it have?

$$81.0 - 35 = 46$$

11) Name or write the chemical formula for the following compounds.

Sulfurous acid H_2SO_3

Mercury (II) oxide HgO

Hydroiodic acid HI

Carbon tetrachloride CCl_4

NH_4OH ammonium hydroxide

$CuCl_2$ copper (II) chloride

$\text{H}_3(\text{PO}_4)$ phosphoric acid

NH_3 ammonia

12) Calculate the **average atomic weight** of silicon. $\sum \text{mass} \times \% \text{ abundance}$

$$^{28}\text{Si} \text{ 27.98 at 92.23% abundance} \quad 27.98 \times .9223 = 25.81$$

$$^{29}\text{Si} \text{ 28.98 at 4.680% abundance} \quad 28.98 \times .04680 = 1.356$$

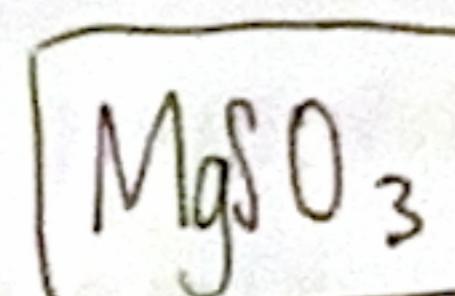
$$^{30}\text{Si} \text{ 29.97 at 3.090% abundance} \quad 29.97 \times .03090 = 0.926$$

$$28.09 \text{ amu}$$

13) A compound contains 23.3% magnesium, 30.7% sulfur, and 46.0% oxygen. What is the **empirical formula**?

$$\frac{23.3 \text{ g Mg}}{1} \times \frac{1 \text{ mol Mg}}{24.31 \text{ g}} = 0.958 \text{ mol} / 0.958 = 1$$

$$\frac{30.7 \text{ g S}}{1} \times \frac{1 \text{ mol S}}{32.06 \text{ g}} = 0.958 \text{ mol} / 0.958 = 1$$



$$\frac{46.0 \text{ g O}}{1} \times \frac{1 \text{ mol O}}{16.00 \text{ g}} = 2.875 \text{ mol} / 0.958 \approx 3$$

14) A chemist used 4.07×10^{24} formula units of Li_2O in the lab and needs it to be converted to grams for her lab report. **How many grams of Li_2O will she report?**

$$\frac{4.07 \times 10^{24} \text{ fmu Li}_2\text{O}}{1} \times \frac{1 \text{ mol Li}_2\text{O}}{6.022 \times 10^{23} \text{ fmu}} \times \frac{29.88 \text{ g}}{1 \text{ mol Li}_2\text{O}} = \boxed{202 \text{ g Li}_2\text{O}}$$

15) How many **atoms** are present in 50.0g of dinitrogen pentoxide?

$$\frac{50.0 \text{ g N}_2\text{O}_5}{1} \times \frac{1 \text{ mol N}_2\text{O}_5}{108.02 \text{ g}} \times \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol N}_2\text{O}_5} = \boxed{2.79 \times 10^{23} \text{ atoms}}$$

16) What is the **percent mass** of oxygen in copper (II) sulfate?

$$\text{Cu: } 1 \times 63.55 \text{ g} = 63.55 \text{ g} \quad \text{Cu SO}_4$$

$$\text{S: } 1 \times 32.06 \text{ g} = 32.06 \text{ g}$$

$$\frac{64.00}{159.61} \times 100 = \boxed{40.1\%}$$

$$\text{O: } 4 \times 16.00 \text{ g} = 64.00 \text{ g}$$

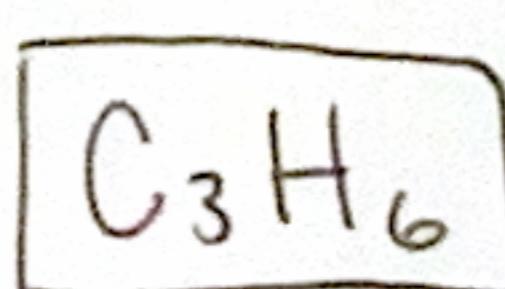
17) Given that the empirical formula for cyclobutene is CH_2 and it has a molar mass of 42g, what is its **molecular formula**?

$$\text{C: } 1 \times 12.01 \text{ g} = 12.01 \text{ g}$$

$$\text{H: } 2 \times 1.01 \text{ g} = 2.02 \text{ g}$$

$$14.03 \text{ g}$$

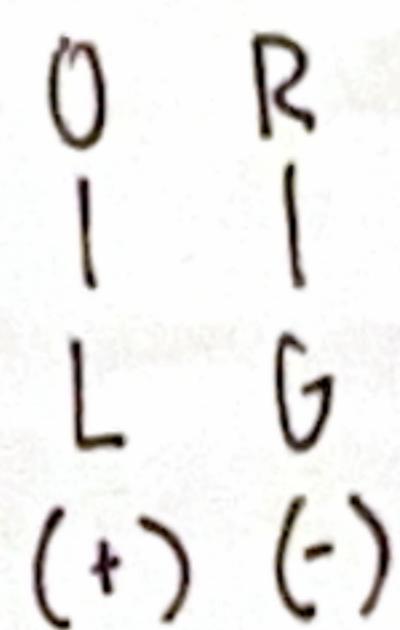
$$42 / 14.03 = 3$$



Chapters 4-6:
Notes/Formulas

$$M = \frac{mol}{L}$$

$$M_1 V_1 = M_2 V_2$$



18) List the **strong acids**: ⁷ HCl, HBr, HI, HClO₄, HClO₃, HNO₃, H₂SO₄

19) List the **strong bases**: alkali metals -OH & heavy alkaline earth metals -OH

20) The net ionic product of an **acid base reaction** is always water $H^+ + OH^- \rightarrow H_2O$

21) Define the following terms:

Solute- substance dissolved in solution

Solvent- substance doing the dissolving

Strong Electrolyte- completely dissociated

Weak Electrolyte- partially dissociated

Precipitate- insoluble product

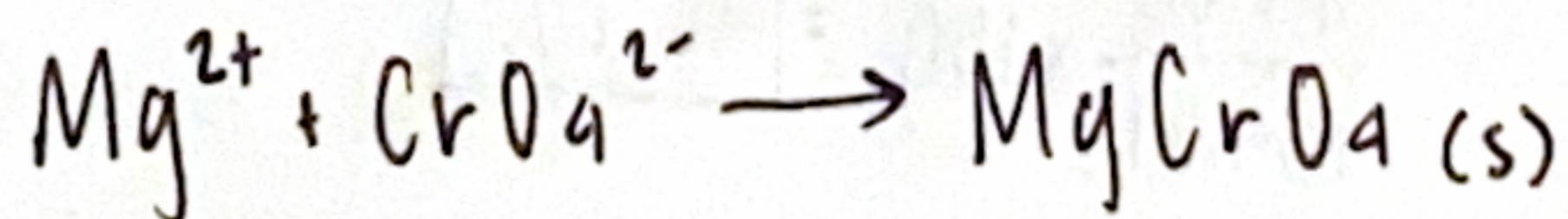
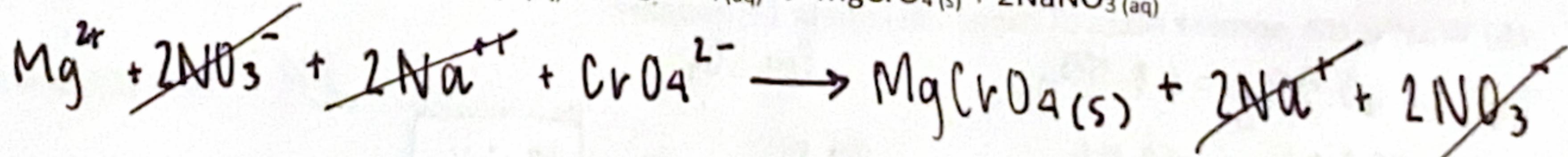
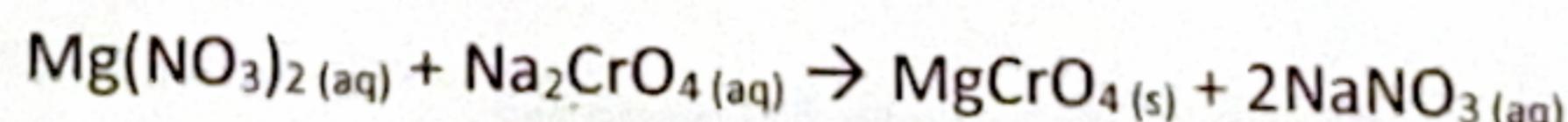
Neutralization- acid & base dissociate to a neutral pH in solution

Oxidation- loss of electrons

Reduction- gain of electrons

Combustion- addition of oxygen & heat to a hydrocarbon; produces CO₂ + H₂O

22) Write the **ionic and net ionic equation** for the following reaction:



23) What is the **molarity** of a solution with 10.7 grams of NaCl dissolved in 0.25 liters of water?

$$M = \frac{0.183 \text{ mol}}{0.25 \text{ L}}$$

$$\frac{10.7 \text{ g NaCl}}{58.44 \text{ g}} = 0.183 \text{ mol}$$

$$\boxed{M = 0.732}$$

24) How many milliliters of 5.0 M copper (II) sulfate solution must be added to dilute a 160 mL solution of 0.30M copper (II) sulfate?

$$M_1V_1 = M_2V_2$$

$$0.30M(160\text{mL}) = 5.0M(\text{mL})$$

$$V_2 = 9.6\text{mL}$$

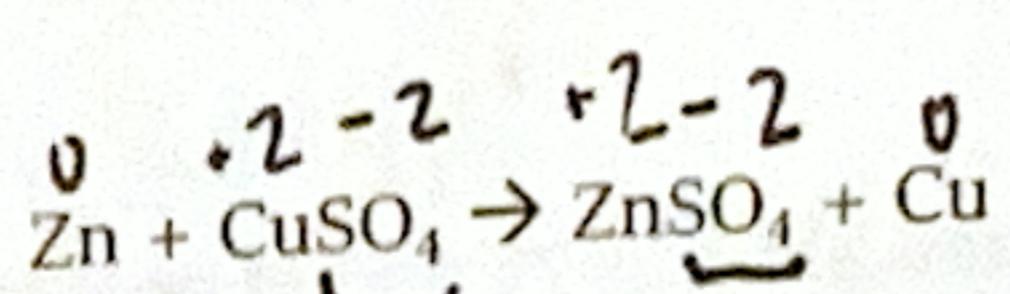
25) If 25.00 mL of HCl solution with a concentration of 0.750 M is neutralized by 23.45 mL of NaOH, what is the concentration of the base?

$$0.0250\text{L HCl (0.750M)} = 0.01875 \text{ mol HCl} \times \frac{1 \text{ mol NaOH}}{1 \text{ mol HCl}} \times \frac{1}{0.02345\text{L}} = 0.7996\text{M}$$

$$M = \frac{\text{mol}}{\text{L}}$$

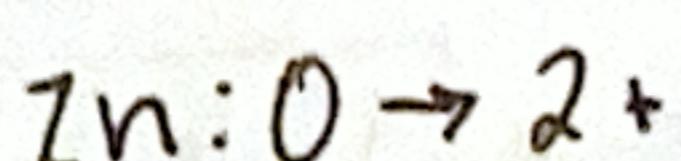


26) Determine the following.



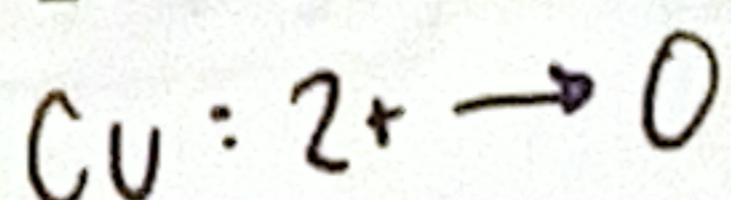
O R
| |

Oxidized: Zinc



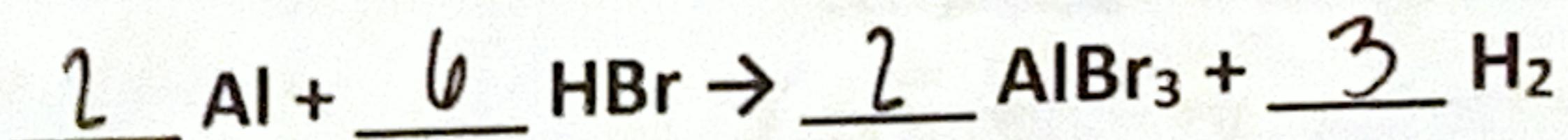
L G
(+) (-)

Reduced: Copper



Net ionic equations:

27) Use the following equation for parts a-d:



a) When 3.22 moles of Al react with 4.96 moles of HBr, how many moles of H₂ are formed?

$$\frac{3.22 \text{ mol Al}}{1} \times \frac{3 \text{ mol H}_2}{2 \text{ mol Al}} = 4.83 \text{ mol H}_2$$

$$\frac{4.96 \text{ mol HBr}}{1} \times \frac{3 \text{ mol H}_2}{6 \text{ mol HBr}} = 2.48 \text{ mol H}_2 \star$$

b) What is the limiting reactant?

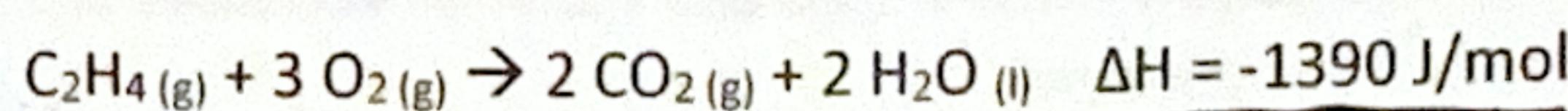
c) What kind of reaction is this?

Jingle replacement

d) The calculated yield of aluminum bromide is 4.05g, while the expected yield was 4.12g. What is the percent yield of aluminum bromide?

$$\frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{4.05 \text{ g}}{4.12 \text{ g}} \times 100 = 98.3\%$$

28) The combustion of ethane, C₂H₄, is an exothermic reaction.



$$1 \text{ mol C}_2\text{H}_4 = -1390 \text{ J/mol}$$

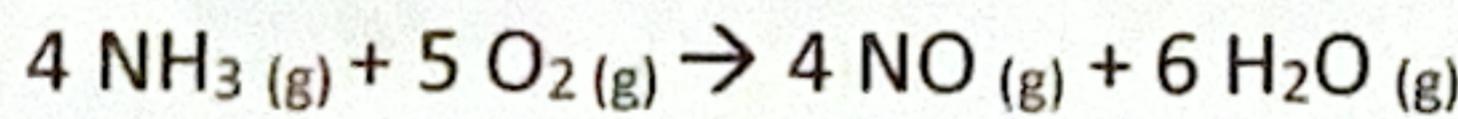
Calculate the amount of heat given off when 4.79 g of C₂H₄ reacts with excess oxygen.

$$\frac{4.79 \text{ g C}_2\text{H}_4}{1} \times \frac{1 \text{ mol C}_2\text{H}_4}{28.0 \text{ g}} \times \frac{-1390 \text{ J/mol}}{1 \text{ mol C}_2\text{H}_4} = 238 \text{ J}$$

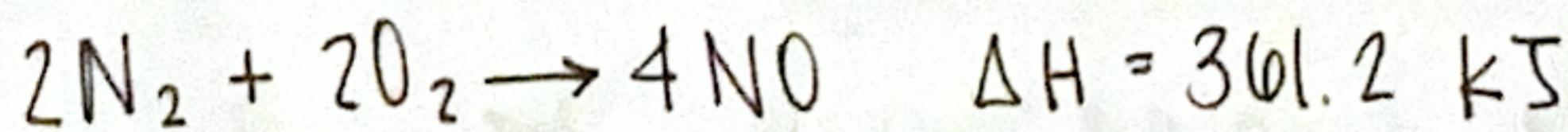
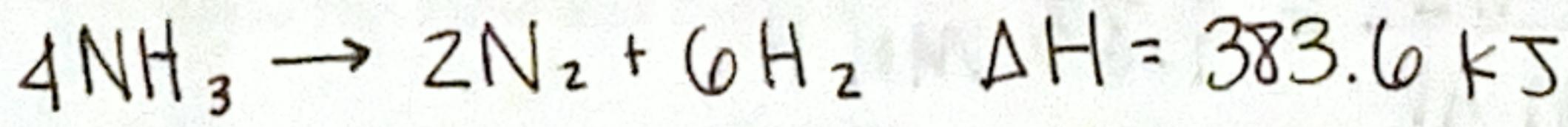
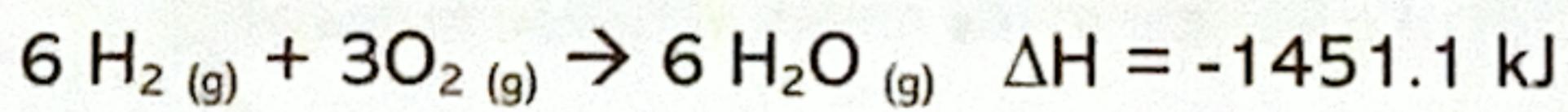
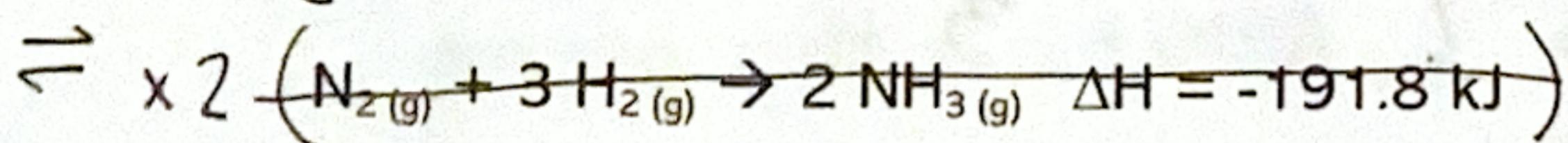
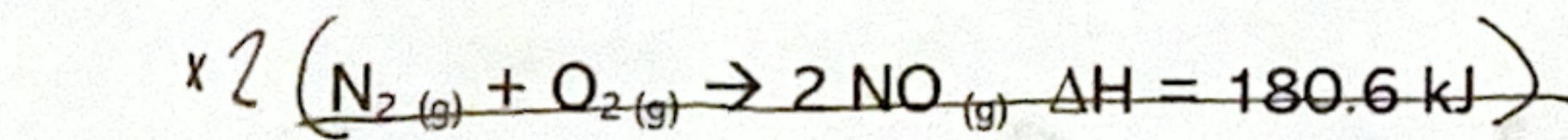
29) A system does 30.4 kJ of work and absorbs 73.0 kJ of heat from the environment. What is the change in internal energy of the system?

$$-30.4 \text{ kJ} + 73.0 \text{ kJ} = 42.6 \text{ kJ}$$

30) Ammonia burns in the presence of a platinum catalyst to produce nitric oxide, NO.



What is the heat of reaction at constant pressure? Use the following thermochemical equations:



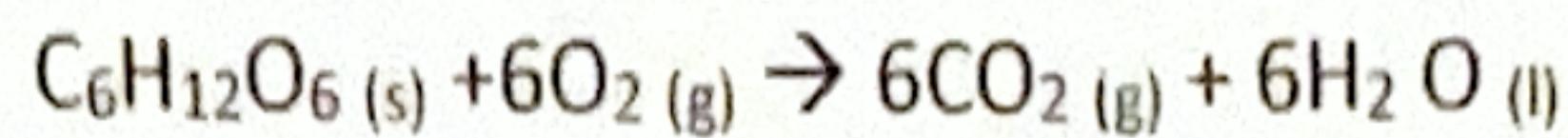
$$\Delta H = -706.3 \text{ kJ}$$

31) When 12.0 g of fructose, C₆H₁₂O₆, is burned with oxygen in a calorimeter, the temperature of the calorimeter increases by 2.58 °C. If the heat capacity of the calorimeter and its contents is 9.90 kJ/°C, how much heat was produced by this reaction?

$$q = C_s M \Delta t$$

$$q = 9.90 \text{ kJ/}^\circ\text{C} (12.0 \text{ g}) (2.58^\circ\text{C})$$

$$q = 307 \text{ kJ}$$



32) Using the equation above and the relative ΔH values, calculate the change in enthalpy for the overall reaction.

ΔH_f for the following:

$$[-393.5 + 6(-285.8)] - (-1260) = \boxed{-848 \text{ kJ/mol}}$$

$\text{C}_6\text{H}_{12}\text{O}_6 \text{ (s)}$ -1260 kJ/mol

$\text{CO}_2 \text{ (g)}$ -393.5 kJ/mol

$\text{H}_2\text{O (l)}$ -285.8 kJ/mol

33) Write the full electron configuration for the following elements.

Copper $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^10$

Bromine $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^10 4p^5$

Potassium ion $1s^2 2s^2 2p^6 3s^2 3p^6$

34) Write the noble electron configuration for the following elements.

Aluminum $[\text{Ne}] 3s^2 3p^1$

Calcium $[\text{Ar}] 4s^2$

Oxygen ion $[\text{Ne}]$

35) What does each quantum number represent and what are its possible values?

n : principle quantum #
↳ period #

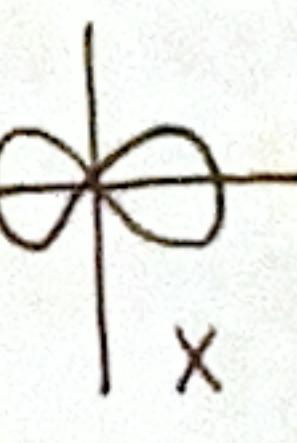
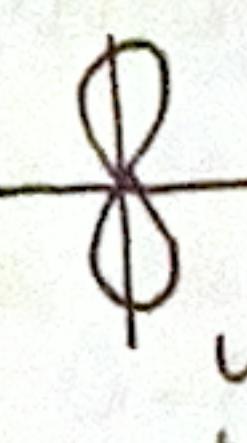
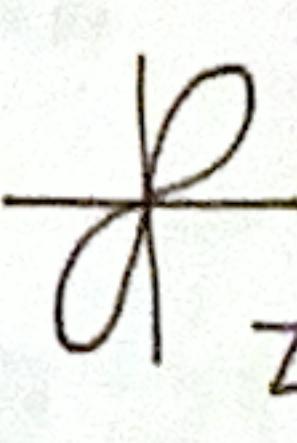
m_l : magnetic quantum #
↳ orbital orientation

l : angular momentum #
↳ type of orbital
(0=s, 1=p, 2=d, 3=f)

m_s : magnetic #
↳ spin direction ($\frac{1}{2}$ or $-\frac{1}{2}$)

36) Draw a s and p orbital. Then state how many electrons and possible orientations a s, p, d, and f orbital can have.

s:  1 orientation

p:    3 orientations

d: 5 orientations

f: 7 orientations

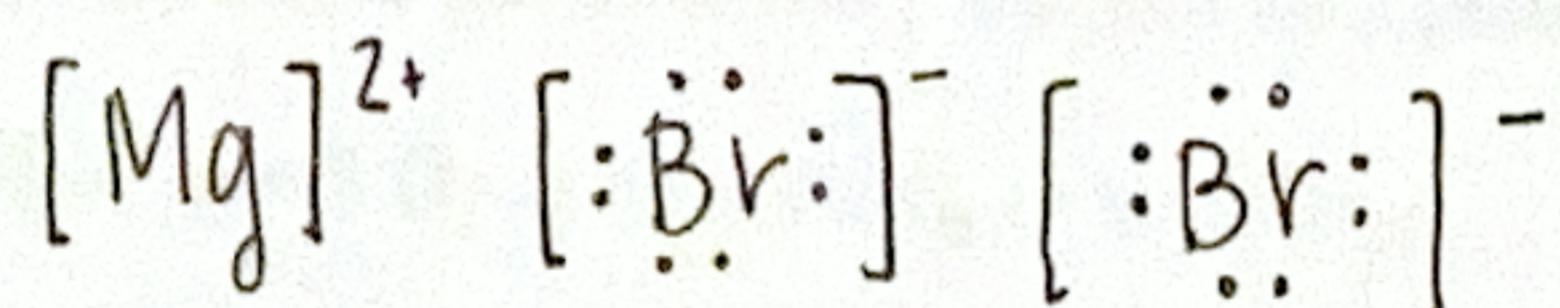
Chapters 7-9: Notes/Formulas

37) A chemical reaction that releases heat to the surroundings is said to be _____ and has a _____ ΔH at constant pressure.

- a) Endothermic, positive
- b) Endothermic, negative
- c) Exothermic, negative**
- d) Exothermic, positive

38) Draw the Lewis structure for the following compounds, identify its overall polarity, calculate formal charge around the central atom, determine its molecular geometry, and state the hybridization.

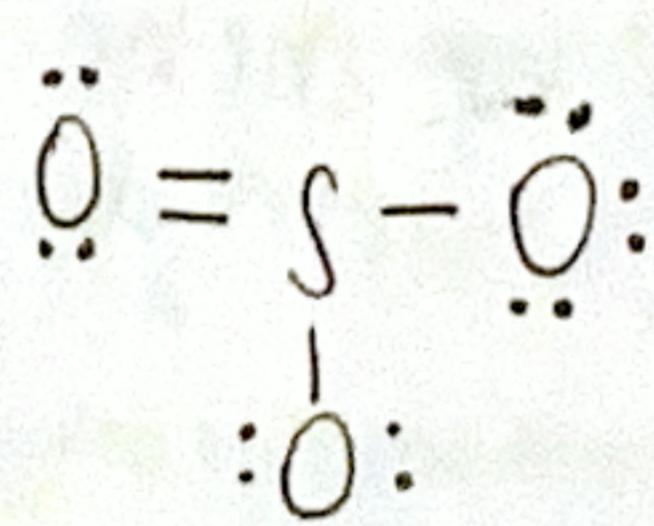
MgBr₂ ionic!



SO_3

$$S: 1 \times 0 \text{ ve} = 6$$

$$0.3 \times 6 \text{ ve} = \frac{18}{24}$$



$$FC: 6 - 4 - 0 = 2 +$$

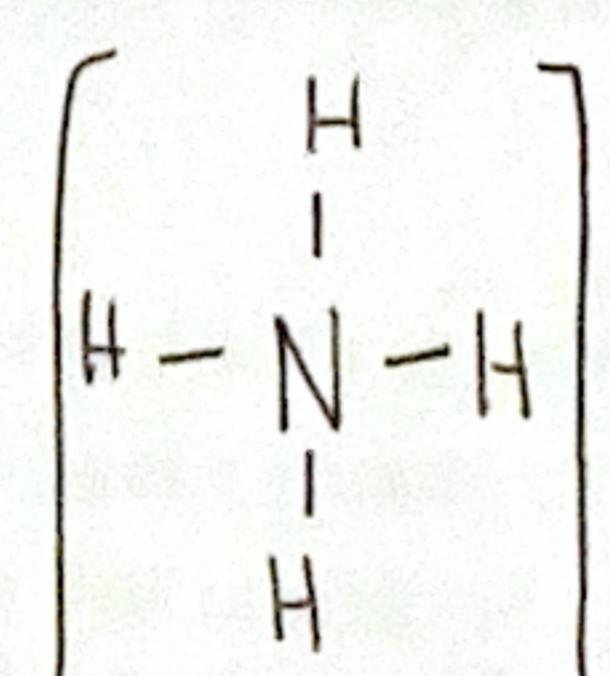
Trigonal planar = SP^2
NON-polar

$$\text{NH}_4^+$$

$$N: 1 \times 5 \text{ ve } = 5$$

$$H: 1 \times 4 \text{ ve } \underline{\underline{4}}$$

9.



$$FC: 5 - 4 - 0 = 1 +$$

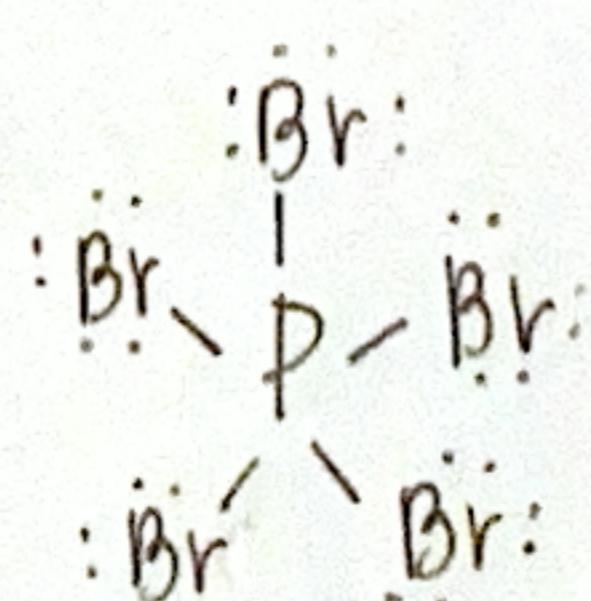
Tetrahedral = sp^3
Non-polar

PBr₅

$$P: 1 \times 5 \text{ ye} = 5$$

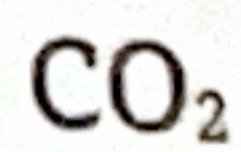
$$\text{By: } 5 \times 7 \text{ ve } = 35$$

40ve

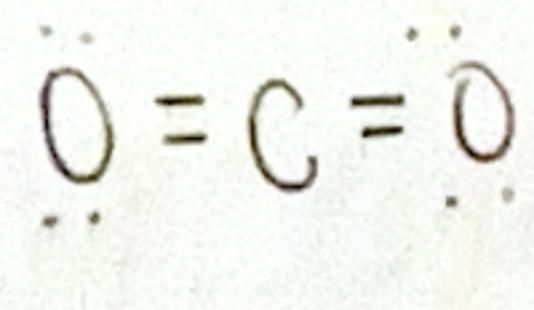


$$FC: 5 - 5 - 0 = 0$$

Trigonal bipyramidal: sp^4
NON-polar



$$\begin{array}{r} \text{C: } 1 \times 4 \text{ ve} = 4 \\ \text{O: } 2 \times 6 \text{ ve} = 12 \\ \hline 16 \end{array}$$



$$\text{FC: } 4 - 4 - 0 = 0$$

Linear = SP

Non-polar

39) Complete the following table.

Molecular Geometry	Bond Angle
Linear	180°
Trigonal planar	120°
Tetrahedral	109.5°

40) In hybrid orbitals, a sigma bond is head-to-head overlap, and a pi bond is side-to-side overlap. Sigma bonds are stronger than pi bonds because this bond overlaps at the internuclear axis where electrons are more likely present. In a triple bond, there are 1 sigma bonds and 2 pi bonds.

41) Which of the following lists arranges the elements in order of *increasing atomic radius*?

- A. N < C < B < Be < Li
- B. Li < Be < B < C < N
- C. Be < B < C < N < O
- D. O < N < C < B < Be

42) Which sequence shows the elements in order of *decreasing electronegativity*?

- A. Cl > S > P > Mg > Na
- B. Na > Mg > P > S > Cl
- C. S > Cl > P > Mg > Na
- D. Cl > P > S > Mg > Na

Chapters 10-11:

Notes/Formulas

43) The gas law that represents an *inverse* relationship is Boyle's law.

44) The gas laws that represent direct relationships are Charles's law

Gay-Lussac's law, and Avogadro's law.

45) Determine the volume occupied by 2.34 grams of carbon dioxide gas at STP = 1.00 atm = 273 K

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$V = \frac{0.0532 \text{ mol} (0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}) (273 \text{ K})}{1.00 \text{ atm}} = 1.19 \text{ L}$$

300 K

46) A 3.50-L container holds a mixture of helium and argon at 27°C . The mixture contains 0.80 mol of He and 0.20 mol of Ar. The total pressure of the mixture is 1.04 atm. Calculate the **partial pressure** of each gas.

$$PV = nRT \quad P_{\text{He}} = \frac{0.80 \text{ mol} (0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}) (300 \text{ K})}{3.50 \text{ L}} = 5.63 \text{ atm}$$

$$P = \frac{nRT}{V}$$

$$P_{\text{Ar}} = \frac{0.20 \text{ mol} (0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}) (300 \text{ K})}{3.50 \text{ L}} = 1.41 \text{ atm}$$

47) A sample of chlorine gas (Cl_2) is at a pressure of 1.20 atm and a temperature of 25°C . Calculate the **density** of Cl_2 gas under these conditions.

$$d = \frac{PM}{RT} = \frac{1.20 \text{ atm} (35.45 \text{ g/mol})}{0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} (298 \text{ K})} = \frac{1.74 \text{ g/L}}{+ 273 \over 298 \text{ K}}$$

48) A sample of neon gas occupies 3.20 L at a pressure of 0.950 atm and a temperature of 28°C . If the conditions change to a pressure of 1.20 atm and a temperature of 15°C , what will the new volume of the gas be?

$$\frac{V_2 P_1 T_1}{V_1} = \frac{P_2 T_2 V_1}{V_2} \quad V_2 = \frac{P_2 T_2 V_1}{P_1 T_1} = \frac{1.20 \text{ atm} (288 \text{ K}) (3.20 \text{ L})}{(0.950 \text{ atm}) (301 \text{ K})} = 3.87 \text{ L}$$

49) List the 5 postulates of the kinetic molecular theory that describe the behavior of ideal gasses.

- 1)
- 2)
- 3)
- 4)
- 5)

refer back to the gas laws WS

50) What type(s) of intermolecular forces are found in the following?
a. H_2O_2 Hydrogen bonding, dipole-dipole, London dispersion

b. CH_3F Dipole-dipole, London dispersion

c. PF_3 Dipole-dipole, London dispersion

d. $\text{C}_6\text{H}_5\text{OH}$ Hydrogen bonding, dipole-dipole, London dispersion

51) Ways to increase the strength of molecular forces:
Increase molecular size/surface area/# of electrons

52) Which of the following boils at the **highest** temperature?

- a) C_2H_6
- b) C_3H_8
- c) C_4H_{10}
- d) C_5H_{12}

53) Which of the following phase changes is(are) endothermic?

1. melting 3. sublimation 5. deposition

2. vaporization 4. condensation 6. freezing

- a) 1, 2, and 3
- b) 4, 5, and 6
- c) 1 and 2 only
- d) 4 and 6 only

54) The predominant intermolecular force in $\text{CH}_3\text{-NH-CH}_3$ is _____.

- London dispersion forces
- ion-dipole forces
- dipole-dipole forces
- hydrogen bonding *STRONGEST!*

55) Using the phase diagram, identify the correct state of matter in each region.

- $\text{A} = \text{liquid}$, $\text{B} = \text{solid}$, $\text{C} = \text{gas}$, $\text{D} = \text{supercritical fluid}$
- $\text{A} = \text{solid}$, $\text{B} = \text{liquid}$, $\text{C} = \text{gas}$, $\text{D} = \text{supercritical fluid}$
- $\text{A} = \text{solid}$, $\text{B} = \text{liquid}$, $\text{C} = \text{supercritical fluid}$, $\text{D} = \text{gas}$
- $\text{A} = \text{gas}$, $\text{B} = \text{liquid}$, $\text{C} = \text{solid}$, $\text{D} = \text{supercritical fluid}$

