

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

H₃(PO₄) phosphoric acid

NH₃ ammonia

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

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

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

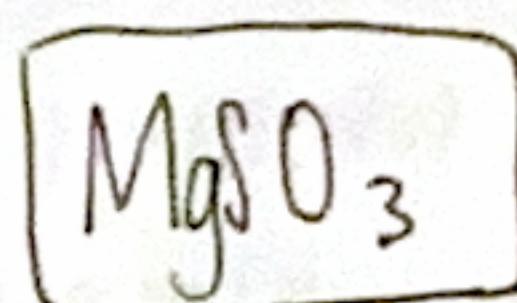
$$^{30}\text{Si} \ 29.97 \text{ at } 3.090\% \text{ abundance} \quad 29.97 \times .03090 = 0.926$$
$$\underline{28.09 \text{ amu}}$$

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

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

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

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



14) A chemist used 4.07×10^{24} formula units of Li₂O in the lab and needs it to be converted to grams for her lab report. How many grams of Li₂O 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?

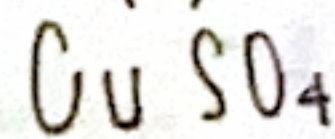
$$\frac{50.0 \text{ g N}_2\text{O}_5}{1} \times \frac{1 \text{ mol N}_2\text{O}_5}{108.02 \text{ g}} \times \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol N}_2\text{O}_5} = \boxed{2.79 \times 10^{23} \text{ atoms}}$$

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

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

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

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



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

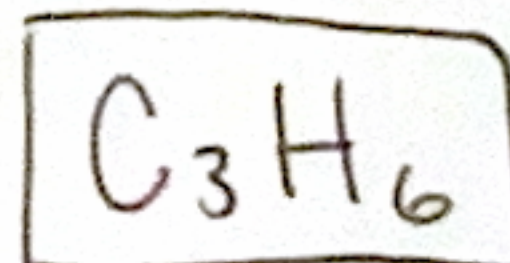
17) Given that the empirical formula for cyclobutene is CH₂ and it has a molar mass of 42g, what is its molecular formula?

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

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

$$\underline{14.03 \text{ g}}$$

$$42 / 14.03 = 3$$



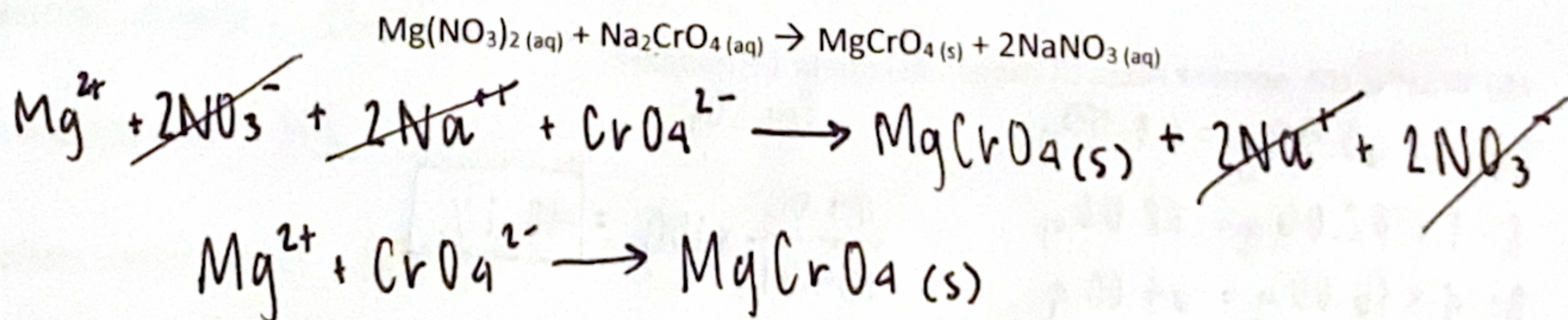
Chapters 4-6:
Notes/Formulas

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

$$M_1 V_1 = M_2 V_2$$

O	R
I	I
L	G
(+)	(-)

- 18) List the strong acids: HCl , HBr , HI , HClO_4 , HClO_3 , HNO_3 , H_2SO_4
- 19) List the strong bases: alkali metals $-\text{OH}$ & heavy alkaline earth metals $-\text{OH}$
- 20) The net ionic product of an acid base reaction is always water $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$
- 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 $\text{CO}_2 + \text{H}_2\text{O}$
- 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?

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

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

$$M = 0.732$$

- 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?

$$M_1 V_1 = M_2 V_2$$

$$0.30M(160mL) = 5.0M(V_2)$$

$$V_2 = 9.6mL$$

- 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?

$$.0250L$$

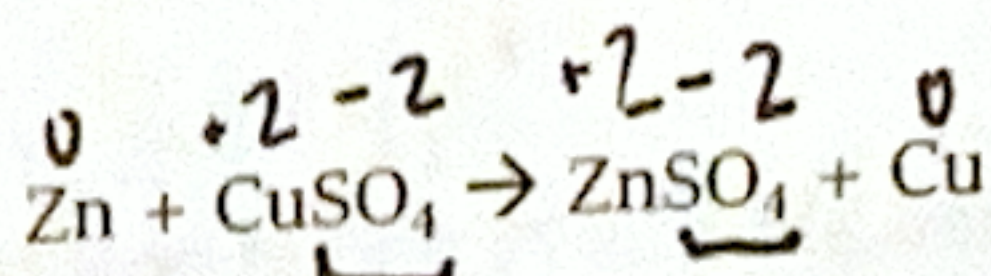
$$.02345L$$

$$.0250L \text{ HCl } (0.750M) = 0.01875 \text{ mol HCl} \times \frac{1 \text{ mol NaOH}}{1 \text{ mol HCl}} \times \frac{1}{0.02345L} = 0.7996M$$

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



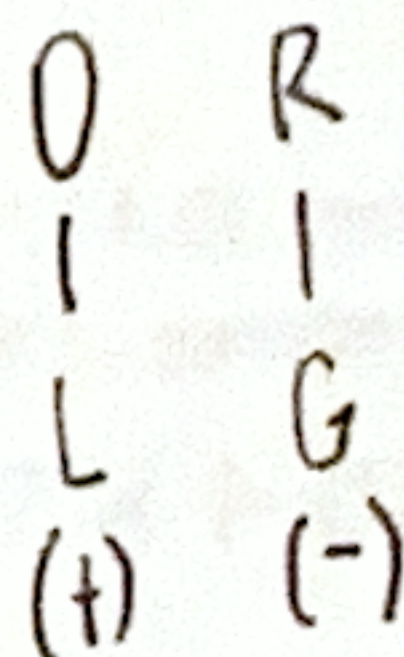
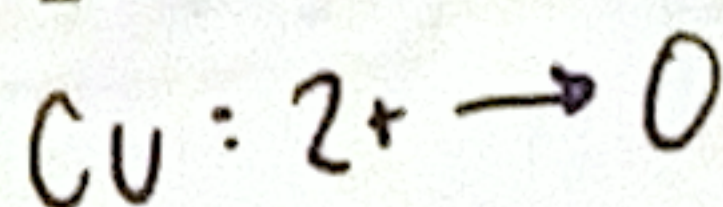
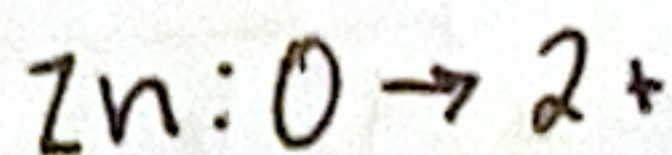
- 26) Determine the following.



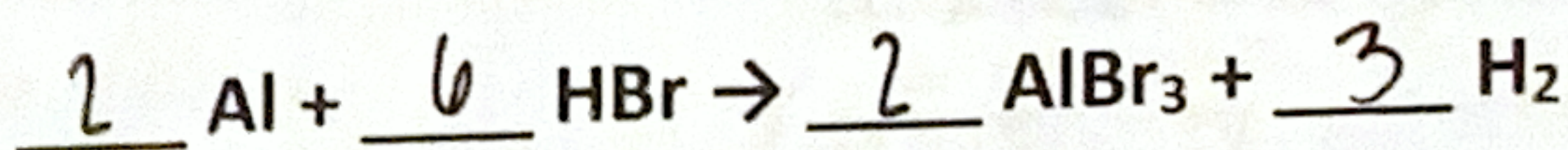
Oxidized: ZINC

Reduced: COPPER

Net ionic equation:



- 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?

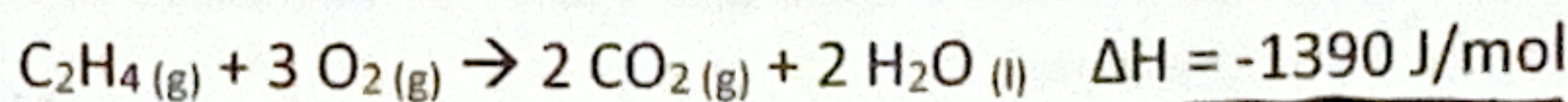
- c) What kind of reaction is this?

single 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?

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

- 28) The combustion of ethane, C_2H_4 , is an exothermic reaction.



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

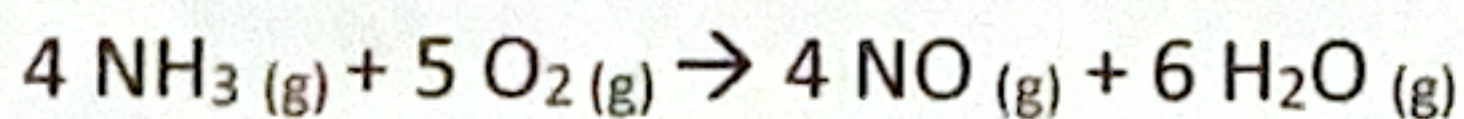
Calculate the amount of heat given off when 4.79 g of C_2H_4 reacts with excess oxygen.

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

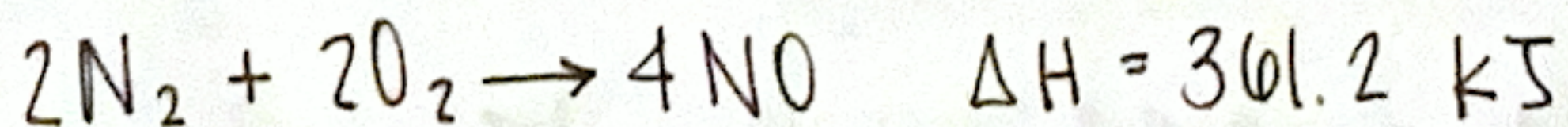
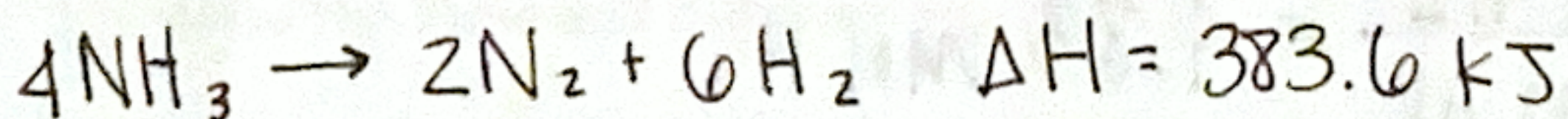
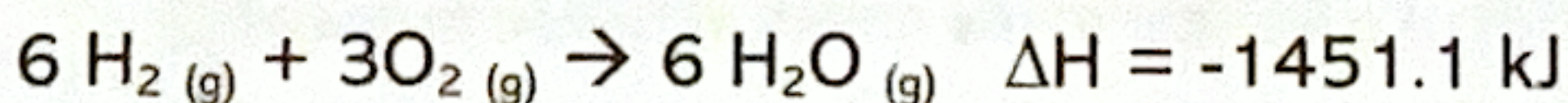
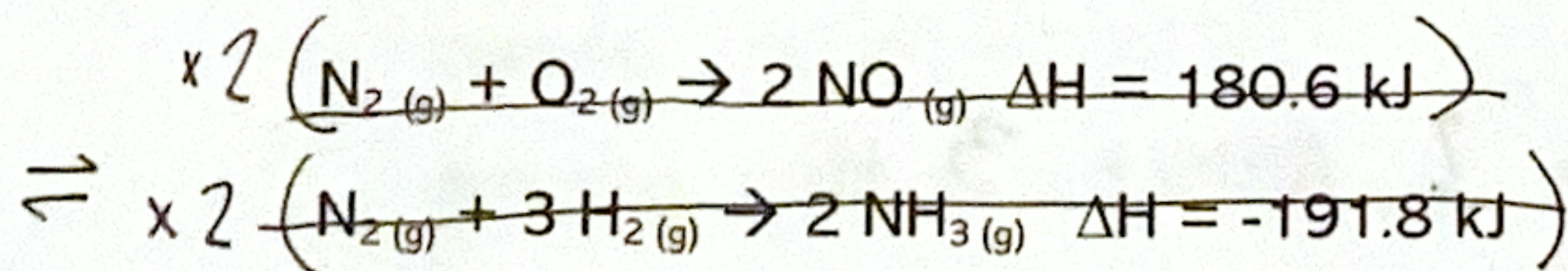
- 29) A system does 30.4 kJ of work and absorbs 73.0 kJ of heat from the environment. What is the **change in internal energy** of the system?

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

- 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:



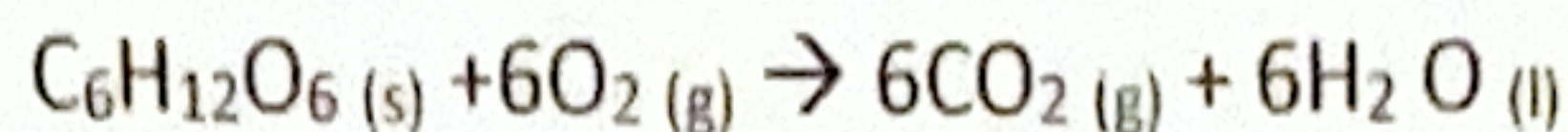
$$\boxed{\Delta H = -706.3 \text{ kJ}}$$

- 31) When 12.0 g of fructose, $\text{C}_6\text{H}_{12}\text{O}_6$, 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 $9.90 \text{ kJ/}^\circ\text{C}$, how much heat was produced by this reaction?

$$q = C_s m \Delta t$$

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

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



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

$\text{H}_2\text{O} (\text{l})$ -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 #
 \angle period #

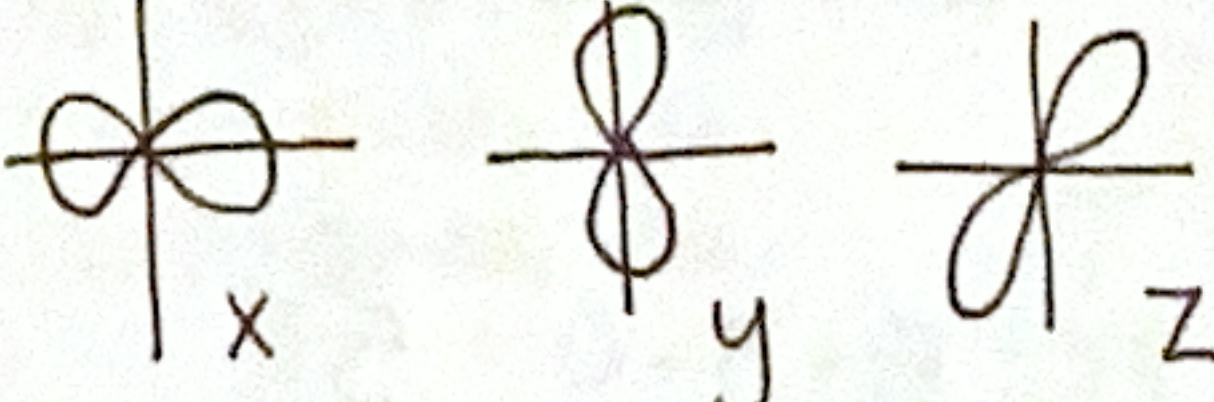
m_l : magnetic quantum #
 \angle orbital orientation

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

m_s : magnetic #
 \angle 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

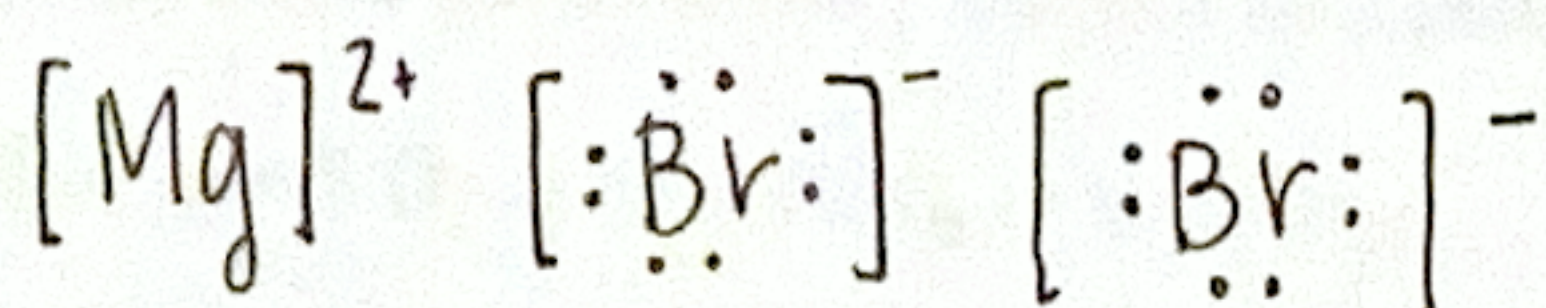
Chapters 7-9:
Notes/Formulas

37) A chemical reaction that release 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.

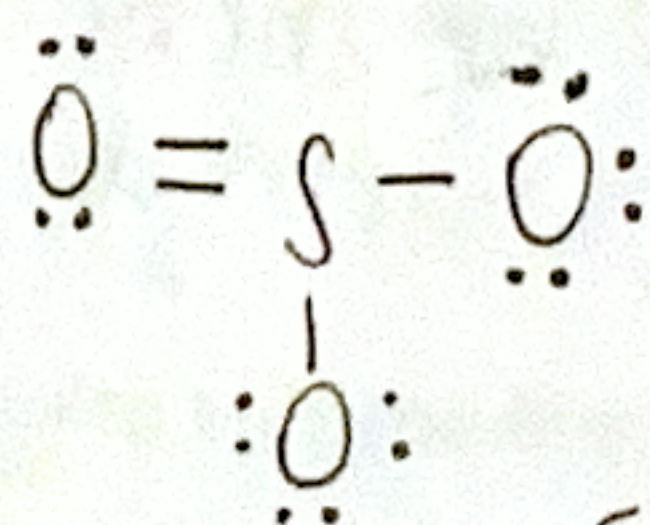
MgBr₂ ionic!



SO₃

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

$$\text{O}: 3 \times 6 \text{ ve} = \frac{18}{24}$$



$$\text{FC}: 6 - 4 - 0 = 2+$$

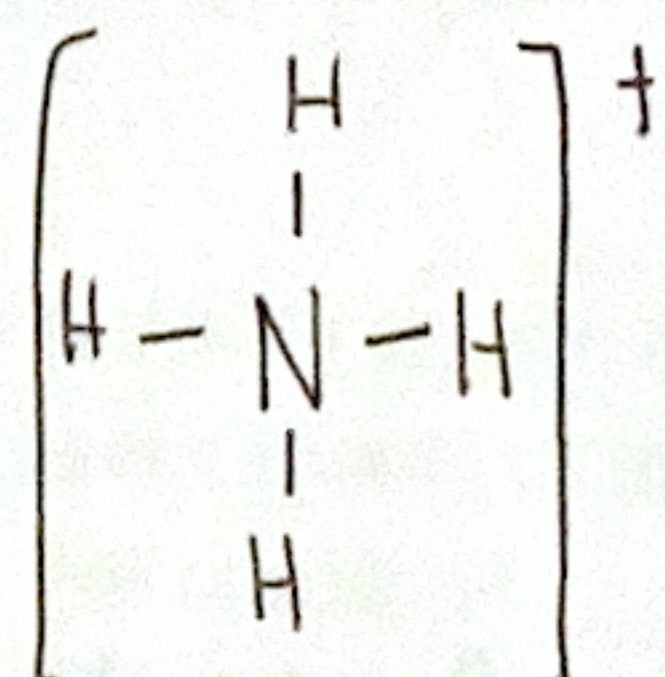
Trigonal planar = sp^2
Non-polar

NH₄⁺

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

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

$$5 - 1 = 8 \text{ ve}$$



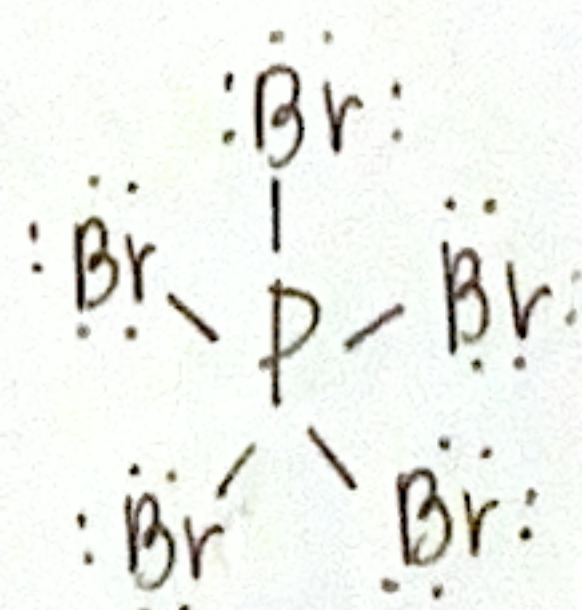
$$\text{FC}: 5 - 4 - 0 = 1+$$

Tetrahedral = sp^3
Non-polar

PBr₅

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

$$\text{Br}: 5 \times 7 \text{ ve} = \frac{35}{40 \text{ ve}}$$

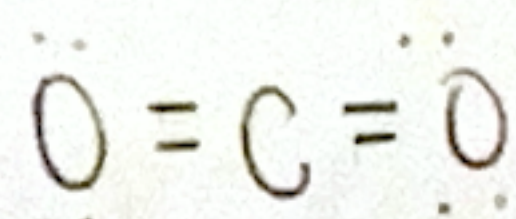


$$\text{FC}: 5 - 5 - 0 = 0$$

Trigonal bipyramidal = sp^3
Non-polar

CO₂

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



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

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 of occupied by 2.34 grams of carbon dioxide gas at STP = 1.00 atm, 273 K

$$PV = nRT$$

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

$$\frac{2.34 \text{ g CO}_2}{44.01 \text{ g}} = 0.0532 \text{ mol}$$

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

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 ~~7.04 atm~~ ^{300 K} Calculate the partial pressure of each gas.

$$PV = nRT$$

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

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

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

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.

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

$$\begin{matrix} + 273 \\ 298 \text{ K} \end{matrix}$$

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?

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

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

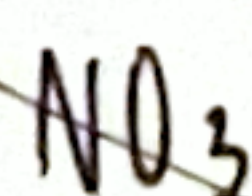
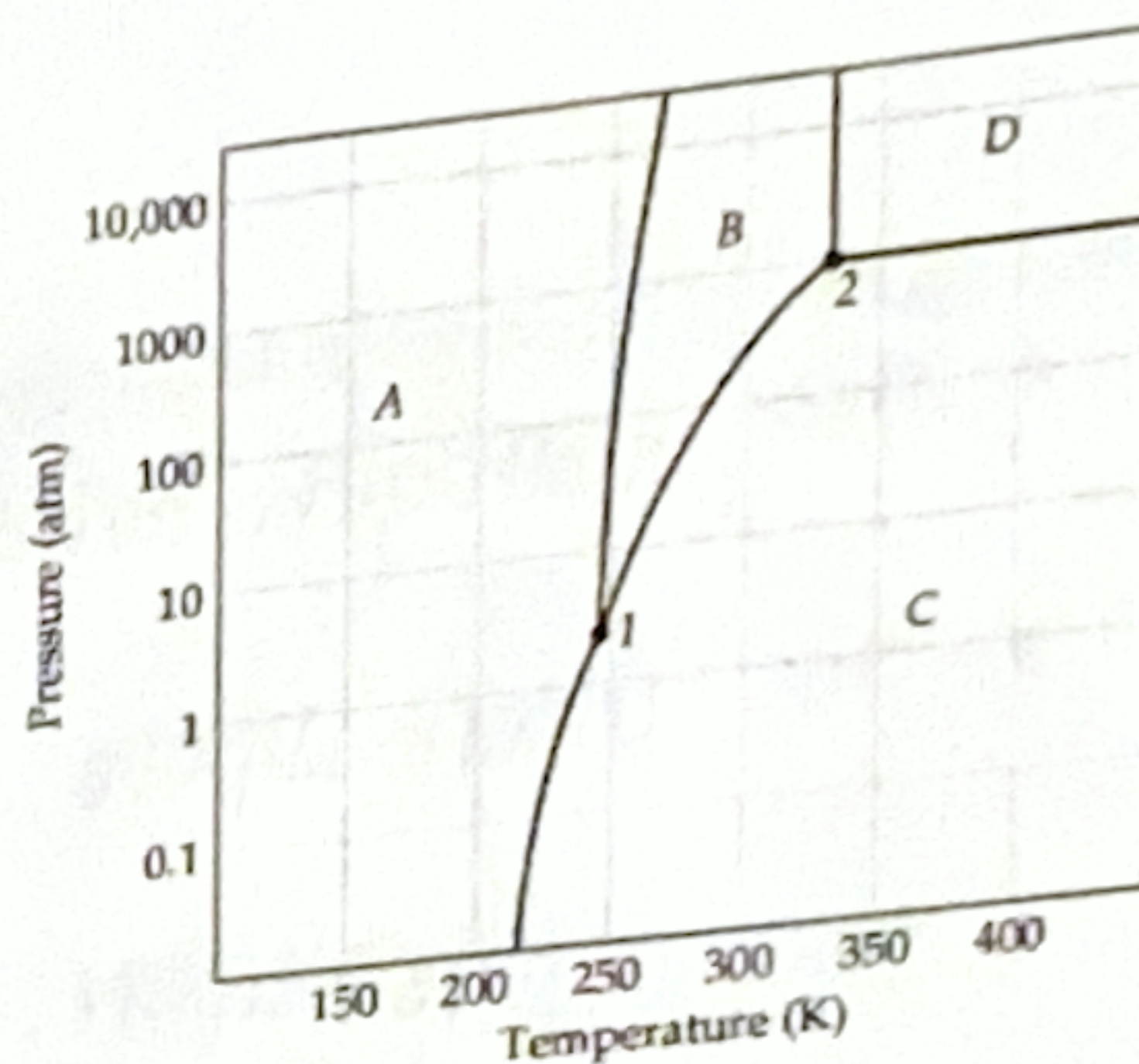
54) The predominant intermolecular force in $\text{CH}_3\text{-NH-CH}_3$ is _____.

- a) London dispersion forces
- b) ion-dipole forces
- c) dipole-dipole forces
- d) hydrogen bonding

d) hydrogen bonding *strongest!*

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

- a) A=liquid, B=solid, C=gas, D=supercritical fluid
- b) A=solid, B=liquid, C=gas, D=supercritical fluid**
- c) A=solid, B=liquid, C=supercritical fluid, D=gases
- d) A=gases, B=liquid, C=solid, D=supercritical fluid



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

~~$\text{O: } 3 \times 6 \text{ ve} = 18$~~

~~$23 + 1 = 24$~~

