

Chemistry 107 : Final Exam

The 150 pts final exam consists of 14 questions and students have 2 hours to complete the exam. Answers must be written in the box provided or else no credit is provided. Use the empty space provided to do your work. A periodic table is provided at the end. Fill in your name along with your student ID number.

Problem 1 : True/False Determine whether the statement is true or false. (20 pts)

- (a) Catalysts speed up the chemical reaction by lowering the activation Energy. (E_A)

- (b) The atomic number of a substance is the number of neutrons that an element has.

- (c) Photons from red lights have lower energy than violet light.

- (d) As the wavelength of light increases, the photon energy decreases as well

- (e) The mass of an atom is the sum of the masses of neutrons, protons, and electrons.

- (f) Matter and energy are neither created nor destroyed.

- (g) Suppose a system is in thermal equilibrium with a heat bath. When the temperature of the heat bath increases, the temperature of the system increases.

- (h) The boiling point of molecules depends on the strength of intermolecular forces.

- (i) Carbon atoms can form more than 4 bonds.

- (j) Boiling of liquids occurs when the vapor pressure of the liquid is less than the atmospheric pressure.

Problem 2 : Nomenclature Provide either the molecular formula or compound name for the following. (13 pts)

(a) Sulfurous acid

(b) Chromium(VI) oxide

(c) V_2O_5

(d) Vanadium(V) acetate

(e) $Sr(C_2H_3O_2)$

(f) $HClO_3$

(g) $(NH_4)_2SO_4$

(h) Carbonic acid

(i) Sodium bicarbonate

(j) CaO

(k) SF_4

(l) $BeCl_2$

(m) Sodium permanganate

Problem 3 : Molarity Magnesium sulfate (MgSO_4) can be used as a soaking solution to relieve minor sprains, bruises, muscle aches or discomfort, joint stiffness or soreness, and tired feet. Answer the following questions and report all results to 3 significant figures. (12 pts)

- (a) Determine the mass percent of each element in MgSO_4 .

- (b) A scientist attempts to prepare 5.00L of 2M MgSO_4 . How many grams of MgSO_4 is needed ?

- (c) Suppose the solution in part b) needs to be diluted to make 2.00L of 0.25M MgSO_5 , how much volume in L is needed from 2M MgSO_4 ?

Problem 4 : Thermal Equilibrium 700.0g of aluminum (Al) metal block is heated to 350.0°C and then, dropped into 1,000.g of water (H₂O) at 0°C. The specific heats of H₂O and Al are 4.184 J/(g °C) and 0.890 J/(g °C), respectively. Determine the final temperature at which the Al and H₂O are in thermal equilibrium. Report to 4 significant figures. (12 pts)

Problem 5 : Relative Atomic Mass Boron has only two naturally occurring isotopes (Boron-10 and Boron-11). The mass of Boron-10 is 10.01294 amu and the mass of Boron-11 is 11.00931 amu. The relative abundances of Boron-10 and Boron-11 are 0.1998 and 0.8002. Report to 3 significant figures. Calculate the relative atomic mass. (4 pts)

Problem 6 : Atoms and Ions Complete the table with the symbol, atomic number Z , atomic mass A , number of protons (p^+), number of electrons e^- , number of neutrons n , and charge. (10 pts)

Symbol	Z	A	p^+	e^-	n	Charge
Sn	50		50		63	
O^{2-}		16				
	26				31	$2+$
	19			19	16	$1+$
Xe		130				

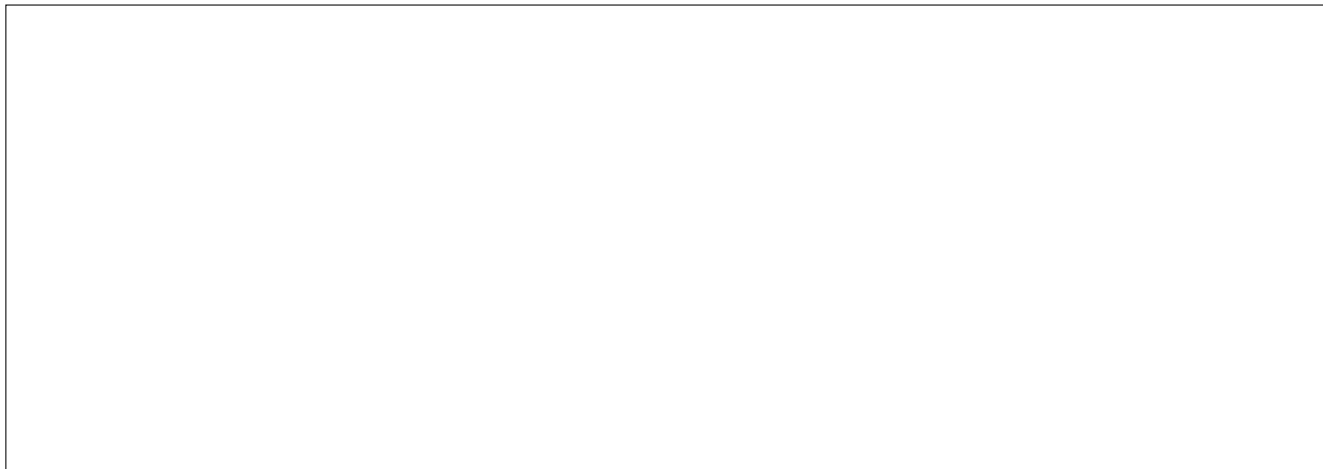
Problem 7 : Empirical and Molecular Formulas Answer the following questions. (10 pts)

- (a) Mining iron requires removing impurities such as sulfur. Suppose a sample is found to contain 63.52% iron and 36.48% sulfur. Determine the empirical formula

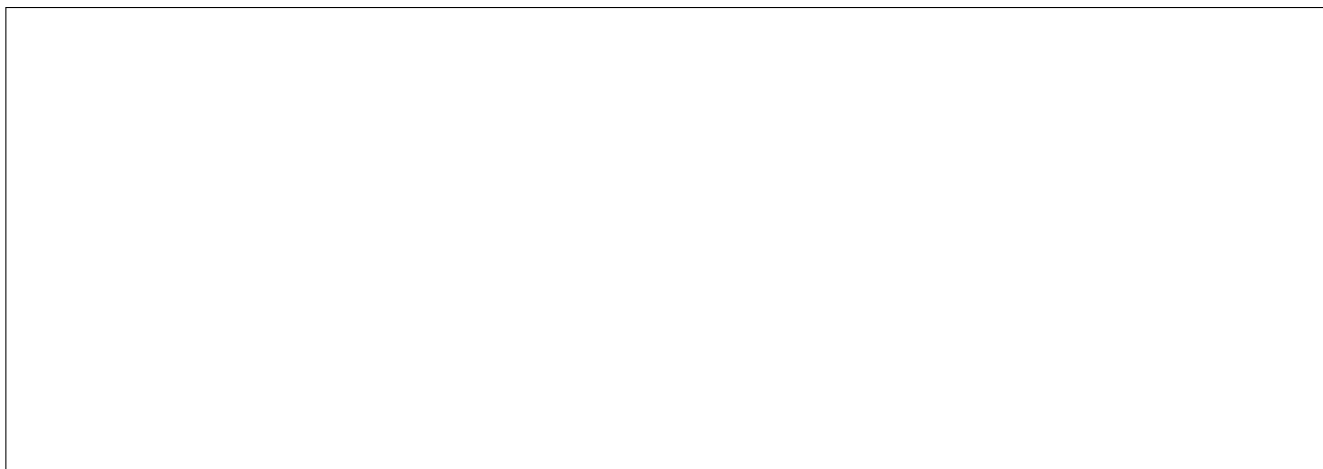
- (b) In class, we dealt with many different hydrocarbons. Determine the molecular formula of the compound with an empirical formula of CH and a molar mass of 78.110g/mol.

Problem 8 : Drawing Lewis Structures Draw the Lewis structures for the following compounds, identify the geometric shape, and whether the compound is polar or nonpolar. If there are resonance structures, then include them in your answer.(18 pts)

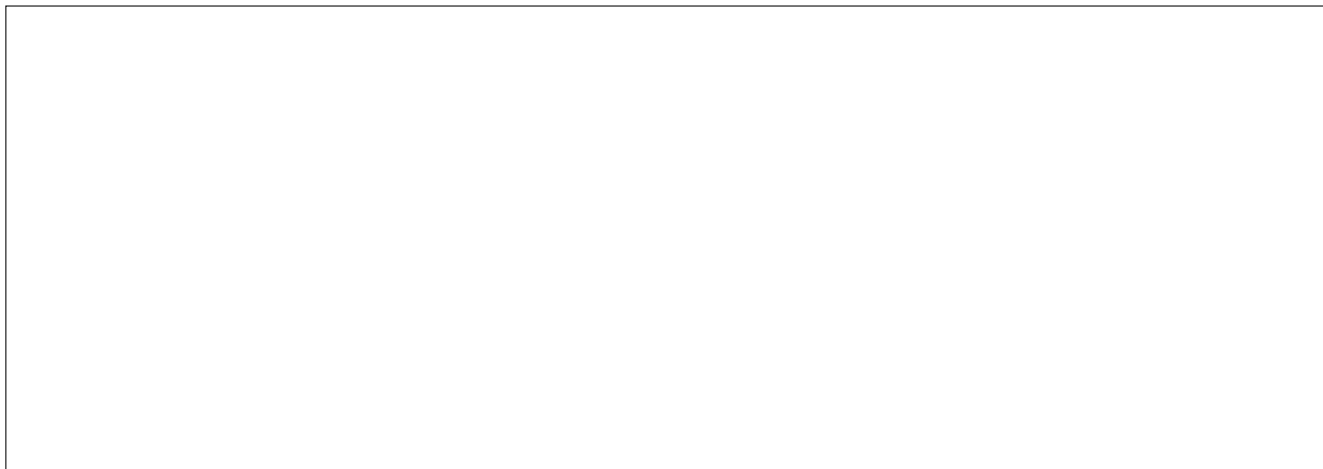
(a) HSCN



(b) BeCl



(c) O₃



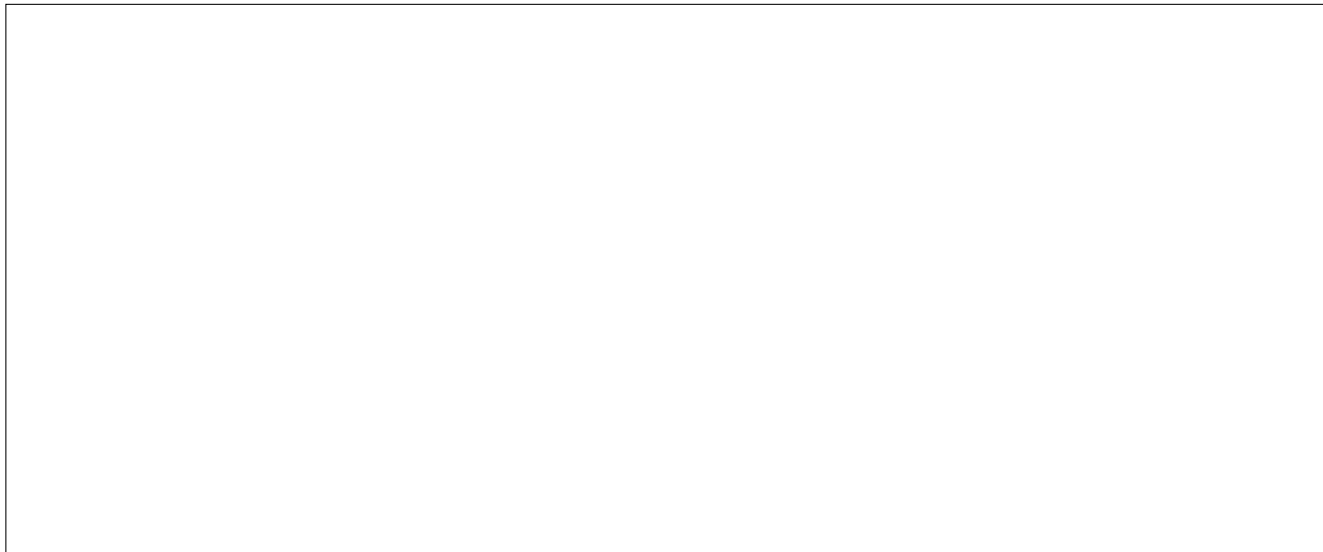
(d) NH_3

(e) H_3O^+

(f) CO_3^{2-}

Problem 9 : Applications of Ideal Gas Law The following questions are applying the ideal gas law. Report values to 3 significant figures. (12 pts)

- (a) Suppose a fixed amount of H_2 gas is stored inside a container. Sketch a graph describing the relationship between temperature and pressure. Describe this relationship.



- (b) What is the density of laughing gas, dinitrogen monoxide, N_2O , at a temperature of 325K and a pressure of 113.0 kPa?



- (c) A sample of H_2 gas occupies 1.50L at 80.0°C and 3.00atm. What volume does H_2 gas will it occupy at 185°C and 5.00 atm?



Problem 10 : Ideal Gas and Chemical Equation Automobile air bags are inflated with nitrogen gas (N_2), which is formed by the decomposition of solid sodium azide (NaN_3). The other product is sodium metal (Na). (6 pts)

- (a) Write the balanced chemical equation of the decomposition of sodium azide including states.

- (b) Calculate the volume of nitrogen gas at 27 °C and 756 torr formed by the decomposition of 125 g of sodium azide.

Problem 11 : Acid-Base Reaction To neutralize sulfuric acid (H_2SO_4), sodium hydroxide (NaOH) is used to form a salt and water. Report to 3 significant figures. (6 pts)

- (a) Write the balanced chemical equation including states.

- (b) Suppose there is 50mL of 1M $\text{H}_2\text{SO}_4(\text{aq})$, how much volume in L of 1.25M $\text{NaOH}(\text{aq})$ is needed to completely react with phosphoric acid ?

Problem 12 : Predicting and Ranking Properties Rank the following properties. (12 pts)

- (a) Rank elements from highest to lowest first ionization energy : F, S, He, Fr, Cl

- (b) Rank elements from highest to lowest electronegativity : H, N, O, Cs, F

- (c) Rank elements from largest to smallest atomic radius : Ne, Cs, Li, F, B

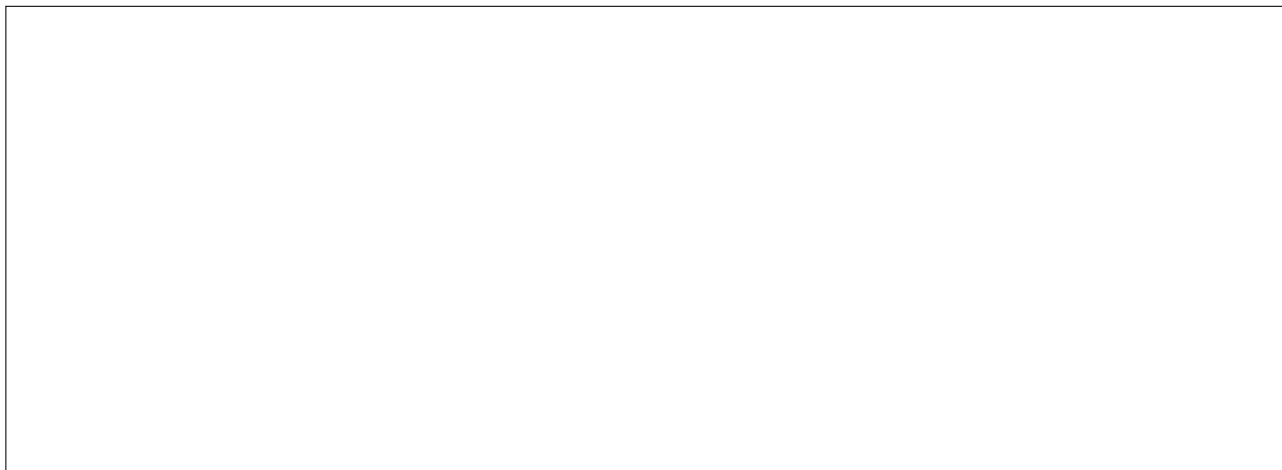
- (d) Ranking ions from largest to smallest atomic radius : H^+ , I^- , Li^+ , F^- , O^{2-}

- (e) Rank the following compounds from highest to lowest boiling points : H_2O , $\text{C}_{12}\text{H}_{26}$, NH_3 , NO , CH_2O

- (f) Rank the following compounds from highest to lowest vapor pressure : H_2O , $\text{C}_{12}\text{H}_{26}$, NH_3 , NO , CH_2O

Problem 13 : Heating Curve of Water Suppose you are heating solid ice at -10°C to water vapor at 120°C . The specific heats of ice, water, and water vapor are $2.03 \text{ J}/(\text{g } ^{\circ}\text{C})$, $4.18 \text{ J}/(\text{g } ^{\circ}\text{C})$, and $2.02 \text{ J}/(\text{g } ^{\circ}\text{C})$, respectively. the molar heat of fusion of ice is $6,010 \text{ J/mol}$ and heat of vaporization of water is $4.07 \times 10^4 \text{ J/mol}$. (10 pts)

- (a) Sketch the heating curve described in the problem labeling the x-axis as heat added and y-axis as the temperature.



- (b) Calculate the total heat added to heat solid ice at -10°C to water vapor at 120°C .



Class
Id number

Name

Problem 14 : Chemistry 107 Write a paragraph (at least 4 sentences) answering the following questions and share your overall impression of the course. What did you learn in chemistry 107? How has this class helped you toward your career and personal goals? What can be done to improve the course? (5 pts)

Chemistry 107 : Apppendix 1 - Periodi Table, Formulas and Constants

$$q = mC\Delta T$$

$$E = \frac{hc}{\lambda} = h\nu$$

$$h = 6.626 \times 10^{-34} \text{ J s}$$

$$c = \lambda\nu$$

$$c = 3.00 \times 10^8 \text{ m/s}$$

$$N_A = 6.022 \times 10^{23}$$

$$PV = nRT$$

$$R = 0.08205 \text{ (L atm)/(mol K)} = 8.3145 \text{ (L kPa)/(mol K)} \\ = 62.364 \text{ (L Torr)/(mol K)}$$

1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.94	4 Be Beryllium 9.012															9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305															17 Cl Chlorine 35.45	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078															35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62															53 I Iodine 126.904	54 Xe Xenon 131.293
55 Cs Cesium 132.905	56 Ba Barium 137.327															85 At Astatine [210]	86 Rn Radon [222]
87 Fr Francium [223]	88 Ra Radium [226]															117 Ts Tennessine [293]	118 Og Oganesson [294]
*Lanthanide series		57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.242	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.045		
**Actinide series		89 Ac Actinium [227]	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium [237]	94 Pu Plutonium [244]	95 Am Americium [243]	96 Cm Curium [247]	97 Bk Berkelium [247]	98 Cf Californium [251]	99 Es Einsteinium [252]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]		