

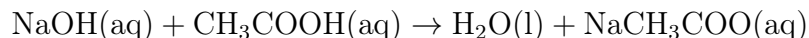
Chemistry 123 : Exam 2A

The 60 pts exam consists of 5 questions and students have the whole class period 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 : Molarity - Acid/Base Reaction Titration is a technique used to determine an unknown of a solution. (12 pts)

- (a) To begin the experiment, 4 mL of 6.00 M NaOH stock solution is diluted to 240 mL. What is the new concentration ?

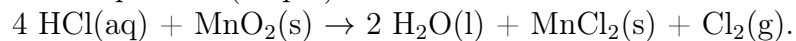
- (b) Given the NaOH(aq) concentration from part a), NaOH(aq) is used to titrate acetic acid (CH₃COOH) by the chemical equation



Determine what volume of NaOH(aq) solution is needed to react with 0.300g CH₃COOH.

- (c) Using the NaOH(aq) concentration from part a), you titrate 0.4274 g of unknown monoprotic acid, which only releases one hydrogen ion (H⁺). To completely react all the acid, you used 35.00 mL of NaOH(aq) solution. What is the molar mass of the unknown acid? Hint : Recall the units for molar mass (g/mol).

Problem 2 : Limiting Reagent Small amounts of chlorine gas can be generated in the laboratory from the reaction of manganese(IV) oxide with hydrochloric acid. The following is the balanced chemical equation. (12 pts)



- (a) Given 42.7 g HCl(aq) and 67.0 g MnO₂(s), which one is the limiting reagent?

- (b) What is the maximum amount of Cl₂(g) produced in g? This is also known as the theoretical yield.

- (c) How much of the excess reagent in g is leftover?

- (d) If 18.5 g of Cl₂(g) is collected, determine the percent yield.

Problem 3 : Thermal Equilibrium (12 pts)

(a) True/False. If two objects are in contact and reach thermal equilibrium, there is no flow of heat between the two objects.

(b) 550.0g of Al metal block is heated to 500.0°C and then, dropped into 1,000.g of water at 0°C. The specific heats of water and Al are 4.184 J/(g °C) and 0.9211 J/(g °C), respectively. Determine the final temperature at which the Al and water are in thermal equilibrium. Report to 4 significant figures.

(c) Describe using illustrations and/or equations to show how thermal equilibrium is achieved. Include the initial and final states of the Al and water.

Problem 4 : Charles' Law Given a fixed amount of gas at constant pressure. Answer the following questions. (12 pts)

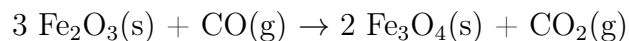
- (a) Starting from the ideal gas law $PV = nRT$. Show how you can arrive at Charles' law. Include all steps to receive full credit.

- (b) If a sample of chlorine gas occupies 50.0mL at 100.°C, what is its volume at 25.0°C?

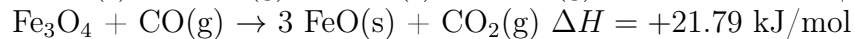
- (c) Calculate the temperature (in Celsius) when 2.00L at 21.0°C is compressed to 1.00L.

- (d) Draw the graph of the relationship between volume (V) and temperature (T) for an ideal gas. Describe the relationship.

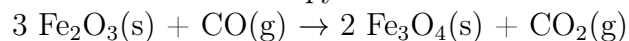
Problem 5 : Hess's Law Given the overall reaction : (12 pts)



Given the following data :



(a) Determine the enthalpy for the overall reaction :



(b) Is the overall reaction exothermic or endothermic ?

(c) Given your answer in part (b), sketch the energy diagram for the overall reaction. Include in your diagram the relative energies of the reactants (Fe_2O_3 , CO) and products (Fe_3O_4 , CO_2), activation energy (E_A), and energy difference (ΔE).

Chemistry 123 : Apppendix 2 - Formulas and Constants

$$\text{percent yield} = \frac{\text{Actual}}{\text{Theoretical}} \times 100\%$$

$$M_1V_1 = M_2V_2$$

$$P_1V_1 = P_2V_2$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$q = mc\Delta T$$

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		21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.922	34 Se Selenium 78.97	35 Br Bromine 79.904	36 Kr Krypton 83.798		
37 Rb Rubidium 85.468		38 Sr Strontium 87.62		39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium [97]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.904	54 Xe Xenon 131.293		
55 Cs Cesium 132.905		56 Ba Barium 137.327		* 57 - 70										85 At Astatine [210]	86 Rn Radon [222]						
87 Fr Francium [223]		88 Ra Radium [226]		** 89 - 102										116 Lv Livermorium [293]	118 Og Oganesson [294]						
Lanthanide series																				70 Yb Ytterbium 173.045	
Actinide series																				102 No Nobelium [259]	