

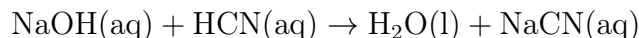
Chemistry 123 : Exam 2A

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, 5 mL of 12.00 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 0.350g HCN.

- (c) Using the NaOH(aq) concentration from part a), you titrate 0.290 g of unknown monoprotic acid, which only releases one hydrogen ion (H⁺). To completely react all the acid, you used 25.20 mL of NaOH(aq) solution. What is the molar mass of the unknown acid? Hint : Recall the units for molar mass (g/mol).

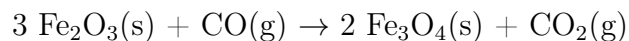
Problem 2 : Thermal Equilibrium (12 pts)

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

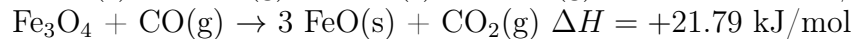
(b) 450.0g of Fe metal block is heated to 350.0°C and then, dropped into 1,000.g of water at 0°C. The specific heats of water and Fe are 4.184 J/(g °C) and 0.451 J/(g °C), respectively. Determine the final temperature at which the Al and water are in thermal equilibrium. Report to 4 significant figures.

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

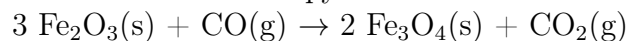
Problem 3 : Hess's Law Given the overall reaction : (12 pts)



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).

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

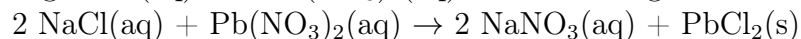
- (a) Starting from the ideal gas law $PV = nRT$. Show how you can arrive at Charles' law. Include all steps to receive full credit.

- (b) If a sample of chlorine gas occupies 100.0mL at 100.°C, what is its volume at 25.0°C?

- (c) Calculate the temperature (in Celsius) when 3.00L 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 : Limiting Reagent In a precipitation reaction, lead Chloride (PbCl_2) is produced by mixing NaCl(aq) and $\text{Pb(NO}_3)_2\text{(aq)}$. The following is the balanced chemical equation. (12 pts)



- (a) Given 15.3 g NaCl(aq) and 60.8 g $\text{Pb(NO}_3)_2$, which one is the limiting reagent ?

- (b) What is the maximum amount of $\text{PbCl}_2\text{(s)}$ produced in g ? This is also known as the theoretical yield.

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

- (d) If 34.2 g of $\text{PbCl}_2\text{(s)}$ is collected, determine the percent yield.

Chemistry 123 : Apppendix 2 - Formulas and Constants

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

$$M_1V_1 = M_2V_2$$

$$P_1V_1 = P_2V_2$$

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

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

$$q = mc\Delta T$$

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