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Chemistry 107 : Exam 2A

The 100 pts exam consists of 8 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 and formulas are provided at the end. Additional scratch paper will be provided. 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) Chemical reactions that release heat to the surrounding are endothermic reactions.

(c) For a solution at concentration M, doubling the volume of the solution leads to doubling the concentration.

(d) When mixing 1L of 90°C water and 0.5L of 10°C water, the final temperature at thermal equilibrium is 50°C.

(e) For a chemical reaction, the theoretical yield of a product depends on the excess reagent.

(f) As the wavelength increases, the energy of the photon decreases.

(g) Chemical equations are balanced by changing the subscripts of the compounds.

(h) An example of an endothermic process is the melting of ice into water.

(i) 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.

(j) The Bohr model can accurately predict the spectra of large atoms.

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Problem 2 : Thermal Equilibrium (12 pts)

(a) 700.0g of Cu 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 copper are 4.184 J/(g °C) and 0.3850 J/(g °C), respectively. Determine the final temperature at which the Cu and water are in thermal equilibrium. Report to 4 significant figures.

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

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Problem 3 : Nomenclature Provide either the molecular formula or compound name for the following. (12 pts)

(a) Magnesium oxide

(b) Carbon Monoxide

(c) $HClO_4$

(d) $Ca(HCO_3)_2$

(e) Carbonic acid

(f) H_3PO_4

(g) $(NH_4)_2Cr_2O_7$

(h) BF_3

(i) Phosphorus pentafluoride

(j) Sulfurous acid

(k) Chromium(VI) oxide

(l) V_2O_5

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Problem 4 : Preparing Solutions Anhydrous calcium chloride ($CaCl_2$) can easily absorb water from the air. To prepare a solution, the stable solid calcium chloride dihydrate ($CaCl_2 \cdot 2H_2O$) is more suitable to prepare stock solutions. Answer the following questions and report to 3 significant figures. (12 pts)

(a) A scientist prepares 2L stock solution of 5M $CaCl_2$. Determine what mass (in g) of $CaCl_2 \cdot 2H_2O$ needed to prepare the solution.

(b) Using the prepared 5M $CaCl_2$ stock solution, the scientist is diluting the solution to make 250.mL of 1.5M $CaCl_2$. What volume in L of stock solution is needed to dilute to prepare 250.mL of 1.5M $CaCl_2$?

(c) From part (b), describe how to dilute concentrated 5M $CaCl_2$ solution to make 250.mL of 1.5M $CaCl_2$. Include the solvent and main lab equipment(s) used to perform the dilution.

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Problem 5 : Predicting Chemical Reactions For the following reagents, determine the products formed by writing the balanced chemical equation including states and if there is no reaction, write "no reaction." (10 pts)

(a) Solid iron wool ignited in the presence of oxygen gas

(b) Placing solid lithium metal into water

(c) The combustion of fructose ($C_6H_{12}O_6$) in the presence of oxygen gas

(d) Mixing aqueous silver nitrate and aqueous potassium dichromate

(e) Mixing aqeuous Copper(II) Sulfate and aqueous sodium hydroxide

Problem 6 : Acid-Base Reaction To neutralize phosphoric acid, sodium hydroxide 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 phosphoric acid, how much volume in L of 1.25M sodium hydroxide is needed to completely react with phosphoric acid ?

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Problem 7 : Combustion Reaction Methane is a colorless, odorless gas which is used as a fuel in most gas stoves to cook food. Per year, the US uses approximately 31.13 trillion ($\times 10^{12}$) ft^3 of methane per year. Approximately 2% of that is used for cooking. Report to 4 significant figures. (14 pts)

(a) Write the balanced chemical equation including states of the combustion reaction of methane.

(b) In the presence of excess oxygen gas, determine the amount of carbon dioxide is produced in g ? Report in scientific notation and the density of methane is $19.06 g/ft^3$.

(c) The combustion reaction of methane releases 810.0 kJ/mol. Is this an exothermic or endothermic reaction ? How much heat is generated from cooking ? Report in scientific notation.

(d) Gas companies add a compound which has an odor to help detect gas leaks should they arise. The compound that is added to natural gas is call t-butyl mercaptan and has the formula C_4H_9SH. Predict the products by writing out the balanced chemical equation including states.

(e) From part (c), determine the amount of carbon dioxide in kg is produced from 1kg of t-butyl mercaptan.

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Problem 8 : Limiting Reagent and Percent Yield Small amounts of chlorine gas can be generated in the laborator from the reaction of manganese(IV) oxide with hydrochloric acd. Report to 3 significant figures. (14 pts)

(a) Balance the following chemical equation :
$HCl(aq) + MnO_2(s) \rightarrow H_2O(l) + MnCl_2(s) + Cl_2(g)$.

(b) What is the theoretical yield of Cl_2 produced from 42.7g HCl and 67.0g MnO_2 ?

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

(d) If 50g of $Cl_2(g)$ is collected, determine the percent yield.

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Chemistry 107 : Appendix 1 - Periodic Table

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Chemistry 107 : Apppendix 2 - Formulas and Constants

$$q = mC\Delta T$$
$$E = \frac{hc}{\lambda} = h\nu$$
$$h = 6.626 \times 10^{-34} \text{J s}$$
$$c = \lambda\nu$$
$$c = 3.00 \times 10^{8} \text{m/s}$$