Review Packet #4 - Random Topics

Stoichiometry

1) A sample of dolomitic limestone containing only $CaCO_3$ and $MgCO_3$ was analyzed.
(a) When a 0.2800 gram sample of this limestone was decomposed by heating, 75.0 milliliters of CO_2 at 750 mm Hg, and 20°C were evolved. How many grams of CO_2 were produced?
(b) Write equations for the decomposition of both carbonates described above.
(c) It was also determined that the initial sample contained 0.0448 gram of calcium. What percent of the limestone by mass was $CaCO_3$?
(d) How many grams of the magnesium-containing product were present in the sample in (a) after it had been heated?

2. Water is added to 4.267 grams of UF_6. The only products are 3.730 grams of a solid containing only uranium, oxygen, and fluorine and 0.970 gram of a gas. The gas is 95.0 percent fluorine, and the remainder is hydrogen.
(a) From these data, determine the empirical formula of the gas.
(b) What fraction of the fluorine of the original compound is in the solid and what fraction in the gas after the reaction?
(c) What is the formula of the solid product?
(d) Write a balanced equation for the reaction between UF_6 and H_2O. Assume that the empirical formula of the gas is the true formula.

3. The molecular formula of a hydrocarbon is to be determined by analyzing its combustion products.
(a) (3 points) The hydrocarbon burns completely, producing 7.2g of water and 14.15g of CO_2 at standard conditions. What is the hydrocarbon's empirical formula?
(b) (2 points) Calculate the mass in grams of O_2 required for the complete combustion of the sample of the hydrocarbon described in (a).
(c) (1 point) Using mass spec, the molecular mass of the main isotope of the hydrocarbon is 56 amu. What is the molecular formula of the hydrocarbon?

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Bonding

1) Explain each of the following in terms of atomic and molecular structures and/or intermolecular forces.
(a) Solid K conducts an electric current, whereas solid KNO_3 does not.
(b) $SbCl_3$ has a measurable dipole moment, whereas $SbCl_5$ does not.
(c) The normal boiling point of CCl_4 is 77 °C, whereas that of CBr_4 is 190 °C.
(d) NaI(s) is very soluble in water whereas I_2(s) has a solubility of only 0.03 gram per 100 grams of water.

2) Explain each of the following in terms of the electronic structure and/or bonding of the compounds involved.
(a) At ordinary conditions, HF (normal boiling point = 20°C) is a liquid, whereas HCl (normal boiling point = -114°C) is a gas.
(b) Molecules of AsF_3 are polar, whereas molecules of AsF_5 are nonpolar.
(c) The N-O bonds in the NO_2^- ion are equal in length, whereas they are unequal in HNO_2.
(d) For sulfur, the fluorides SF_2, SF_4, and SF_6 are known to exist, whereas for oxygen only OF_2 is known to exist.

3) Using principles of chemical bonding and/or intermolecular forces, explain each of the following.
(a) Xenon has a higher boiling point than neon has.
(b) Solid copper is an excellent conductor of electricity, but solid copper chloride is not.
(c) SiO_2 melts at a very high temperature, while CO_2 is a gas at room temperature, event though Si and C are in the same chemical family.
(d) Molecules of NF_3 are polar, but those of BF_3 are not.

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Electrochemistry

1) $Sr(s) + Mg^{2+} <===> Sr^{2+} + Mg(s)$

Consider the reaction represented above that occurs at 25°C. All reactants and products are in their standard states. The value of the equilibrium constant, K_{eq}, for the reaction is 4.2×10^{17} at 25°C.

(a) Predict the sign of the standard cell potential, E°, for a cell based on the reaction. Explain your prediction.

(b) Identify the oxidizing agent for the spontaneous reaction.

(c) How would the cell potential change if the reaction were carried out at 25°C with a 1.0-molar solution of $Mg(NO_3)_2$ and a 0.10-molar solution of $Sr(NO_3)_2$? Explain.

(d) When the cell reaction in (d) reaches equilibrium, what is the cell potential?

2) A solution of $CuSO_4$ was electrolyzed using platinum electrodes by passing a current through the solution. As a result, there was a decrease in both $[Cu^{2+}]$ and the solution pH; one electrode gained in weight and a gas was evolved at the other electrode.

(a) Write the cathode half-reaction that is consistent with the observation above.

(b) Write the anode half-reaction that is consistent with the observations above.

(c) Sketch an apparatus that can be used for such an experiment and label its necessary components.

(d) List the experimental measurement that would be needed in order to determine from such an experiment the value of the faraday.

3) A direct current of 0.125 ampere was passed through 200 milliliters of a 0.25-molar solution of $Fe_2(SO_4)_3$ between platinum electrodes for a period of 1.100 hours. Oxygen gas was produced at the anode. The only change at the cathodes was a slight change in the color of the solution. At the end of the electrolysis, the electrolyte was acidified with sulfuric acid and was titrated with an aqueous solution of potassium permanganate. The volume of the $KMnO_4$ solution required to reach the end point was 24.65 milliliters.

(a) How many faradays were passed through the solution?

(b) Write a balanced half-reaction for the process that occurred at the cathode during the electrolysis.

(c) Write a balanced net ionic equation for the reaction that occurred during the titration with potassium permanganate.

(d) Calculate the molarity of the $KMnO_4$ solution.