ipt Instituto Politécnico de Tomar

Exam – **General Chemistry** - 24 January 2019

$R = 8.314\ JK^{-1}mol^{-1} = 0.082\ atm\ L\ mol^{-1}K^{-1}$; $N_A = 6.022\times10^{23}$; $h = 6.626\times10^{-34}\ J.s$; $c = 3\times10^{8}\ m.s^{-1}$

Maximum time: 2H30m

I

1. Indicate the name or the chemical formula of the following compounds: a) $Ca(HSO_4)_2$; b) NH_4NO_3 c) SF_6; d) iron chloride (III); e) calcium oxide; f) potassium permanganate.

2. Ascorbic acid (or vitamin C) has the following molecular formula: $C_6H_8O_6$.

2.1. Calculate the elemental composition of vitamin C.

2.2. 10 g of vitamin C are dissolved in a volume of water enough to prepare a 125 mL solution. Calculate the molar concentration and the molality of the solution (admit $\rho = 1$ g/mL).

3. Sulfur dichloride is used in the vulcanization of rubbers. It can be prepared by the following reaction: $S_8(s) + Cl_2(g) \rightarrow S_2Cl_2(l)$

3.1. Balance the equation.

3.2. Starting with a mixture of 32 g of sulfur and 71 g of chlorine, indicate the limitante reagent and calculate the mass of S_2Cl_2 that can be obtained.

II

1. A sample of metal was irradiated with UV light with the wavelength of 162 nm. Calculate the bond energy of the electron in the atom, knowing that the electron is ejected with a kinetic energy of 5.34×10^{-19} J.

2. Describe the characteristic of a *s* orbital and a *p* orbital and draw the shape of the two orbital's. What type of orbital's do not exist: 1p; 2s; 2d; 3d; 3f; 4g.

3. The chemical bond in ozone is stronger or weaker than in oxygen? Justify using the Lewis structures.

III

1. It was released in a given effluent a **gas** formed by chlorine and oxygen with a yellow-green color. After being collected it was obtained a value for its density of 7.71 g/L at 36 °C and 2.88 atm. Calculate the molar mass of the compound a the molecular formula.

2. Each water molecule can form until a maximum of four hydrogen bonds. Sketch that bonds a show how the density of water changes with temperature in the interval from -1 to 20 °C.

3. Machines are spreading **salt** in the roads to melt ice and snow preventing the blocking of those roads. Explain the motive of this procedure (why don't we spread sand for instance?)

IV

1. In gaseous phase, at 400 °C, Isopropyl Alcohol, $(CH_3)_2CHOH$, decomposes in acetone, $(CH_3)_2CO$, an important industrial solvent, being the reaction endothermic: $(CH_3)_2CHOH\ (g) \Leftrightarrow (CH_3)_2CO\ (g) + H_2\ (g)$. How the amount of acetone changes when a mixture in equilibrium is subjected to a decreasing of pressure? And with an increase of temperature? Justify.

2. Calculate the equilibrium constant for the reaction $2\ SO_2\ (g) + O_2\ (g) \Leftrightarrow 2\ SO_3\ (g)$ at 1100 K, knowing the mixing sulfur dioxide and oxygen (in a reactor with fixed capacity at 1100 K) with partial pressures of 1.00 atm and 0.500 atm, respectively, the total pressure at equilibrium is 1.35 atm.

3. Aniline, $C_6H_5NH_2$ it's a very important amine from the industrial point of view, utilized to produce dyes. It's a weak base with $K_b = 3.8 \times 10^{-10}$ at 25ºC. Calculate the pH of a solution of concentration 0.4 M in saturated aniline.