

MASTER'S DEGREE IN CHEMICAL TECHNOLOGY

Frequency of **Chemistry of Surfaces and Interfaces** - January 8, 2015

$R = 8.314 \text{ J.K}^{-1}.\text{mol}^{-1} = 0.082 \text{ atm L.mol}^{-1}.\text{K}^{-1}$; $1 \text{ atm} = 101325 \text{ Pa} = 760 \text{ mmHg}$

Maximum Duration: 2H30m

I

1. The surface tension of mercury is 470 dine.cm^{-1} at 273 K . Calculate the capillary depression in a 1 mm diameter tube if the contact angle is $\Theta = 140^\circ$. ($1 \text{ dine} = 10^{-5} \text{ N}$; $\rho_{\text{Hg}} = 13.6 \text{ g/cm}^3$). At 298 K the value would be higher or lower? Explain.

2. The surface tension of aqueous solutions of methanol at 293 K is given in the table:

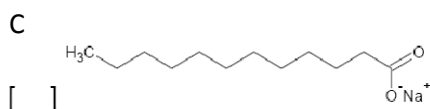
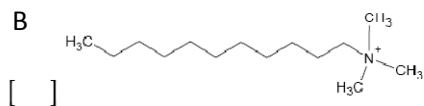
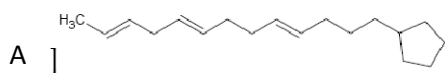
$C/\text{mol.dm}^{-3}$	0.0264	0.0536	0.1050	0.2110	0.4330
$\gamma / \text{mN.m}^{-1}$	68.00	63.14	56.31	48.08	38.87

2.1. Calculate the surface area occupied by a molecule of methanol.

2.2. Make a sketch of the variation of surface tension with concentration for a homologous series of alcohols, from methanol to butanol, justifying.

II

1. Consider the following molecules:



1.1 Which of these molecules can act as surfactant agent? Justify the answer.

1.2. One way to characterize this type of molecules is the HLB scale. Refer to the practical importance of the scale, and the way that can be calculated the value of HLB for a given surfactant agent

2. Characterize an emulsion, giving examples. Describe the major factors that determine the type of emulsion.

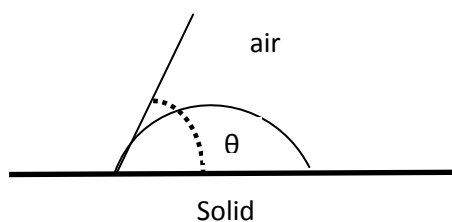
III

1. The Freundlich isotherm can be written as $V = k.p^{1/n}$, where k and n are constants, V is the volume of gas adsorbed per unit mass of adsorbent and p is the equilibrium pressure. The data in the table below refer to the adsorption of methane on 10 g of coal at 0°C .

P/ mmHg	100	200	300	400
V/ $\text{cm}^3 \cdot \text{g}^{-1}$	97.5	144	182	214

Verify that the data follow the Freundlich isotherm and calculate the corresponding constants.

2. Consider a drop of a pure liquid on the surface of a solid in equilibrium with the atmospheric air as shown below:



where θ is the contact angle. If you added a surfactant agent the contact angle will vary in what sense? Justify.

IV

Discuss the importance of the study of the Chemistry of surfaces and interfaces, and mention some of the areas of chemical technology where it finds applications.