EASTERN UNIVERSITY, SRI LANKA
THIRD EXAMINATION IN SCIENCE (EXTERNAL DEGREE)
EXCH 302 QUANTUM CHEMISTRY, ELECTROCHEMISTRY, METALLURGY AND INDUSTRIAL CHEMISTRY.
REPEAT2002/2003 (2004)

ANSWER FOUR QUESTIONS ONLY. **Time:03 Hours**

Planck constant $h = 6.626 \times 10^{-34}$ Js, Mass of an electron $m_e = 9.1 \times 10^{-31}$ kg
Charge of an electron $= 1.602 \times 10^{-19}$ C, 1 eV $= 1.6019 \times 10^{-19}$ J

1. (a) Show that the angular wave functions

$\Gamma_1(\theta,\phi) = (5/16\pi)^{1/2} (3\cos^2\theta - 1)$ and
$\Gamma_2(\theta,\phi) = (3/4\pi)^{1/2} \sin\theta \cos\phi$ are orthogonal to each other.

(b) Briefly comment on wave particle duality. Calculate the de Broglie wavelength of the electron in the ground state of the hydrogen atom, given that its kinetic energy is 13.6 eV.

2. (a) Write down the Schrodinger equation for hydrogen atom. Assume that the mass of an electron is m and that of the nucleus is M; electron and the nucleus have co-ordinates (x, y, z) respectively. Identify all the other symbols used.

(b) State Born – Oppenheimer approximation and write down the Schrodinger equation obtained after applying this approximation on the above system in polar co-ordinates.

Given that

$$\nabla^2\phi = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial\psi}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial r}\left(\sin\theta\frac{\partial\psi}{\partial\theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2\psi}{\partial\phi^2}$$

4. (a) (i) state what binary and ternary electrolytes are and give three examples of each.
(ii) Write brief accounts on asymmetric effect and electrophoretic effect.

(b) (i) Define the term molar conductivity.
(ii) The resistance of a cell containing 0.01 M KCl solution at 25^0C was found to be 152 Ω whereas the specific conductance of this solution at the same temperature was found to be 21.453×10^{-4} $\Omega^{-1}cm^{-1}$. A 0.02 M solution of another substance in the same cell at the same temperature had a resistance of 675 Ω. Calculate the molar conductivity of this substance.

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5. (a) (i) Write down the Debye-Hückel equation for mean ion activity and mean ion activity coefficient of electrolytes and identify the terms in it.

(ii) 2 liter of a solution contains 0.03, 0.04, 0.01 moles of NaCl, $CaCl_2$ and $MgCl_2$. respectively, calculate

(a) the ionic strength of the solution

(b) mean activity coefficient of the electrolyte NaCl in the solution.

6. (a) How can you determine molar conductivity at infinite dilution (Λ^{α}) of CH_3COOH by using the known values of Λ^{α} of strong electrolyte? Molar conductivity ($\Omega^{-1}m^{-2}mol^{-1}$) of NaCl, HCl and CH_3COONa are 126.4×10^{-4}, 426.1×10^{-4} and 91.0×10^{-4} respectively.

(b) Show how you can determine activity coefficient by using emf measurement.

7. (a) Outline the raw materials used in the production of Portland cement. Discuss the dry process of manufacture of Portland cement, indicating the important step.

(b) Describe, briefly a method each to determine SiO_2, Fe_2O_3, CaO and MgO in cement.

8. What are the raw materials used in the process of making glass? Write a descriptive account of the glass forming process.

9. (a) Briefly describe, using examples, the four methods that are widely used to concentrate ores.

(b) Write a descriptive account of the common process involved in the manufacture of ceramic.

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