EASTERN UNIVERSITY, SRI LANKA

FIRST YEAR FIRST SEMESTER EXAMINATION IN SCIENCE

2016/2017 (AUGUST/ SEPTEMBER 2018)

CH 1013 PRINCIPLES OF CHEMISTRY -I

Answer all questions *Time: 03 hours*

Gas constant (R) = 8.314 J mol^{-1} K^{-1} 2.303 $\frac{RT}{F}$ = 0.0591 V Faraday constant (F) = 96500 Cmol^{-1}

Plank's constant (h) =6.63x10^{-34} Js, Velocity of light(C) = 3x10^{8} ms^{-1}, Mass of electron=9.1 x10^{-31} kg, ε_o= 8.854 x 10^{-12} C^{2}N^{2}m^{-2}, e = 1.602 x 10^{-19} C, 1eV = 1.6 X 10^{-19} J

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1) a) *Define* the following terms.

i) Extensive properties ii) Adiabatic process

(10 marks)

b) i) *Write* the mathematical expression for the first and second laws of thermodynamics.

ii) 2 moles of an ideal gas (C_v = 2.5 R) is maintained in a volume of 11.2 dm^3 at 273 K. The temperature of the gas is raised to 373 K. *Calculate* w, ΔU, q , and ΔH at constant volume

iii) *Calculate* the work done for an isothermal reversible expansion of 3 moles of Hydrogen gas from volume 2 dm^3 to 100 dm^3 at 273 K, which obeys to the equation of state $P\ (v - \beta) = nRT$ where β is a constant and its value is 0.015 dm^3.

(50 marks)

Contd.

c) i) Using the first and second laws of thermodynamics *show that* the entropy change (Δ on heating of 'n' moles of substance reversibly from temperature T_1 to T_2 at const volume is,

$$\Delta S = C_v \, ln\left(\frac{T_2}{T_1}\right)$$

Assume that C_v is independent of temperature.

ii) *Calculate* the entropy change (ΔS) of 2 moles of an ideal gas (C_v = 2.5 R) at 27 ^{0} C heated to 127 ^{0} C

(20 mark

d) *Show that* the following auxiliary relations for a reversible process.

i) $dA = -SdT - PdV$

ii) $dH = TdS + VdP$

(20 mark

2) a) i) By using $A = A\,(V,T)$, *derive* the Maxwell relation

$$\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$$

iii) Using the above Maxwell relation, *derive* the thermodynamic equation of state

$$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P \qquad (Hint: dU = TdS - PdV)$$

iii) *Show that* for an ideal gas $\left(\frac{\partial U}{\partial V}\right)_T = 0$

(30 mark

b) The following redox reaction occurs in a cell:

$$Mg(s) + Sn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Sn(s)$$

i) *Write* the half-cell reactions.

iii) *Represent* the electrochemical cell

iv) *Calculate* the standard electrode potential $E^{\ominus}_{cell}$ for this cell at 298 K.

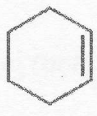
v) *Calculate* the change in standard Gibb's free energy ($\Delta G^{\ominus}$) at 298 K.

($E^{\ominus}_{Mg^{2+},\,Mg}$ = - 2.37 V, $E^{\ominus}_{Sn^{2+},\,Sn}$ = - 0.14 V)

(40 mark

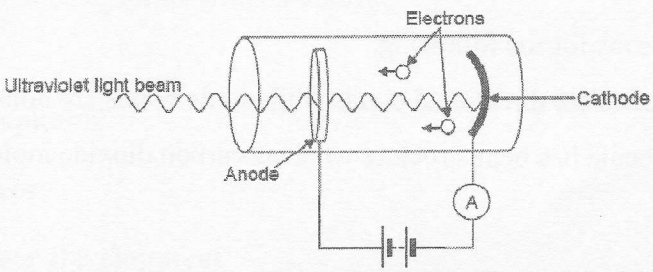
Contd.

e) *Predict* the product(s) obtained from addition of singlet dichlorocarbene (Cl_2C:) to each of the following compounds

(i)  (ii)  (iii)  (iv) 

(20 Marks)

5 a) The photo-electric effect has many practical applications. A photocell, such as the one below used in burglar alarm systems.



Ultraviolet light of wavelength 100 nm is used to illuminate the photocell. When a person interrupts the ultraviolet beam, the sudden drop in current activates a switch, which sets off the alarm.

i) *Define* the terms 'threshold frequency', 'work function' and 'photoelectric effect'.

ii) The work function of the metal used as a cathode in the photocell is 8.7×10^{-19} J. *Calculate* the velocity at which the electrons are emitted.

iii) *What* conclusion about the nature of light is drawn from the photoelectric effect?

(30 marks)

b) Briefly *describe* the following,

i) Fajan's rules for chemical bonding

ii) Non-valence cohesive forces

iii) Dalton's atomic theory

(30 marks)

c) Briefly *explain* the postulates of Bohr Theory?

(20 marks)

Contd.

d) What does Heisenberg's uncertainty principle say about an electron in an atom?

(20 marks)

6 a) *Write* the four quantum numbers for each of seven electrons in nitrogen atom in the ground state.

(20 marks)

b) *Describe* the bonding in CH_3^+ using the valence-bond theory.

(20 marks)

c) *Explain* the reasons for the following,

(i) Covalent bonds are directional bonds while ionic bonds are non-directional.

(ii) Water molecule has bent structure whereas carbon dioxide molecule is linear.

(30 marks)

d) The following questions pertain to the nitric oxide (NO) molecule,

i) *Draw* the molecular orbital energy diagram for this molecule. *Label* all of the orbitals specifically.

ii) *Write* the molecular electron configuration for the molecule

iii) *Indicate* whether the species is paramagnetic or diamagnetic

iv) *Determine* the bond order for the molecule

v) *Compare* the relative stability of this molecule to NO^+ and NO^-

(30 marks)

End of paper