RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. in Applied Sciences
First year Semester I Examination – March 2021

CHE 1201 – GENERAL CHEMISTRY

Answer any **FOUR** questions only **Time: Two (2) hours**

Planck constant	=	6.626×10^{-34} J s	Velocity of light	=	2.99×10^{8} m s^{-1}
Avogadro constant	=	6.02×10^{23} mol^{-1}	Rydberg constant	=	1.09×10^{7} m^{-1}
Mass of the electron	=	9.1×10^{-31} kg	Electron charge	=	1.60×10^{-19} C
Permittivity of vacuum =		8.85×10^{-12} kg^{-1} m^{-3} A^2 (or F m^{-1})			

Use of a non-programmable calculator is permitted.

1. a) State and explain how the fundamental postulates of Bohr theory refined the drawbacks of Rutherford's model of an atom.

(30 marks)

b) Consider an atom whose nucleus has a charge Z_e and an electron moving round the nucleus in an orbit of radius r. Derive a relationship that shows the total energy, $E_T = \left(-\frac{1}{n^2}\right) \times$ constant. Centripetal force $= \frac{MV^2}{r}$, and electrostatic attraction, $F = \frac{Ze^2}{4\pi\epsilon_0 r^2}$ where Z is the atomic number and ε_0 is the permittivity of free space.

(35 marks)

c) Calculate the ionization energy of hydrogen atom in kJ mol^{-1}.

(35 marks)

2. a) State Broglie hypothesis and Heisenberg's uncertainty principle

(20 marks)

b) Calculate the uncertainty in position of an electron moving at a speed of 0.05% of that of light. Is the uncertainty in position larger or smaller than the de Broglie wavelength of the electron?

(15 marks)

c) Briefly discuss the (i) contribution of Max Planck to explain the experimental distribution of energy in the spectrum of a black body and (ii) Ultraviolet Catastrophe

(35 marks)

d) What is meant by photoelectric effect? It requires a photon with a minimum of 6.94 $\times 10^{-34}$ J of energy to eject an electron from a polished Zn surface.

(i) Does electromagnetic radiation with wavelength 210 nm suffice to do this?

(ii) If it does, what is the maximum kinetic energy of the electron ejected?

(30 marks)

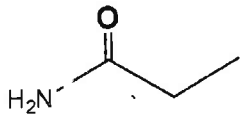
3. a) Draw resonance structures with formal charge on each atom for the cyanate ion OCN^- and comment on the stability of each structure.

(30 marks)

b) In water, acetate anion, CH_3COO^- is more stable than CH_3COOH. Explain

(15 marks)

c) What do you mean by term hybridization? Deduce the hybridization of carbon, nitrogen and oxygen atom in the following molecule.



(30 marks)

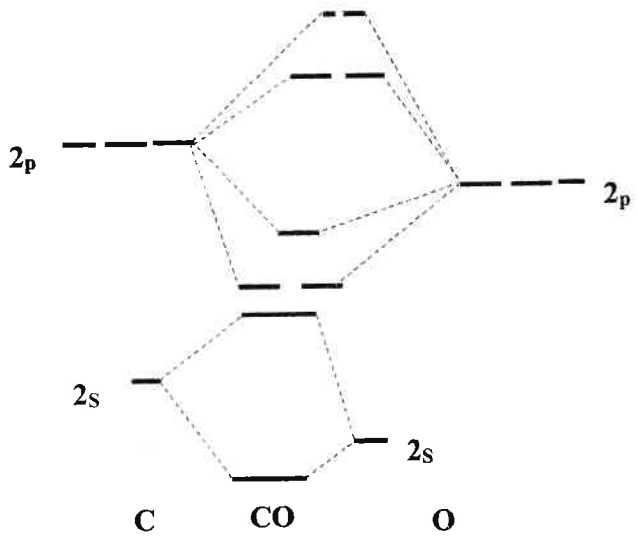
d) The molecular orbital diagram of CO molecule is given below.

(i) Label and insert all electrons present in atomic orbitals and molecular orbitals.

(ii) Determine the bond order of CO molecule.

(iii) Write the electronic configuration of CO molecule.

(25 marks)



4. a) Describe the structural differences between B_2H_6 and C_2H_6. Explain with illustrations.

(30 marks)

b) Be and Mg are both group 2 elements. Among the two elements Mg shows hexahydrated complexes, whereas Be does not. Justify your answer.

(20 marks)

c) The compound trimeth ylamine [$(CH_3)_3N$] and trisilylamine [$(SiH_3)_3N$] have similar formulae, but totally di ferent structures. Explain the above statement using orbital diagrams.

(30 marks)

d) Write a short note on inte halogen compounds

(20 marks)

5. a) Calculate the lattice energy, U in kJ mol^{-1} for ZnO in the wurtzite structure using the Born-Lande equation and us ng a Born-Haber cycle. Compare the two answers and comment on it.

$$U = -\frac{N_A A Z^2 e^2}{4\pi\varepsilon_0 ro}\left(1-\frac{1}{n}\right)$$

Hint: $r_0 = 1.99 \times 10^{-10}$ m, the Born exp nent, n = 8, and A (Madelung constant) = 1.641 for the wurtzite structure, and Z = charge on the ion.

	$H^{\ominus}$ / kJ mol^{-1}
Energy of sublimation for Zn(s)	130.4
1st ionization energy for Zn(g)	418.61
2nd ionization energy for Zn(g)	1733
Bond dissociation energy for O_2(g)	497
Electron affinity values of oxygen:	
$O(g) + e^- \rightarrow O^-(g)$	141
$O^-(g) + e^- \rightarrow O^{2-}(g)$	- 780
Heat of formation for ZnO(s)	- 350.51

(50 marks)

b) (i). Define the terms polarizability and polarizing power.

(ii). AgCl is insoluble in water whereas AgF is soluble. Explain

(iii). $NaHCO_3$ reacts with an aqueous solution of $FeCl_3$ generating carbon dioxide but not with an aqueous solution of $FeCl_2$. Justify your answer.

(30 marks)

c) The Dipole moment of HCl is 1.11 D, and the distance between the two atoms is 127 pm. Comment on the covalent character of the HCl bond?

(20 marks)

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