



RAJARATA UNIVERSITY OF SRI LANKA  
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree  
First Year – Semester I Examination – May/ June 2016

CHE 1201 – GENERAL CHEMISTRY / GENERAL AND INORGANIC CHEMISTRY

Time: Two (02) hours

Answer question No. 1 (compulsory) and any other three (3) questions.

The use of a non-programmable calculator is permitted.

Atmospheric Pressure =  $10^5$  Pa ( $\text{N m}^{-2}$ )

Avogadro Number ( $N_A$ ) =  $6.023 \times 10^{23} \text{ mol}^{-1}$

Planck Constant ( $h$ ) =  $6.63 \times 10^{-34} \text{ J s}$

Universal Gas Constant ( $R$ ) =  $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

Velocity of Light ( $c$ ) =  $3 \times 10^8 \text{ m s}^{-1}$

- (1) (a) What are the possible values of spin quantum number ( $s$ ) for an electron with  $l = 1$  and  $m = 1$ ? Give reason(s) for your answer.
- (b) Give reasons(s) as to why the Rutherford's planetary model for the atom was a failure.
- (c) State the Pauli Exclusion Principle and justify the conclusion obtained from it.
- (d) What do you understand by the dual nature of microparticles?
- (e) Which element of the following pairs has smaller first ionization energy? Justify your answer.
- (i) Ca or Be;                      (ii) Ca or K;                      (iii) Cl or I
- (f) Which of the following substances contain H-bonds and which is the most soluble in water?
- $\text{CH}_3\text{-OH}$ ;  $\text{CH}_4$ ;  $\text{CH}_3\text{-CH}_3$ ;  $\text{HCl}$
- (g) The bond angle H-N-H in  $\text{NH}_3$  equals  $107^\circ 48'$ , whereas the bond angle F-N-F in  $\text{NF}_3$  is equal to  $102^\circ 30'$ . Briefly explain the difference in bond angles of the above compounds.

- (h). Briefly explain the fact that a number of compounds which might be expected from Radius Ratio rule to have a cubic structure, in fact adopt an octahedral structure.
- (i) The electronegativity of element M is equal to 0.9, whereas the electronegativity of element N is 3.0. What type of bond will be formed between M and N? Give reason(s) for your answer.
- (j) Give reason(s) as to why many transition elements and their compounds show catalytic properties.

(130 Marks)

- (2) (a) Briefly explain the difference between the Bohr orbit and the Schrodinger orbital.

(20 Marks)

- (b) (i) Given the atomic numbers of Be and B are 4 and 5 respectively, determine which element has higher first ionization energy. Briefly explain your answer.
- (ii) Give reason(s) as to why there is a sudden increase in the third ionization energy of Be (from 1757 to 18847 kJ mol<sup>-1</sup>), compared to that of B (from 2427 to 3659 kJ mol<sup>-1</sup>).

(25 Marks)

- (c) State the Heisenberg uncertainty principle. Using this principle, show that the position and velocity of a macro-body can be determined simultaneously.

(20 Marks)

- (d) Calculate the uncertainty in position ( $\Delta x$ ) of a dust particle, if 0.1% error in the measurement of velocity is allowed. Assume that the velocity of the particle is equal to 10<sup>-6</sup> m s<sup>-1</sup> and the mass of the particle equals 10<sup>-14</sup> kg. Comment on the result considering that the diameter of the particle is 10<sup>-6</sup> m.

(25 Marks)

- (3) (a) Define the following terms.

- (i) Electron cloud; (ii) Effective nuclear charge;  
(iii) Bond angle; (iv) Coordinate bond

(20 Marks)

- (b) Give reason(s) as to why s electrons can be involved in  $\sigma$  bonding only, whereas the p electrons are involved in  $\sigma$  and  $\pi$  bonding.

(20 Marks)

- (c) Why the d-block elements are also called transition elements? Give reason(s) as to why the transition elements are very good at forming complexes.

(20 Marks)

- (d) Account for the following observations.

- (i) The solubility of MgSO<sub>4</sub>(s) in water is greater than that of BaSO<sub>4</sub>(s).

- (ii) Thermodynamically, aluminium should react with water and air, but it is stable in both.

(30 Marks)

- (4) (a) Write down the general form of Schrodinger equation defining the symbols used. (20 Marks)

- (b) Acceptable solutions to the above equation that are physically possible must have four special properties. What are they? (20 Marks)

- (c) Explain the bonding in  $\text{CO}_2$  molecule using the Valence Bond theory. (30 Marks)

- (d) Define the group oxidation state of the p-block elements. Briefly explain the occurrence of oxidation states, two units less than the group oxidation state. (20 Marks)

- (5) (a) What do you understand by the positive, negative and zero overlap of atomic orbitals? Illustrate your answer using suitable examples. (20 Marks)

- (b) List the rules for linear combination of atomic orbitals. (15 Marks)

- (c) Draw diagrams to show how the overlap of two p atomic orbitals produces a set of  $\pi$  molecular orbitals. Give the wave functions of the molecular orbitals. (20 Marks)

- (d) The internuclear distance (R) and lattice energy (U) for the crystals LiF and MgO are given below.

Crystal	R ( $\text{\AA}$ )	U ( $\text{kJmol}^{-1}$ )
LiF	2.01	- 1004
MgO	2.10	- 3933

Briefly explain the large difference between lattice energies of these two crystals.

(15 Marks)

- (e) What products are formed when Li, Na and K burn in air? Write down the balanced chemical equation for each of the reaction.

(20 Marks)