**RAJARATA UNIVERSITY OF SRI LANKA**
**FACULTY OF APPLIED SCIENCES**

**B.Sc. in Applied Sciences**
**First Year - Semester I Examination – May 2022**

**CHE 1201 – GENERAL CHEMISTRY**

**Time: Two (02) hours**

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Answer **question number 1 (compulsory) and any other three (03) questions**

Use of a non-programmable calculator is permitted.

Planck's constant ($h$)= $6.626 \times 10^{-34}$ J s  Velocity of light (c) = $2.99 \times 10^{8}$ m $s^{-1}$

Avogadro's number ($N_A$) = $6.02 \times 10^{23}$ $mol^{-1}$

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1. a) State the postulates of Bohr theory

(10 marks)

b) i. Explain the de Broglie model of the hydrogen atom and state the mathematical condition required to fit the electron wave into Bohr orbit? Hence, show the quantization of angular momentum.

ii. Define an orbital in quantum theory

iii. Draw $\Psi^2$ and radial probability distribution versus distance plots for 1s, 2s and 3s orbitals of the hydrogen atom. How many radial nodes does each have?

iv. The energies (E) of the electron in a hydrogenlike ion are given by

$$E_n = -(2.18 \times 10^{-18})Z^2\left(\frac{1}{n^2}\right)$$

Where n is the principal quantum number and Z is the nuclear charge of the atom. Calculate the ionization energy (in kJ $mol^{-1}$) of the $He^+$ ion.

(60 marks)

c) i. State Heisenberg's uncertainty principle.

ii. What is photoelectric effect? Define threshold frequency and show its mathematical relation to kinetic energy of photoejected electrons.

(30 marks)

2. a) i. Compare and contrast between the valence bond theory and molecular orbital theory

ii. What are hybrid orbitals?

iii. Draw bonding and antibonding orbitals formed by linear and sideways overlap of two p-orbitals. Indicate the nodal plane in each case. (40 marks)

b) $N_2^+$ ion can be prepared by bombarding the $N_2$ molecule with fast moving electrons.

Draw the molecular orbital diagram of $N_2^+$ ion and compare the bond stability, magnetic properties, and bond length relative to $N_2$ molecule. (60 marks)

3. a) i. Draw a Lewis structure and resonance structures for A) S-N-$O^-$ and B) O-C-S

ii. Explain, which of the resonance structures of above two is most stable. (40 marks)

b) Deduce the hybridization and the most stable geometry of the following species.

i. $ICl_2^-$ ii. $XeF_4$ iii. $[Fe(CN)_6]^{4-}$ (40 marks)

c) Explain the following:

i. AgF is soluble in water whereas AgI does not

ii. Thermal stability of carbonates of alkaline earth metals increases down the group in the periodic table.

(20 marks)

4. a) In general, the element hydrogen is placed in group IA in the periodic table. However, there are some rationales that it can be fitted into other groups as well. State the three positions in which hydrogen can be placed in the periodic table and give two justifications for each.

(20 marks)

b) Compare and contrast the molecular hydrides and the metallic hydrides.

(20 marks)

c) Alkali metal salts are consisted with strong ionic bonds. However, these salts are water soluble. Explain. (20 marks)

d) Complete and balance the reactions below.

i. $(CH_3)_3Ga\ (g) + AsH_3 \longrightarrow$ *hint*: a displacement reaction

ii. $Cl_2(g) + OH^-(aq) \longrightarrow$ *hint*: a disproportionation

iii. $CCl_4(l) + HF\ (g) \longrightarrow$ (15 marks)

e) Differentiate the structural geometries of trimethyl amine $N(CH_3)_3$ and trisilyl amine $N(SiH_3)_3$ with the use of orbital illustrations. Comment on the changes in properties of two molecules attributed to their geometries. (25 marks)

5 a) Boron is a group 3A element where carbon is a group 4A element in the periodic table. However, both of these elements form $A_2H_6$ type molecules where A = Boron / Carbon. With the help of orbital illustrations, describe the structure of these two molecules. (25 marks)

b) $F_2$ shows lower bond dissociation energy compared to other members in the halogen family. Account for the observation. (20 marks)

c) Account for the high reactivity of halogens. (20 marks)

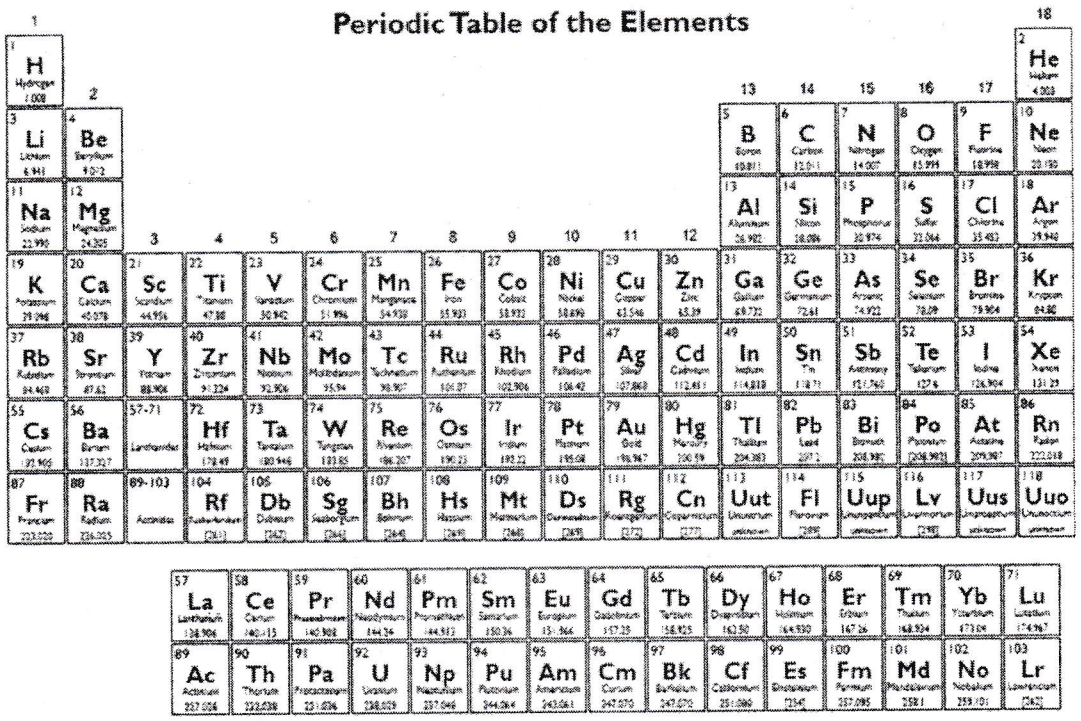
d) Second ionization energies of Cr and Cu are noticeably higher than those of the other transition metals in the period. Describe. (20 marks)

e) Explain the following:

$Ti^{+4}$ is more stable than $Ti^{+3}$.

$Mn^{+2}$ is more stable than $Mn^{+3}$.

$TiCl_3$ is more acidic than $TiCl_2$. (15 marks)

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