Chemistry 2026
Term Paper 01

Chemistry II

1 hour and 15 minutes

Index No:

* A Periodic Table is provided on last page.

* **Use of calculators is not allowed.**

* Universal gas constant, $R = 8.314$ J K^{-1} mol^{-1}

* Avogadro constant, $N_A = 6.022 \times 10^{23}$ mol^{-1}

* **In answering this paper, you may represent alkyl groups in a condensed manner**.

Example: H─C─C─ group may be shown as CH$_3$CH$_2$ ─

PART A - Structured Essay

* Answer **all** the questions on the question paper itself.

* Write your answer in the space provided for each question. Please note that the space provided is sufficient for the answer and that extensive answers are not expected.

PART- B - Essay

* Answer the given question. Use the papers supplied for this purpose.

* At the end of the time allotted for this paper, tie the answers to the two Parts A and B together so that Part A is on top and hand them over to the supervisor.

* You are permitted to remove only Parts B of the question paper from the Examination Hall.

For Examiner's Use Only

Part	Question No.	Marks
	1	
A	2	
B	3	
Total		
Percentage		

Final Mark

In Numbers	
In Letters	

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Part A – Structured Essay

Answer **all two** questions on this paper itself. (Each question carries **100** marks)

01)

A. Arrange the following species in ascending order of the mentioned properties within brackets.

    i.   B, N, Mg, S (Number of unpaired electrons)

....

    ii.   Mg, Al, P, Si (Second ionization energy)

....

    iii. H_3O^+, H_2O, $^-NH_2$, NH_4^+ (Bond angles)

....

    iv. Ca^{2+}, K^+, Al^{3+}, Mg^{2+} (Cationic radius)

....
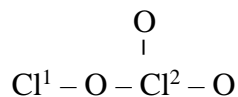
B.

    i.   Draw the most acceptable Lewis dot-dash structure for the Cl_2O_3 molecule. The skeleton is given below.
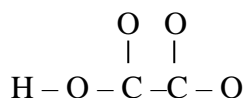
$$\begin{array}{c} O \\ | \\ Cl - O - Cl - O \end{array}$$
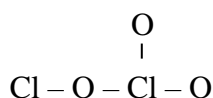
    ii.   State the oxidation states of the two Cl atoms drawn in the structure in (i) above. The chlorine atoms are numbered as shown below.
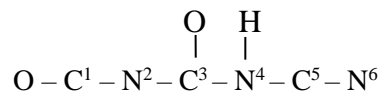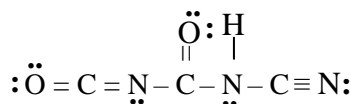
$$\begin{array}{c} O \\ | \\ Cl^1 - O - Cl^2 - O \end{array}$$

Cl^1 - ....

Cl^2 - ....

    iii.   Draw two acceptable resonance structures for the ion $HC_2O_4^-$.

$$\begin{array}{c} O \quad O \\ | \quad | \\ H - O - C - C - O \end{array}$$

             Skeleton

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iv. Fill in the given table based on the labelled skeleton of the Lewis dot-dash structure shown below.

$$\ddot{O} : H$$
$$\| \quad |$$
$$: \ddot{O} = C = \underset{\cdot\cdot}{N} - C - \underset{\cdot\cdot}{N} - C \equiv N :$$

$$O \quad H$$
$$| \quad |$$
$$O - C^1 - N^2 - C^3 - N^4 - C^5 - N^6$$

	C^1	N^2	C^3	N^4	C^5
VSEPR pairs					
Electron pair geometry					
Shape					
Hybridization					

- Parts (v) to (vii) are based on the Lewis dot-dash structure given in part (iv). Labelling of atoms is similar to that of part (iv).

v. Identify the atomic/hybrid orbitals that take part in forming the following σ bonds.

   a. $O - C^1$ O ……………… C^1 ………………

   b. $C^1 - N^2$ C^1 ……………… N^2 ………………

   c. $N^2 - C^3$ N^2……………… C^3 ………………

   d. $C^3 - N^4$ C^3 ……………… N^4 ………………

   e. $N^4 - C^5$ N^4 ……………… C^5 ………………

   f. $C^5 - N^6$ C^5 ……………… N^6 ………………

vi. State the approximate bond angles around the following atoms.

   C^1 - ...., N^2 - ...., C^3 - ...., N^4 - ...., C^5 - ....

vii. Arrange the atoms C^1, N^2, C^3, N^4, and C^5 in the increasing order of their electronegativities.
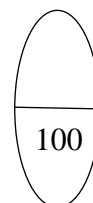
   .... < .... < .... < .... < ....

C.
    i. Consider a wave with an energy of 5419.8 kJ mol^{-1} per one mole of protons.

       a. Calculate the wavelength of the above wave.

       b. Which region of the electromagnetic spectrum does the above wave belong to?

....

100

02)

A.

    i. Write the electronic configuration of element M with atomic number 42.

....

    ii. What is the number of valence electrons in the M^{2+} ion formed by the above M?

....

    iii. Write the sets of quantum numbers that are possible for the above valence electrons in part (ii).

....
....
....
....

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iv.   Mention the type/s of intermolecular forces that exist in followings.

    a.   In an Ar (l) -

    ....

    ....

    b. I_2 solution dissolved in aqueous KI solution –

    …………………………………………………………………………………………

    …………………………………………………...

    c.   In an aqueous Cl_2 solution –

    …………………………………………………………………………………………

    …………………………………………………...
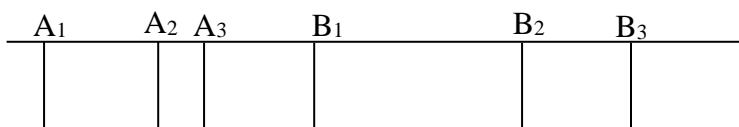
B.

Figure 1 shows the first five electronic energy levels of the H atom (n = 1, 2, 3, 4, 5).

Figure 2 shows six lines of the emission electronic spectrum of the H atom.

n = 5 ────────────────────

n = 4 ────────────────────

n = 3 ────────────────────

n = 2 ────────────────────

n = 1 ────────────────────

Figure 1

A₁   A₂ A₃   B₁   B₂   B₃
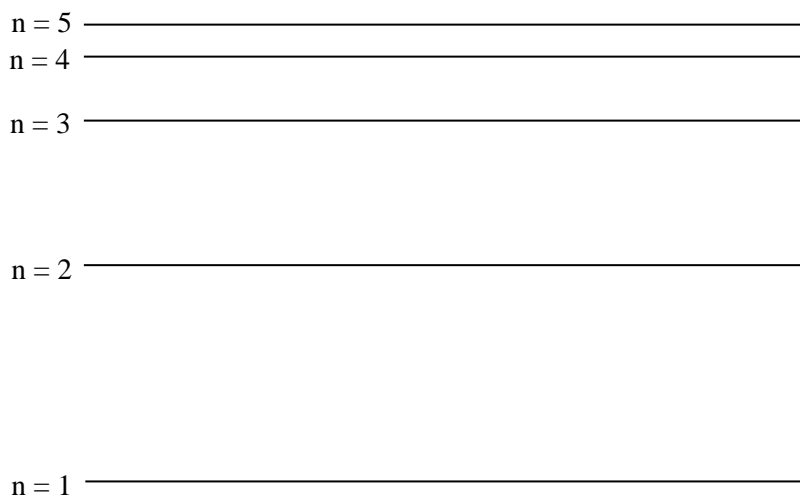
Figure 2

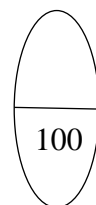A_1, A_2, and A_3 are the first three lines belonging to the same series in this emission spectrum.

B_1, B_2, and B_3 are the first three lines of a subsequent series in the same emission spectrum.

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i. **Draw six** arrows between the energy levels in **Figure 1** to show the electronic transitions corresponding to the six spectral lines in **Figure 2. A₁** is coloured.

ii. Clearly **label in Figure 1** these arrows appropriately as **A₁, A₂, A₃, B₁, B₂,** and **B₃**.

iii. **Strike off the inappropriate** word, within the bracket, in the following sentence:

The frequencies of the spectral lines **(increase/decrease)** from **A₁** to **B₃**.

C. Put a (√) sign for the correct statements and (×) sign for the wrong statements.

i. The metallic property of the elements in the second period of the periodic table ....
decreases across the period and that increases down a group.

ii. Modern periodic table is based on the atomic masses of the elements. ....

iii. Electronegativity is a property of an isolated atom. ....

iv. The de Broglie wavelength of particles of different masses travelling with the same ....
velocities is inversely proportional to the mass of the particles.

v. Covalent radius of an atom is smaller than the van der Waals radius of it. ....

vi. The nature of the positive rays depends upon the gas taken in the discharge tube. ....

vii. The boiling point of HCHO is higher than that of HCOOH. ....

viii. Fe^{3+} ion contains 5 unpaired electrons. ....

100

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Part B-Essay

Answer the following question.

03)

A. Following are the ionization energies of the elements L, G, and Q in kJ mol^{-1}.

$$L(g) \xrightarrow{897} L^+(g) \xrightarrow{1754} L^{2+}(g) \xrightarrow{14820} L^{3+}(g) \xrightarrow{20960} L^{4+}(g)$$

$$G(g) \xrightarrow{799} G^+(g) \xrightarrow{2422} G^{2+}(g) \xrightarrow{3651} G^{3+}(g) \xrightarrow{24970} G^{4+}(g)$$

$$Q(g) \xrightarrow{578} Q^+(g) \xrightarrow{1817} Q^{2+}(g) \xrightarrow{2741} Q^{3+}(g) \xrightarrow{10813} Q^{4+}(g)$$

  i.   What are the elements belonging to the same group from the elements given above?
Give reasons for your answer briefly.

  ii.   To which group of the periodic table do other elements belong?

B.

  i.   The below equation is used to calculate the formal charge on an atom in a molecule or polyatomic ion.

FC = (Number of valence electrons in the atom) – [(Number of bonds + Number of electrons in lone pairs)]

Calculate the formal charge on the S atom in the below molecules and ions.

     a. H_2S b. SO_3^{2-} c. SO_4^{2-}

  ii.   Oxidation number is used to determine the number of electrons transferred among the atoms. Determine the oxidation number of the S atom in the molecules and ions given below.

     a. H_2S b. SO_3^{2-} c. SO_4^{2-}

  iii.   Arrange the following species in the increasing order of the electronegativity of the S atom.

     a. H_2S b. SO_3^{2-} c. SO_4^{2-}

C. Arrange the following into the increasing order of the given property. Explain the reasons for your answers.

  i.   Thermal stability of $Be(NO_3)_2$, $Mg(NO_3)_2$, $Ca(NO_3)_2$

  ii.   The number of VSEPR units around the central atom in HCN, NH_3, ICl_3

  iii.   The boiling point of H_2O, H_2S, H_2Se

  iv.   The bond length of the C-O bond in CO_2, CO_3^{2-}, CO

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Periodic Table

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	La-Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	Ac-Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lb	117 Ts	118 Og

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr