Roll No. _____ **NLCS/11/Chemistry(043)/20**

Half Yearly Examination 2024 – 2025

Time - 3:00 Hrs. **M.M. 70**

General Instructions: All questions are compulsory.

Read the following instructions carefully and follow them :

(i) This question paper contains 33 questions. All questions are compulsory.

(ii) This question paper is divided into five sections Section A, B, C, D and E.

(iii) Section A questions number 1 to 16 are multiple choice type questions. Each question carries 1 mark

(iv) Section B questions number 17 to 21 are very short answer type questions. Each question carries 2 marks

(v) Section C questions number 22 to 28 are short answer type questions. Each question carries 3 marks

(vi) Section D questions number 29 and 30 are case-based questions. Each question carries 4 marks

(vii) Section E questions number 31 to 33 are long answer type questions. Each question carries 5 marks

SECTION – A

Questions no. 1 to 16 are Multiple Choice type Questions, carrying 1 mark each.

Q.1 The % of copper and oxygen in samples of CuO obtained by different methods were found to be the same. This proves the law of:

(a) Constant Proportion (b) Reciprocal Proportion

(c) Multiple Proportion (d) Conservation of mass

Q.2 One amu is equal to :

(a) 1.33×10^{-8}g (b) 1.66×10^{-4}g (c) 1.66×10^{-16}g (d) 1.66×10^{-24}g

Q.3 The empirical formula of Acetic acid is

(a) CH_3COOH (b) C_2H_4O (c) CH_2O (d) CHO

Q.4 If Pauli's exclusion principle is not known, the electronic arrangement of lithium atom is

(a) $1s^2\ 2s^1$ (b) $1s^1\ 2s^2$ (c) $1s^3$ (d) $1s^2\ 2s^1\ 2p^1$

Q.5 In photoelectric effect the number of photo-electrons emitted is proportional to :

(a) Intensity of incident beam (b) Frequency of incident beam

(c) Wavelength of incident beam (d) All

Q.6 Which set represents isoelectronic species?

(a) Na^+, Mg^{+2}, Al^{+3}, Cl^- (b) Na^+, Ca^{+2}, Sc^{+3}, F^- (c) K^+, Cl^-, Mg^{+2}, Sc^{+3} (d) K^+, Cl^-, Ca^{+2}

Q.7 The correct order of second I.P. values of carbon, nitrogen, oxygen and fluorine is

(a) C > N > O > F (b) O > N > F > C (c) O > F > N > C (d) F > O > N > C

Q.8 The number of electrons in the valence shell of the central atom of a molecule is 8. The molecule is :

(a) BeH_2 (b) SCl_2 (c) SF_6 (d) BCl_3

Q.9 The number of antibonding electron pairs in O_2^{2-} molecular ion on the basis of molecular orbital theory is :

(a) 2 (b) 3 (c) 4 (d) 5

Q.10 For a cyclic process, the condition is :

(a) $\Delta U = 0$ (b) $\Delta H = 0$ (c) $\Delta U > 0$ and $\Delta H > 0$ (d) both $\Delta U = 0$ and $\Delta H = 0$

Q.11 In which of the following sets, all properties belong to same category (all extensive or all intensive) ?

(a) Mass, Volume, Specific heat (b) Temperature, Concentration, Volume

(c) Heat capacity, Concentration, Entropy (d) Enthalpy, Entropy, Volume

Q.12 A reaction will never be spontaneous at any temperature and pressure provided.

(a) ΔS positive and ΔH positive (b) ΔS positive and ΔH negative

(c) ΔS negative and ΔH positive (d) ΔS negative and ΔH negative

For Questions number 13 to 16, two statements are given one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

Q.13 Assertion (A) : Significant figures for 0.200 is 3 where as for 200 it is 1.
Reason (R) : Zero at the end or right of a number are significant provided they are not on the right side of the decimal point.

Q.14 Assertion (A) : All isotopes of a given element show the same type of chemical behaviour.
Reason (R) : The chemical properties of an atom are controlled by the number of electrons in the atom.

Q..15 Assertion (A) : Boron has a smaller first ionisation enthalpy than beryllium.
Reason (R) : The penetration of a 2s electron to the nucleus is more than the 2p electron hence 2p electron is more shielded by the inner core of electrons than the 2s electrons.

Q.16 Assertion (A) : Though the central atom of both NH_3 and H_2O molecules are sp^3 hybridised, yet H–N–H bond angle is greater than that of H–O–H.
Reason (R) : This is because nitrogen atom has one lone pair and oxygen atom has two lone pairs

SECTION – B

Q.17 What is the difference between molality and molarity?

Q.18 Calculate the total number of angular nodes and radial nodes present in 3p orbital.

Q.19 The radius of Na^+ cation is less than that of Na atom. Give reason.

Q.20 Explain the shape of BrF_5

Q.21 Identify the state functions and path functions out of the following :
enthalpy, entropy, heat, temperature, work, free energy

OR

What will be the relation between Cp and Cv ?

SECTION – C

Q.22 (i) Define the law of multiple proportions. Explain it with two examples.

(ii) The density of 3 molal solution of NaOH is 1.110 g mL^{-1}. Calculate the molarity of the solution.

Q.23 (i) The reactant which is entirely consumed in reaction is known as limiting reagent.
In the reaction $2A + 4B \rightarrow 3C + 4D$, when 5 moles of A react with 6 moles of B, then
(a) which is the limiting reagent? (b) calculate the amount of C formed?

(ii) How many significant figures should be present in the answer of the following calculations?

$$\frac{0.50 \times 1.2345 \times 1.01}{2.11}$$

Q.24 (i) Give the electronic configurations of the elements : $_{19}K$, $_{25}Mn$, $_{20}Ca$

(ii) Find the energy of each of the photons which

(a) corresponds to light of frequency 3 x 10^{15} Hz (b) have wavelength of 0.50 A°.

Q.25 (i) Nitrogen (14.0 u), phosphorus (31.0 u) and arsenic (74.9 u) have similar properties. Do they form a Doebereiner's triad?

(ii) Why is first ionization enthalpy of nitrogen greater than that of oxygen ?

Q.26 (i) Explain the shape of I_3^- ion.

(ii) Which of the following have identical bond order ?

CN^-, O_2^- , NO^+, CN^+

Q.27 (i) What is an adiabatic process ?

(ii) An exothermic reaction A $\rightarrow$ B is spontaneous in the backward direction. What will be the sign of ΔS for the forward reaction ?

Q.28 (i) Which of the thermodynamic properties out of E, S, T, P, V, H and G are intensive properties and why ?

(ii) Predict the sign of entropy change in the following reaction :

$O_{2\,(g)} + 2SO_{2\,(g)} \rightarrow 2SO_{3\,(g)}$

SECTION – D

Q.29 Rutherford's model could not explain the stability of the atom and the line spectra of the elements. To overcome these drawbacks, Neils Bohr put forward another model of atom called 'Bohr's model of atom'. It postulates that electrons revolve around the nucleus only in discrete orbits also called stationary states and designated as 1, 2, 3,4 etc. or K, L, M, N etc. Expressions were put forward for calculation of energy of the electron in any orbit (called Bohr formula) and also for calculation of radius of any orbit or velocity of electron in any orbit. Like energy, the angular momenta of the electron in different orbits have quantized (discrete) values. Further, it was explained that electronic energy in any orbit has a negative value and it increases as we move outwards from the nucleus, the gap narrowing down between the successive orbits. This model could explain the simultaneous appearance of a large number of lines in the hydrogen spectrum as well the line spectrum of hydrogen. Bohr formula helps to calculate the ionization energy of the atoms.

1. The electron in the ground state of the hydrogen atom absorbs 12.1 eV of energy. It will jump to the orbit

   (a) 2^{nd} (b) 3^{rd} (c) 4^{th} (d) 5^{th}

2. The radius of which of the following orbit is same that of the first Bohr's orbit of hydrogen atom

   (a) He^+ (n = 2) (b) Li^{+2} (n = 2) (c) Li^{+2} (n = 2) (d) Be^{+3} (n = 2)

3. Assertion– The energy levels K, L, M etc. of an atom are called stationary states.
   Reason– The energy levels of an atom are called stationary states because they are present at a fixed distance from the nucleus.

4. Assertion– Electronic energy is always negative and it increases as we move outwards from the nucleus.
   Reason– Electron carries negative charge and attraction on the electrons decreases as we move outwards from the nucleus.

Q.30 Some reactions are exothermic while some other reactions are endothermic. The heat evolved or absorbed in a reaction is generally expressed in terms of ΔH, called enthalpy change of the reaction. Its value depends upon a number of factors like quantities of reactants, their physical state, temperature, allotropic modification etc. Two most common types of enthalpy changes are the enthalpy of formation and enthalpy of combustion. In general, enthalpy change accompanying any reaction is called enthalpy of

reaction. Knowing the enthalpies of formation of the reactants and the products, the enthalpy of combustion or enthalpy of any reaction can be calculated, applying Hess's law. In fact, Hess's law helps to calculate the enthalpy change of any reaction from the enthalpy changes of certain other suitable reactions. –

(i) Which of the following reactions is endothermic ?

(a) $CaCO_3 \rightarrow CaO + SO_2$ (b) $Fe + S \rightarrow FeS$

(c) $NaOH + HCl \rightarrow NaCl + H_2O$ (d) $CH_4 + {}_2O_2 \rightarrow CO_2 + 2H_2O$

(ii) The enthalpy of combustion at 25°C of H_2, cyclohexene (C_6H_{10}) and cyclohexane (C_6H_{12}) are – 241, – 3800 and – 3920 kJ/mol respectively. The heat of hydrogenation of cyclohexene is :

(a) – 121 kJ/mole (b) +121 kJ/mole (c) – 242 kJ/mole (d) +242kJ/mole

(iii) Assertion– Greater the enthalpy of combustion of any fuel, greater is its calorific value.

Reason– Enthalpy of combustion of a substance is the heat produced when one mole of the substance is completely burnt in oxygen

(iv) Assertion– Standard enthalpy of formation of graphite is taken as zero but that of diamond is not zero.

Reason– Graphite is more stable allotropic form of carbon than diamond.

SECTION – E

Q.31 (i) The reactant which is entirely consumed in reaction is known as limiting reagent. In the reaction

$2A + 4B \rightarrow 3C + 4D$, when 5 moles of A react with 6 moles of B, then

(a) which is the limiting reagent ? (b) calculate the amount of C formed ?

(ii) Calculate the mass percent of calcium, phosphorus and oxygen in calcium phosphate $Ca_3(PO_4)_2$.

OR

(i) Write short note on law of multiple proportional

(ii) Write short note on Avagadro law?

Q.32 (i) Explain why cations are smaller and anions are larger in radii than their parent atoms?

(ii) In terms of period and group, where would you locate the element with Z = 114 ?

OR

(i) What would be the IUPAC name and symbol for the element with atomic number 120?

(ii) Short note on diagonal relationship?

Q.33 (i) Out of o and n-bonds, which one is stronger and why ?

(ii) What order of C—H bond lengths do you expect in C_2H_4 and C_2H_2 and why ?

OR

(i) Draw the shapes of the following hybrid orbitals : sp, sp_2 and sp_3.

(ii) According to VSEPR explain geometry & shape of NH_3

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