DIRECTORATE OF EDUCATION, GNCT OF DELHI

MID-TERM PRACTICE PAPER

Class-XI

Chemistry (043)

Time Allowed: 3 Hours **Maximum Marks: 70**

General Instructions:

- There are **33** questions in this question paper with internal choice.
- **SECTION A** consists of 16 multiple-choice questions carrying 1 mark each.
- **SECTION B** consists of 5 short answer questions carrying 2 marks each.
- **SECTION C** consists of 7 short answer questions carrying 3 marks each.
- **SECTION D** consists of 2 case-based questions carrying 4 marks each.
- **SECTION E** consists of 3 long answer questions carrying 5 marks each.
- All questions are compulsory.
- Use of log tables and calculators is not permitted.

SECTION A

Directions (Q. Nos. 1–16): Multiple-choice questions with one correct answer. Each question carries 1 mark.

1. The molality of a 2.5 M solution of ethanol (C_2H_5OH) in water having a density of 1.025 g mL^{-1} is:
[Molar mass of C_2H_5OH = 46 g mol^{-1}]
(a) 2.75 m
(b) 2.44 m
(c) 2.98 m
(d) 1.25 m

2. The number of significant figures in 0.005080 is:

(a) 3

(b) 4

(c) 6

(d) 7

3. The number of angular nodes and radial nodes in a 3d orbital respectively are:

(a) 2, 0

(b) 1, 1

(c) 2, 1

(d) 0, 2

4. Which of the following species has a permanent non-zero dipole moment ($\mu \neq 0$)?

(a) SiF_4

(b) XeF_4

(c) SF_4

(d) PCl_5

5. According to Molecular Orbital Theory, which of the following species is diamagnetic and has a fractional bond order?

(a) O_2^+

(b) He_2^+

(c) H_2^-

(d) N_2^+

6. In the chemical equation: $\mathbf{3\ Br_2 + 6\ OH^- \rightarrow 5\ Br^- + BrO_3^- + 3\ H_2O}$, bromine undergoes:

(a) Only oxidation

(b) Only reduction

(c) Both oxidation and reduction

(d) Neither oxidation nor reduction

7. Which of the following elements forms a basic oxide?

(a) Cl

(b) P

(c) Ba

(d) N

8. An electron, an α-particle, a proton, and a neutron are moving with the same kinetic energy. The maximum de Broglie wavelength is associated with:

(a) α-particle

(b) Neutron

(c) Proton

(d) Electron

9. Which of the following molecules has sp^3d^2 hybridization and a square planar geometry?

(a) SF_6

(b) XeF_4

(c) BrF_5

(d) $SiCl_4$

10. Among the following, the molecule with the smallest bond angle is:

(a) H_2O

(b) H_2S

(c) NH_3

(d) CH_4

11. The oxidation state of phosphorus in phosphoric acid (H_3PO_4) is:

(a) +3

(b) +4

(c) +5

(d) +6

12. The total number of nodes associated with a 4p orbital is/are:

(a) 1

(b) 2

(c) 3

(d) 4

Directions (Q. Nos. 13–16): In questions 13 to 16, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option from the choices given below:

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

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

(c) A is true but R is false.

(d) A is false but R is true.

13. Assertion (A): The dipole moment of *cis*-1,2-dichloroethene is higher than *trans*-1,2-dichloroethene.
Reason (R): In *trans*-isomer, the two C-Cl bond moments are in opposite directions and cancel out each other.

14. Assertion (A): The configuration of Cr is [Ar] $3d^5$ $4s^1$ instead of [Ar] $3d^4$ $4s^2$.
Reason (R): Half-filled subshells have extra stability due to greater exchange energy and symmetrical distribution of electrons.

15. Assertion (A): Oxygen has a less negative electron gain enthalpy than sulfur.
Reason (R): Oxygen atom is smaller in size, leading to strong interelectronic repulsions in its relatively compact 2p subshell.

16. Assertion (A): Boron has a higher first ionization enthalpy than beryllium.
Reason (R): 2p electron of boron is shielded by the 2s electrons from the nucleus and is easier to remove than a 2s electron of beryllium.

SECTION B

Q. Nos. 17–21 are short answer type questions carrying 2 marks each. There is an internal choice in

one question.

17. (a) Define limiting reagent.

(b) A sample of pure water, whether collected from a river or prepared in the laboratory, contains hydrogen and oxygen combined in a 1:8 mass ratio. Explain which law this illustrates.

18. (a) What are isoelectronic species?

(b) Arrange the following isoelectronic ions in increasing order of their ionic radii: N^{3-}, O^{2-}, Mg^{2+}, Al^{3+}.

19. Identify the substance oxidized, substance reduced, oxidizing agent, and reducing agent in the following redox reaction:

$2\ Fe^{3+}\ (aq) + Sn^{2+}\ (aq) \rightarrow 2\ Fe^{2+}\ (aq) + Sn^{4+}\ (aq)$

OR

Assign the oxidation numbers of the underlined elements:

(a) $K\underline{Mn}O_4$

(b) $\underline{Cr}_2O_7^{2-}$

20. (a) Mention two molecules that violate the octet rule by exhibiting an expanded octet.

(b) Predict the total number of lone pairs of electrons in a molecule of XeF_2.

21. Consider the following electronic configuration of an atom with 3 valence electrons in the 2p subshell: $2p_x^2\ 2p_y^1\ 2p_z^0$.

(a) Which fundamental rule or principle is violated by this arrangement?

(b) State the principle and write the correct orbital diagram representation.

SECTION C

Q. Nos. 22–28) are short answer type questions carrying 3 marks each. There is an internal choice in one question.

22. (a) Mention one difference between orbit and orbital.

(b) Write the electronic configurations of following species:

(i) Fe^{2+} (Z = 26)

(ii) Cu (Z = 29)

23. (a) An element has atomic number Z = 37. Predict its period, group number, and block in the periodic table.

(b) Explain why the first ionization enthalpy of nitrogen (Z = 7) is higher than that of oxygen (Z = 8).

24. Calculate the energy and radius associated with the second Bohr orbit of Li^{2+} ion.

[Given: Bohr radius, a_0 = 52.9 pm, Energy of first orbit of H-atom = -2.18×10^{-18} J]

25. The elements of the 3rd period of the Periodic Table are:

Na, Mg, Al, Si, P, S, Cl, Ar

Identify the element which has:

(a) The highest first ionization enthalpy.

(b) The most negative electron gain enthalpy.

(c) The largest atomic size.

26. An organic substance on analysis was found to contain 40.0% carbon, 6.67% hydrogen, and 53.33% oxygen by mass. The molecular mass of the compound was determined to be 180 g mol^{-1}.

Calculate the empirical formula and molecular formula of the compound.

[Atomic masses: C = 12 u, H = 1 u, O = 16 u]

OR

50.0 g of nitrogen gas (N_2) and 10.0 g of hydrogen gas (H_2) are mixed to produce ammonia (NH_3) gas according to the equation:

N_2 (g) + 3 H_2 (g) → 2 NH_3 (g)

(a) Identify the limiting reagent.

(b) Calculate the mass of NH_3 formed.

(c) Calculate the mass of unreacted excess reagent remaining.

27. Balance the following redox equation in acidic medium:

$Cr_2O_7^{2-}$ (aq) + SO_3^{2-} (aq) → Cr^{3+} (aq) + SO_4^{2-} (aq)

28. (a) Out of NH_3 and NF_3, which has higher dipole moment and why?

(b) Draw the resonating structures of ozone (O_3) molecule and show the formal charge on each oxygen atom.

SECTION D

Q. Nos. 29–30 are Case-based questions carrying 4 marks each. Read the given information carefully and answer the questions.

29. In chemical laboratory operations, the concentration of standard solutions must be established accurately. Titration is a common analytical method where a solution of known concentration (titrant) is added to a solution of unknown concentration until the equivalence point is reached. Measurement precision indicates how closely multiple independent measurements agree with one another, whereas accuracy reflects proximity to the true value.

To standardize an unknown sodium hydroxide (NaOH) solution, a student took four 25.0 mL samples of 0.20 M oxalic acid solution, $(COOH)_2 \cdot 2H_2O$, and titrated them against the NaOH solution using phenolphthalein indicator.

The neutralization reaction is:

$$\mathbf{(COOH)_2 + 2\ NaOH \rightarrow (COONa)_2 + 2\ H_2O}$$

The recorded volumes of NaOH consumed in four trials are listed in following table:

Trial Number	Volume of Oxalic Acid (mL)	Volume of NaOH Consumed (mL)
1	25.0	20.4
2	25.0	20.0
3	25.0	20.0
4	25.0	20.0

(a) Define molarity.

(b) Why is standard oxalic acid solution called a primary standard solution?

(c) Calculate the molarity of the NaOH solution using the concordant volume.

OR

(c) Commercial concentrated nitric acid contains 69% HNO_3 by mass and has a density of 1.42 g mL^{-1}. Calculate the molarity of this nitric acid solution.

[Molar mass of HNO_3 = 63 g mol^{-1}]

30. Read the passage and answer the questions:

The Valence Shell Electron Pair Repulsion (VSEPR) model assumes that valence electron pairs surrounding an atom repel one another, and they adopt spatial positions that minimize this mutual electrostatic repulsion. The magnitude of repulsive interactions between electron pairs follows the sequence:

Lone Pair - Lone Pair (lp - lp) > Lone Pair - Bond Pair (lp - bp) > Bond Pair - Bond Pair (bp - bp).

These repulsions lead to deviations from idealized regular geometries (such as tetrahedral, trigonal bipyramidal, or octahedral). Moreover, when multiple bonds are present, they exert stronger repulsive forces than single bonds.

(a) Deduce the number of bonding pairs and lone pairs in ClF_3 and state its molecular geometry.

(b) Although both CH_4 and H_2O have four electron pairs around the central atom, the H-C-H angle in methane is 109.5°, whereas the H-O-H angle in water is 104.5°. Explain using VSEPR theory.

(c) Explain the shape of SF_4 and NH_3 molecules on the basis of VSEPR theory.

OR

(c) On the basis of VSEPR theory, predict the shape, hybridization, and draw the structure of the I_3^- (triiodide) ion.

SECTION E

Q. Nos. 31–33 are long answer type questions carrying 5 marks each. Internal choice is provided in all questions.

31. (a) Account for the following:

(i) Cations are smaller than their parent neutral atoms, while anions are larger.

(ii) Fluorine has a lower electron gain enthalpy than chlorine despite having a higher electronegativity.

(iii) The first ionization enthalpy of gallium (Z = 31) is slightly higher than that of aluminium (Z = 13).

(b) Write the IUPAC name and official symbol of an element with atomic number Z = 117.

(c) Write the general electronic configuration of *f*-block elements.

OR

(a) Define ionization enthalpy. Explain any two factors that determine its magnitude in an atom.

(b) Explain the following observations:

(i) Second electron gain enthalpy of sulfur is positive, whereas the first is negative.

(ii) Li exhibits anomalous properties from rest of the alkali metals.

(iii) Noble gases have exceptionally high positive electron gain enthalpies.

32. (a) Write the molecular orbital configuration of the O_2^{2-} (peroxide) ion. Determine its bond order and deduce its magnetic property.

(b) Describe the hybridization and bonding involved in PCl_5. Explain why the axial bonds are weaker and longer than equatorial bonds.

OR

(a) Distinguish between a σ (sigma) bond and a π (pi) bond on the basis of:

(i) Mode of orbital overlap.

(ii) Free rotation of atoms around the internuclear axis.

(b) Explain the following with suitable rationale:

(i) Water (H_2O) is a liquid at room temperature while hydrogen sulfide (H_2S) is a gas.

(ii) *o*-Nitrophenol is steam volatile, while *p*-nitrophenol has a higher boiling point and is non-volatile.

(iii) BeF_2 has polar Be-F bonds but its net dipole moment is zero.

33. (a) State Heisenberg's Uncertainty Principle.

A microscopic particle of mass 1.0×10^{-10} g is moving with a velocity of 50 m s^{-1}. If the velocity is

measured with an accuracy of 0.01%, calculate the minimum uncertainty in determining its position. [Given: $h = 6.626 \times 10^{-34}$ J s, $\pi = 3.14$]

(b) Write the four quantum numbers (n, l, m_l, m_s) for the valence electron in a potassium atom (Z = 19).

(c) What is the maximum number of emission spectral lines produced when an excited electron in the 5th shell of a hydrogen atom de-excites to the ground state?

OR

(a) State Pauli's Exclusion Principle.

(b) Calculate the de Broglie wavelength associated with a fast-moving neutron of kinetic energy 0.04 eV.

[Given: 1 eV = 1.6×10^{-19} J, Mass of neutron = 1.675×10^{-27} kg, $h = 6.626 \times 10^{-34}$ J s]

(c) Sketch the boundary surface diagram of a d_{z^2} orbital.