**INDIAN SCHOOL SALALAH**

**FIRST TERM EXAMINATION – SEPTEMBER 2024**

**CHEMISTRY (043)**

**Class: XI**                                                    **Date: 30-09-2024**

**Time:  3 Hrs.**                                              **Maximum Marks: 70**

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*General Instructions:*

*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 (MCQ) type questions carrying 1 mark each.*

*(iv) Section B – questions number 17 to 21 are Very Short Answer (VSA) type questions carrying 2 marks each.*

*(v) Section C – questions number 22 to 28 are Short Answer (SA) type questions carrying 3 marks each.*

*(vi) Section D – questions number 29 & 30 are case-based questions carrying 4 marks each.*

*(vii) Section E – questions number 31 to 33 are Long Answer (LA) questions carrying 5 marks each.*

*(viii) There is no overall choice given in the question paper. However, an internal choice has been provided in all the sections except section A.*

*(ix) Use of calculators is NOT allowed.*

[$h = 6.63 \times 10^{-34}$ jsec, $R_H = 1.09 \times 10^7$ m$^{-1}$, mass of Electron $9.1 \times 10^{-31}$ Kg, Charge on electron = $1.6 \times 10^{-19}$ C, Speed of light = $3 \times 10^8$ m/s, At mass: Mn=55, H=1, O=16, Na=23, S=32, C=12, He=4, Cl=35.5, Ca=40,]

# SECTION A

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

1 Considering x-axis as the internuclear axis which out of the following will not form a sigma **1** bond.

    (a) 1s and 1s                   (b) 1s and $2p_x$

    (c) $2p_y$ and $2p_y$            (d) 1s and 2s.

2 Which one of the following molecules has zero dipole moment **1**

    (a) $NH_3$                         (b) $PCl_3$

    (c) $BH_3$                         (d) $PH_3$

3 In $NO_3^-$ ion, the number of bond pairs and lone pairs of electrons on nitrogen atom are **1**

    (a) 2, 2                         (b) 3, 1

    (c) 1, 3                         (d) 4, 0

4 Which of the following element contains the greatest number of atoms? **1**

    (a) 4g H                      (b) 46g Na

    (c) 40g Ca                  (d) 12g He

5 One of the statements of Dalton's atomic theory is given below: **1**

"Compounds are formed when atoms of different elements combine in a fixed ratio"

Which of the following laws is related to this statement?

    (a) Law of conservation of mass       (b) Law of definite proportions

    (c) Gay Lusaac's Law               (d) Avogadro law

6 The mass percent of oxygen in Carbon dioxide is **1**

    (a) 0.73                        (b) 36

    (c) 14.6                        (d) 73

7 Total number of orbitals associated with third shell will be _____. **1**

    (a) 2                          (b) 4

    (c) 9                          (d) 3

8 The elements in which electrons are progressively filled in 4f-orbital are called **1**

    (a) actinoids                    (b) transition elements

    (c) lanthanoids                (d) halogens

9 Which of the following elements can show covalency greater than 4? **1**

    (a) Be                        (b) F

    (c) S                         (d) B

10  If travelling at same speeds, which of the following matter waves have the shortest  **1**
    wavelength?

      (a) Electron                                    (b) Alpha particle ($He^{2+}$)

      (c) Neutron                                     (d) Proton

11  While finding boiling point of water 100 ml of water was heated for 4 minutes. It was found  **1**
    that the temperature rises from 25ºC to 55ºC. The change in temperature in Kelvin scale will
    be:
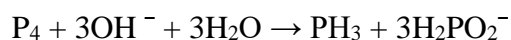
      (a) 30                                          (b) 303

      (c) 240                                         (d) 300

12  Identify the correct statements with reference to the given reaction  **1**

$$P_4 + 3OH^- + 3H_2O \rightarrow PH_3 + 3H_2PO_2^-$$

      (a) Phosphorus is undergoing reduction only.

      (b) Phosphorus is undergoing oxidation only.

      (c) Phosphorus is undergoing oxidation as well as reduction.

      (d) Phosphorus is undergoing neither oxidation nor reduction.

**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.

13  Assertion (A) : All isotopes of a given element show the same type of physical behaviour.  **1**
    Reason (R) : The chemical properties of an atom are controlled by the number of electrons
    in the atom.

14  Assertion (A): Electron gain enthalpy becomes less negative as we go down a group.  **1**
    Reason (R): Size of the atom increases on going down the group and the added electron
    would be farther from the nucleus.

15  Assertion (A): Among halogens fluorine is the best oxidant.  **1**
    Reason (R): Fluorine has the most negative electron gain enthalpy.

16  Assertion (A) : The decomposition of hydrogen peroxide to form water and oxygen is an  **1**
    example of disproportionation reaction.
    Reason (R) : The oxygen of peroxide is in –1 oxidation state and it is converted to zero
    oxidation state in $O_2$ and –2 oxidation state in $H_2O$.

## SECTION B

17   (A) Draw the resonating structure of carbonate ion.                                                    **2**

**OR**

(B) What is resonance? Draw resonance hybrid structure of ozone molecule.

18   The wavelength range of the visible spectrum extends from violet (400 nm) to red (750 nm).   **2**
Express these wavelengths in frequencies.

19   Among the elements B, Al, C and Si,                                                               **2**

(a) which element has the highest first ionisation enthalpy?

(b) which element has the most metallic character?

Justify your answer in each case.

20   (A) Calculate mass percent of calcium in (i) Calcium oxide (ii) Calcium hydrogen carbonate.   **2**

**OR**

(B) Use the data given in the following table to calculate the molar mass of naturally
occurring argon isotopes:

| Isotope | Isotopic molar mass | Abundance |
|---|---|---|
| $^{36}Ar$ | $35.96755$ g mol$^{-1}$ | 0.337% |
| $^{38}Ar$ | $37.96272$ g mol$^{-1}$ | 0.063% |
| $^{40}Ar$ | $39.9624$ g mol$^{-1}$ | 99.600% |

21   Calculate the oxidation number of phosphorus in the following species.                          **2**

      (a) $H_3PO_3$                                  (b) $PO_4^{3-}$
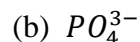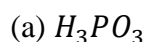
## SECTION C

22   Although both carbon dioxide and water are triatomic molecules, their shapes are different.   **3**
Explain this with the help of proper structure.

23   (a) An atom of an element contains 29 electrons and 35 neutrons. Deduce the number of   **3**
protons and the electronic configuration of the element.

(b) An atomic orbital has n = 3. What are the possible values of azimuthal and magnetic
quantum numbers.

(c) Using s, p, d, f notations, describe the orbital with the following quantum numbers.

      (i) n = 3; $\ell$ =1 (ii) n=4; $\ell$ =3

24   A compound contains 4.07 % hydrogen, 24.27 % carbon and 71.65 % chlorine. Its molar   **3**
mass is 98.96 g. Find its empirical and molecular formulas.

25  (A) Dinitrogen and dihydrogen react with each other to produce ammonia. Calculate the mass **3**
    of ammonia produced if 200g dinitrogen reacts with 100 g of dihydrogen.
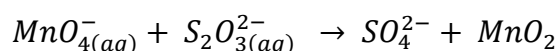
<div align="center">**OR**</div>

    (B) Chlorine is prepared in the laboratory by treating manganese dioxide ($MnO_2$) with
    aqueous hydrochloric acid according to the reaction

$$4HCl_{(aq)} + MnO_{2(s)} \rightarrow 2H_2O_{(l)} + MnCl_{2(aq)} + Cl_{2\,(g)}$$
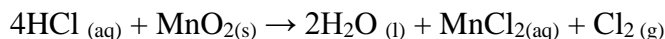
    How many grams of $MnCl_2$ will be produced when 5.0 g of HCl reacts with 5.0 g of
    manganese dioxide?

26  (A) Balance the given ionic equation in acidic medium.

$$MnO_{4(aq)}^{-} + S_2O_{3(aq)}^{2-} \rightarrow SO_4^{2-} + MnO_2$$

**3**

<div align="center">**OR**</div>

    (B) Write balanced chemical equation for the following reaction:

    Permanganate ion $MnO_4^{-}$ reacts with sulphur dioxide gas in acidic medium to produce
    $Mn^{2+}$ and hydrogensulphate ion.

27  (a) Write atomic number and IUPAC name of the element having symbol 'Ubn'. **3**

    (b) Predict the group number and period number of the element having atomic number 53.

    (c) Compare the electron gain enthalpy of fluorine and chlorine. Justify your answer.

28  (a) Consider the chemical equation given below **3**

$$Cr_2O_{7(aq)}^{2-} + Fe_{(aq)}^{2+} \rightarrow Cr^{3+} + Fe^{3+}$$
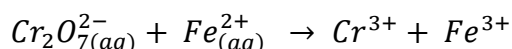
    Identify the chemical species that

    (i) oxidised      (ii) reduced      (iii) oxidizing agent      (iv) reducing agent

    (b) Define the term 'disproportionation reaction' with suitable example.


<div align="center">**SECTION D**</div>

**The following questions are case-based questions. Read the case carefully and answer the
questions that follow.**

29  Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic orbitals
    combine to form two molecular orbitals called bonding molecular orbital and anti-bonding
    molecular orbital. Energy of anti-bonding orbital is raised above the parent atomic orbitals
    that have combined and the energy of the bonding orbital is lowered than the parent atomic
    orbitals.

    Different atomic orbitals of one atom combine with those atomic orbitals of the second atom
    which have comparable energies and proper orientation. Further, if the overlapping is head
    on, the molecular orbital is called 'Sigma', (σ) and if the overlap is lateral, the molecular
    orbital is called 'pi', (π). The molecular orbitals are filled with electrons according to the

same rules as followed for filling of atomic orbitals. However, the order for filling is not the same for all molecules or their ions. Bond order is one of the most important parameters to compare the strength of bonds.

**Answer the following questions:**

a  Differentiate between bonding and antibonding molecular orbital on the basis of their stability. **1**

b  Find the bond order of nitrogen molecule. **1**

c  (i) Write MO electronic configuration of helium molecule. Explain why it does not exist? **2**

<div align="center">

**OR**

</div>

   (ii)   Compare the magnetic character of oxygen and nitrogen molecule using proper electronic configuration.

30  The difficulties of the Rutherford model were overcome by Niels Bohr in 1913 in his model of the hydrogen atom. Bohr postulated that electron moves around the nucleus in circular orbits. Only certain orbits can exist and each orbit corresponds to a specific energy. Bohr calculated the energy of electron in various orbits and for each orbit predicted the distance between the electron and nucleus. Bohr model, though offering a satisfactory model for explaining the spectra of the hydrogen atom, could not explain the spectra of multi-electron atoms. The reason for this was soon discovered. In Bohr model, an electron is regarded as a charged particle moving in a well-defined circular orbit about the nucleus. The wave character of the electron is ignored in Bohr's theory. An orbit is a clearly defined path and this path can completely be defined only if both the exact position and the exact velocity of the electron at the same time are known. This is not possible according to the Heisenberg uncertainty principle. Bohr model of the hydrogen atom, therefore, not only ignores the dual behaviour of electron but also contradicts Heisenberg uncertainty principle.

Erwin Schrödinger, in 1926, proposed an equation called Schrödinger equation to describe the electron distributions in space and the allowed energy levels in atoms. This equation incorporates de Broglie's concept of wave-particle duality and is consistent with Heisenberg uncertainty principle.

a  State Heisenberg uncertainty principle. **1**

b  Name the experiment which led to the discovery of nucleus. **1**

c  (i) Calculate the wavelength of an electron moving with a velocity of $2.05 \times 10^7$ m s$^{-1}$. **2**

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**OR**

</div>

   (ii) A microscope using suitable photons is employed to locate an electron in an atom within a distance of 0.1 Å. What is the uncertainty involved in the measurement of its velocity?

## SECTION E

31 (A)(i) Calculate the total number of electrons present in one mole of methane.    **5**

(ii) What is the energy in joules, required to shift the electron of the hydrogen atom from the first Bohr orbit to the fifth Bohr orbit and what is the wavelength of the light emitted when the electron returns to the ground state?

**OR**

(B) (i) A 25 watt bulb emits monochromatic yellow light of wavelength of $0.57\mu m$. Calculate the rate of emission of quanta per second.

(ii) What is the wavelength of light emitted when the electron in a hydrogen atom undergoes transition from an energy level with $n = 4$ to an energy level with $n = 2$?

32 (A) (i) What is the basic difference between the terms electron gain enthalpy and    **5** electronegativity?

(ii)     How do atomic radius vary in a period and in a group? Explain the variation.

(iii)    How would you explain the fact that the first ionization enthalpy of sodium is lower than that of magnesium but its second ionization enthalpy is higher than that of magnesium.

**OR**

(B) (i) Explain why cation are smaller and anions larger in radii than their parent atoms?

(ii)    Among the second period elements the actual ionization enthalpies are in the order $Li < B < Be < C < O < N < F < Ne$.

Explain why:       (1) Be has higher ionization enthalpy than B

(2)   O has lower ionization enthalpy than N and F.

(iii)   The first ionization enthalpy values (in $kJ\ mol^{-1}$) of group 13 elements are:

B     Al     Ga     In     Tl
801   577    579    558   589

How would you explain this deviation from the general trend.

33 Answer any **FIVE** of the following:    **5**

(a) Draw Lewis dot structure of ammonia.

(b) Ionic compounds do not conduct electricity in solid state. Why?

(c) Define lattice enthalpy.

(d) Explain why $BeH_2$ molecule has a zero dipole moment although the Be-H bonds are polar?

(e) Why are the axial bonds longer as compared to equatorial bonds in phosphorous pentachloride?

(f) Using suitable example show intramolecular hydrogen bonding.

(g) What is the total number of sigma and pi bonds in the ethene molecule.