| INDIAN SCHOOL AL WADI AL KABIR | | |
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| **Class: XI** | **Department of Science 2026-27**<br>**Sub: CHEMISTRY** | **Date: 05/05/2026** |
| **Worksheet No: 02** | **Chapter: Structure of Atom** | **Note:**<br>**A4 FILE FORMAT** |
| **CLASS & SEC:** | **NAME OF THE STUDENT:** | **ROLL NO.** |

## Multiple Choice Questions:

1. Number of angular nodes for 4d orbital is ___________.

   a. 4    b. 3    c. 2    d. 1

2. For an electron with principal quantum number 3, how many orbitals are possible?
   a. 5
   b. 7
   c. 9
   d. 3

3. Iso-electronic species are:
   a. $F^-$, $O^{-2}$
   b. $F^-$, O
   c. $F^-$, $O^+$
   d. $F^-$, $O^{+2}$

4. Which quantum number identifies two electrons in the same orbital?
   a. Principal quantum number    b. Angular momentum quantum number
   c. Magnetic quantum number    d. Spin quantum number

5. Which statement about orbital nodes is correct?
   a. Angular nodes equal principal quantum number
   b. Total nodes = n - 1
   c. Radial nodes = n + l - 1
   d. Angular nodes = n + l

6. The Heisenberg Uncertainty Principle is most applicable to:
   a. Macroscopic objects
   b. Subatomic particles

c. Planetary motion
d. Sound waves

7. An orbital where n = 4 and l = 2 is designated as:
   a. 4s
   b. 4p
   c. 4d
   d. 4f

8. Which of the following quantum numbers determines the shape of an orbital?
   a. Principal quantum number (n)
   b. Azimuthal quantum number (*l*)
   c. Magnetic quantum number (*ml*)
   d. Spin quantum number (*ms*)

9. The correct order of increasing energy of atomic orbitals is:
   a. 5p<4f<6s<5d   b. 5p<6s<4f<5d
   c. 4f<5p<5d<6s   d. 5p<5d<4f<6s

10. Which of the following statements about the Bohr model of the atom is false?
   a. Electrons move in circular orbits around the nucleus.
   b. Each orbit corresponds to a specific energy level.
   c. Electrons can exist between energy levels.
   d. The energy of an electron is quantised.

11. Assertion: According to the Heisenberg uncertainty principle, it is impossible to determine both the exact position and momentum of an electron simultaneously.
   Reason**:** The path of an electron in an atom is clearly defined.
   a. Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
   b. Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.
   c. Assertion is correct, but the reason is a wrong statement.
   d. Assertion is wrong, but the reason is a correct statement.

12. Assertion: The angular momentum of an electron in a hydrogen atom is quantised.
   Reason: According to Bohr's model, the angular momentum of an electron is an integral multiple of $nh/2\pi$.
   a. Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
   b. Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.
   c. Assertion is correct, but the reason is a wrong statement.
   d. Assertion is wrong, but the reason is a correct statement

## 2 Marks Questions

13. What are radial nodes, and how many radial nodes are present in the 3p orbital?
14. State Hund's Rule of Maximum Multiplicity and explain its significance in electronic configuration.

15. Wavelengths of different radiations are given below :
 $\lambda$ (A) = 300 nm
 $\lambda$ (B) = 300 μm
 $\lambda$ (C) = 3 nm
 $\lambda$ (D) = 30 Å. Arrange these radiations in increasing order of their energies.
16. Explain why the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9 4s^2$ does not represent a ground state configuration.

## 3 Marks Questions

17. (a)What is the lowest value of n that allows g orbitals to exist?
 (b)An electron is in one of the 3d orbitals. Give the possible values of n, l and ml for this electron.
18. A table tennis ball has a mass of 10 g and a speed of 90 m/s. If speed can be measured With an accuracy of 4%, what will be the uncertainties in speed and position?
19. Calculate the wavelength of an electron moving with a velocity of $2.5\times10^{6}$ m/s (Use mass of electron=$9.1\times10^{-31}$ kg and h=$6.626\times10^{-34}$ Js)
20. Calculate the uncertainty in the position of a particle with a mass of 1.0kg and an uncertainty in velocity of 0.1m/s. Use Heisenberg's uncertainty principle, where h=$6.626\times10^{-34}$ Js

# 5 Marks Questions

21. a. Calculate the energy change when an electron in a hydrogen atom transitions from the *n*=5 to the *n*=2 level.
 b. Differentiate between an atomic orbital and a Bohr orbit in terms of their descriptions of electron position.

22. Explain the concept of atomic orbitals and how quantum numbers determine them. Provide examples of how the quantum numbers *n*, *l*, and *ml* define specific orbitals.

23. The electron energy in a hydrogen atom is given by $E_n = -\frac{2.18\times10^{-18}}{n^2}$ J.
 Calculate the energy required to remove an electron completely from the n=2 orbit.
 What is the longest wavelength of light in cm that can be used to cause this transition?

## Answers

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| 1. | c. 2 |
| 2 | c. 9 |
| 3. | a. $F^-$, $O^{-2}$ |
| 4. | d. Spin quantum number |
| 5. | b. Total nodes = n – 1 |
| 6. | b. Subatomic particles |
| 7. | c. 4d |
| 8. | b. Azimuthal quantum number (*l*) |
| 9. | b.5p<6s<4f<5d |
| 10. | c.Electrons can exist between energy levels. |

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| 11. | c.Assertion is correct, but the reason is a wrong statement. |
| 12. | a. Both assertion and reason are correct statements, and reason is the correct explanation of the assertion. |
| 13. | Radial nodes are regions where the probability density of finding an electron is zero. The 3p orbital has 1 radial node. |
| 14. | Hund's Rule of Maximum Multiplicity states that for degenerate orbitals (orbitals with the same energy), electrons will fill each orbital singly before any orbital gets a second electron, and all singly occupied orbitals will have electrons with the same spin. This rule is significant because it minimises electron-electron repulsions, leading to a more stable configuration with lower energy. |
| 15. | $E = h\nu$ or $= hc/\lambda$ or $E \propto 1/\lambda$<br>$\lambda(A) = 300$ nm $= 300 \times 10^{-9}$ m or $= 3 \times 10^{-7}$ m;<br>$\lambda(B) = 300 \times 10^{-6}$ m $= 3 \times 10^{-4}$ m<br>$\lambda(C) = 3 \times 10^{-9}$ m,<br>$\lambda(D) = 30 \times 10^{-10}$ m $= 3.0 \times 10^{-9}$ m<br>∴ Increasing order of energies is: B < A < C = D |
| 16. | In the ground state, electrons fill orbitals in order of increasing energy, following the Aufbau Principle. The correct ground state configuration would be $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$ |
| 17. | a. minimum value of n = 5<br>b. n=3, l=2, ml = -2, -1, 0, +1, +2. |
| 18. | $m = 10 \text{ g} = \frac{10}{1000} = 0.01 \text{ kg}$, $c = 90 \text{ m s}^{-1}$<br>Uncertainty in speed of ball $= \frac{90 \times 4}{100} = 3.6 \text{ m s}^{-1}$<br>$\Delta x = \frac{h}{4\pi m \Delta V} = \frac{6.626 \times 10^{-34} \text{ J s}}{4 \times 3.14 \times 0.01 \text{ kg} \times 3.6 \text{ m s}^{-1}}$<br>$= 1.46 \times 10^{-33}$ m |
| 19. | $\lambda = \frac{h}{m \cdot v}$<br>$\lambda = \frac{6.626 \times 10^{-34}}{9.1 \times 10^{-31} \times 2.5 \times 10^{6}} = 2.9 \times 10^{-10}$ m |
| 20. | $\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$<br>$\Delta x \geq \frac{6.626 \times 10^{-34}}{4\pi \times 0.1} = 5.3 \times 10^{-34}$ m |
| 21. | a. $\Delta E = -2.18 \times 10^{-18}(1/5^2 - 1/2^2) = 45.78 \times 10^{-20}$ J<br>b. An atomic orbital is a region in space where there is a high probability of finding an electron, described by wavefunctions and quantum mechanics. A Bohr orbit, in contrast, is a fixed circular path at a certain distance from the nucleus, as proposed by Bohr's model. Atomic orbitals provide a more accurate representation of electron behaviour. |
| 22. | • **Atomic Orbitals**: Atomic orbitals are regions in an atom where there is a high probability of finding electrons. They are solutions to the Schrödinger equation for electrons in atoms and describe the spatial distribution of electrons. |

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| | • **Quantum Numbers**:<br>• **Principal Quantum Number (*n*)**: Determines the energy level and size of the orbital. Higher *n* values correspond to higher energy levels and larger orbitals. For example, n=1 for the first energy level, n=2for the second, and so on.<br>• **Azimuthal Quantum Number (*l*)**: Determines the shape of the orbital. The value of *l* ranges from 0 to *n*−1. Each value of *l* corresponds to a specific type of orbital (0 = s, 1 = p, 2 = d, 3 = f). For example, *l*=0 for s orbitals, which are spherical.<br>• **Magnetic Quantum Number (*ml*)**: Determines the orientation of the orbital in space. The value of *ml* ranges from −*l* to +*l*. For example, for a p orbital (*l*=1), *ml* can be -1, 0, or +1, corresponding to the *px*, *py*, and *pz* orbitals.<br>• **Examples**:<br>• An electron with *n*=2, *l*=1, and *ml*=0 is in a 2*p* orbital oriented along the *y*-axis (assuming *ml*=0 corresponds to the *py* orbital in a particular coordinate system).<br>• An electron in the 3*dxy* orbital would have *n*=3, *l*=2, and a specific *ml* value corresponding to the *xy* plane. |
| 23 | Calculation of energy required<br><br>The energy required is the difference in the energy when the electron jumps from orbit with n = ∞ to orbit with n = 2.<br><br>The energy required (ΔE) = $E_\infty - E_2$<br><br>$= 0 - \left(-\frac{2.18\times10^{-18}}{4}\text{J}\right)$<br><br>$= 5.45 \times 10^{-19}$ J.<br><br>ΔE = hv = hc / λ.<br><br>$\lambda = \frac{hc}{\Delta E} = \frac{(6.626 \times 10^{-34}\text{ J s}) \times (3 \times 10^{8}\text{ ms}^{-1})}{(5.45 \times 10^{-19}\text{ J})}$<br><br>n= $3.644 \times 10^{-7}$<br>m = $3.644 \times 10^{-7} \times 10^{2}$<br>= $3.645 \times 10^{-5}$ cm. |

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