

Structure Of Atom

Short Answer Type Questions

1. Arrange s, p and d sub-shells of a shell in the increasing order of effective nuclear charge (Z_{eff}) experienced by the electron present in them.
2. Show the distribution of electrons in oxygen atom (atomic number 8) using orbital diagram.
3. Nickel atom can lose two electrons to form Ni^{2+} ion. The atomic number of nickel is 28. From which orbital will nickel lose two electrons.
4. Which of the following orbitals are degenerate?
 $3d_{xy}$, $4d_{xy}$, $3d_{z^2}$, $3d_{yz}$, $4d_{yz}$, $4d_{z^2}$
5. Calculate the total number of angular nodes and radial nodes present in 3p orbital.
6. The arrangement of orbitals on the basis of energy is based upon their $(n+l)$ value. Lower the value of $(n+l)$, lower is the energy. For orbitals having same values of $(n+l)$, the orbital with lower value of n will have lower energy.
 - I. Based upon the above information, arrange the following orbitals in the increasing order of energy.
 - (a) 1s, 2s, 3s, 2p
 - (b) 4s, 3s, 3p, 4d
 - (c) 5p, 4d, 5d, 4f, 6s
 - (d) 5f, 6d, 7s, 7p
 - II. Based upon the above information, solve the questions given below :
 - (a) Which of the following orbitals has the lowest energy?
4d, 4f, 5s, 5p
 - (b) Which of the following orbitals has the highest energy?
5p, 5d, 5f, 6s, 6p
7. Which of the following will not show deflection from the path on passing through an electric field?
Proton, cathode rays, electron, neutron.
8. An atom having atomic mass number 13 has 7 neutrons. What is the atomic number of the atom?

9. Wavelengths of different radiations are given below :

$$\lambda(A) = 300 \text{ nm} \quad \lambda(B) = 300 \mu\text{m} \quad \lambda(C) = 3 \text{ nm} \quad \lambda(D) = 30 \text{ \AA}$$

Arrange these radiations in the increasing order of their energies.

10. The electronic configuration of valence shell of Cu is $3d^{10}4s^1$ and not $3d^94s^2$. How is this configuration explained?
11. The Balmer series in the hydrogen spectrum corresponds to the transition from $n_1 = 2$ to $n_2 = 3, 4, \dots$. This series lies in the visible region. Calculate the wave number of line associated with the transition in Balmer series when the electron moves to $n = 4$ orbit. ($R_H = 109677 \text{ cm}^{-1}$)
12. According to de Broglie, matter should exhibit dual behaviour, that is both particle and wave like properties. However, a cricket ball of mass 100 g does not move like a wave when it is thrown by a bowler at a speed of 100 km/h. Calculate the wavelength of the ball and explain why it does not show wave nature.
13. What is the experimental evidence in support of the idea that electronic energies in an atom are quantized?
14. Out of electron and proton which one will have, a higher velocity to produce matter waves of the same wavelength? Explain it.
15. A hypothetical electromagnetic wave is shown in Fig. 2.2. Find out the wavelength of the radiation.

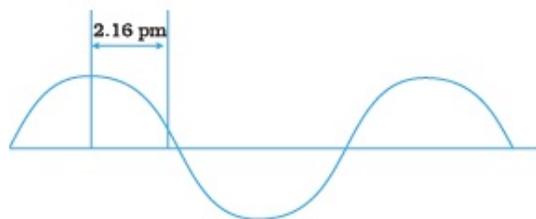


Fig. 2.2

16. Chlorophyll present in green leaves of plants absorbs light at $4.620 \times 10^{14} \text{ Hz}$. Calculate the wavelength of radiation in nanometer. Which part of the electromagnetic spectrum does it belong to?
17. What is the difference between the terms orbit and orbital?

18. Table-tennis ball has a mass 10 g and a speed of 90 m/s. If speed can be measured within an accuracy of 4% what will be the uncertainty in speed and position?
19. The effect of uncertainty principle is significant only for motion of microscopic particles and is negligible for the macroscopic particles. Justify the statement with the help of a suitable example.
20. Hydrogen atom has only one electron, so mutual repulsion between electrons is absent. However, in multielectron atoms mutual repulsion between the electrons is significant. How does this affect the energy of an electron in the orbitals of the same principal quantum number in multielectron atoms?

Matching Type Questions

In some of the following questions, one option of left column may be correlated to more than one option in the right column.

1. Match the following species with their corresponding ground state electronic configuration.

Atom / Ion	Electronic configuration
(i) Cu	(a) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$
(ii) Cu^{2+}	(b) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
(iii) Zn^{2+}	(c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$
(iv) Cr^{3+}	(d) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$
	(e) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$

2. Match the quantum numbers with the information provided by these.

Quantum number	Information provided
(i) Principal quantum number	(a) orientation of the orbital
(ii) Azimuthal quantum number	(b) energy and size of orbital
(iii) Magnetic quantum number	(c) spin of electron
(iv) Spin quantum number	(d) shape of the orbital

3. Match the following rules with their statements :

Rules	Statements
(i) Hund's Rule	(a) No two electrons in an atom can have the same set of four quantum numbers.
(ii) Aufbau Principle	(b) Half-filled and completely filled orbitals have extra stability.
(iii) Pauli Exclusion Principle	(c) Pairing of electrons in the orbitals belonging to the same subshell does not take place until each orbital is singly occupied.
(iv) Heisenberg's Uncertainty Principle	(d) It is impossible to determine the exact position and exact momentum of a subatomic particle simultaneously.
	(e) In the ground state of atoms, orbitals are filled in the order of their increasing energies.

4. Match the following

(i) X-rays	(a) $\nu = 10^0 - 10^4 \text{ Hz}$
(ii) UV	(b) $\nu = 10^{10} \text{ Hz}$
(iii) Long radio waves	(c) $\nu = 10^{16} \text{ Hz}$
(iv) Microwave	(d) $\nu = 10^{18} \text{ Hz}$

5. Match the following

(i) Photon	(a) Value is 4 for N shell
(ii) Electron	(b) Probability density
(iii) ψ^2	(c) Always positive value
(iv) Principal quantum number n	(d) Exhibits both momentum and

wavelength

6. Match species given in Column I with the electronic configuration given in Column II.

Column I

- (i) Cr
- (ii) Fe^{2+}
- (iii) Ni^{2+}
- (iv) Cu

Column II

- (a) $[\text{Ar}]3d^84s^0$
- (b) $[\text{Ar}]3d^104s^1$
- (c) $[\text{Ar}]3d^64s^0$
- (d) $[\text{Ar}]3d^54s^1$
- (e) $[\text{Ar}]3d^64s^2$

Assertion and Reason Type Questions

In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below each question.

1. 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.

- (i) Both A and R are true and R is the correct explanation of A.
- (ii) Both A and R are true but R is not the correct explanation of A.
- (iii) A is true but R is false.
- (iv) Both A and R are false.

2. Assertion (A) : Black body is an ideal body that emits and absorbs radiations of all frequencies.

Reason (R) : The frequency of radiation emitted by a body goes from a lower frequency to higher frequency with an increase in temperature.

- (i) Both A and R are true and R is the correct explanation of A.
- (ii) Both A and R are true but R is not the explanation of A.
- (iii) A is true and R is false.
- (iv) Both A and R are false.

3. Assertion (A) : It is impossible to determine the exact position and exact momentum of an electron simultaneously.

Reason (R) : The path of an electron in an atom is clearly defined.

- (i) Both A and R are true and R is the correct explanation of A.
- (ii) Both A and R are true and R is not the correct explanation of A.
- (iii) A is true and R is false.
- (iv) Both A and R are false.

Long Answer Type Questions

1. What is photoelectric effect? State the result of photoelectric effect experiment that could not be explained on the basis of laws of classical physics. Explain this effect on the basis of quantum theory of electromagnetic radiations.
2. Threshold frequency, ν_0 is the minimum frequency which a photon must possess to eject an electron from a metal. It is different for different metals. When a photon of frequency $1.0 \times 10^{15} \text{s}^{-1}$ was allowed to hit a metal surface, an electron having $1.988 \times 10^{19} \text{ J}$ of kinetic energy was emitted. Calculate the threshold frequency of this metal. Show that an electron will not be emitted if a photon with a wavelength equal to 600 nm hits the metal surface.
3. When an electric discharge is passed through hydrogen gas, the hydrogen molecules dissociate to produce excited hydrogen atoms. These excited atoms emit electromagnetic radiation of discrete frequencies which can be given by the general formula

$$\bar{\nu} = 109677 \left[\frac{1}{n_i^2} - \frac{1}{n_f^2} \right]$$

What points of Bohr's model of an atom can be used to arrive at this formula? Based on these points derive the above formula giving description of each step and each term.

4. Calculate the energy and frequency of the radiation emitted when an electron jumps from $n = 3$ to $n = 2$ in a hydrogen atom.
5. Why was a change in the Bohr Model of atom required? Due to which important development (s), concept of movement of an electron in an orbit was replaced by, the concept of probability of finding electron in an orbital? What is the name given to the changed model of atom?