Atomic Structure

Date Planned : __ / __ / __	CBSE Pattern	Expected Duration : 90 Min
Actual Date of Attempt : __ / __ / __	Level - 0	Exact Duration :_____

Very Short Answer Type (1 Mark)

1. 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?

2. Calculate the number of angular nodes and radial nodes present in $3p$ orbital.

3. An atom having atomic mass number 13 has 7 neutrons. What is the atomic number of the atom?

4. An atomic orbital has $l = 3$, what are the possible values of m.

5. Using s, p and d notations, describe the orbitals with following quantum numbers:

(A) $n = 1, \ell = 0$ **(B)** $n = 2, \ell = 0$ **(C)** $n = 3, \ell = 1$ **(D)** $n = 4, \ell = 2$

6. Is angular momentum of an electron in an atom quantized? Explain.

Short Answer Type-I (2 Marks)

7. The Balmer series in the hydrogen spectrum corresponds to the transition to $n_1 = 2$ from $n_2 = 3, 4, \ldots\ldots$. This series lies in the visible region. Calculate the wave number of line associated with the transition in Balmer series when the electron moves from $n = 4$ orbit.
(R_H = 109677 cm^{-1})

8. According to de Broglie, matter should exhibit dual behaviour, which is both particle and wave nature. 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.

9. Chlorophyll present in green leaves of plants absorbs light at 4.620×10^{14}Hz. Calculate the wave length of radiation in nanometer. Which part of the electromagnetic spectrum does it belong to?

10. 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?

11. Hydrogen atom has only one electron, so mutual repulsion between electrons is absent. However, in multi-electron species 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 multi-electron species?

12. The distance between 4th and 3rd Bohr orbits of He^+ is :

13. A hydrogen atom in the ground state is excited by monochromatic radiation of wavelength λ Å. The resulting spectrum consists of maximum 15 different lines. What is the value of wavelength λ ?

($R_H = 109737 \, cm^{-1}$)

Short Answer Type-II (3 Marks)

14. State limitations of Rutherford's model of the atom.

15. Define atomic emission spectrum.

16. What are the laws of photoelectric emission?

17. Why are Bohr's orbits also known as energy levels.

18. Electrons jump from fourth energy level to finally first energy level in one mole hydrogen atom. How many maximum possible numbers of photons can be emitted?

19. Arrange the electrons represented by the following sets of quantum numbers in decreasing order of energy.

(A) $n = 4, \ \ell = 0, m = 0, s = +1/2$ **(B)** $n = 3, \ \ell = 1, m = 1, s = -1/2$

(C) $n = 3, \ \ell = 2, m = 0, s = +1/2$ **(D)** $n = 3, \ \ell = 0, m = 0, s = -1/2$

Long Answer Type (5 Marks)

20. **(A)** Calculate the number of electrons which will together weigh one gram.
     (B) Calculate the mass and charge of one mole of electrons.

21. **(A)** Calculate the total number of electrons present in one mole of methane.
     (B) Find (a) the total number and (b) the total mass of neutrons in 7 mg of ^{14}C
         (Assume that the mass of neutron = 1.675×10^{-27} kg)
     (C) Find (a) the total number and (b) the total mass of protons in 34 mg of NH_3 at S.T.P. (Assume the mass of proton = 1.6726×10^{-27} kg)

22. A photon of wavelength 4×10^{-7} m strikes on metal surface, the work function of the metal being 2.13 eV. Calculate

     (A) the energy of the photon (eV)   **(B)** the kinetic energy of the emission and
     (C) the velocity of the photoelectron
         (1 eV = 1.602×10^{-19} J).

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

24. How much energy is required to ionise a hydrogen atom if the electron occupies n = 5 orbit? Compare your answer with the ionisation energy of hydrogen atom (energy required to remove the electron from n = 1 orbit).

25. Following results were observed when sodium metal is irradiated with different radiations.
Calculate (a) threshold wavelength and (b) Planck's constant.

λ (nm)	500	450	400
$v \times 10^6 (m\,s^{-1})$	2.55	4.35	5.20