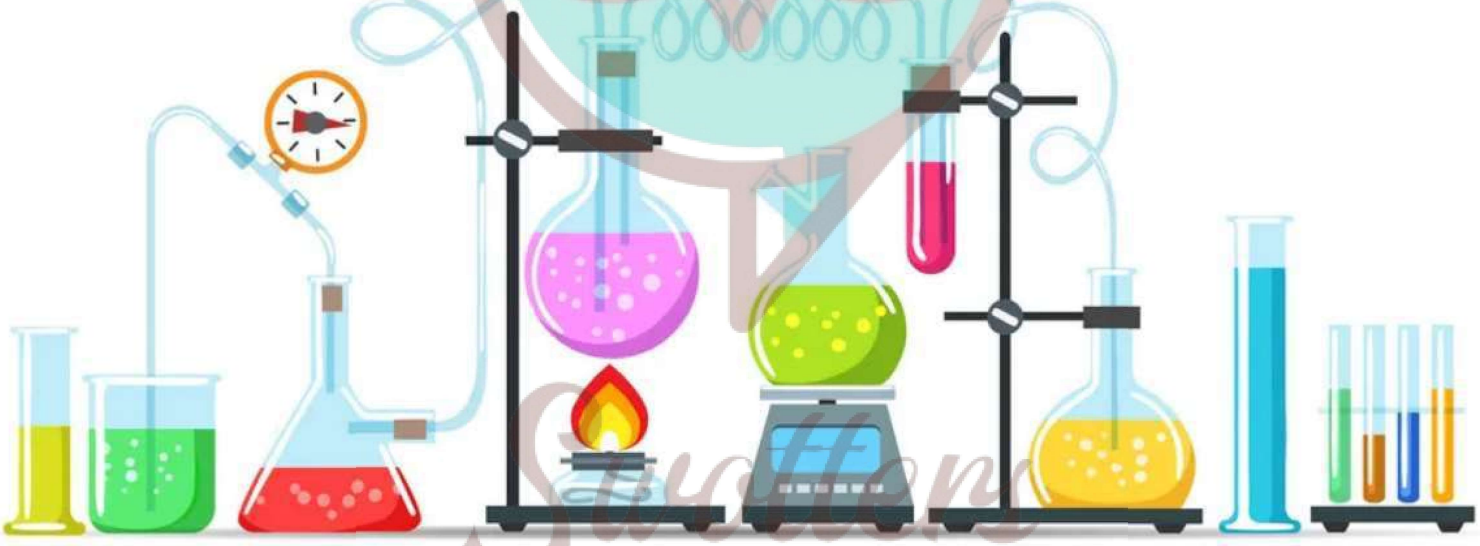
CHEMISTRY



Important Questions

Multiple Choice questions-

Question 1. Which of the following pair of ions have same paramagnetic moment?

(a) Cu^{+2}, Ti^{+3}

(b) Mn^{+2}, Cu^{+2}

(c) Ti^{+4}, Cu^{+2}

(d) Ti^{+3}, Ni^{+2}

Question 2. The charge to mass ratio of α – particles is approximately …… the charge to mass ratio of protons

(a) Twice

(b) Half

(c) Four times

(d) Six times

Question 3. The frequency of a wave of light is $12 \times 10^{14} s^{-1}$. The wave number associated with this light

(a) $5 \times 10^{-7} m$

(b) $4 \times 10^{-8} cm^{-1}$

(c) $2 \times 10^{-7} m^{-1}$

(d) $4 \times 10^{4} cm^{-1}$

Question 4. In a multi – electron atom, which of the following orbitals described by the three quantum numbers will have the same energy in the absence of magnetic acid and electric fields?
(a) n = 1, l = 0, m = 0 (b) n = 2, l = 0, m = 0 (c) n = 2, l = 1, m = 1 (d) n = 3, l = 2, m = 1 (e) n = 3, l = 2, m = 0

(a) (a) and (b)

(b) (b) and (c)

(c) (c) and (d)

(d) (d) and (e)

Question 5. The electronic transitions from n = 2 to n = 1 will produce shortest wavelength in (where n = principal quantum state)

(a) Li^{2+}

(b) He^{+}

(c) H

(d) H^+

Question 6. In a hydrogen atom, if energy of an electron in ground state is 13.6 eV, then that in the 2nd excited state is

(a) 1.51 eV

(b) 3.4 eV

(c) 6.04 eV

(d) 13.6 eV

Question 7. The credit of discovering neutron goes to

(a) Rutherford

(b) Thomson

(c) Goldstein

(d) Chadwick

Question 8. The maximum number of electrons that can be accommodated in fifth energy level is

(a) 10

(b) 25

(c) 50

(d) 32

Question 9. According to Aufbaus principle, which of the three 4d, 5p and 5s will be filled with electrons first

(a) 4d

(b) 5p

(c) 5s

(d) 4d and 5s will be filled simultaneously

Question 10. A hydrogen atom in its ground state absorbs 10.2 eV of energy. The orbital angular momentum is increased by (Given Planck constant h = 6.6×10^{-34} Jsec)

(a) 1.05×10^{-34} Jsec

(b) 3.16×10^{-34} Jsec

(c) 2.11×10^{-34} Jsec

(d) 4.22×10^{-34} Jsec

Question 11. The ionization enthalpy of hydrogen atom is 1.312×10^6 J mol^{-1}. The energy required to excite the electron in the atom from n = 1 to n = 2 is

(a) 8.51×10^5 Jmol-1

(b) 6.56×10^5 Jmol-1

(c) 7.56×10^5 Jmol-1

(d) 9.84×10^5 Jmol$^{-1/sup>}$

Question 12. For principal quantum number n = 4, the total number of orbitals having l = 3 is

(a) 3

(b) 7

(c) 5

(d) 9

Question 13. Maximum number of electrons in a subshell with l = 3 and n = 4 is

(a) 10

(b) 12

(c) 14

(d) 16

Question 14. Which hydrogen-like species will have same radius as that of Bohr orbit of hydrogen atom?

(a) n = 2, Li^{2+}

(b) n = 2, Be^{3+}

(c) n = 2, He^{+}

(d) n = 3, Li^{2+}

Question 15. The magnetic quantum number specifies

(a) Size of orbitals

(b) Shape of orbitals

(c) Orientation of orbitals

(d) Nuclear Stability

Very Short:

1. How many total electrons are present in nitrate ion?

2. The nucleus of the atom of an element does not contain a neutron. Name the element and what does its nucleus consists of.

3. What are nucleons?

4. Write electronic configurations of Chromium (At. Np. = 24).

5. Which of the following has the smallest de-Broglie wavelength? O_2, H_2, a proton, an electron

6. How many unpaired electrons are there is a carbon atom in the ground state?

7. What type of spectrum is obtained when light emitted from the discharge tube containing hydrogen gas is analyzed?

8. What is the maximum number of electrons in an atom having n = 3, l = 1 and s = $+\frac{1}{2}$?

9. Name the spectral line in the spectrum of H-atom obtained when an electron jumps from n = 4 to n = 2.

10. Give some examples of electromagnetic radiation.

Short Questions:

1. Enumerate the important characteristics of anode-rays (or positive rays). How this study led to the discovery of proton?
2. What are anode-rays? Illustrate their formation by a diagram.
3. Describe the important properties of cathode-rays. What is concluded about the nature of these rays?
4. What are the main features of Rutherford's model of an atom?
5. What is meant by the dual nature of radiation?
6. Describe the drawback to Rutherford's model of the atom.
7. What is the value of?
   (i) Charge to mass ratio (e/m) of electrons,
   (ii) Charge of electrons,
   (iii) Mass of an electron?

Long Questions:

1. Describe the shape of s – and p – orbitals What do you mean by node or nodal surface?
2. How does the Schrodinger wave equation help to understand the probability of finding the electron near the nucleus? What do you mean by an orbital?
3. How many nucleons are present in an atom Nobelium, No? How many electrons are present in the atom? How many nucleons may be considered neutrons?
4. Complete the following table:

Particle	Atomic No.	Mass No.	No. of electrons	No. of protons	No. of neutrons
Sodium atom	11	—	—	—	12
Aluminium ion	—	27	10	—	—
Chloride ion	—	—	18	—	18
Phosphorus atom	—	31	—	15	—
Cuprous ion	—	—	28	—	35

5. Find the number of protons, electrons an-d neutrons in (a) $13^{27}A^{3+}$

Assertion Reason Questions:

1. 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.

   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. 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.

   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.

Case Study Based Question:

1. The atomic theory of matter was first proposed on affirm scientific basis by John Dalton, a British schoolteacher in 1808. His theory, called Dalton's atomic theory, regarded the atom as the ultimate particle of matter Dalton's atomic theory was able to explain the law of conservation of mass, law of constant composition and law of multiple proportion very successfully. However, it failed to explain the results of many experiments. In mid 1850s many scientists mainly Faraday began to study electrical discharge in partially evacuated tubes, known as cathode ray discharge tubes. Electrical discharge carried out in the modified cathode ray tube led to the discovery of canal rays carrying positively charged particles. The characteristics of these positively charged particles are listed below.

    1) Unlike cathode rays, mass of positively charged particles depends upon the nature of gas present in the cathode ray tube. These are simply the positively charged gaseous ions.

    2)The charge to mass ratio of the particles depends on the gas from which these originate.

    3) Some of the positively charged particles carry a multiple of the fundamental unit of electrical charge.

    4) The behaviour of these particles in the magnetic or electrical field is opposite to that observed for electron or cathode rays.

The smallest and lightest positive ion was obtained from hydrogen and was called proton. This positively charged particle was characterised in 1919. Later, a need was felt for the presence of electrically neutral particle as one of the constituent of atom. These particles were discovered by Chadwick (1932)by bombarding a thin sheet of beryllium byα-particles. When electrically neutral particles having a mass slightly greater than that of protons were emitted. He named these particles as neutrons. J. J. Thomson, in 1898, proposed that an atom possesses a spherical shape (radius approximately 10–10 m) in which the positive charge is uniformly distributed. The electrons are embedded into it in such a manner as to give the most stable electrostatic arrangement Many different names are given to this model, for example, plum pudding, raisin pudding or watermelon. This model can be visualised as a pudding or watermelon of positive charge with plums or seeds (electrons)embedded into it. An important feature of this model is that the mass of the atom is assumed to be uniformly distributed over the atom. Rutherford and his students (Hans Geiger and Ernest Marsden) bombarded very thin gold foil with α–particles. Rutherford's famous α–particle scattering experiment. The observations of Scattering experiment are as follows-:

(i) most of the α–particles passed through the gold foil undeflected.

(ii) a small fraction of the α–particles was deflected by small angles.

(iii) a very few α–particles (~1 in 20,000)bounced back, that is, were deflected by nearly 180°.

On the basis of observations and conclusions from this experiment, Rutherford proposed the nuclear model of atom. According to this model:

(i) The positive charge and most of the mass of the atom was densely concentrated in extremely small region. This very small portion of the atom was called nucleus by Rutherford.

(ii) The nucleus is surrounded by electrons that move around the nucleus with a very high speed in circular paths called orbits. Thus, Rutherford's model of atom resembles the solar system in which the nucleus plays the role of sun and the electrons that of revolving planets.

(iii) Electrons and the nucleus are held together by electrostatic forces of attraction.

1) The atomic theory of matter was first proposed on affirm scientific basis by.

(a) John Dalton

(b) Ernest Rutherford

(c) J. Thomson

(d) Henry Moseley

2) The cathode rays start from ..... and move towards the .....

(a) Anode , Cathode

(b) Centre , Anode

(c) Cathode , Anode

(d) Cathode , Centre

3) Negatively charged particles in atoms , called .....

(a) Protons

(b) electrons

(c) Neutron

(d) Positron

(4) The smallest and lightest positive ion was obtained from ..... and was called proton.

(a) Oxygen

(b) Nitrogen

(c) Carbon

(d) Hydrogen

(5) Electrically neutral particles having a mass slightly greater than that of protons, these particles termed as ……

(a) Protons

(b) electrons

(c) Neutron

(d) Positron

2. The presence of positive charge on the nucleus is due to the protons in the nucleus. As established earlier, the charge on the proton is equal but opposite to that of electron. Atomic number (Z) = number of protons in the nucleus of an atom = number of electrons in a neutral atom. protons and neutrons present in the nucleus are collectively known as nucleons. The total number of nucleons is termed as mass number (A) of the atom.

mass number (A) = number of protons (Z) + number of neutrons (n).

Isobars are the atoms with same mass number but different atomic number for example, $6^{14}C$ and $7^{14}N$. On the other hand, atoms with identical atomic number but different atomic mass number are known as Isotopes. For example, considering of hydrogen atom again, 99.985%of hydrogen atoms contain only one proton. This isotope is called protium ($1^{1}H$). Rest of the percentage of hydrogen atom contains two other isotopes, the one containing 1 proton and 1neutron is called deuterium ($^{2}_{1}D$, 0.015%)and the other one possessing 1 proton and 2neutrons is called tritium ($^{1}_{3}T$)..the studies of interactions of radiations with matter have provided immense information regarding the structure of atoms and molecules. Niels Bohrutilised these results to improve upon the model proposed by Rutherford. Two developments played a major role in the formulation of Bohr's model of atom. These were:

(i) Dual character of the electromagnetic radiation which means that radiations possess both wave like and particle like properties, and

(ii) Experimental results regarding atomic spectra.

James Maxwell (1870) was the first to give a comprehensive explanation about the interaction between the charged bodies and the behavior of electrical and magnetic fields on macroscopic level. He suggested that when electrically charged particle moves undercalculation, alternating electrical and magnetic fields are produced and transmitted. These fields are transmitted in the forms of waves called electromagnetic waves or electromagnetic radiation. radiations are characterised by the properties, namely, frequency (v) and wavelength (λ).The SI unit for frequency (v) is hertz(H_z, s^{-1}), after Heinrich Hertz. It is defined as the number of waves that pass a given pointing one second. Wavelength should have the units of length and as you know that the SI units of length is meter (m). Since electromagnetic radiation consists of different kinds of waves of much smaller wavelengths, smaller units are used. In vacuum all types of electromagnetic radiations, regardless of wavelength, travel at the same speed, i.e., 3.0×10^{8}m

s^{-1} (2.997925× 10^8 ms^{-1}, to be precise). This is called speed of light and is given the symbol 'c'. The frequency (ν), wavelength (λ) and velocity of light(c) are related by the following equation .

$c = \nu \lambda$

The other commonly used quantity specially in spectroscopy, is the wavenumber. It is defined as the number of wavelengths per unit length. Its units are reciprocal of wavelength unit, i.e., m^{-1}. However commonly used unit is cm^{-1}

1) The presence of positive charge on the nucleus is due to the ..... in the nucleus.

(a) Protons

(b) Neutrons

(c) Electron

(d) Nucleons

2) Atomic Number is denoted by .....

(a) A

(b) Z

(c) N

(d) M

3) Atomic Mass number is denoted by .....

(a) M

(b) Z

(c) N

(d) A

4) ..... are the atoms with same mass number but different atomic number.

(a) Isotopes

(b) Allotropes

(c) Isobars

(d) None of above

5) Atoms with identical atomic number but different atomic mass number are known as ..

(a) Isotopes

(b) Allotropes

(c) Isobars

(d) None of above

Answer Key:

MCQ

1. (a) Cu^{+2}, Ti^{+3}
2. (b) Half
3. $4 \times 10^{4} cm^{-1}$
4. (d) (d) and (e)
5. (a) Li^{2+}
6. (a) 1.51 eV
7. (d) Chadwick
8. (c) 50
9. (9) 5s
10. (a) 1.05×10^{-34} Jsec
11. (d) $9.84 \times 10^{5} J\ mol^{-1}$
12. (b) 7
13. (c) 14
14. (b) n = 2, Be^{3+}
15. (c) Orientation of orbitals

Very Short Answer:

1. No. of electrons in NO3– ion
= No. of electrons on N + No. of electrons on 3 oxygen atoms + one ē
= 7 + 3 × 8 + 1 = 32 electrons.

2. The nucleus of hydrogen. It contains only one proton.

3. The neutrons and protons present in the nucleus of an atom are collectively called nucleons.

4. Cr = 24 = $1s^2$, $2s^2$ $2p^6$, $3s^2$ $3p^6$ $3d^5$, $4s^1$.

5. According to the de-Broglie equation $\lambda = \frac{h}{m \times v}$ for same value of velocity $\lambda \propto \frac{1}{m}$

$\therefore$ O_2 molecule has shortest wavelength.

6. C = 6 = $1s^2$, $2s^2$, $2p^1x$ $2p^1y$. There are only two unpaired electrons.

7. Emission line spectrum.

8. Three electrons (one each in $3p_x$' $3p_y$', $3p_z$').

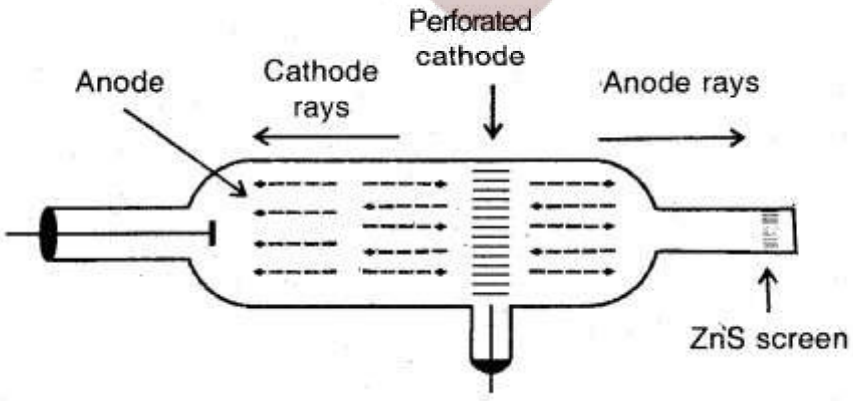
9. Balmer Series.

10. Y-rays, X-rays, UV-rays, visible rays, radio waves, etc.

Short Answer:

Ans: 1. The mass of positive particles which constitute these rays depend upon the nature of the gas in the tube. The charge/mass (e/m) ratio of anode-rays is not constant but depends upon the nature of gas in the tube. The value of e/m is greatest for the lightest gas, hydrogen the electric charge on a lightest positively charged particle from hydrogen gas was found to be exactly equal in magnitude but opposite in sign to that of the electron. This lightest positively charged particle from hydrogen gas was named the proton. The mass of a proton is almost 1836 times that of the electron.

Ans: 2. Anode-rays. If a perforated cathode is used in the discharge tube experiment, it is found that a certain type of radiation also travels from anode to cathode. These are called anode rays or positive rays.



Production of anode rays

Ans: 3. The cathode rays possess the following properties:

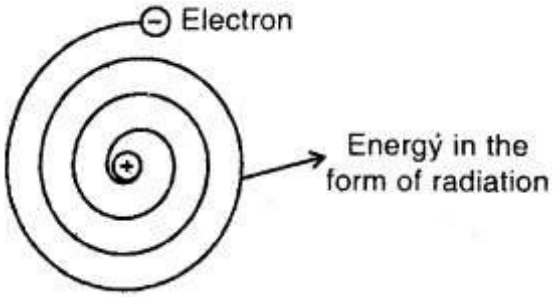
1. Travel in straight lines perpendicular to the surface of the cathode.
2. Consists of material particles.
3. Have got the heating effect.
4. Consists of negatively charged particles.
5. Produce X-rays when they strike against hard metals like copper, tungsten, platinum, etc.
6. Produce fluorescence when they strike glass or certain other materials like zinc sulfide.
7. Penetrate through thin aluminum foils and other metals.
8. Affect the photographic plates.

Ans: 4. The main features of this model are:

1. Atom is spherical and consists of two parts: Nucleus and extra-nuclear part.
2. The entire mass and entire positive charge are concentrated in a very small region at the center known as the nucleus.
3. The space surrounding the nucleus known as the extra-nuclear part is negatively charged so an atom as a whole is neutral.
4. Most of the extra-nuclear part is empty.
5. The electrons are not stationary but are revolving around the nucleus at very high speeds like planets revolving around the Sun.

Ans: 5. The fact that light energy is carried in terms of packets of energy (i.e., photons) as suggested by Planck's theory means that light has a particle character. At the same time, the fact light has a wave character. These experimental facts led Einstein to suggest that light has a dual character, i.e., it behaves both like a wave and like a particle.

Ans: 6. The main drawback is that it could not explain the stability of an atom. Maxwell has shown that when electric charge is subjected to acceleration, it emits energy in the form of radiations. In Rutherford's model of the atom, electrons are orbiting the nucleus and hence the direction of their velocity is constantly changing, i.e., electrons are accelerating.
This will cause the electrons will have lesser and lesser energy and will get closer and closer to the nucleus until at last, it spirals into the nucleus and thus does not provide a stable model of the atom.



Ans: 7. J. Thomson determined the value of e/m for electron by the study of deflection of electron beam under the simultaneous influence of electric and magnetic field perpendicular to each other, the e/m value is 1.76 × 108 coulomb per gram of electrons

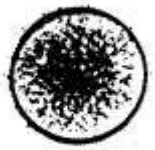
The charge of electrons was measured by Millikan in 1909 by his famous 'oil drop' experiment. It was found to be 1.60 × 10-19 coulombs.

The mass of electrons is 9.1 × 10-28 g.

Long Answer:

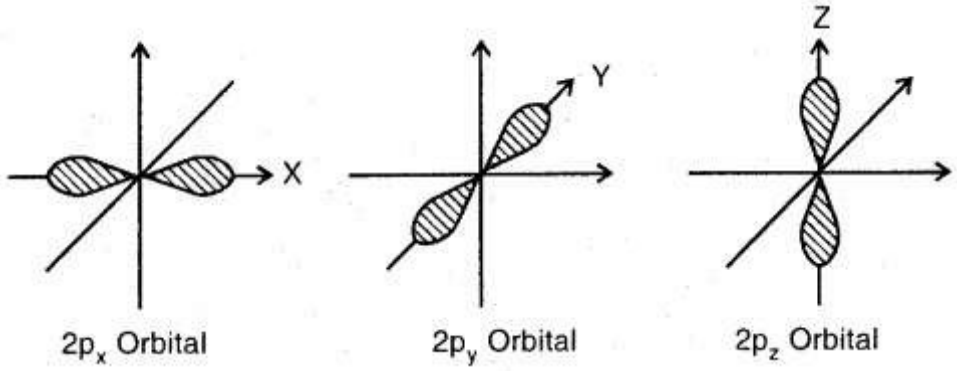
Ans: 1. Shapes of Orbitals:

s-orbitals: These are spherically symmetrical and non-directional. Shapes of 1s and 2s orbitals are shown in Fig. The effective volume of 2s orbital is larger than is orbital. Another important feature of 2s orbital is that there is a spherical shell within 2s (region without dots) where the probability of finding the electron is zero. This is called a node or a nodal surface. There are (n - 1) nodes in an s-orbital (where n is the energy level).


1s-Orbital

2s-Orbital

p-orbitals: There are three p-orbitals designated as px', py' or pz' which are oriented along the three mutually perpendicular axis x, y, and 2. Each, orbital consists of two lobes symmetrical about the particular axis and has a dumbbell shape. The two lobes are separated by a nodal plane.



Shapes of three 2p orbitals

The two lobes of each orbital are separated by a plane having x zero electron density. This plane is known as a nodal plane.

Ans: 2. Probability Picture of Electrons:

Schrodinger incorporated the requirements of the uncertainty principle and de Broglie's concept of matter waves and proposed a mathematical equation to describe the behavior of an electron in an atom. The equation was known as the Schrodinger wave equation.

The Schrodinger wave equation is

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}+\frac{\partial^2\psi}{\partial z^2}+\frac{8\pi^2 m}{h^2}(E-V)\,\psi=0$$

where x, y, and z are three space coordinates,

m is the mass of the electron,

h is Planck's, constant

E is the total energy and V is the potential energy of the electron, ϕ (Greek letter psi) is the amplitude of the wave, called wave function, $\frac{\partial 2\psi}{\partial x2}$ refers to the second derivative of ϕ with respect to x only and so on.

The solution of this equation gave the mathematical expression which gives information about the various energy states and other measurable properties such as the radiation frequencies emitted or absorbed for the hydrogen atom. The solutions of the Schrodinger wave equation are called wave functions and are denoted by the symbol ϕ.

The physical significance of wave function: In the physical sense ϕ gives the amplitude of the wave associated with the electron. We know that in the case of light waves, the square of

the amplitude, of the wave at a point is proportional to the intensity of light. Extending the same concept of electron wave motion, the square of the wave function, ϕ2 may be taken as the intensity of electrons at any point.

In other words, ϕ^2 determines the probability density. Thus, ϕ^2 has been called the probability density and ϕ the probability amplitude. Thus, the solutions of the Schrodinger wave equation replace the discrete energy levels or orbits proposed by Bohr and led to the concept of the most probable regions in space in terms of $\phi 2^2$.

A large value of ϕ^2 means a high probability of finding the electron at that place and a small value of ϕ^2 means low probability. If ϕ^2 is almost zero at a particular point, it means that the probability of finding the electron at that point is negligible. Therefore, the wave mechanics approach gives meaningful wave functions which describe the position and energy levels of electrons in an atom.

Concept of Orbital: An orbital is a region in space around the nucleus where the probability of finding the electrons is maximum.

Ans: 3. Nucleons = 254, electrons = 102 and neutrons 254 - 102 = 152.

Ans: 4.

Particle	Atomic No.	Mass No.	No. of electrons	No. of protons	No. of neutrons
Sodium atom	11	23	11	11	12
Aluminium ion	13	27	10	13	14
Chloride ion	17	35	18	17	18
Phosphorus atom	15	31	15	15	16
Cuprous ion	29	64	28	29	35

Ans: 5.

Name of the particle	Mass No.	Atomic No.	Protons	No. of Electrons	Neutrons
Oxygen	16	8	8	8	8
Sodium ion	23	11	11	10	12
Bromine	80	35	35	35	45

Assertion Reason Answer:

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

2. (ii) Both A and R are true but R is not the explanation of A.

Case Study Answer:

1. Answer:

(1) (a) John Dalton

(2) (c) Cathode, Anode

(3) (b) electrons

(4) (d) Hydrogen

(5) (c) Neutron

2. Answer:

(1) (a) Protons

(2) (b) Z

(3) (d) Z

(4) (c) Isobars

(5) (a) Isotopes