Atomic Structure

Introduction, Fundamental Particles

1. Dalton's Atomic Theory

i. Matter is composed of tiny indivisible particles called atoms which are the building blocks of all elements.

ii. All atoms of the given element are identical in size, mass and characteristics.

iii. The atoms of one element are different from the atoms of all other elements.

iv. The compounds contain atoms of different elements combined in whole number ratios.

v. Atoms can neither be created nor destroyed in chemical reactions.

This theory explains successfully the law of conservation of mass, law of constant proportions and law of multiple proportions but it can't explain why glass or ebonite generate electricity when rubbed with silk or fur.

2. The cathode rays are produced when a gas at low pressure (0.01 mm of Hg) is subjected to high electric discharge (10,000 Volts).

The characteristics of cathode rays are

i. The cathode rays start from cathode

(–ve electrode) and move towards the anode (+ve electrode).

ii. The cathode rays are invisible but their behaviour can be observed with the help of fluorescent material such as zinc sulphide. Cathode rays also can produce phosphorescence.eg: Television picture tube.

iii. The cathode rays travel in straight line in the absence of electric or magnetic field.

iv. The cathode rays are deflected towards the positively charged plate in the presence of electric field and South Pole in the magnetic field. This shows that the cathode rays consist of a stream of negatively charged particles called electrons. The name electron was suggested by Stoney.

v. Cathode rays produced are independent of the nature of the cathode material and nature of the gas present in the cathode ray tube.

3. The extent of deviation of the particles from their path in the presence of electrical and magnetic fields increases with

   i. Increase in The magnitude of the charge on the particle.

   ii. Decrease in the mass of the particle.

   iii Increase in the voltage across the electrodes or the strength of the magnetic field.

4. Thomson determined the value of charge to mass ratio as,

5. The charge on the electron was determined by Millikan by oil drop experiment method

   as -1.6022×10^{-19}C.

6. The rest mass of electron is calculated by Thomson as 9.1094×10^{-31} Kg.

7. The mass of an electron is approximatelyth$1/1837^{th}$, the mass of hydrogen atom. The mass of electron in relative units is 0.0005486 amu.

8. The mass of moving electron = $\dfrac{\text{rest mass of electron}}{\sqrt{1-\left(\dfrac{v}{c}\right)^2}}$.

   Here v is the velocity of electron and c is the velocity of light. When 'v' becomes equal to 'c', mass of the moving electron becomes infinity.

9. If velocity increases, mass of electron increases and specific charge of electron decreases.

10. The charge on one mole electrons is 1Faraday i.e. 96500columbs.

11. The mass of one mole electrons is 0.55mg.

12. Goldstein observed positive rays by using perforated cathode in discharge tube.

13. The anode rays are attracted towards the negative plate in the electric field and towards North Pole in magnetic field. This means that these rays consist of positively charged particles. A proton is   a subatomic particle which carries a unit positive charge. The name proton was suggested by Rutherford.

14. Specific charge of positive rays is not constant. It is maximum when hydrogen gas is taken in the discharge tube. The e/m of proton (H$^+$) is 9.58×10^7 C kg^{-1}.

15. Mass of a proton is 1.672×10^{-27}kg   or 1.00727amu.

16. Mass of one mole of protons is 1.007g.

17. The mass of proton is 1836 times the mass of electron and is nearly equal to the mass of hydrogen atom.

18. A neutron is a sub atomic particle which carries no charge. Neutron was discovered by James Chadwick by bombarding lighter elements with alpha particles.

    Eg: Neutrons are formed when beryllium-9 is bombarded with alpha particles.

19. The mass of neutron has been found to be 1.675×10^{-27} kg or 1.008665 amu. It is 1838 times the mass of electron and is very slightly heavier than the mass of a proton.

20. The existence of the nucleus was discovered by Rutherford by the á - ray scattering experiment

21. Most of the á - particles passed through the gold foil i.e., the atom has largely empty space.

    b) Few of the - particles were scattered from their paths. It was concluded that positive charge is concentrated at one point called "nucleus".

22. Rutherford's atomic model can't explain

    i) Stability of atom,   ii) Electronic structure of atom   iii) Line spectrum of hydrogen

23. Except protium, atoms of all other elements contain electron, proton and neutrons. These are called fundamental particles.

24. Atomic number (Z) is the number of protons in the nucleus.

25. Mass number (A) is the sum of number of protons and number of neutrons in the nucleus.

26. Number of Neutrons = Mass number (A) – Atomic number (Z)

27. Atoms with identical atomic numbers but different mass numbers are known as isotopes.

    Eg: $_1H^1$, $_1H^2$, $_1H^3$

28. Atoms with same mass number but different atomic number are called isobars.

    Eg: $_6C^{14}$ & $_7N^{14}$

29. Isotopes have same chemical properties but different physical properties.

30. Atomic mass of many elements are in fractions due to existence of Isotopes.

Nature of Electro Magnetic Radiation

Wave Theory, Blackbody Radiations, Planck's Quantum Theory, Photo Electric Effect

1. Cosmic rays, γ - rays, X - rays, UV light, visible light, Infrared light, micro waves, TV waves and radio waves are called electromagnetic radiations as they are associated with both electric and magnetic properties.

2. Electromagnetic radiations travel even in vacuum and no medium is required for their propagation.

3. The distance between two neighbouring troughs or crests in wave is known as wave length. It is expressed in m, cm, A^0 , nm, mμ . $1nm=1m\mu=10A^0$, $1A^0 =! 0\text{-}8cm$

4. The number of waves that pass through a given point in one second is called frequency. Its units are cycles / second (cps) or Hertz (Hz).

5. The number of wave lengths per centimetre or the reciprocal of wave length is called Wave Number. $(\bar{\nu})$. It has unit's cm^{-1}. Or m^{-1}

6. The height of the crest or depth of the trough of a wave is called amplitude.It is a measure of the intensity or brightness of a beam of light.

7. The distance travelled by a wave in one second is called its velocity.The units of velocity are m/sec or cm/sec.

8. All types of electromagnetic radiations have the same velocity which is equal to $3\times10^{10}\,cm\,/\sec\,or\,3\times10^8\,m\,/\sec$

Relationship between Wave Characteristics

9. $\nu = \dfrac{C}{\lambda}$ or $\lambda = \dfrac{C}{\nu}$ ...... (1) $\qquad\qquad$ $\bar{\nu} = \dfrac{1}{\lambda}\ =\dfrac{\nu}{C}$ ...... (2)

    Where, $\nu =$ frequency in $\sec^{-1}$, $\lambda =$ wavelength in cm C = velocity of light $= 3\times10^{10}\,cm\,/\sec$

    $\bar{\nu} =$ wave number in cm^{-1}

10. The wave length of UV light is $\qquad\qquad$ $1800 - 3800\ A^0$

    The wave length of visible light is $\qquad$ $3800 - 7600\ A^0$

    The wave length of IR radiation is $\qquad$ $7600 - 3\times10^6\ A^0$

11. The properties of light like diffraction and interference can be explained by the wave nature of the electromagnetic radiation.Wave theory failed to explain the phenomena of photo electrical effect.

12. A perfect absorber and perfect emitter of radiant of energy.is called a Black body

13. A hollow metallic sphere coated inside with platinum black and having a small hole in its wall acts as a black body.

14. The radiation of different wave lengths or frequencies is emitted by a hot Black body

15. At a given temperature, the intensity of radiation increases with wavelength, reaches a maximum and then decreases. With increase in temperature, the peak of curve increases but shifts towards the shorter wavelength
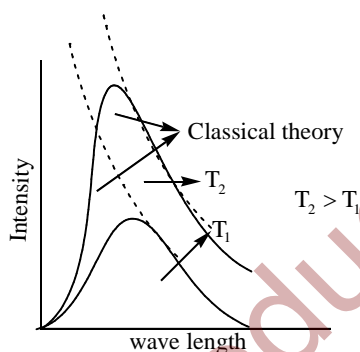
16. Max Planck proposed quantum theory to explain the black body radiations.

17. The energy emitted by hot substance is not continuous but is discontinuous in the form of Packets called quanta.

18. The energy emitted in the form of quanta is propagated as Waves.

19. The energy of a quantum is directly proportional to the frequency of the radiation.

20. The energy of a quantum is $E = h\nu = \dfrac{hc}{\lambda} = hc\ \overline{\nu}$

   Where h is Planck's constant i.e. 6.625×10^{-27} erg $-$ sec or 6.625×10^{-34} Joule $-$ sec

   C is Velocity of light $= 3 \times 10^{10}$ cm / sec or 3×10^{8} m / sec

   $\nu =$ Frequency of radiation in

   $\lambda =$ Wave length in cm

   $\overline{\nu} =$ Wave number in cm^{-1}

21. A body can absorb or emit in whole number of quantum $E = nh\nu$.

22. Planck's equation determines dual nature i.e both wave nature and particle nature of light.

23. Ejection of electrons from the surface of a metal by irradiating it with light of suitable frequency is called photo electric effect.It is readily exhibited by alkali metals except Li.

24. For any metal surface to emit electrons, light of a certain minimum frequency called threshold frequency is required.

25. With an increase in the frequency of the light, the velocity of the emitted electron increases.

26. With an increase in the intensity of the light, the number of electrons emitted i.e. photo current increases.

27. The K.E of the emitted electron is given, K.E.= $1/2 \, mv^2 = h\nu - h_0$

    Where ν, is the frequency of the light and ν_0 is threshold frequency

    $h\upsilon = w + kE$ Or $\quad h\upsilon = h\upsilon_o + kE$

28. Threshold frequency.is charecteristic of the metal and vary from one metal to another.

29. Threshold frequency of Alkali metals is Na>K>Rb>Cs.