Calcium (Ca)	40.0

- The atomic mass of an element expressed in grams is known as gram atomic mass. (Gram atomic mass is also known as gram atomic weight)
- The number of times a molecule of a compound is heavier than the $\frac{1}{12}$ of the mass of C-12 atom, is known as its molecular mass.
- The molecular mass of a substance expressed in grams is known as gram molecular mass.

Calculations of Molecular Mass

The molecular mass is equal to the sum of the atomic masses of all atoms present in one molecule of the substance. H_2O consists of two atoms of hydrogen and one atom of oxygen, so molecular mass of H_2O is equal to sum of atomic masses of two hydrogen atom (i.e., $2 \times 1 = 2$) and atomic mass of one atom of oxygen (i.e., $1 \times 16 = 16$). Thus molecular mass of $H_2O = 2 + 16 = 18$.

- **Formula unit mass :** It is equal to the sum of atomic masses of all the atoms in a formula unit. In case of **ionic compounds** like NaCl formula mass is **58.5** (23 + 35.5 = 58.5)
- **Mole concept :** The number of particles present in one mole (i.e. 6.023×10^{23} particles) is called **Avogadro's number or Avogadro's constant.** Mole is a collection of 6.022×10^{23} particles. They may be atoms, molecules, ions, electrons, protons etc.
- **Mole :**

  1 mole molecules = gm molecular mass

  Number of moles (in a substance)

$$= \frac{\text{Mass of substance in grams}}{\text{grams molecular mass}}$$

$$= \frac{\text{Volume of gas in litre (at N.T.P.)}}{22.4}$$

One mole of magnesium (Mg) = 6.02×10^{23} magnesium atoms

= 24 gram of Mg^{24}

One mole of atomic nitrogen (N^{14}) = 6.02×10^{23} nitrogen atoms

= 14 gram of N^{14}.

One mole of molecular nitrogen (N_2) = 6.02×10^{23} N_2 molecules

= 28 gram of N_2 molecules.

Mole and Gram Atomic Mass

Since 1 mole of any atomic substance is equal to its gram atomic mass and contains 6.023×10^{23} atoms of that element therefore gram atomic mass of an element is defined as the mass of Avogadro number of atoms [i.e., mass of 6.023×10^{23} atoms]. For example,

Mass of 6.023×10^{23} atoms of oxygen = 16 g

Mole and Gram Molecular Mass

One gram molecular mass of any molecular substance is its gram molecular mass and contains 6.023×10^{23} molecules of that substance. Therefore, gram molecular mass of any substance is defined as the mass of Avagadro's number of molecules (i.e., mass of 6.023×10^{23} molecules) of that substance. For example,

Mass of 6.023×10^{23} molecules of oxygen (O_2) = 32 g

- Mass of a single atom $= \frac{\text{Atomic mass (g mole}^{-1})}{6.023 \times 10^{23}\text{ atom}}$

  Mass of a single molecule $= \frac{\text{Molar mass (g mole}^{-1})}{6.023 \times 10^{23}\text{ molecules}}$

- In case of gases, a mole is defined as that amount of the gas which has a volume of 22.4 litres at STP.

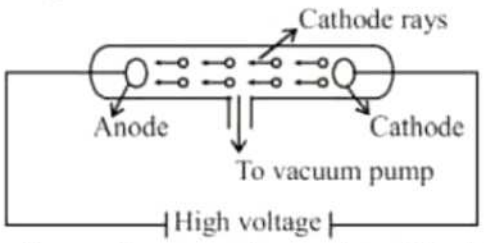
  1 mole of CO_2 gas = 22.4 litres at NTP

  1 mole of helium gas (He) = 22.4 litres at NTP

CATHODE RAYS (ELECTRONS)

When a *high potential difference* of 20,000 volts is applied *across a gas* taken in a *discharge tube* at *low*

pressure of about 0.001 torr, some *radiations* are *emitted from the cathode*. These move towards the anode. These rays are called *cathode rays* because *they emanate from the cathode.*



This experiment was done by **J.J. Thomson** an English physicist.

Properties of Cathode Rays

(i) The cathode rays are constituted by fast moving *electrons.*

(ii) These rays travel in a *straight line.*

(iii) These rays posses *mechanical energy.*

(iv) These rays *produce heat* when focussed on metals.

(v) These rays produce *flourescenes* when focussed on metals.

(vi) They affects the photographic plate.

(vii) They are deflected by electric and magnetic field.

(viii) They ionize the gases through which they pass.

ANODE RAYS OR CANAL RAYS OR POSITIVE RAYS (PROTONS)

If we use a perforated cathode in the *discharge tube* and then apply high voltage and if the pressure is below 0.001 mm Hg, we will observe a new type of rays coming through perforation in the cathode. These rays were initially called *anode rays* as they move from anode side through the gas. In a discharge tube, when the *gas atoms lose electrons, they acquire a positive charge and move away from the anode.*

Properties of Anode Rays

(i) They travel in a *straight line.*

(ii) They can produce *mechanical effects.*

(iii) Anode rays are *positively charged*.

(v) The nature of anode rays depends upon the gas taken in the discharge tube.

(vi) The mass of anode rays particles is almost equal to the mass of an atom from which it is formed.

Note : Unlike cathode rays which originate from the metals or electrodes which constitute cathode, the anode rays never originate from anode. These are the positive residues which are left when electrons are knocked out of the atoms of the gases enclosed in the discharge tube.

- *Electron*, *proton* and *neutron* are subatomic particles.

The credit for discovery of these particles goes to **Electron** — J.J. Thomson and **Proton** — E. Goldstein

Another subatomic particle which is *neutral* and has a mass approx. equal to that of a proton was called **neutron** and was discovered by **chadwick**. The neutron is a neutral particle found in the nucleus of an atoms. Atom of all elements contain neutron (except hydrogen atom which does not contain neutron). The relative mass of neutron is 1 amu and it carries no charge (i.e., it is neutral)

Properties of Atomic Particles (Comparative)

	Particle	Electron	Proton	Neutron
(i)	Symbol	e or e^-	p	n
(ii)	Nature	Negatively charged	Positively charged	neutral (no charge)
(iii)	(a) Charge (b) Unit charge	(a) -1.6×10^{-19}C (b) –1	(a) $+1.6 \times 10^{-19}$C (b) + 1	0 0
(iv)	Mass (a) amu (b) kg	(a) 0.0005486 amu (b) 9.1×10^{-31} kg	(a) 1.00753 amu (b) 1.67265×10^{-27} kg	(a) 1.00893 amu (b) 1.67495×10^{-27} kg
(v)	Location	Extra nuclear space	nucleus	nucleus
(vi)	Notation	$_{-1}e^0$	$_1^1p$	$_0n^1$
(vii)	Relative mass	1/1840	1	1

THOMSONS MODEL OF ATOM

J.J. Thomson was the first to propose separately structure of atom in the form of a model.

He suggested the following structure in 1899, which was based on his experimental work.

Various postulates suggested are :

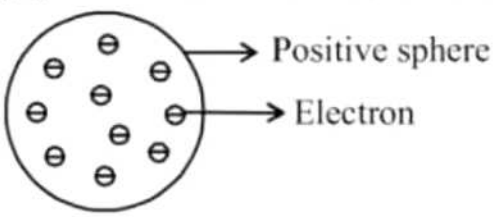
(i) Inside an atom electron are present.

(ii) These electrons are embedded in a sphere of positive charge

(iii) Mass of an atom is due to electrons only

(iv) The negative and positive charge balance each other

(v) Atom as a whole is neutral.



Drawbacks of Thomson's Model

This model failed to explain the results of experiments done by other scientists.

RUTHERFORD'S MODEL OF THE ATOM

Rutherford (1911) performed scattering experiment by bombarding fast moving α-particles, emitted from a radioactive substance, on thin foil (4×10^{-5} cm thick) of the metals like silver, gold, copper, platinum, etc.

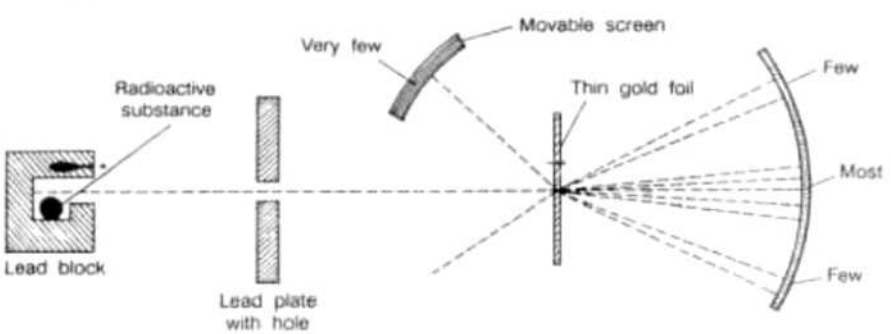


Fig. Rutherford's α -particle scattering experiment.

The observations led to the following conclusions.

(i) Most of the α-particles (nearly 99%) passed through the metal foil (Au, Ag, Pt, etc.) undeflected.

(ii) Some of the α-particles underwent deflection by small angles.

(iii) Very few α-particles (1 in 20,000) returned back suffering a deflection of 180°.

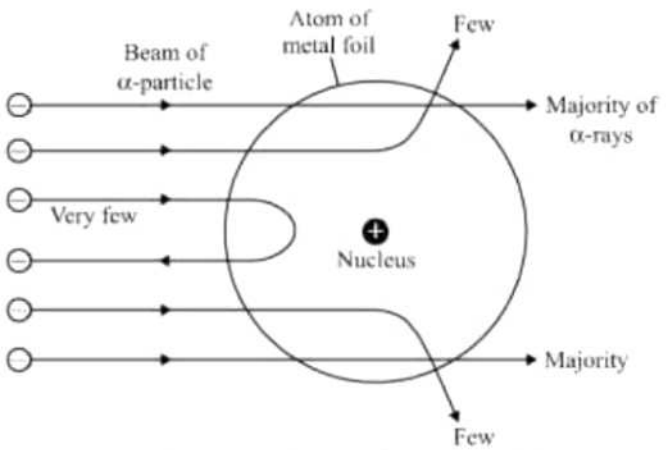


Fig. Scattering of α-particles

This experiment led Rutherford to conclude the main features as follows :

(i) Most of the space in the atom is largely empty as most of the α-particles pass straight through the atom.

(ii) Centre of the atom has a heavy positively charged body, called **nucleus**, which repel positively charged α-particles and thus explains the scattering phenomenon.

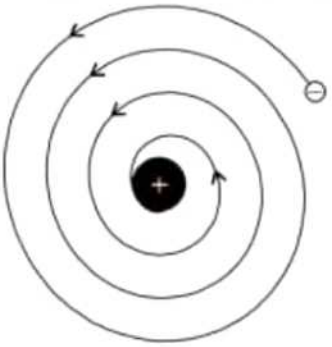
(iii) Whole of the atomic mass is concentrated in the nucleus i.e., the central nucleus is rigid and hence a-particles which strike on it are thrown back.

(iv) Since very few α-particles are deflected back, the size of the nucleus must be very small (radius nearly 10^{-13} cm) compared to the total volume of the the atom (radius nearly 10^{-8} cm). It shows that nucleus is 1/100000 in size compared to the total size of the atom.

Drawbacks of the Rutherford Theory

An electron revolving around the nucleus in a circular path will continuously lose energy and fall into the nucleus. However, the nucleus is found to be quite stable. Thus, Rutherford could not explain the stability of the nucleus in the light of continuous loss of the energy of the electron.

The stability of the atom is explained by Bohr's theory of atom in terms of orbits of fixed energies.



BOHR'S MODEL OF AN ATOM

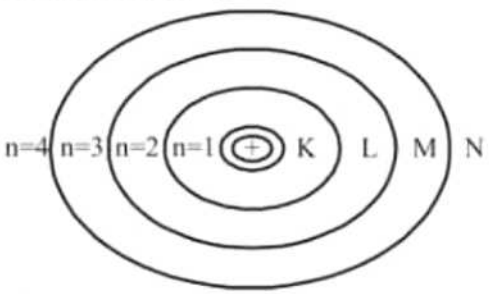
In order to explain the objections raised for Rutherford's model. **Neils Bohr** in 1912 gave a new model of atom called **Bohr's model.** Accoridng to this model

(i) An atom consists of a small positively charged **nucleus** situated at its centre.

(ii) The negatively charged electrons revolve around the nucleus in *certain definite circular paths* called *energy levels.*

(iii) Each energy level is associated with a *definite amount of energy.*

(iv) The energy levels are either numbered 1, 2, 3, 4 (n = 1, 2, 3, 4 ....) or designated as K, L, M, N ..... outwards from the nucleus.



(v) The change in energy of an electron takes place only when it jumps from a lower energy level to a higher energy level (gain of energy) or when it jumps from a higher energy level to a lower energy level (Loss of energy). It means that as long as the electrons remain in a given energy level, they neither gain nor lose energy and atom remains stable.

Arrangement of Electrons in an Atom

The arrangement of electrons in various **shells** (energy levels) of an atom of the element is known as **Electronic configuration**.

The maximum number of electrons that could be put in a particular shell (i.e., energy levels was given by **Bohr** and **Bury**.

According to Bohr-Bury Scheme

(i) The maximum number of electrons that can be accommodated in any energy level is given by $2n^2$ where $n = 1, 2, 3, 4, ...$ (for $K, L, M, N.....$)

For $\frac{1st}{n}$ orbit or K-shell, it will be

$= 2 \times 1^2 = 2$

For $\frac{2nd}{n}$ orbit or L-shell, it will be

$= 2 \times 2^2 = 8$

For $\frac{3rd}{n}$ orbit or M-shell, it will be

$= 2 \times 3^2 = 18$

For $\frac{4th}{n}$ orbit or N-shell, it will be

$= 2 \times 4^2 = 32$

(ii) The maximum number of electrons in the outermost orbit will be 8 electrons even if it has capacity to accommodate more electrons.

(iii) The next to the outermost shell cannot accommodate more than 18 electrons even if it has a capacity to accommodate more.

(iv) Electrons are not accommodated in a given shell. Unless earlier shells are filled, that is stepwise filling of shells is followed.

Atomic Number

Each element has been assigned an atomic number (Z) that describes the number of protons in the nucleus of an atom of that element. i.e., atomic number (Z) = number of proton = number of electron (in a neutral atom).

Mass Number

The nucleus of an atom is also described by a mass number (A), which is the sum of the number of protons and neutrons in the nucleus. The differ-

ence between the mass number and the atomic number of an atom is therefore equal to the number of neutrons in the nucleus of that atom.

Mass number (A) = number of protons + number of neutrons

or Number of neutrons = A – Z

The carbon atom has a mass number of 12 because it contains six protons and six neutrons.

Isotopes

Atoms with the same atomic number but different mass numbers are called isotopes. Carbon, for example, has the three naturally occurring isotopes shown in Figure : ^{12}C, ^{13}C, and ^{14}C. Carbon-12 (^{12}C) has six protons and six neutrons, ^{13}C has six protons and seven neutrons, and ^{14}C has six protons and eight neutrons.

The characteristics of isotopes are:

(i) They have different atomic masses (mass number)

(ii) They have the same atomic number.

(iii) They have the same electronic configuration.

(iv) They have the same valence electrons.

(v) They have the same chemical properties.

(vi) They have slightly different physical properties.

Applications of Isotopes

Isotopes are used in various fields. For example.

(i) Isotope of uranium is used as a fuel in nuclear reactor

(ii) Isotope of cobalt is used in treatment of cancer

(iii) Isotope of iodine is used in treatment of goitre.

Isobars

Atoms whose atomic numbers are different but mass numbers are same. Such atoms are called isobars. Some important examples of Isobars are as follows : Argon $_{18}Ar^{40}$, Potassium $_{19}K^{40}$ and Calcium $_{20}Ca^{40}$ are Isobars.

The characteristics of isobars are

(i) They have the same mass number.

(ii) They have different atomic numbers.

(iii) They have different number of protons.

(iv) They have different electronic configurations.

(v) They have different number of valence electrons.

(vi) They have different chemical properties.

RADIOACTIVITY

- It was discovered by Henry Becquerel but term radioactivity was given by Madam Curie. It is the process of spontaneous disintegration of nucleus and is measured by Geiger counter.
- It is a nuclear phenomenon, thus remains unaffected by external factors like temperature, pressure, etc.

Radioactive Rays

- Radioactivity involves emission of, and γ rays or particles. The original unit of radioactivity is curie (Ci). Curie is replaced by becquerel (Bq) in SI unit.

Alpha (α) Rays

- These rays consist of positively charged helium nuclei (He^{++}). They have +2 unit charge and 4 mass.
- They have low penetrating power but very high ionising power and kinetic energy.
- An α-emission reduces the atomic mass by 4 and atomic number by 2, thus, the new nuclei formed occupy a position two places left to the parent nuclei in the periodic table.

Beta (β) Rays

- These rays consist of negatively charged electrons ($_{-1}e^{0}$) and have – 1 unit charge and zero mass.
- These are more dangerous than α-rays.
- These have high penetrating power as compared to -rays.

- A -emission increased the atomic number by one with no change in atomic mass, thus, the new nuclei obtained occupy a position one place right to the parent nuclei in the periodic table.

Gamma (γ) Rays

- These are electromagnetic radiation and have very high penetrating power.
- These have low ionising power and kinetic energy.
- Their emission does not affect the position of nuclei in the periodic table.

Half-Life Period

- It is the time in which a radioactive substance remains half of its original amount.

Nuclear Fission

- It is a process in which a heavy nucleus is broken down into two or more lighter fragments.
- It is usually accompanied with the emission of neutrons and large amount of energy. It is used in nuclear reactor and atom bomb.

Atom Bomb

- It is based on uncontrolled nuclear fission. It contains ^{235}U or ^{239}Pu as fuel.

Nuclear Reactor

- It is a device that is used to produce electricity and permits a controlled chain nuclear fission.
- It contains fuels, e.g. $_{92}U^{235}$, moderator (e.g. graphite and heavy water, D_2O) to slow down neutrons and control rods (made up of boron steel or cadmium) to absorb neutrons.
- It may also contain liquid sodium as coolant.

Nuclear Fusion

- It is a process which involves fusion of two or more lighter nuclei to give a heavier nuclei.

- It occurs only at extremely high temperature (> 106 K), so also called thermonuclear reactions.
- It is used in hydrogen bomb. Energy of Sun is also a result of a series of nuclear fusion reactions.

Hydrogen Bomb

It contains a mixture of deuterium oxide (D_2O) and tritium oxide (T_2O) in a space surrounding an ordinary atom bomb.

Radiocarbon Dating

- It is used in determining the age of carbon bearing materials such as wood, animal fossils, etc. It is based on the concentration of carbon and carbon isotopes.

Uranium Dating

It is used to determine the age of earth, minerals and rocks.

Uses of Radioisotopes

1. Iodine-131 is employed to study the structure and activity of thyroid gland. It is also used in internal radiation therapy for the treatment of thyroid disease.
2. Iodine-123 is used in brain imaging.
3. Cobalt-60 is used in external radiation therapy for the treatment of cancer.
4. Sodium-24 is injected along with salt solution to trace the flow of blood.
5. Phosphorus-32 is used for leukemia therapy.
6. Carbon-14 is used to study the kinetics of photosynthesis.

GENERAL CONCEPTS OF CHEMISTRY

The study of chemistry is sub-divided into various branches such as:

(i) Physical chemistry

(ii) Inorganic chemistry

(iii) Organic chemistry
(iv) Biochemistry
(v) Analytical chemistry
(vi) Industrial chemistry
(vii) Agricultural chemistry
(viii) Applied chemistry

Exercise

DIRECTIONS : This section contains multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) out of which only one is correct.

1. Neon is
   (a) monoatomic
   (b) diatomic
   (c) triatomic
   (d) tetra atomic
2. Which of the following has an atomicity of 4?
   (a) H_2O
   (b) NH_3
   (c) PCl_5
   (d) CCl_4
3. The element present in water and hydrogen peroxide are
   (a) hydride and oxide
   (b) hydrogen and oxide
   (c) hydride and oxygen
   (d) hydrogen and oxygen.
4. The formula of barium phosphate is
   (a) $BaPO_4$
   (b) $Ba_2(PO_4)_3$
   (c) $Ba(PO_4)_3$
   (d) $Ba_3(PO_4)_2$
5. If the formula of a chloride of a metal is MCl_3, the formula of metal phosphate is
   (a) M_2PO_4
   (b) MPO_4
   (c) M_2PO_4
   (d) $M(PO_4)_3$
6. Which of the following is a binary compound of oxygen and hydrogen?
   (a) H_2O
   (b) H_2O_2
   (c) Both H_2O and H_2O_2
   (d) None of these
7. In a chemical change the total weight of the reacting substances compared to total weight of products is

(a) never the same
(b) always less
(c) always more
(d) always the same

8. The cathode ray experiment was done for the first time by
(a) J.J. Thomson
(b) John Dalton
(c) Goldstein
(d) Rutherford

9. The charge on an electron is
(a) 1.6×10^{-6} coulombs
(b) 1.6×10^{-20} coulombs
(c) 1.6×10^{-19} coulombs
(d) 1.6×10^{-16} coulombs

10. The nucleus of an atom contains
(a) protons
(b) electrons
(c) protons and neutrons
(d) neutrons

11. In an atom valence electron are present in
(a) outermost orbit
(b) next to outermost orbit
(c) first orbit
(d) any one of its orbit

12. The maximum number of electrons that can be accommodated in third shell (n = 3) is
(a) 2
(b) 8
(c) 18
(d) 10

13. In an atom, the constituent electrons
(a) do not move
(b) are uniformly distributed
(c) move around the nucleus in fixed energy levels.
(d) move around the nucleus in a random way.

14. What is the number of valence electrons of Al?
(a) 1
(b) 2
(c) 3
(d) 4

15. Which of the following statements is incorrect for cathode rays?

(a) They move in straight line
(b) Their nature depends upon the nature of gas present in the discharge tube.
(c) They cost shadow of solid objects placed in their path
(d) They get deflected towards positive charge.

16. The isotopes of an element have
(a) same number of neutrons
(b) same atomic number
(c) same mass number
(d) None of these

17. Which of the following statements is not correct for Bohr's model of an atom?
(a) The nucleus of an atom is situated at its centre
(b) The electrons move in circular orbits
(c) Electrons jumps from one orbit to another
(d) An electron neither loses nor gains energy when it jumps from one orbit to another.

18. The atomic number of an element is 11 and its mass number is 23. The correct order representing the number of electrons, protons and neutrons respectively in this atom is
(a) 11, 11, 12
(b) 11, 12, 11
(c) 12, 11, 11
(d) 23, 11, 23.

19. Which of the following pairs are isotopes?
(a) Oxygen and ozone
(b) Ice and steam
(c) Nitric oxide and nitrogen dioxide
(d) Hydrogen and deuterium.

20. An atom which has mass number of 14 and has neutron is an
(a) isotopes of oxygen
(b) isobar of oxygen
(c) isotope of carbon
(d) isobar of carbon

21. Which of the following have equal number of neutrons and protons?
(a) Hydrogen
(b) Deuterium

(a) They move in straight line
(b) Their nature depends upon the nature of gas present in the discharge tube.
(c) They cost shadow of solid objects placed in their path
(d) They get deflected towards positive charge.

16. The isotopes of an element have
(a) same number of neutrons
(b) same atomic number
(c) same mass number
(d) None of these

17. Which of the following statements is not correct for Bohr's model of an atom?
(a) The nucleus of an atom is situated at its centre
(b) The electrons move in circular orbits
(c) Electrons jumps from one orbit to another
(d) An electron neither loses nor gains energy when it jumps from one orbit to another.

18. The atomic number of an element is 11 and its mass number is 23. The correct order representing the number of electrons, protons and neutrons respectively in this atom is
(a) 11, 11, 12
(b) 11, 12, 11
(c) 12, 11, 11
(d) 23, 11, 23.

19. Which of the following pairs are isotopes?
(a) Oxygen and ozone
(b) Ice and steam
(c) Nitric oxide and nitrogen dioxide
(d) Hydrogen and deuterium.

20. An atom which has mass number of 14 and has neutron is an
(a) isotopes of oxygen
(b) isobar of oxygen
(c) isotope of carbon
(d) isobar of carbon

21. Which of the following have equal number of neutrons and protons?
(a) Hydrogen
(b) Deuterium

(c) Fluorine
(d) Chlorine

22. The relative atomic masses of many elements are not whole numbers because
(a) they cannot be determined accurately
(b) the atoms ionize during determination of their masses
(c) existence of isotopes
(d) presence of impurities

23. Which of the following has a charge of +1 and a mass of1 amu ?
(a) A neutron
(b) A proton
(c) An electron
(d) A helium nucleus

24. Which of the following describes an isotope with a mass number of 99 that contains 56 neutrons in its nucleus ?
(a) $^{99}_{56}Ba$
(b) $^{43}_{56}Ba$
(c) $^{99}_{43}Tc$
(d) $^{56}_{43}Tc$

25. Which of the following isotopes is used as the standard for atomic mass ?
(a) ^{12}C
(b) ^{16}O
(c) ^{13}C
(d) ^{1}H

26. Which of the following is not a basic particle of an element ?
(a) An atom
(b) A molecule
(c) An ion
(d) None of these

27. Members of which of the following have similar chemical properties ?
(a) isotope
(b) isobars
(c) allotropes
(d) both isotopes and allotropes

28. A natural phenomenon that supports the experimental conclusion that atoms are divisible is
    (a) allotropy
    (b) radioactivity
    (c) cracking
    (d) None of these
29. While performing cathode ray experiments, it was observed that there was no passage of electric current under normal conditions. Which of the following can account for this observation ?
    (a) Dust particles are present in air
    (b) Carbon dioxide is present in air
    (c) Air is a poor conductor of electricity under normal conditions
    (d) None of the above
30. The fluorescence on the walls of discharge tube is due to–
    (a) cathode rays
    (b) anode rays
    (c) canal rays
    (d) None of the above
31. Which of the following electronic configurations is wrong–
    (a) Be (d) = 2, 2
    (b) O (8) = 2, 6
    (c) S (16) = 2, 6, 8
    (d) P (15) = 2, 8, 5
32. $^{55}_{25}Mn^{++}$ has –
    (a) 25 protons and 30 neutrons
    (b) 25 neutrons and 25 protons
    (c) 25 electrons and 40 protons
    (d) None of the above
33. Which one of the following statement is not true ?
    (a) Most of the space in an atom is empty
    (b) The total number of neutrons and protons is always equal in a neutral atom
    (c) The total number of electrons and protons in an atom is always equal
    (d) The total number of electrons in any energy level can be calculated by the formula $2n^2$
34. From amongst the following chemical species :
    (a) $^{39}_{18}Ar$
    (b) $^{40}_{19}K^{+}$

(c) $^{41}_{20}Ca^{++}$

(d) $^{42}_{20}Ca^{+}$

The one having identical electronic configurations are

(a) (a) and (b)

(b) (b) and (d)

(c) (c) and (d)

(d) (a), (b) and (c)

35. Which one of the following pairs is correctly matched ?

(a)	Mass Spectrograph	:	Chadwick
(b)	Atomic number	:	Moseley
(c)	Neutron	:	Millikan
(d)	Measurement of charge of an electron	:	Aston

---

36. An atom has 7 electrons in its M-shell and contains 18 neutrons in its nucleus. What is its mass number ?

(a) 25

(b) 27

(c) 35

(d) 43

37. Which of the following compounds do not conform to the Law of Multiple Proportions?

(a) NaCl and $BaCl_2$

(b) CaO and Na_2O

(c) H_3PO_4 and $Ca_3(PO_4)_2$

(d) NaCl and AgCl

38. Which of the following exhibit variable valency?

(a) Sodium

(b) Chromium

(c) Copper

(d) Zinc

(a) (a) and (b)

(b) (b) and (c)

(c) (c) and (d)

(d) (b) and (d)

39. Which of the following pairs of substances illustrate the law of multiple proportions?

(i) CO, CO_2
(ii) H_2O, D_2O
(iii) N_2O, NO
(iv) NaCl, NaI

Select the correct answer using the codes given below:

(a) (i) and (ii)
(b) (ii) and (iii)
(c) (ii) and (iv)
(d) (i) and (iii)

40. In a chemical reaction, A combines with B to form AB with C to form A_2C. What would be obtained if B and C combine together ?
(a) B_2C
(b) BC
(c) BC_2
(d) B_3C

41. Which one of the following elements does not have two electrons in the K-shell ?
(a) Hydrogen
(b) Helium
(c) Neon
(d) Sulphur

42. An element X forms an oxide XO_3. What is the valency of X ?
(a) 1
(b) 2
(c) 3
(d) 6

43. The atomic number of an element X is 12. What is the formula of its azide ?
(a) X_2N_3
(b) $X(N_3)_2$
(c) X_3N_2
(d) XN_3

44. An element *A* has valencies equal to 3 and 5. It combines with another element *B* having valency equal to 2. What are formulae of the compounds thus formed?
(a) A_5B_3 and A_2B_5
(b) A_3B_2 and A_5B_2
(c) A_2B_3 and A_2B_5
(d) A_2B_3 and A_3B_5

(i) CO, CO_2
(ii) H_2O, D_2O
(iii) N_2O, NO
(iv) NaCl, NaI

Select the correct answer using the codes given below:

(a) (i) and (ii)
(b) (ii) and (iii)
(c) (ii) and (iv)
(d) (i) and (iii)

40. In a chemical reaction, A combines with B to form AB with C to form A_2C. What would be obtained if B and C combine together ?
(a) B_2C
(b) BC
(c) BC_2
(d) B_3C

41. Which one of the following elements does not have two electrons in the K-shell ?
(a) Hydrogen
(b) Helium
(c) Neon
(d) Sulphur

42. An element X forms an oxide XO_3. What is the valency of X ?
(a) 1
(b) 2
(c) 3
(d) 6

43. The atomic number of an element X is 12. What is the formula of its azide ?
(a) X_2N_3
(b) $X(N_3)_2$
(c) X_3N_2
(d) XN_3

44. An element *A* has valencies equal to 3 and 5. It combines with another element *B* having valency equal to 2. What are formulae of the compounds thus formed?
(a) A_5B_3 and A_2B_5
(b) A_3B_2 and A_5B_2
(c) A_2B_3 and A_2B_5
(d) A_2B_3 and A_3B_5

45. The atomic weights are expressed in terms of atomic mass unit. Which one of the following is used as a standard?
(a) $^{1}H_{1}$
(b) $^{12}C_{6}$
(c) $^{16}O_{8}$
(d) $^{35}Cl_{17}$

46. Which one of the following laws explains the formation of carbon monoxide and carbon dioxide from carbon and oxygen?
(a) Law of conservation of mass
(b) Law of multiple proportions
(c) Law of reciprocal proportions
(d) Law of difinite proportions

47. What is the mass (in grams) of 3 moles of N?
(a) 14
(b) 28
(c) 42
(d) 56

48. Which of the following correctly represents 360 g of water?
(i) 2 moles of H_2O
(ii) 20 moles of water
(iii) 6.022×10^{23} molecules of water
(iv) 1.2044×10^{25} molecules of water
(a) (i)
(b) (i) and (iv)
(c) (ii) and (iii)
(d) (ii) and (iv)

49. Which of the following would weigh the highest?
(a) 0.2 mole of sucrose ($C_{12}H_{22}O_{11}$)
(b) 2 moles of CO_2
(c) 2 moles of $CaCO_3$
(d) 10 moles of H_2O

50. Dalton's atomic theory successfully explained
(i) Law of conservation of mass
(ii) Law of constant composition
(iii) Law of radioactivity
(iv) Law of multiple proportion

(a) (i), (ii) and (iii)
(b) (i), (iii) and (iv)
(c) (ii), (iii) and (iv)
(d) (i), (ii) and (iv)

51. Which of the following statements about Rutherford's model of atom are correct?
(i) Considered the nucleus as positively charged
(ii) Established that the α-particles are four times as heavy as a hydrogen atom
(iii) Can be compared to solar system
(iv) Was in agreement with Thomson's model
(a) (i) and (iii)
(b) (ii) and (iii)
(c) (i) and (iv)
(d) only (i)

52. In the Thomson's model of atom, which of the following statments are correct?
(i) The mass of the atom is assumed to be uniformaly distributed over the atom
(ii) The positive charge is assumed to be uniformaly distributed over the atom
(iii) The electrons are uniformaly distributed in the positively charged sphere
(iv) The electrons attract each other to stabilise the atom
(a) (i), (ii) and (iii)
(b) (i) and (iii)
(c) (i) and (iv)
(d) (i), (iii) and (iv)

53. Rutherford's α-particle scattering experiment showed that
(i) electrons have negative charge
(ii) the mass and positive charge of the atom is concentrated in the nucleus
(iii) neutron exists in the nucleus
(iv) most of the space in atom is empty
Which of the above statements are correct?
(a) (i) and (iii)
(b) (ii) and (iv)

(c) (i) and (iv)
(d) (iii) and (iv)

54. In a sample of ethyl ethanoate ($CH_3COOC_2H_5$) the two oxygen atoms have the same number of electrons but different number of neutrons. Which of the following is the correct reason for it?
(a) One of the oxygen atoms has gained electrons
(b) One of the oxygen atoms has gained two neutrons
(c) The two oxygen atoms are isotopes
(d) The two oxygen atoms are isobars.

55. Atomic models have been improved over the years. Arrange the following atomic models in the order of their chronological order
(i) Rutherford's atomic model
(ii) Thomson's atomic model
(iii) Bohr's atomic model
(a) (i), (ii) and (iii)
(b) (ii), (iii) and (i)
(c) (ii), (i) and (iii)
(d) (iii), (ii) and (i)

56. In carbon disulphide (CS_2), the mass of sulphur in combination with 3.0 g of carbon is :
(a) 4.0 g
(b) 6.0 g
(c) 64.0 g
(d) 16.0 g

57. What mass of carbon dioxide (CO_2) will contain 3.011×10^{23} molecules?
(a) 11.0 g
(b) 22.0 g
(c) 4.4 g
(d) 44.0 g

58. Which of the following elements has same number of protons, electrons and neutrons?
(a) Al
(b) Mg
(c) P
(d) Cl

59. No. of valence electrons in an element ${}^{14}_{7}X$ is :
(a) 5
(b) 1

(c) 7
(d) 3

60. Which one of the following has the largest number of atoms?
(a) 71 g of Chlorine
(b) 48 g of Magnesium
(c) 127 g of Iodine
(d) 4 g of Hydrogen

61. What is the number of P atoms in 1 mole of P_4?
(a) 1.504×10^{23}
(b) 6.023×10^{23}
(c) 1.209×10^{23}
(d) 2.409×10^{24}

62. How many oxygen atoms are there in 63 g of HNO_3 ?
(a) 3
(b) 2.007×10^{23}
(c) 6.023×10^{23}
(d) 1.807×10^{24}

63. What is the SI unit of radioactivity?
(a) curie
(b) ohm
(c) Becquerel
(d) Roentgen

64. Which of the following rays is negatively charged?
(a) α Rays
(b) β Rays
(c) γ Rays
(d) All of the above

65. Atom Bomb is based on the principle of
(a) Controlled Nuclear Fusion
(b) Uncontrolled Nuclear Fusion
(c) Controlled Nuclear Fission
(d) Uncontrolled Nuclear Fission

66. Radiocarbon Dating is used for the age determination of
(a) Fossils
(b) Wood
(c) Both 1 & 2
(d) None of these

67. If half life of a radioactive substance is 50 years what fraction will be left after 150 years, if start with original amount?

(c) 7
(d) 3

60. Which one of the following has the largest number of atoms?
(a) 71 g of Chlorine
(b) 48 g of Magnesium
(c) 127 g of Iodine
(d) 4 g of Hydrogen

61. What is the number of P atoms in 1 mole of P_4?
(a) 1.504×10^{23}
(b) 6.023×10^{23}
(c) 1.209×10^{23}
(d) 2.409×10^{24}

62. How many oxygen atoms are there in 63 g of HNO_3 ?
(a) 3
(b) 2.007×10^{23}
(c) 6.023×10^{23}
(d) 1.807×10^{24}

63. What is the SI unit of radioactivity?
(a) curie
(b) ohm
(c) Becquerel
(d) Roentgen

64. Which of the following rays is negatively charged?
(a) α Rays
(b) β Rays
(c) γ Rays
(d) All of the above

65. Atom Bomb is based on the principle of
(a) Controlled Nuclear Fusion
(b) Uncontrolled Nuclear Fusion
(c) Controlled Nuclear Fission
(d) Uncontrolled Nuclear Fission

66. Radiocarbon Dating is used for the age determination of
(a) Fossils
(b) Wood
(c) Both 1 & 2
(d) None of these

67. If half life of a radioactive substance is 50 years what fraction will be left after 150 years, if start with original amount?

(a) 1/4
(b) 1/6
(c) 7/8
(d) 7/4

Hints & SOLUTIONS

1. **(a)**
2. **(b)** NH_3 has total 4 atom thus its atomicity is 4.
3. **(d)** Chemical formula of water and hydrogen peroxide are H_2O and H_2O_2 respectively.
4. **(d)**
5. **(b)** $MCl_3 \longrightarrow M^{3+} + 3Cl^-$

   $M^{3+} + PO_4^{3-} \longrightarrow MPO_4$
6. **(c)**
7. **(d)** Law of conservation of mass.
8. **(a)**
9. **(c)**
10. **(c)**
11. **(a)**
12. **(c)** Maximum number of electrons that can be accommodated in any shell is given by $2n^2$. Thus for third shell n = 3, $2(c)^2 = 18$
13. **(c)**
14. **(c)**
15. **(b)**
16. **(b)**
17. **(d)** Electron gain or loose energy during its transmission between various energy levels.
18. **(a)**
19. **(d)**
20. **(c)**
21. **(b)** Deuterium has one proton and one neutron.
22. **(c)**
23. **(b)**
24. **(c)** Number of neutrons = Mass number – Atomic number

    $= 99 - 43 = 56$
25. **(a)**
26. **(b)**
27. **(c)**
28. **(b)**
29. **(c)**
30. **(a)**
31. **(c)** Right electronic configuration is 2, 8, 6
32. **(a)**
33. **(b)**
34. **(c)** Electronic configuration of the following chemical species

$^{39}_{18}Ar$ 2, 8, 8

$^{40}_{19}K^{+}$ 2, 8, 8, 1

$^{41}_{20}Ca^{++}$ 2, 8, 8, 2 — identical electronic configurarion

$^{42}_{20}Ca^{+}$ 2, 8, 8, 2

35. (b) Scientist Discovery

Moseley – Atomic number

Chadwick – Neutron

Millikan – Measurement of charge of an electron.

Aston – Mass spectrograph

36. (c) Number of neutrons = 18

Number of electrons = Number of protons

= 2 + 8 + 7 = 17

Mass number = no. of protons + no. of neutrons

= 17 + 18 = 35

37. (d) According to law of multiple proportions when two elements combine then the mass of one of the element which combine with fixed mass bear a simple whole number ratio.

∴ NaCl and AgCl do not confirm to the law of multiple proportions.

38. (b) Chromium and copper exhibits variable valency. They possess incomplete of d-subshells.

39. (d) According to law of multiple proportion, when two elements combine then the mass of one of the element which combine with fixed mass bear a simple whole number ratio.

Eg. CO & CO_2, N_2O & NO

16 : 32 28 : 14

1 : 2 2 : 1

40. (a) From AB valency of A = valency of B = 1

From A_2C, valency of C = 2

∴ Formula for compound formed by B and C is B_2C.

41. (a)

Atoms	no.of e^{-1}s	e^- in shell (k)
Hydrogen	1	1
Helium	2	2
Neon	10	2
Sulphur	16	2

∴ Hydrogen does not have 2^{e^-} in the K-shell

42. (c) The valency of X is 3 in XO_3 because it is a trivalent oxide.