Date: 24/9/2021

Q1. What are canal rays?

Q2. If an atom contains one electron and one proton, will it carry any charge or not?

Q3. On the basis of Rutherford's model of an atom, which subatomic particle is present in the nucleus of an atom?

Q4. What do you think would be the observation if the α-particle scattering experiment is carried out using a foil of a metal other that gold?

Q5. Name the three sub-atomic particles of an atom.

Q6. Rutherford's alpha-particle scattering experiment was responsible for the discovery of

(a) Atomic Nucleus (b) Electron (c) Proton (d) Neutron.

Q7. Which one of the following is a correct electronic configuration of sodium?

(a) 2, 8 (b) 8, 2, 1 (c) 2, 1, 8 (d) 2, 8, 1

Q8. On the basis of Thomson's model of an atom, explain how the atom is neutral as a whole.

Q9. Draw a sketch of Bhor's model of an atom with three shells.

Q10. Helium atom has an atomic mass of 4 u and two protons in its nucleus. How many neutrons does it have?

Q11. What are the limitations of J.J Thomson's model of the atom?

Q12. Write the distribution of electrons in carbon and sodium atom.

Q13. If K and L shells of an atom are full, then what would be the total number of electrons in the atom?

Q14. If $Z = 3$, what would be the valency of the element? Also, name the element.

Q15. Number of valence electrons in Cl^- ion are:

(a) 16 (b) 8 (c) 17 (d) 18

Q16. If number of electrons in an atom is 8 and number of protons is also 8, then (a) what is the atomic number of the atom? and (b) what is the charge on the atom?

Q17. If bromine atom is available in the form of, say, two isotopes $^{79}_{35}Br$ (49.7%) and $^{81}_{35}Br$ (50.3%), calculate the average atomic mass of bromine atom.

Q18. The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes $^{16}_{8}X$ and $^{18}_{8}X$ in the sample?

Q19. For the following statements, write T for True and F for False:

(a) J.J. Thomson proposed that the nucleus of an atom contains only nucleons.

(b) A neutron is formed by an electron and a proton combining together. Therefore, it is neutral.

(c) The mass of an electron is about $\frac{1}{2000}$ times that of proton.

(d) An isotope of iodine is used for making tincture iodine, which is used as a medicine.

Q20. Compare the properties of electrons, protons and neutrons.

Q21. What are the limitations of Rutherford's model of the atom?

Q22. Describe Bohr's model of the atom.

Q23. Summarise the rules for writing of distribution of electrons in various shells for the first eighteen elements.

Q24. How will you find the valency of chlorine, sulphur and magnesium?

Q25. Define valency by taking examples of silicon and oxygen.

Q26. Na^+ has completely filled K and L-shell. Explain.

Q27. Complete the following table:

Atomic number	Mass number	Number of neutrons	Number of protons	Number of electrons	Name of the atomic species
9	—	10	—	—	—
16	32	—	—	—	Sulphur
—	24	—	12	—	—
—	2	—	1	—	—
—	1	0	1	0	—

Q28. Explain with examples (a) Atomic number, (b) Mass number, (c) Isotopes and (d) Isobars. Give any two uses of isotopes.

Q29. Composition of the nuclei of two atomic species *X* and *Y* are given as under:

		X	*Y*
Protons	=	6	6
Neutrons	=	6	8

Give the mass numbers of *X* and *Y*. What is the relation between the two species?

Q30. For the symbol H, D and T tabulate three sub-atomic particles found in each of them.

Q31. Write the electronic configuration of any one pair of isotopes and isobars.

Q32. Compare all the proposed models of an atom given in this chapter.

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S1. Canal rays are positively charged radiations which were discovered by E. Goldstein in 1886. These rays travel in a direction opposite to cathode rays. These rays are also called anode rays or positive rays. Canal rays led to the discovery of positively charged subatomic particle known as proton.

S2. An electron has unit negative charge whereas a proton has unit positive charge. Both these charges are in equal magnitude. Therefore, the atom is electrically neutral and it will not carry any charge.

S3. Proton is the subatomic particle present in the nucleus of an atom.

S4. If the α-particle scattering experiment is carried out using a foil of a metal other than gold, the observations will be the same as on using a gold foil.

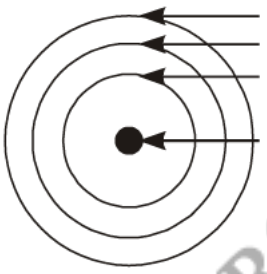
S5. These subatomic particles of an atom are electron, proton and neutron.

S6. (a) Atomic Nucleus.

S7. **(d)** The correct electronic configuration of sodium is (d) 2, 8, 1.

S8. According to Thomson's model, an atom is made up of a positively charged sphere in which electrons are embedded. The negative and positive charges are equal in magnitude because the atom has the same number of electrons and protons. This explains that the atom is neutral as a whole.

S9.



S10. Atomic mass = Mass number = Number of Protons + Number of neutrons

$\therefore$ Number of neutrons = Atomic mass – Number of protons

$= 4 - 2 = 2$

Hence, helium atom has two neutrons.

S11. Thomson's model of atom could explain the electrical neutrality of the atom but it failed to explain the results of scattering experiments performed by Rutherford. Consequently, it was rejected in favour of Rutherford's model of atom.

S12. Distribution of electrons in carbon atom (Atomic number = 6) is 2, 4. It has 2 electrons in its K-shell, 4 electrons in its L-shell.

Distribution of electrons in sodium atom (Atomic number = 11) is 2, 8, 1. It has 2 electrons in K-shell, 8 electrons in L-shell and 1 electron in M-shell.

S13. The maximum number of electrons ($2n^2$) to be accommodated by K ($n = 1$) and L ($n = 2$) shells of an atom are $2(2\times1^2)$ and $8(2\times2^2)$ respectively. If K and L-shells are full, then the total number of electrons will be $2 + 8 = 10$.

S14. If $Z = 3$, the atomic number of the element is 3. The electronic configuration of the element is 2, 1. Since, it has 1 electron in its outermost (valency) shell, the valency of the element is 1.

The name of the element with atomic number (Z) 3 is lithium.

S15. (b) 8.

S16. (a) Atomic number = Number of protons

The atom has 8 protons.

Hence, the atomic number of the atom is 8.

(b) There are 8 electrons and 8 protons in the atom. An electron has a unit – ve charge while the proton has unit + ve charge. Thus:

$$\text{Total negative charge} = 8 \times (-1) = -8$$

$$\text{Total positive charge} = 8 \times 1 = 8$$

$$\text{Net charge} = -8 + 8 = 0$$

Thus, the atom has no net charge.

S17. Average atomic mass of bromine atom = $\frac{79 \times 49.7 + 81 \times 50.3}{100} = 80.006$ u.

S18. Suppose the percentage of isotope ${}^{16}_{8}X$ is x. Then the percentage of ${}^{18}_{8}X$ is $100 - x$.

$$\text{The average atomic mass} = \frac{16x + 18(100 - x)}{100} = 16.2$$

or $$16x + 1800 - 18x = 16.2 \times 100$$

or $$-2x = 1620 - 1800 = -180$$

or $$x = \frac{-180}{-2} = 90$$

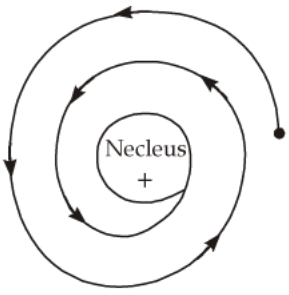
Hence, ${}^{16}_{8}X$ is 90% and ${}^{18}_{8}X$ is 100 – 90 = 10%.

S19. (a) F (b) F (c) T (d) F.

S20. Comparison of electrons, protons and neutrons is done in the following table:

Property	Electron	Proton	Neutron
1. Symbol	e^- or ${}_{-1}e^0$	p^+ or ${}_1p^1$	n or ${}_0n^1$
2. Charge	Unit negative or 1.6×10^{-19} coulomb	Unit positive or 1.6×10^{-19} coulomb	No charge or neutral
3. Mass	1/840th of H atom (Negligible)	1 u (equal to 1 atom of H)	1 u (equal to 1 atom of H)
4. Location in atom	Outside the nucleus	Nucleus of atom	Nucleus of atom
5. Number in atom	Equal to proton	Equal to electron	Equal or greater than proton

S21. Rutherford's atom failed to explain the stability of the atom. It was pointed out that Rutherford's atom should be highly unstable due to continuous loss in energy of the moving electron.



Any electron (charged particle) moving in a circular orbit around the nucleus would undergo acceleration. As a result, it would radiate (lose) energy and ultimately fall into the nucleus. If this were so, the atom should be highly unstable and would not have existed in its present form. In other words, Rutherford's atom should collapse but it is wrong because atoms do not collapse and are quite stable.

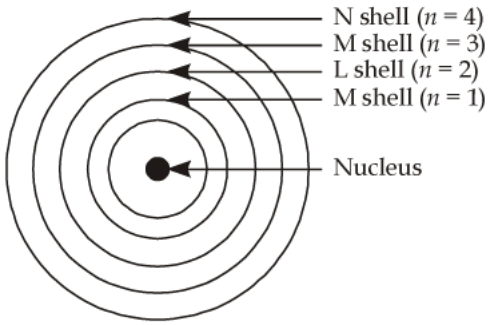
S22. Bohr's model of the atom: Neil Bohr put forward the following postulates about the model of an atom:

(a) Electrons revolve around the nucleus in discrete orbits or stationary states.

(b) While revolving in discrete orbits, the electrons do not radiate energy.

(c) So long as an electron revolves in a particular orbit, it neither emits nor absorbs energy.

(d) The energy levels are numbered as 1, 2, 3, 4, ... etc., starting from the nucleus of the orbit. These numbers 1, 2, 3, 4, ... etc., are known as principal quantum numbers.



The energy levels can also be designated as K, L, M, N, ... etc., shells.

(e) When an electron jumps from one energy level to the other, the energy is emitted or absorbed in the form of bundles of energy called quanta or photon of energy.

(f) The energy of photon, $E = E_2 - E_1$, where E_2 and E_1 are the energies of the orbits in the final and initial states.

S23. According to Bohr-Bury scheme, the distribution of electrons in different orbits is governed by the following rules:

(a) The maximum number of electrons which can be accommodated in an orbit is given by $2n^2$, where n represents the serial number of the orbit starting from the nucleus. For example:

Serial number of orbit (n) (Principal quantum number)	Shell	Maximum number of electrons ($2n^2$)
1	K	$2 \times 1^2 = 2$
2	L	$2 \times 2^2 = 8$
3	M	$2 \times 3^2 = 18$
4	N	$2 \times 4^2 = 32$ .... etc.

(b) In a stable atom, the outermost orbit can have maximum 8 electrons and the last but one (Penultimate) orbit can accommodate maximum 18 electrons.

S24. Valency of an element is the number of electrons lost, gained or shared by its atom to complete the octet (8 electrons) in the outermost shell.

To find the valency of chlorine: The atomic number of chlorine is 17. It has 17 electrons.Its electronic configuration is 2, 8, 7. It requires 1 electron to complete its octet in the last shell. Hence, valency of chlorine is –1.

To find the valency of sulphur: The atomic number of sulphur is 16. It has 16 electrons. Its electronic configuration is 2, 8, 6. It needs two electrons in order to complete its octet in the valency shell. Therefore, valency of sulphur is –2.

To find the valency of magnesium: The atomic number of magnesium is 12. It has 12 electrons. Its electronic configuration is 2, 8, 2. It will have to loose 2 electrons in order to have 8 electrons in its last shell. So valency of magnesium is +2.

S25. Valency is the combining capacity of the element. Valency may be defined as the number of electrons in the last or outermost or valency shell of an atom of the element which are lost, gained or shared by the atom to complete the octet (8 electrons) in the last orbit.

The atomic number of silicon is 14. Its electronic configuration is 2, 8, 4. So it has 4 electrons in its outermost shell. It forms compounds by sharing of electrons. As it shares four electrons, its valency is four.

The atomic number of oxygen is 8. Its electronic configuration is 2, 6. Oxygen has 6 valency electrons. It forms compounds by gaining electrons.

For elements having more than 4 electrons in the valence shell, we use the following relation for valency:

Valency = 8 – Number of electrons in the outermost shell.

Hence, Valency of oxygen = 8 – Number of valence electrons = 8 – 6 = 2.

S26. The atomic number of sodium (Na) is 11. Its electronic configuration is 2, 8, 1. It shows that there are 2 electrons in K-shell, 8 electrons in L-shell and 1 electron in M-shell.

When sodium atom loses 1 electron, it forms sodium ion, Na^+ which has 10 electrons. It has 2 electrons in K-shell and 8 electrons in L-shell. K-shell ($n = 1$) can have maximum $2 \times 1^2 = 2$ electrons and L-shell ($n = 2$) can accommodate maximum $2 \times 2^2 = 8$ electrons. Hence, Na^+ has completely filled K and L-shells.

S27. The complete table is as under:

Atomic number	Mass number	Number of neutrons	Number of protons	Number of electrons	Name of the atomic species
9	19	10	9	9	Fluorine
16	32	16	16	16	Sulphur
12	24	12	12	12	Magnesium
1	2	1	1	1	Deuterium
1	1	0	1	0	Hydrogen ion

S28. (a) **Atomic Number:** Atomic number of an element is equal to the number of protons present in the nucleus of an atom of the element. It is denoted by Z. For hydrogen $Z = 1$ because there is only one proton in the nucleus of the atom. Similarly for carbon, $Z = 6$.

(b) **Mass Number:** Mass number of an element is the sum of the total number of protons and neutrons present in the nucleus of the atom. For example, mass number of carbon is 12 because it has 6 protons and 6 neutrons in the nucleus. Protons and neutrons together are called nucleons. In the notation for an atom, the atomic number, mass number and the symbol of the element are to be written as

Mass number

Symbol

Atomic number

For example, nitrogen as written as ${}^{14}_{7}N$.

(c) **Isotopes:** Isotopes are defined as the atoms of the same element having the same atomic number but different mass numbers.

Hydrogen has three isotopes namely protium (${}^{1}_{1}H$), deuterium (${}^{2}_{1}H$) and tritium (${}^{3}_{1}H$). Protium, deuterium and tritium are also represented by H, D and T respectively. Chlorine occurs in nature in two isotopic forms with masses 35 u and 37 u in the ratio of 3 : 1. Mass of an atom of any natural element is taken as the average mass of all the naturally occuring atoms of that element. The average atomic mass of chlorine atom can be calculated as under:

$$= 35 \times \frac{75}{100} + 37 \times \frac{25}{100}$$

$$= \frac{105}{4} + \frac{37}{4} = \frac{142}{4} = 35.5\,u$$

(d) **Isobars:** Atoms of different elements with different atomic number but having the same mass number are known as isobars. For example, calcium and argon have atomic numbers 20 and 18 respectively. But both of them have the same mass number 40. Hence, these elements are isobars.

S29. Mass number = Number of protons + Number of neutrons

$\therefore$ Mass number of $X = 6 + 6 = 12$

Mass number of $Y = 6 + 8 = 14$

The two atomic species X and Y have the same atomic number as 6 but different mass numbers as 12 and 14 respectively. Therefore, X and Y are isotopes of each other.

S30.

Symbol of atom	Proton (p)	Electron (e)	Neutrons (Mass number – Proton)
H (Hydrogen), $_1H^1$	1	1	1 – 1 = 0
D (Deuterium), $_1H^2$	1	1	2 – 1 = 1
T (Tritium), $_1H^3$	1	1	3 – 1 = 2

S31. **Pair of isotopes : $^{35}_{17}Cl$ and $^{37}_{17}Cl$.**

Electronic configuration is 2, 8, 7 because both the atoms have the same atomic number and the same number of electrons as 17.

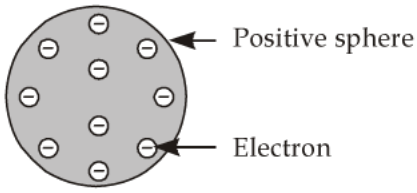
Pair of isobars : $^{40}_{18}Ar$ and $^{40}_{20}Ca$.

Electronic configuration of Ar (Argon) atomic number 18 is 2, 8, 8.

Electronic configuration of Ca (Calcium) with atomic number 20 is 2, 8, 8, 2.

S32. **Thomson model of an atom:** Thomson proposed a model of atom similar to that of Christmas pudding. The electrons, in a sphere of positive charge where like currents (dry fruits) in a spherical Christmas pudding. We can also think of atom as watermelon; where positive charge is spread all over like the red edible part of the watermelon, while the electrons are studded in the positively charged sphere, like the seeds in the watermelon as shown in the figure.

Thomson proposed that:

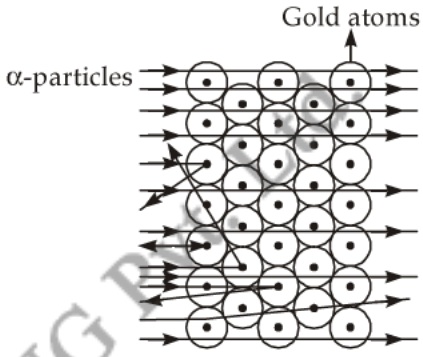


(a) An atom consists of a positively charged sphere and the electrons are embedded in it.

(b) The negative and positive charges are equal in magnitude. So the atom as a whole is electrically neutral.

But thomson model could not explain the results of various experiments.

Rutherford's model of tom: Rutherford performed an experiment to arrive at the arrangement of particles in an atom. He bombarded a gold foil with fast moving α-particles. α-particles are helium nuclei with a mass of 4 u and a charge of +2. The following observations were made:



(a) Most of the fast moving α-particles passed straight through the gold foil (see figure)

(b) Some of the particles were deflected by the foil by small angles.

(c) One out of 1200 particles appeared to rebound.

Rutherford made the following conclusions from the scattering experiment:

(a) Most of the space inside the atom is empty because most of the α-particles passed through the gold foil without getting deflected.

(b) Very few particles were deflected from their path, indicating that the positive charge of the atom occupies very little space.

(c) A small fraction of α-particles were deflected by 180°, indicating that all the positive charge and the mass of the atom were concentrated in a very small volume within the atom..

On the basis of his conclusions on the scattering experiment, Rutherford put forward his theory of structure of atom. Main points of the theory are:

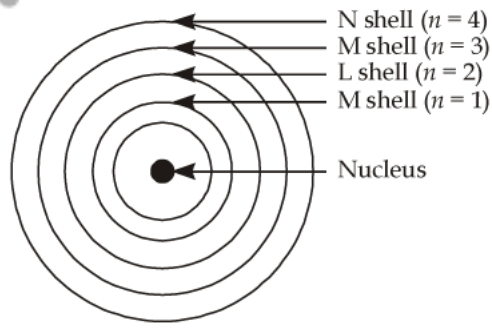
(a) There is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus.

(b) The electrons revolve around the nucleus in well-defined orbits.

(c) The size of the nucleus is very small as compared to the size of the atom.

Drawbacks of Rutherford Theory: Any charged particle which is moving in a circular path would lose energy and finally fall into the nucleus. This would lead to destruction of atom. But we know that this does not happen. Atom is quite stable. Rutherfored model does not explain this anomaly.

Bohr's model of atom: To explain the objections against Rutherford model of structure of atom, Bohr put forward his theory of structure of atom. Main points of the theory are:



(a) Only certain special orbits, known as discrete orbits of electrons are allowed inside the atom.

(b) While revolving in discrete orbits, the electrons do not radiate energy.

These orbits or shells are called energy levels, which are shown in the figure.