PART-I (SHORT QUESTIONS)

Q.2 Write short answers to any SIX (6) questions.

(i) What are the main postulates of Dalton's Atomic Theory?

Ans. Dalton's Atomic Theory:

According to Dalton:

(1) An atom is an indivisible, hard, dense sphere.

(2) Atoms of the same element are alike.

(3) Atoms combine in different ways to form a compound.

(ii) Write two/four characteristics of cathode rays.

Ans. Characteristics of Cathode Rays:

The cathode rays were studied in detail and their properties were determined, which are given below:

(1) These rays travel in a straight line perpendicular to the cathode surface.

(2) They can cast a sharp shadow of an opaque object if placed in their path.

(3) They are deflected towards positive plate in an electric field showing that they are negatively charged.

(4) They raise temperature of the body on which they fall.

(5) J.J. Thomson discovered their charge/mass (e/m) ratio.

(6) Light is produced when these rays hit the sides of the discharge tube.

(7) It was found that the same type of rays were emitted no matter which gas and which cathode was used in the discharge tube.

(iii) Write down two/four properties of canal rays.

Ans. The properties of canal rays are as follow:

(1) These rays travel in a straight line in a direction opposite to cathode rays.

(2) Their deflection in electric and magnetic field proved that these were positively charged.

(3) The nature of canal rays depends upon the nature of gas, present in the discharge tube.

(4) These rays do not originate from the anode. In fact these rays are produced when the cathode rays or electrons collide with residual gas molecules present in the discharge tube and ionize them as following:

$$M + e^- \longrightarrow M^+ + 2e^-$$

(5) Mass of these particles was found equal to that of a proton or simple multiple of it.

(iv) How neutron was discovered? Write down some properties of a neutron.

Ans. Discovery of Neutron:

In 1932, James Chadwick discovered a neutron. When he bombarded alpha particles on a beryllium target, he observed that highly penetrating radiations were produced. These radiations were called neutrons.

Equation:

$$^{9}_{4}Be + ^{4}_{2}He \longrightarrow ^{12}_{6}C + {}_{0}n^{1} \text{ (neutron)}$$

Properties of a Neutron:

Properties of a neutron are as following:

(1) Neutrons carry no charge i.e. they are neutral.

(2) They are highly penetrating.

(3) Mass of these particles was nearly equal to the mass of a proton.

(v) How the canal rays are produced in the discharge tube?

Ans. These rays do not originate from the anode. In fact these rays are produced when the cathode rays or electrons collide with the residual gas molecule present in the discharge tube and ionize them as follows:

$$M + e^{-} \longrightarrow M^{+} + 2e^{-}$$

(vi) How it was concluded that cathode rays are fast moving particles called electrons?

Ans. It was observed that when an opaque object is placed in the path of cathode rays, they cast the shadow of the given object. This fact suggested that these are not rays but they are fast moving material particles. Later, they were given the name electrons.

(vii) Who discovered an electron, a proton and a neutron?

Ans. In 1897,JJ. Thomson discovered electron.

In 1886, Goldstein discovered positively charged particles called protons.

In 1932, James Chadwick discovered a neutron.

(viii) Describe the defects of Rutherford's atomic model.

Ans. Defects in Rutherford's Model:

Although Rutherford's experiment proved that the 'plum-pudding' model of an atom was not correct, yet it had following defects:

(1) According to classical theory, electrons being the charged particles should release or emit energy continuously and they should ultimately fall into the nucleus.

(2) If the electrons emit energy continuously, they should form a continuous spectrum but in fact, line spectrum was observed.

(ix) How Rutherford concluded from his experiment that atom has a nucleus located at the centre of the atom?

Ans. Rutherford bombarded alpha-particles on very thin (i.e. 0.00004 cm thick) gold foil and noted his observations which were as following:

(1) He observed that most of the particles passed through the gold foil un-deflected.

Result:

This shows that most of the volume occupied by an atom is empty.

(2) Out of 20000 particles, only a few were deflected at fairly large angles and very few bounced back on hitting the gold foil.

Result:

The deflection of few particles proved that there is a "centre of positive charges" in an atom, which is called 'nucleus' of an atom.

These two observations prove that nucleus is located at the centre of an atom.

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Q.3 Write short answers to any FIVE (5) questions.

(i) As long as electron remains in an orbit, it does not emit or absorb energy. When it does emit or absorb energy?

Ans. As long as electron remains in a particular orbit it does not radiates or absorbs energy. The energy is emitted or absorbed only when an electron jumps from one orbit to another.

(1) When an electron jumps from lower orbit to higher orbit it absorbs energy.

(2) When it jumps back from higher orbit to lower orbit it radiates energy.

(ii) What is classical theory of radiation? How does it differ from quantum theory?

Ans. **Classical theory:**

According to classical theory of radiation, a hot vibrating body radiates energy all the time it is vibrating.

Quantum theory:

According to quantum theory of radiation, a hot vibrating body does not emit or absorb energy continuously but does so discontinuously in the form of small packets or bundles of enery known as quantum or photons in case of light energy.

(iii) How can you prove that angular momentum is quantized?

Ans. **Meaning of Quantization:**

The word "quantization" means that a quantity can change only in whole numbers.

According to Bohr's atomic model, revolving electron in an atom does not absorb or emit energy continuously. The energy of a revolving electron is quantized. It absorbs or emits energy in small packets of energy called quantum.

Formula:

The angular momentum (mvr) of an electron revolving around the nucleus is given by the following equation:

$$mvr = \frac{nh}{2\pi}$$

To Prove that Angular Momentum is Quantized

For 1^{st} orbit, $n = 1$

By putting the value of $n = 1$, we get

$$mvr = \frac{h}{2\pi}$$

For 2^{nd} orbit, $n = 2$

By putting the value of $n = 2$, we get

$$mvr = 2 \times \frac{h}{2\pi}$$

For 3^{rd} orbit, $n = 3$

By putting the value of $n = 3$, we get

$$mvr = 3 \times \frac{h}{2\pi}$$

Conclusion:

The angular momentum for $n = 2$ is twice the angular momentum for $n = 1$.

The angular momentum for $n = 3$ is thrice the angular momentum for $n = 1$

The electron is bound to remain in one of these orbits and not in between them.

Hence, we conclude that angular momentum of an electron is quantized.

(iv) Calculate the angular momentum of 1st orbit?

Ans. Angular Momentum of 1st Orbit:

Given Data:

Here, $n = 1$, $h = 6.63 \times 10^{-34}$ Js, $\pi = 3.14$

Formula:

$$\text{Angular Momentum} = mvr = \frac{nh}{2\pi}$$

Calculations:

Putting the values we get

$$mvr = \frac{1 \times 6.63 \times 10^{-34} \text{Js}}{2 \times 3.14}$$

$$= \frac{1 \times 6.63 \times 10^{-34} \text{ kgm}^2\text{s}^{-2}\text{s}}{2 \times 3.14}$$

$[\because \text{Js} = \text{Nms} = \text{kgms}^{-2}\text{ms} = \text{kgm}^2\text{s}^{-1}]$

$$mvr = 1.0 \times 1\ 0^{-34} \text{ kgm}^2\text{s}^{-1}$$

(v) Differentiate between Rutherford' atomic theory and Bohr's atomic theory.

Ans. Differences between Rutherford's Atomic Theory and Bohr's Atomic Theory:

Rutherford's atomic theory and Bohr's atomic theory differ from each other in the following respects:

Rutherford's Atomic Theory	Bohr's Atomic Theory
(1) It was based on Classical Theory.	(1) It was based upon Quantum Theory.
(2) Electrons revolve around the nucleus.	(2) Electrons revolve around the nucleus in orbits of fixed energy.
(3) No idea about orbits and angular momentum was introduced.	(3) Bohr's Theory is based on the idea of orbits had quantized angular momentum.
(4) Atoms should produced continuous spectrum.	(4) Atoms should produce line spectrum.
(5) Atoms should collapse.	(5) Atoms should exit.

(vi) Differentiate between a shell and a sub-shell with examples.

Ans. Shells:

"Shells are the main energy levels that electrons occupy while revolving around the nucleus."

Names of Energy Levels:

Energy levels are represented by 'n' values such as 1, 2, 3, ... and so on.

Names of Shells:

When energy levels are called shells, they are designated as K, L, M, N and so on.

Sub-shell:

"A shell consists of a smaller shells called sub-shells or orbitals".

Names (Symbols) of Sub-shells:

Each subshell or orbital is designated by a small alphabetical italic letters such as '*s*', '*p*', '*d* and '*f*.

(vii) What is maximum electron holding capacity of each shell? Find with the help of formula.

Ans. The maximum capacity of any shell to accommodate the electrons is measured by $2n^2$ formula.

To Find No. of Electrons in Each Shell:

For K shell, $n = 1, \Rightarrow 2(1)^2 = 2$

$\therefore$ K shell can accommodate 2 electrons.

For L shell, $n = 2, \Rightarrow 2(2)^2 = 8$

$\therefore$ L shell can accommodate 8 electrons.

For M shell, $n = 3, \Rightarrow 2(3)^2 = 18$

$\therefore$ M shell can accommodate 18 electrons.

For N shell, $n = 4, \Rightarrow 2(4)^2 = 32$

$\therefore$ N shell can accommodate 32 electrons.

(vii) How will you calculate the number of subshells in a shell. Give the maximum number of electrons in s, p, d and f subshells.

Ans. Number of Subshells in a Shell:

The number of subshells in a shell is equal to quantum number 'n'. Where 'n' represents the shell. Its values are n = 1, 2, 3, ...

Shell Number	Shell	No. of Subshells	Name of a Subshell	Max. No. of Electrons in Subshell
N = 1	K	1	1s	'*s*' subshell can accommodate maximum 2 electrons.
N = 2	L	2	2s, 2p	'*p*' subshell can accommodate maximum 6 electrons.
N = 3	M	3	3s,3p,3d	'*d*' subshell can accommodate maximum 10 electrons.
N = 4	N	4	4s, 4p, 4d, 4f	'*f*' subshell can accommodate maximum 14 electrons.

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Q.4 Write short answers to any FIVE (5) questions.

(i) Why do the isotopes of an element have different atomic masses?

Ans. Isotopes of an element have different atomic masses due to different number of neutrons in their nucleus. For example, carbon has three isotopes i.e. $^{12}_{6}C$, $^{13}_{6}C$ and $^{14}_{6}C$. In these isotopes of carbon, $^{12}_{6}C$ has six 6 protons and 6 neutrons, in $^{13}_{6}C$ there are 6 protons and 7 neutrons but in $^{14}_{6}C$ there are 6 protons and 8 neutrons.

(ii) What is meant by isotopes? Give examples.

Ans. Isotopes: *"Isotopes are atoms of an element having same atomic number (Z) but different mass number (A)".*

Examples: Carbon has three isotopes, $^{12}_{6}C$, $^{13}_{6}C$ and $^{14}_{6}C$. These isotopes have 6, 7 and 8 neutrons in their nuclues respectively.

(iii) What are the isotopes of hydrogen? Draw their atomic structure.

Ans. Isotopes of Hydrogen:

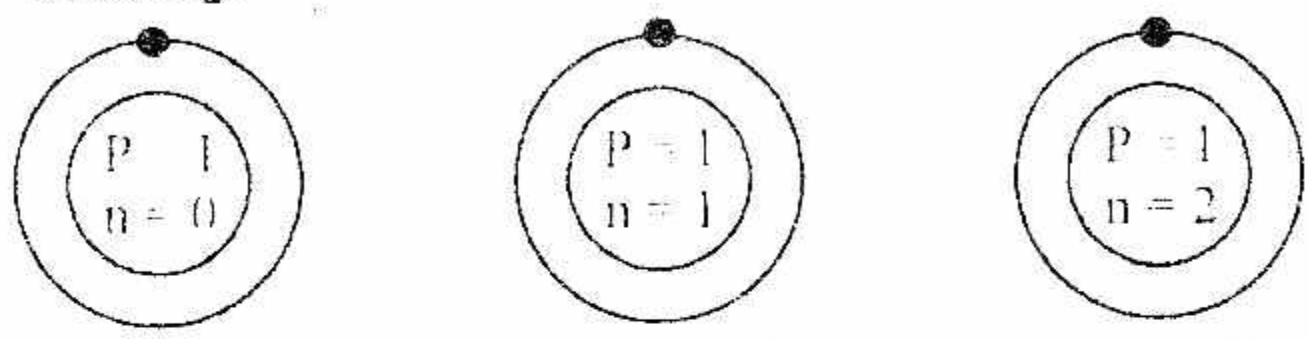
The three isotopes of hydrogen are named as protium ($^{1}_{1}H$) deuterium ($^{2}_{1}H$) and Tritum ($^{3}_{1}H$). Each one of them has 1 proton and 1 electron, but number of neutrons are different as shown in figure:

Atomic Structure of Hydrogen Isotopes:

The isotopes are represented as following:

Atomic Structure of Hydrogen Isotopes:

The atomic structure of isotopes is represented as following:



Protium ($^{1}_{1}H$) deuterium ($^{2}_{1}H$) tritium ($^{3}_{1}H$)

(iv) What are the isotopes of carbon? Give their atomic structure.

Ans. Isotopes of Carbon:

Carbon also has three isotopes which are:

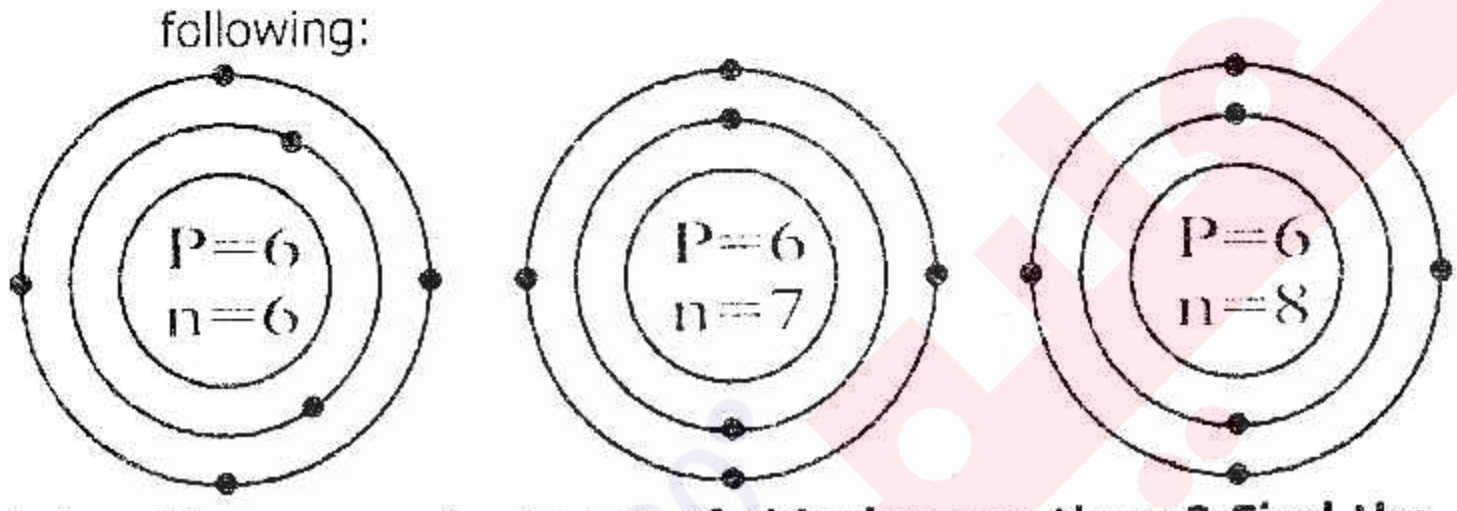
(1) Carbon-12 $(^{12}_{6}C)$

(2) Carbon-13 $(^{13}_{6}C)$

(3) Carbon-14 $(^{14}_{6}C)$

Atomic Structure:

The atomic structure of each isotope of a carbon is as following:



(v) How many isotopes of chlorine are there? Find the no. of neutrons in each of them.

Ans. Isotopes of Chlorine:

There are two isotopes of chlorine. These are:

(i) Cl-35 or $^{35}_{17}Cl$ **(ii)** Cl-37 or $^{37}_{17}Cl$

To Find No. of Neutrons:

Symbol	Atomic Number (Z)	Mass Number (A)	No. of Protons	No. of Neutrons
$^{35}_{17}Cl$	17	35	17	n = A – Z n = 35 – 17 = 18
$^{37}_{17}Cl$	17	37	17	n = A – Z n = 37 – 17 = 20

(vi) Differentiate between radioactive-isotopes dating and radio-carbon dating.

Ans. Radioactive-Isotope Dating:

"The age determination of very old objects based on the half-lives of the radioactive isotope is called radioactive-isotope dating."

Radio-Carbon Dating:

"The method of age determination of old carbon containing objects (fossils) by measuring the radioactivity of C-14 in them is called radio-carbon dating or simply carbon dating."

(vii) How radio isotopes are used for the treatment of cancer?

Ans. Radio isotopes are used both for skin cancer and organ cancer.

Skin Cancer: For the treatment of skin cancer, isotopes likep-32 and Sr-90 are used because they emit less penetrating beta radiations.

Organ Cancer: For cancer, Co-60, affecting within the body, is used because it emits strongly penetrating gamma rays.

(viii) Give the use of radio isotopes in the field of power generation.

Ans. Applications in Power Generation:

Radioactive isotopes are used to generate electricity by carrying out controlled nuclear fission reactions in nuclear reactors.

For example, when U-235 is bombarded with slow moving neutrons, the uranium nucleus breaks up to produce Barium-139 and Krypton-94 and three neutrons.

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{139}_{56}Ba + {}^{94}_{36}Kr + 3({}^{1}_{0}n) + \text{Energy}$$

A large amount of energy is released which is used to convert water into steam in boilers. The steam then drives the turbines to generate electricity. This is the peaceful use of atomic energy for development of a nation.

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PART-II (LONG/DESCRIPTIVE QUESTIONS)

Q.5 **(a)** How were cathode rays produced? What are their seven major characteristics? **(4)**

(b) Draw a labeled diagram to show the presence of protons in the discharge tube and explain how canal rays were produced? **(3)**

Ans. **(a)** **See Chapter 2 Q.No.17**

(b) **See Chapter 2 Q.No.25**

Q.6 **(a)** Describe Rutherford's experiment and his atomic model in detail. **(4)**

(b) Explain Bohr's Atomic Theory. Also write down its postulates. **(3)**

Ans. **(a)** **See Chapter 2 Q.No.37**

(b) **See Chapter 2 Q.No.44**

Q.7 **(a)** What do you mean by electronic configuration? What are basic requirements while writing electronic configuration of an element (atom)? **(4)**

(b) Write down applications or uses of isotopes in different field of life? **(3)**

Ans. **(a)** **See Chapter 2 Q.No.57**

(b) **See Chapter 2 Q.No.71**

Q.8 **(a)** Differentiate between shell and subshell. How many electrons are accommodated in shell and subshell? **(4)**

(b) Describe the electronic configuration of Na^{+}, $Mg2^{+}$, $Al3^{+}$ ions. Do they have the same number of electrons in the outermost shell? **(3)**

Ans. **(a)** **See Chapter 2 Q. No.11**

(b) **See Chapter 2 Ex. Q.No.8**

Q.7 **(a)** According to energy level describe the method by Which shell and sub-shells filled by electrons. **(4)**

(b) What is isotopes? Describe the isotopes of hydrogen with diagram? **(3)**

Ans. **(a)** **See Chapter 2 Q.No.12**

(b) **See Chapter 2 Q.No.17**

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PART-III (PRACTICAL QUESTIONS)

10. (i) What is meant by Dry ice

(ii) If equal amounts of sodium chloride are and benzoic acid are taken separately and heated under similar conditions which one will melt first?

Ans. (i) When carbon dioxide gas (CO_2) is passed through a small hole under pressure it changes into white solid called dry-ice.

(ii) Sodium chloride is an inorganic compound while benzoic acid is an organic compound. Since inorganic compounds have stronger intermolecular forces while organic compounds have weaker intermolecular forces, thus, benzoic acid will melt earlier than the sodium chloride.

11. (i) Why two different compounds have different melting points?

(ii) Why HCl is used to remove mortar from the bricks?

Ans. (i) Melting point of a substance depends upon its nature. Since two different types of compounds have different intermolecular forces among their moles or atoms that is why they have different melting points.

(ii) HCl is a strong acid. Mortar consists of calcium hydroxide [$Ca(OH)_2$]. Thus, it is soluble in HCl and forms soluble calcium chloride. Its chemical equation is as following:

$$2HCl_{(aq)} + Ca(OH)_{2\,(aq)} \longrightarrow CaCl_{2(aq)} + 2H_2O_{(l)}$$

12. (i) Can vapourization of water be also called sublimation?

(ii) How will you prepare 250cm^3 0.001M oxalic acid solution from the given 0.2M solution?

Ans. (i) On heating, conversion of water into vapours is called evaporation. Thus, vapourization of water is not a sublimation property of a water.

(ii) Solution:

We know that

Given solution M_1V_1 = Required solution M_2V_2

or $V_1 = \dfrac{M_2V_2}{M_1}$

Putting the values

$$V_1 = \frac{0.001 \times 250}{0.2} = 1.25\ cm^3$$

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