Unit 2

Atomic Structure

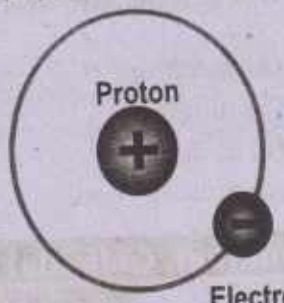
Descriptive Question

Q.1. (Ex. Q.4 (i)) Explain the structure of a hydrogen atom. 09202001

Ans. Hydrogen atom is the simplest and most abundant element in the universe. Hydrogen atom consists of just one proton in its nucleus and one electron orbiting around the nucleus. This electron is typically found in the first energy level or shell of the atom that is K-shell.

Structure

The structure of hydrogen atom can be visualized as tiny nucleus at the center surrounded by a cloud of probability where the electron can be found. The nucleus of the hydrogen may or may not have neutrons in it. There are three isotopes of hydrogen represented as ${}_1^1H$, ${}_1^2H$ and ${}_1^3H$. All these isotopes have one proton in nucleus and one electron around nucleus but number of neutrons are different. ${}_1^1H$ (Protium) has no neutron in it, ${}_1^2H$ (Deutrium) has one neutron in it while ${}_1^3H$ (Tritium) has two neutrons in it.



Structure of Hydrogen

The electrons doesn't follow a fixed path like planets around the sun but is more accurately described by a probability distribution indicating the finding of electron at a particular location around the nucleus.

Transition of electrons:

The electron in a hydrogen atom occupies the lowest energy level known as the ground state. When energy is added to the atom, the electron can jump to higher energy level but it tends to return to the ground state by emitting energy in the form of light.

Q.2. (Ex. Q.4 (ii)) How does the theory of atomic structure explain the ionization of atoms by a radioactive isotope? 09202002

Ans. When a radioactive isotope undergoes decay, it emits radiation in the form of alpha, beta or gamma particles. These emitted particles can interact with atoms leading to the ionization of atoms.

Theory of atomic structure

According to this theory, atoms are composed of a nucleus containing protons and neutrons surrounded by electrons in various energy levels or shell.

Ionization of atoms by a radioactive source

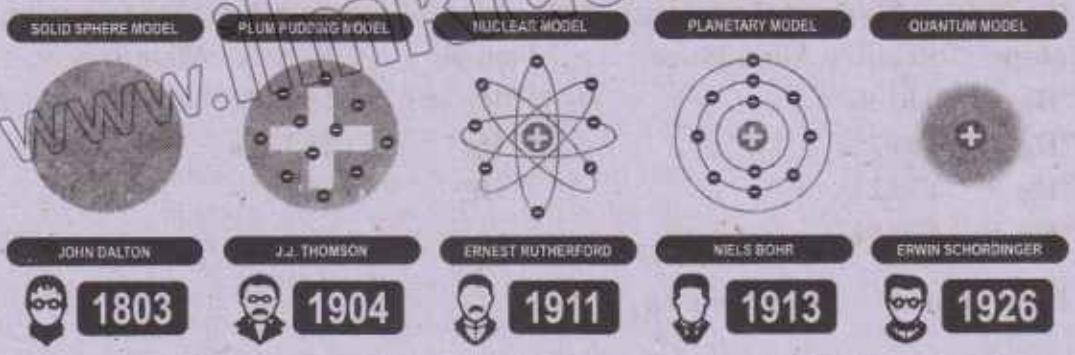
Radiation emitted from a radioactive source causes atoms to ionize. For example, radiation emitted by a radioactive element Radium-226 can remove electrons from the atom. However, this ionizing radiation should have enough energy to remove the tightly bound electron from the orbit of an atom. Electron can be lost because an ionizing radiation collides with the atom and forces the electron to move out of the atom. If an atom of sodium is hit by an ionizing radiation, it may lose an electron. This process converts the atom into a positively charged ion (cation)

$$Na \xrightarrow{\text{ionized}} Na^+ + e^-$$

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However, the electron will be lost only when there is present another atom which can accept it.

$$Cl + e^- \longrightarrow \underset{\text{Anion}}{Cl^-} + \text{Energy}$$



Q.3. (Ex. Q.4 (iii)) What is radioactivity? Explain any three application of radioactive isotopes. 09202003

Ans. Radioactivity: The isotopes of the same element do not have the same physical properties. Several isotopes of the same elements exist whose nuclei are unstable. They emit excess energy in the form of radiation. This process of emission is called **radioactivity** and the isotope which emits energy is called **radioactive isotope**. Every element has one or more radioactive isotope.

Radioactive Decay:

Tritium($^{3}_{1}H$) is a radioactive isotope and the other two are stable and do not emit any radiation. When a radioactive element emits radiation, it is transformed into another element. This process is called **radioactive decay**. This new element may be stable or may be radioactive so that it also emits radiation.

Examples:

$$\underset{(\text{Uranium})}{^{238}_{92}U} \longrightarrow \underset{(\text{Thorium})}{^{234}_{90}Th} + \text{energy}$$

$^{234}_{90}$Thorium is unstable and further disintegrates to give $^{231}_{91}$Pa (Protactinium)

$$\underset{(\text{Thorium})}{^{234}_{90}Th} \longrightarrow \underset{(\text{Protactinium})}{^{234}_{91}Pa} + \text{Energy}$$

$$\underset{(\text{Bismuth})}{^{210}_{83}Bi} \longrightarrow \underset{(\text{Thallium})}{^{206}_{81}Tl} + \text{Energy}$$

Application of Radioactive Isotope:

i. Medical purpose

Radioactive isotopes are useful in medical imaging. Doctors use them to diagnose the disease by injecting the patient with a small amount of radioactive fluid. Technetium-99 is used for diagnostic imaging across human organs like brain, lungs, etc. Doctors use a special camera to watch how the radioactive fluid moves.

ii. Archeological purpose

Radiocarbon dating is a method for finding out the age of an historical object containing organic material with the help of radioactive isotope of carbon ^{14}C. The method involves measuring the proportion of ^{14}C in sample from a dead plant or animal like a piece of wood or a bone which provides information that can be used to calculate when an animal or plant died. The older the sample is, the less ^{14}C is to be detected.

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iii. Construction and power generation purpose

Radioactive isotopes are used to test the strength of metals and concrete mixture. They are used to generate cheap nuclear power and to find oil fields.

Q.4. (Ex. Q.4 (iv)) Find out the relative atomic mass of mercury from the following data.

Isotope	Relative Abundance	Isotope	Relative Abundance
^{196}Hg =	0.0146%	^{199}Hg =	16.34%
^{198}Hg =	10.02%	^{200}Hg =	23.13%
^{201}Hg =	13.22%	^{202}Hg =	29.80%
^{204}Hg =	6.85%		

09202004

Ans: Relative atomic mass of mercury

$$= \frac{0.0146 \times 196 + 10.02 \times 198 + 13.22 \times 201 + 6.85 \times 204 + 16.34 \times 199 + 23.13 \times 200 + 29.80 \times 202}{100}$$

$= 199.387$

Investigative Questions

Q.1 (Ex Q.5 (i)) How can scientists synthesize elements in the laboratory? 09202005

Ans. Scientists can synthesize elements in the laboratory through processes like nuclear fission, nuclear fusion and particle bombardment. These methods involve manipulating atomic nuclei to create new elements that do not exist naturally or are not abundant in nature.

Nuclear Fusion

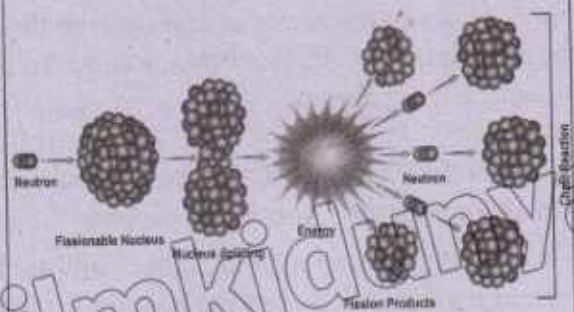
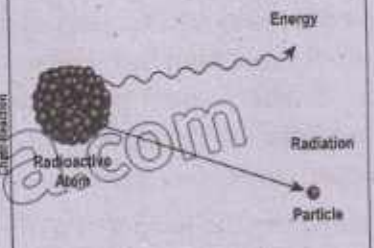
In nuclear fusion, scientists combine atomic nuclei into heavier elements. This process is commonly used in nuclear reactors to generate energy.

Nuclear Fission

It involves splitting of heavy atomic nuclei into lighter elements. This process is commonly used in nuclear reactors to generate energy.

Particle Bombardment

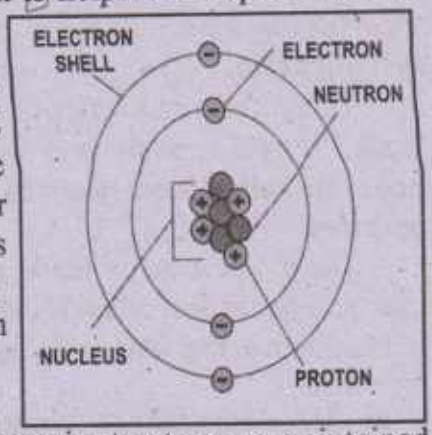
Particle bombardment is another method where high-energy particles are directed at target atoms to induce nuclear reactions and create new elements.

Nuclear Fusion	Nuclear Fission	Particle Bombardment
		

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Q.2 (Ex Q.5 (ii)) A system just like our solar system exists in an atom. Comment on this statement. 09202006

Ans. The idea that an atom is similar to a mini solar system is helpful to explain atomic structure.



In an atom, there is a nucleus at the center, much like the sun in our solar system and electrons revolving around the nucleus like planets orbiting around the sun. This model helps visualize how electrons are arranged around the nucleus. Although the concept of mini solar system is helpful to describe the atomic structure, it also has following contradictions with atomic structure in following aspects:

i. In solar system planets follow predictable orbits around the sun but electrons around the nucleus do not follow fixed paths but follow probability patterns.

ii. The solar system is governed by gravitational forces but atomic structure are maintained by electromagnetic and nuclear forces.

iii. Electrons in an atom can jump between discrete energy levels, emitting and absorbing energy in a process but this jumping does not exist in our solar system.

SLO Based Additional Long Questions

Q.1. How cathode rays are produced? What are their major characteristics? 09202007

Ans. Experiment: A discharge tube is a hard glass tube provided with two metallic electrodes and a vacuum pump to evacuate the gas present in it. When a very high voltage is applied to a gas at a very low pressure present in a glass tube the glass surface behind the positive electrode started to glow, due to the rays emitted from the cathode. These rays were named as cathode rays.

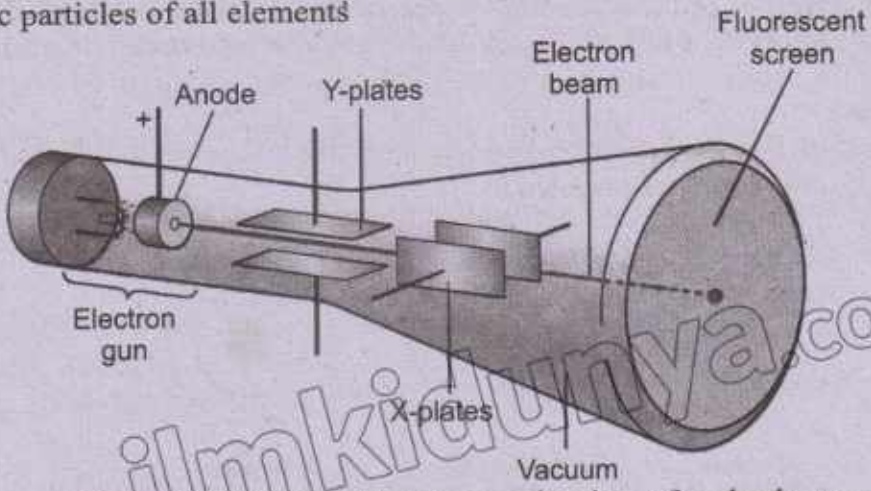
Characteristics of cathode Rays.

In 1897, British physicist Joseph John Thomson studied the properties of cathode rays by passing them through the oppositely charged electric plates.

i. Cathode rays bent towards the positively charged plate showing that they carry negative charge.

ii. Thomson used the findings of his experiments to calculate the mass to charge ratio of cathode rays which finally proved that cathode rays are in fact, negatively charged material particles.

iii. These particles were later named as electrons. It was also shown that electrons are the subatomic particles of all elements



Discharge tube used for the production of cathode rays

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Q.2. Explain how canal rays were produced? 09202008

Ans. Discovery: The presence of positively charged particles in an atom had been first observed by ***E. Goldstein*** *in 1886. It was based on the concept that atoms are electrically* neutral having same number of positive and negative charges.

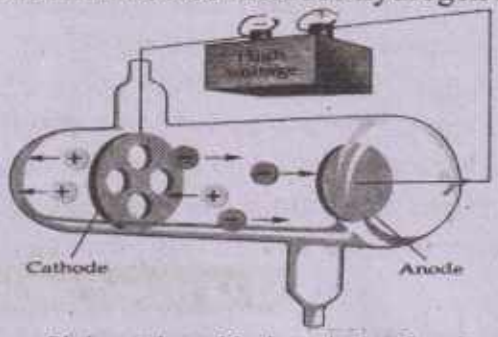
Experiment:

He performed a series of experiments with a gas-discharge tube having a perforated cathode. A new type of rays were produced from the anode which moved towards the cathode. He called these new rays as canal rays or anode rays.

Properties:

i. The properties of these rays seemed to very depending on the gas used in the discharge tube. In fact what he discovered was gas ions and this also included hydrogen ions (H^+). Goldstein at that time knew nothing about its significance.

ii. In 1917, Rutherford performed experiments which proved that the hydrogen nucleus is present in other nuclei. Rutherford thought that a hydrogen nucleus or a proton must be the fundamental building block of all nuclei and also possibly a new fundamental particle as well



Discharge tube used for the production of canal rays.

Q.3. What are isotopes? Explain the isotopes of hydrogen and carbon. 09202009

Isotopes (Iso means 'same' topes means 'position in Periodic Table')

- Definition
- Properties
- Examples
  - i. Isotopes of Carbon
  - ii. Isotopes of Hydrogen

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Ans. All the atoms of an element must necessarily have the same atomic number, but their mass number may vary depending upon the number of neutrons present in the nucleus.

Definition:

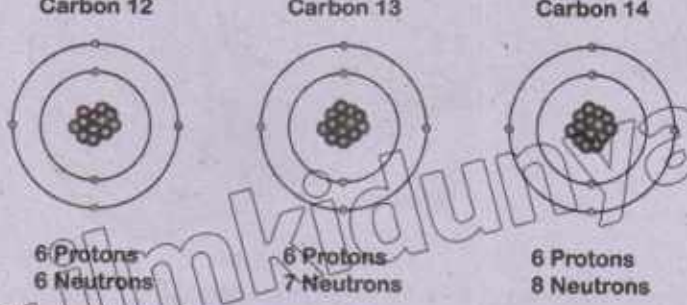
Atoms of the same element having different number of neutrons in their nuclei are called isotopes.

Properties of isotopes:

Chemical properties of the elements are determined by the number of electrons, all isotopes will show almost the same chemical behaviour, although their physical properties may be different.

Isotopes of carbon:

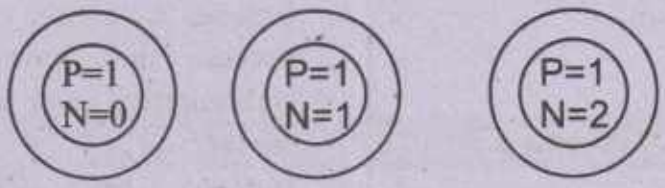
Element carbon has three isotopes as its atoms have six, seven and eight neutrons in their nuclei. These isotopes are represented as ${}^{12}_{6}C$, ${}^{13}_{6}C$, ${}^{14}_{6}C$,.



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Isotopes of Hydrogen:

Hydrogen exists as three isotopes, Hydrogen, Deuterium and Tritium represented by ${}_1^1H$, ${}_1^2H$ and ${}_1^3H$. Hydrogen (${}_1^1H$) is the only atom which does not have a neutron. ${}_1^2H$ has twice the mass of ${}_1^1H$ while the mass of ${}_1^3H$ is thrice the mass of ${}_1^1H$ similarly, the masses of three different isotopes of carbon are different.



Exercise Short Questions

Q.1 Why is it said that almost all the mass of an atom is concentrated in its nucleus? 09202010

Ans. Almost all the mass of an atom is concentrated in its nucleus because the nucleus contains protons and neutrons, which have much greater mass as compared to the electrons that orbit around the nucleus. Protons and neutrons are approximately 1836 times more massive than electrons.

Q.2 Why are elements different from one another? 09202011

Ans. Elements are identified by their atomic numbers. Elements are different from one another because each element has a unique atomic number and different properties. The number of electrons, protons and neutrons in an atom determine its chemical behavior which in turn distinguishes one element from another.

Q.3 How many neutrons are present in ${}_{83}^{210}Bi$? 09202012

Ans. Each bismuth atom will have 83 protons and 83 electrons. The number of neutrons in bismuth will be calculated as follows:

$$n = A - Z$$
$$n = 210 - 83$$
$$= 127$$

So, each bismuth atom will have 127 neutrons in its nucleus.

Q.4 Why is tritium (${}_1^3H$) a radioactive element? 09202013

Ans. Tritium is a radioactive isotope of hydrogen because it has unstable nucleus. Tritium undergoes radioactive decay, emitting low energy beta radiations.

Tritium has two neutrons, one proton and one electron that making it heavier than the other two isotopes of hydrogen (Protium and Deuterium).

Q.5 How can an atom absorb and evolve energy? 09202014

Ans. An atom can evolve or absorb energy through a process called electron transition. When an electron in an atom jumps from low energy orbit to high energy orbit, it absorbs energy and when it jumps back from high energy orbit to low energy orbit, it evolves energy. This energy is evolved or absorbed in the form of electromagnetic radiation, such as light or heat.

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Q.6 Calculate the number of neutrons, protons and electrons in the following atoms. 09202015

$^{195}_{78}Pt$ $^{55}_{25}Mn$ $^{127}_{53}I$

i. $^{195}_{78}Pt$

Solution

Each Pt atom will have 78 protons & 78 electrons.

The no. of neutrons in Pt will be calculated as follow:

$n = A-Z$

$n = 195-78 \Rightarrow 117$

So, each Pt atom will have 117 neutrons, 78 protons &78 electrons.

ii. $^{55}_{25}Mn$

Solution

Each Mn atom will have 25 protons & 25 electrons. The no. of neutrons in Mn will be calculated as follows:

$n = A - Z$

$n = 55 - 25$

$n = 30$

So, each Mn atom will have 30 neutrons, 25 electrons & 25 protons.

iii. $^{127}_{53}I$

Each $^{127}_{53}I$ atom will have 53 protons & 53 electrons. The no. of neutrons in $(^{127}_{53}I)$ will be calculated as follows:

$n = A - Z$

$n = 127 - 53$

$n = 74$

So, each *(I)* atom will have 74 neutrons, 53 protons & 53 electrons.

Q.7 Why isotopes of an element show same chemical properties while their physical properties are different? 09202016

Ans.

i. Isotopes have same chemical properties because they have same electronic configuration and have same atomic number.

ii. Isotopes have different physical properties because they have different mass number.

Q.8 Why does the radioactive isotope emit radiation? Give an example of a radioactive isotope which disintegrates to give a stable atom. 09202017

Ans. Several isotopes of the same elements exist whose nuclei are unstable. They are high in energy. They emit excess energy in the form of radiation. This process of emission is called **radioactivity** and the isotope which emits energy is called **radioactive isotope**. Every element has one or more radioactive isotope.

Example:

$$^{210}_{83}Bi \longrightarrow {}^{206}_{81}Tl + \text{Energy}$$

Q.9 How would you compare the masses of the atoms of C, Mg and *Cl*? 09202018

Ans. The atomic mass of carbon is 12.01 amu

The atomic mass of magnesium is 24.30 amu

The atomic mass of chlorine is 35.45 amu.

To compare their masses, we divide the masses as:

$$\frac{\text{mass of Mg}}{\text{mass of C}} = \frac{24.30}{12.01} = 2.02$$

Mg atoms is 2.02 times havier than C atom.

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$$\frac{\text{mass of } C\ell}{\text{mass of C}} = \frac{35.45}{12.01} = 2.95$$

$C\ell$ atom is 2.95 times havier than C atom.

$$\frac{\text{mass of } C\ell}{\text{mass of Mg}} = \frac{35.45}{24.30} = 1.45$$

$C\ell$ atom is 1.45 times havier than Mg atom. Carbon is lightest atom among these three atoms.

Q.10 Calculate the relative atomic mass of lead (Pb). Isotopic abundances of isotopes are 2.0, 24.0, 22.0 and 52.0 respectively. 09202019

^{204}Pb ^{206}Pb ^{207}Pb ^{208}Pb

Ans. Relative atomic mass of Lead (Pb)

$$= \frac{2 \times 204 + 24 \times 206 + 22 \times 207 + 52 \times 208}{100}$$

$$= 207.22$$

SLO Based Additional Short Questions

Introduction

Q.11 Have you ever thought why some elements are so different from one another? 09202020

Ans. Sulphur looks very different from gold which, in turn, is very different from bromine. Similarly iron is a heavy metal while aluminium and zinc are light metals. Metals are mostly lustrous while non-metals like sulphur and carbon appear dull. The difference in the properties of elements is due to difference in the properties of their constituent atoms.

Structure of Atom

Q.12 Define Nuclear force. 09202021

Ans. The strong attractive force that binds protons and neutrons together. This force is stronger than electrostatic or magnetic forces. This force exists between neutrons and neutrons, protons and protons, and neutrons and protons.

Q.13 Why the mass of electron is neglected for determining the mass of an atom? 09202022

Ans. Protons and neutrons have roughly the same mass, around 1 amu. This mass contributes significantly to the total mass of the atom. Electrons have much less mass, the mass of electron is about 1836 times less than the mass of proton and neutron so their contribution to the total mass of an atom is usually negligible.

Q.14 How many times cesium bigger than Helium? 09202023

Ans. The largest atom cesium is approximately nine times bigger than the smallest atom helium.

Q.15 What is the origin of Cathode & anode Rays? 09202024

Ans. Cathode rays are so named because they are emitted by the cathode in a discharge tube. A very high electrical potential of thousands of volts was applied in the discharge tube which ionized the residual gas atoms present in the tube. The positive ions thus produced travelled towards the cathode as anode or canal rays. When they collided with the cathode they knocked electrons out of its surface. This stream of electrons was called cathode rays.

Q.16 What is the structure of an atom? 09202025

Ans. Lord Rutherford, in 1911. He carried out an experiment in which he hit a stream of alpha particles to a very thin gold foil. From this experiment he concluded that an atom has two portions. A tiny central portion which he called as nucleus and a relatively large area surrounding this, which he called extra nuclear portion. The electrons are present in this extra nuclear portion in the form of cloud around the nucleus.

Q.17 Who first gave the idea of atom? / Briefly describe contribution of Democritus. 09202026

Ans. The idea of atom was first proposed in Greece when the philosopher Democritus

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declared that all matter is made of tiny particles. He named this particle as atom, a particle that cannot be further subdivided.

Q.18 Who discovered an electron, a proton and a neutron? 09202027

Ans. i) Goldstein discovered positively charged particles called protons in 1886.

ii) Thomson found in an atom, the negatively charged particles known as electron in 1897.

iii) Chadwick discovered neutron in 1932.

Q.19 How does electron differ from a neutron? 09202028

Ans.

Electron	Neutron
It is the negatively charged particle.	It is the neutral particle.
It revolves around the nucleus.	It is present in the nucleus.
Mass of electron is 5.486×10^{-4} amu.	Mass of neutron is 1.0087 amu.

Q.20 Differentiate between shell and sub shell with examples of each. 09202029

Ans.

Shell	Sub Shell
Each principle energy level in which an electron revolves around nucleus is called shell.	Each shell further contains one or more sub energy levels called sub shells.
These are represented by K, L, M, N etc.	These are represented by s, p, d, f.

Q.21 What are sub-atomic particles? 09202030

Ans. Sub-atomic particles are the fundamental particles that make up atoms. The three main sub – atomic particles are:

Particle	Charge	Mass
Electron	-1.6022×10^{-19} C	9.109×10^{-31} Kg
Proton	$+1.6022\times10^{-19}$ C	1.673×10^{-27} Kg
Neutron	0.0	1.675×10^{-27} Kg

Q.22 Compare the size of nucleus with the size of atom. 09202031

Ans. Although the nucleus is less than one hundred-Thousandth (1/100,000) of the size of the atom, it contains more than 99.9% of the mass of the atom.

Discovery of Electrons

Q.23 How cathode rays were produced? 09202032

Ans. A discharge tube is a hard glass tube provided with two metallic electrodes and a vacuum pump to evacuate the gas present in it. When a very high voltage is applied to a gas at a very low pressure present in a glass tube the glass surface behind the positive electrode started to glow, due to the rays emitted from the cathode. These rays were named as cathode rays.

Q.24 Discuss characteristics of cathode rays. 09202033

Ans. In 1897, British physicist Joseph John Thomson studied the properties of cathode rays by passing them through the oppositely charged electric plates.

i. Cathode rays bent towards the positively charged plate showing that they carry negative charge.

ii. Thomson used the findings of his experiments to calculate the mass to charge ratio of cathode rays which finally proved that cathode rays are in fact, negatively charged material particles.

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iii. These particles were later named as electrons. It was also shown that electrons are the subatomic particles of all elements.

Atomic Number and Mass Number

Q.25 How ions and isotopes are formed? 09202034

Ans. Changing the number of electrons of an element forms ions, while changing the number of neutrons of an element forms isotopes.

Q.26 Calculate the number of neutrons, protons and electrons in barium $^{137}_{56}Ba$. 09202035

Solution: Each barium atom will have 56protons and 56 electrons. The number of neutrons in barium will be calculated as follows:

$n = A - Z$

$n = 137 - 56 = 81$

So each $^{137}_{56}Ba$ atom will have 81 neutrons, 56 protons and 56 electrons.

Q.27 Define Proton number/ Atomic number. 09202036

Ans. Proton number refers to the number of protons in the nucleus of an atom. It is also known as the atomic number and is indicated by the symbol "Z".

For example: There is only one proton in the nucleus of H atom; therefore its atomic number is 1.

Q.28 Define Nucleon number/ atomic mass. 09202037

Ans. The sum of total number of protons and neutrons in an atom is known as its mass number or nucleon number. It is represented by A.

For Example: Mass of 1st isotope of hydrogen is 1.

$A = Z + n$ or $n = A - Z$

Formula:

Mass number = atomic number + No. of neutron.

Q.29 Give an example of synthetic element. 09202038

Ans. Copernicium (Cn) is a synthetic element and it was discovered in 1996. This metal turns into a gas at room temperature.

Isotopes and their Masses

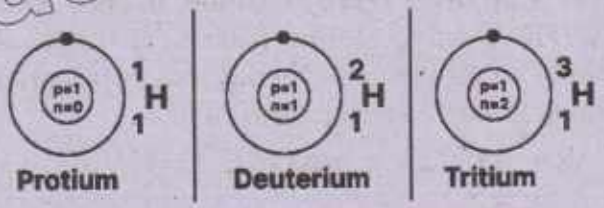
Q.30 Define Isotopes. 09202039

Ans. Isotopes are atoms of an element have the same atomic number but different mass number. This is because atoms of an element can differ in the number of neutrons.

Example: $^{1}_{1}H, ^{2}_{1}H, ^{3}_{1}H$ are isotopes of hydrogen.

Q.31 What are the isotopes of hydrogen? 09202040

Ans. Hydrogen has three isotopes. Hydrogen – 1 (Protium) has no neutron. Its symbols $^{1}_{1}H$. Hydrogen – 2 (deuterium) has one neutron and hydrogen – 3 (Tritium) has two neutrons. Their symbols are $^{2}_{1}H$ and $^{3}_{1}H$ respectively.

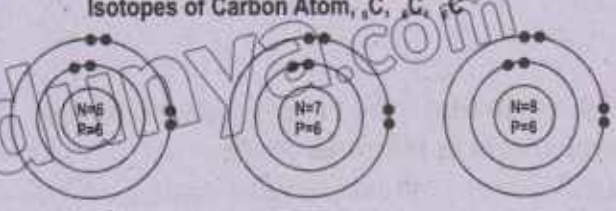


Q.32 What do you know about isotopes of carbon? 09202041

Ans. Isotopes of Carbon

Carbon has three isotopes. Carbon-12, carbon-13 and carbon-14. Almost all the carbon is carbon-12. Its symbol is $^{12}_{6}C$. It has six neutrons and six protons. Carbon-13 has symbol $^{13}_{6}C$, it has seven neutrons and six protons. Carbon-14 has eight neutrons and six protons. Its symbol is $^{14}_{6}C$.

Isotopes of Carbon Atom, $^{12}_{6}C$, $^{13}_{6}C$, $^{14}_{6}C$



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Q.33 Define radioactivity and radioactive isotopes. 09202042

Ans. The isotopes of the same element do not have the same physical properties. Several isotopes of the same elements exist whose nuclei are unstable. They emit excess energy in the form of radiation. This process of emission is called **radioactivity** and the isotope which emits energy is called **radioactive isotope.**

For example: $^{238}_{92}U$ is a radioactive isotope of uranium.

Relative Atomic Mass

Q.34 Define relative isotopic masses. 09202043

Ans. An element usually consists of a few different isotopes with different mass numbers. These mass numbers are called relative isotopic masses. Each isotope will also have its own naturally occurring abundance which is called isotopic abundance.

Q.35 Define atomic mass unit. Why is it needed? 09202044

Ans. The unit for relative atomic mass is called atomic mass unit. Its symbol is "amu". One atomic mass unit is $\frac{1}{12}$th the mass of one atom of carbon-12 isotope.

Need: The mass of an atom is too small to be determined practically. That's why to determine the atomic mass of various elements, atomic mass unit is needed.

Q.36 Define relative isotopic mass. How relative atomic mass can be determined? 09202045

Ans. An element usually consists of different isotopes. The relative atomic mass of an element can be calculated from the relative isotopic masses(m) and isotopic abundances (p) by formula:

$$\text{Relative atomic mass} = \frac{m_1p_1 + m_2p_2 + m_3p_3}{100}$$

Q.37 Calculate relative atomic mass of carbon. 09202046

Ans. The relative atomic mass is a weighed average of the all the naturally occurring isotopes of an element, taking into consideration of their natural abundance. Use general formula Relative atomic mass of $C =$

$$\frac{\text{RA of C-12} \times \text{at.mass of C-12} + \text{RA of C-13} \times \text{at.mass of C-13} + \text{RA of C-14} \times \text{at.mass of C-14}}{100}$$

$$\text{Relative atomic mass of } C = \frac{98.8 \times 12 + 1.1 \times 13 + 0.009 \times 14}{100}$$

$$\text{Relative atomic mass of } C = \frac{1185.6 + 14.3 + 0.126}{100}$$

$$\text{Relative atomic mass of } C = 12.00026 \ amu$$

Q.38 Calculate the relative atomic mass of Krypton (Kr). Isotopic abundances of isotopes 2.0, 12.0, 12.0, 57.0, and 57.0 are 80, 82, 83, 84, 85 respectively. 09202047

Ans. Relative atomic mass of krypton

$$= \frac{80\times 2.0 + 82\times 12.0 + 83\times 12.0 + 84\times 57.0 + 85\times 57.0}{100}$$

$$= 83.7$$

Q.39 Calculate the relative atomic mass of light isotope of chlorine when its relative atomic mass is taken as 35.45. 09202048

Ans. Relative isotopic abundance of Cl-37 = 24.23%

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Relative isotopic abundance of light isotope of chlorine = 75.77%
Relative atomic mass of chlorine = 35.45

$$\text{Relative atomic mass of chlorine} = \frac{Cl \times 75.77 + 37 \times 24.23}{100}$$

$$35.45 = \frac{Cl \times 75.77 + 37 \times 24.23}{100}$$

$$3545 = Cl \times 75.77 + 37 \times 24.23$$
$$3545 - 896.51 = Cl \times 75.77$$
$$2648.49 / 75.77 = Cl$$
$$34.95 = Cl$$

Relative atomic mass of light isotope of chlorine is 34.95

Q.40 What is meant by carbon dating or radio carbon dating? 09202049

Ans Radiocarbon dating is a method for finding out the age of an historical object containing organic material with the help of radioactive isotope of carbon $^{14}_{6}C$. The method involves measuring the proportion of ^{14}C in a sample from a dead plant or animal like a piece of wood or a bone which provides information that can be used to calculate when an animal or plant died. The older the sample is, the less ^{14}C is to be detected.

Q.41 What is gallium that make it unique from other metals? 09202050

Ans. Gallium has many interesting properties. Its melting point is below body temperature so it is liquid at room temperature. It has water like viscosity. It does not evaporate.

Discovery of Neutron

Q.42 How the particles are arranged in a tiny place? What is the structure of an atom? 09202051

Ans. Lord Rutherford, in 1911, carried out a remarkable experiment in which he hit a stream of special type of particles to a very thin gold foil. From this experiment he concluded that an atom has two portions. A tiny central portion which he called as nucleus and a relatively large area surrounding this, which he called extra nuclear portion. It was also discovered that almost all the mass of an atom is concentrated in the nucleus because both the heavy particles i.e. protons and neutrons are found to be present here. In the nucleus these two particles are held together by a strong nuclear force.

Bohr's Atomic Model

Q.43 Write the contribution of Neil Bohr's. 09202052

Ans. In 1913, Niel Bohr proposed a model for the hydrogen atom which is called Bohr's atomic model. According to this model the electron can revolve around the nucleus of the atom in specific paths called orbits or shells. When the electron is revolving in one of these orbits, its energy is fixed. When the electron is present in the orbit which is closest to the nucleus, its energy is minimum and it is called the ground state of the atom.

Q.44 How can atoms be seen? 09202053

Ans. The size of an atom is so small that it is not possible to see it with naked eye. However, a transmission electron microscope (TEM) can be used to see atoms.

Q.45 How to find out the no. of electron in shell? 09202054

Ans. To find out the number of electrons which can be accommodated in these-extra nuclear shells, the scientists have devised a formula called ($2n^2$) formula where n can have values 1,2,3... and so on and they represent the number of shells. Shells have also been named as K, L,M,N ... and so on.

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Q.46 How many times cesium is bigger than helium? 09202055

Ans. The largest atom cesium is approximately nine times bigger than the smallest atom helium.

Q.47 How many atoms does our body replace every year? 09202056

Ans. Every year, our body replaces about 98% of its atoms.

Constructed Response Question

Q.1. Ex Q. 3 (i) Why does the energy of electron increase as we move from first shell to second shell? 09202057

Ans. The energy of an electron increases as we move from the first to the second shell because the second shell is farther away from the nucleus which means that electron in the second shell has high energy as compared to the electron in the first shell. This increase in distance from the nucleus results in a higher energy level for electron in outer shell.

Q.2. Q. 3 (ii) Why is it needed to lower the pressure of the gas inside the discharge tube? 09202058

Ans. Lowering the pressure of the gas inside the discharge tube is necessary because it helps to create a vacuum. This vacuum provides minimum opposition to the electrons emitting from the electrode creating smoothly moving cathode/ canal rays.

Q.3. Q. 3 (iii) What is the classical concept of an electron? How has this concept changed with time? 09202059

Ans. The classical concept of an electron is that electron being the charged particles should release or emit energy continuously and they should ultimately fall into the nucleus. Electron revolve around the nucleus of an atom similar to planets revolve around the sun in the solar system.

However, as scientific knowledge advanced, the concept of electron evolved. Now, it is considered that electron behave like particle as well as wave. Electrons are now described by wave functions that represent the probability of finding an electron in a particular region around the nucleus rather than following a definite path like a planet in orbit. This change in concept has led to a more convinced understanding of the behavior of electrons in atoms and molecules.

Q.4. Q. 3 (iv) Why the nuclei of the radioactive elements are unstable? 09202060

Ans. The nuclei of radioactive elements are unstable because they contain an imbalance of protons and neutrons which leads to an excess of energy within the nucleus. This imbalance causes the nucleus to undergo radioactive decay in order to become more stable.

During radioactive decay, the nucleus emits energy in the form of radiation to achieve a more balanced and stable configuration.

Q.5. Q. 3 (v) During discharge tube experiments, how did the scientists conclude that the same type of electrons and protons are present in all the elements? 09202061

Ans. During discharge tube experiments, scientists observed that the properties of the electrons and protons were the same regardless of the element being studied. They conclude that the same type of electrons and protons are present in all elements. From discharge tube experiments, scientists suggested that electrons are negatively charged particles and protons are positively charged particles. These fundamental particles are consistent across different elements.

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Multiple Choice Questions (Exercise)

1. **How many electrons can be accommodated at the most in the third shell of the elements?** 09202062
(a) 8 (b) 18
(c) 10 (d) 32

2. **What information was obtained from discharge tube experiments?** 09202063
(a) Structure of atom was discovered
(b) Neutrons and protons were discovered
(c) Electrons and protons were discovered
(d) Presence of nucleus in an atom was discovered

3. **Why have isotopes not been shown in the periodic table?** 09202064
(a) Periodic table cannot accommodate a large number of isotopes of different elements.
(b) Some of the isotopes are unstable and they give rise to different elements.
(c)All the isotopes have same atomic number, so there is no need to give them separate places.
(d) Isotopes do not show periodic behavior

4. **Which particle is present in different number in the isotopes?** 09202065
(a) Electron
(b)Neutron
(c) Proton
(d) Both neutron and electron

5. **In which isotope of oxygen there are the equal number of protons, electrons and neutrons?** 09202066
(a) ^{17}O (b) ^{16}O
(c) ^{18}O (d) None of these

6. **What will be the relative atomic mass of nitrogen given the abundances of its two isotopes, ^{14}N and ^{15}N are 99.64 and 0.35 respectively** 09202067
(a) 14.0210 (b)14.0021
(c) 14.2100 (d) 14.1200

7. **How is radio carbon dating useful for archeologists?** 09202068
(a)it helps determine the age of organic matter.
(b) It helps determine the composition of matter.
(c) It helps determine the usefulness of matter.
(d) It helps determine whether the matter is radioactive or not.

8. **What does keep the particles present in the nucleus intact?** 09202069
(a)Particles are held together by strong nuclear force.
(b) Particles are held together by week nuclear force.
(c) Particles are held together by electrostatic force.
(d) Particles are held together by dipolar force.

9. **How do electrons keep themselves away from the oppositely charged nucleus?** 09202070
(a) By keeping themselves stationary
(b) By revolving around the nucleus
(c) Due to their wave-like nature
(d) A magnetic field around the nucleus keeps them away

10. **Rubidium consists of two isotopes ^{85}Rb and ^{87}Rb. The percent abundance of the light isotope is 72.2% What is the percent abundance of the heavier isotope? Its atomic mass is 85.47.** 09202071
(a) 15% (b)27.8%
(c) 37% (d) 72%

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Structure of Atom

11. **M shell has sub-shells:** 09202072
(a) 1s, 2s (b) 2s, 2p
(c) 3s, 3p, 3d (d) 1s, 2s, 3s

12. **A sub-shell that can accommodate 6 electrons is:** 09202073
(a) s (b) b
(c) p (d) f

13. **John Dalton put forward his atomic theory:** 09202074
(a) 1800 (b) 1805
(c) 1903 (d) 1803

14. **Rutherford used a gold foil in his experiment, which had a thickness of:** 09202075
(a) 0.002cm
(b) 0.00004cm
(c) 0.0001cm
(d) 0.001cm

15. **Who performed first experiment to split atom?** 09202076
(a) Soddy
(b) Rutherford
(c) Bohr
(d) Newton

16. **According to Rutherford's atomic theory, atom should produce:** 09202077
(a) Line spectrum
(b) Continuous spectrum
(c) Both a & b
(d) None of these

17. **Quantum means:** 09202078
(a) Variable energy
(b) Fixed energy
(c) High energy
(d) Minimum energy

18. **The relative atomic mass of proton is:** 09202079
(a) 1.673×10^{-27}kg
(b) 1.6749×10^{-27}kg
(c) 9.11×10^{-31}kg
(d) None of these

19. **The relative atomic mass of neutron is:** 09202080
(a) 1.6726×10^{-27}kg
(b) 1.675×10^{-27}kg
(c) 9.11×10^{-31}kg
(d) None of these

20. **The relative atomic mass of electron is:** 09202081
(a) 1.6726×10^{-27}kg
(b) 1.6749×10^{-27}kg
(c) 9.109×10^{-31}kg
(d) None of these

21. **Protons are deflected toward plate:** 09202082
(a) Positive
(b) Negative
(c) both a and b
(d) None of these

22. **The nucleus of an atom is composed of:** 09202083
(a) Electrons
(b) Electrons and protons
(c) Electrons and neutrons
(d) Protons and neutrons

23. **How many electrons can be accommodated in s subshell?** 09202084
(a) 2 (b) 6
(c) 10 (d) 14

24. **Number of electrons that can be accommodated in f-subshell:** 09202085
(a) 2 (b) 6
(c) 10 (d) 14

25. **Which subshells are present in L-shell?** 09202086
(a) s& p
(b) Only s-subshell
(c) Only p-subshell
(d) Subshell

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26. **How many subshells are there in M-shell?** 09202087
(a) 2 (b) 3
(c) 4 (d) 5

27. **N-shell contains number of subshells:** 09202088
(a) 1 (b) 2
(c) 3 (d) 4

28. **An element has 5 electrons in M-shell. Its atomic number is:** 09202089
(a) 5 (b)10
(c) 15 (d) 20

29. **d-subshell can accommodate maximum electrons:** 09202090
(a) 2 (b) 6
(c) 10 (d) 14

30. **The removal of electron from a neutral atom gives rise to:** 09202091
(a) Molecular anion
(b) Molecular cation
(c) Anion
(d) Cation

31. **How many electrons can be accommodated at the most in the third shell of the elements?** 09202092
(a) 8 (b) 18
(c) 10 (d) 32

Atomic Number and Mass Number

32. **Number of neutrons in $^{27}_{13}M$ are:** 09202093
(a) 13 (b) 14
(c) 27 (d) 15

33. **Number of protons in the nucleus of an atom is called:** 09202094
(a) Mass number (b) Atomic number
(c) Electron number (d) Mass Unit

34. **Atom is electrically:** 09202095
(a) Positive particle
(b) Negative particle
(c) Neutral particle
(d) None of these

35. **Atomic number is represented by:** 09202096
(a) Z (b) A
(c) P (d) At

36. **$^{238}_{92}U$ has number of neutrons:** 09202097
(a) 92 (b) 238
(c) 146 (d) 330

37. **Mass number is represented by:** 09202098
(a) A (b) Z
(c) M (d) N_A

Isotopes and their Masses

38. **Which of the following statement is not correct about isotopes?** 09202099
(a) they have same atomic number
(b) they have same number of protons
(c) they have same chemical properties
(d) they have same physical properties

39. **Which isotope is used in nuclear reactors?** 09202100
(a) U-234 (b) U-238
(c) U-235 (d) all of these

40. **Chlorine has two isotopes, both of which have:** 09202101
(a) same mass number
(b) same number of neutrons
(c) different number of protons
(d) same number of electrons

41. **Which isotope is commonly used to irradiate cancer cells?** 09202102
(a) iodine-23
(b) Carbon-14
(c) Cobalt-60
(d) iodine-131

42. **Number of isotopes of hydrogen is:** 09202103
(a) 2 (b) 3
(c) 4 (d) 5

43. **Symbol for Deuterium is:** 09202104
(a) $^{1}_{1}H$ (b) $^{2}_{1}H$
(c) $^{3}_{1}H$ (d) $^{1}_{0}H$

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44. **^{13}C and ^{14}C are both present in nature:** 09202105
(a) 0.1% (b) 0.9%
(c) 1.1 % (d) 1.5 %

45. **The percentage of $^{235}_{92}U$ is found in nature:** 09202106
(a) 97 % (b) 98 %
(c) 0.72 % (d) 0.62 %

46. **Which isotope is used for diagnosis of goiter?** 09202107
(a) Iodine-131 (b) Cobalt-60
(c) P-32 (d) Sr-90

47. **Carbon-14 is used for the:** 09202108
(a) Age determination of old objects
(b) Growth of bones
(c) Diagnosis of goiter
(d) All of these

48. **Mass of Proton in amu is:** 09202109
(a) 1.0073
(b) 1.0087
(c) 1.672×10^{24}
(d) None of these

49. **Predict the boiling point of heavy water (D_2O).** 09202110
(a) 101.4°C (b) 98.2°C
(c) 100°C (d) 105.4°C

50. **What will be the relative atomic mass of hydrogen given the abundances of its two isotopes, 99.9844% and 0.0156%?** 09202111
(a) 1.0078 (b) 1.0784
(c) 1.0800 (d) 1.0700

Answer Key

1	b	2	c	3	c	4	b	5	b
6	b	7	a	8	a	9	b	10	b
11	c	12	c	13	d	14	b	15	b
16	b	17	b	18	a	19	b	20	c
21	b	22	d	23	a	24	d	25	a
26	b	27	d	28	c	29	c	30	d
31	b	32	b	33	b	34	c	35	a
36	c	37	a	38	d	39	c	40	d
41	c	42	b	43	b	44	c	45	c
46	a	47	a	48	a	49	a	50	a

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