Maharashtra State Board
Class IX Science and Technology
Sample Paper – 3
Solution

SECTION A

1.

(A)

(a)

i. If the K and L shells of an atom are full, then the total number of electrons in an atom is **10**.

ii. Waste which contains discarded computer parts is known as **e-waste**.

iii. Recoil of a gun is an example of Newton's **third** law of motion.

(b)

i. False.

The horizontal line of a distance–time graph represents that the distance is not changing with time, i.e. the object is at rest.

ii. False.

Pitch is characterised by the frequency of a wave and loudness by its amplitude. Thus, one cannot conclude anything about the loudness by knowing its pitch.

(B)

i. **(d)** Surface area

The rate of evaporation increases with an increase in surface area.

ii. **(a)** Is equal to the potential energy at h

In accordance with the law of conservation of energy, the total energy at every instant is the same. During the fall of the stone, the sum of its kinetic and potential energy is equal to its potential energy at h. At maximum height, the total energy is equal to the potential energy as the kinetic energy is zero.

iii. **(a)** 30 km towards East

Total displacement = (40 E – 10 W) km

= 30 km towards East

iv. **(a)** The density of liquid B is more than liquid A.

The density of liquid B is more than liquid A as more upthrust is exerted on the body in liquid B, and hence, it sinks less.

v. **(b)** Food and shelter to grow, survive and reproduce.
Living organisms use the abiotic factors around them for food and shelter to grow, survive and reproduce.

2.

i. There are 6.022×10^{23} carbon atoms in one mole of carbon.
$\therefore$ The mass of 6.022×10^{23} carbon atoms is 12 g.

$\therefore$ The mass of one carbon atom = $\frac{12}{6.022 \times 10^{23}} = 1.9927 \times 10^{-23}$g

The mass of 1 carbon atom is 1.9927×10^{-23} g.

ii.

Given acceleration = $2 m / s^2$
Mass = 10 kg
We know that,
Force = Mass $\times$ Acceleration
$\Rightarrow$ Force $= 10 \times 2 = 20$ N
Thus, force of 20 N is needed to produce acceleration of 2 m/s^2.
If 30 N force is applied on a body of 10 kg mass

Then, Acceleration = $\frac{\text{Force}}{\text{Mass}}$

$\Rightarrow$ Acceleration $= \frac{30}{10} = 3 \text{ m} / s^2$

iii. Characteristics of a colloid:
- In a colloid, the particles are distributed uniformly throughout the solution.
- The size of the particles is less than that of the particles in a suspension.
- The particles scatter a beam of light passing through it.
- The particles are not visible to the naked eye.
- A colloidal solution appears homogeneous, but it is actually heterogeneous.

iv.

	Distance	**Displacement**
1	Distance is the length of the actual path followed by a body between the points under consideration.	Displacement is the shortest distance from the initial point to the final point of movement of a body.
2	It does not have direction, so it is a scalar quantity.	It has direction, so it is a vector quantity.
3	Its magnitude is greater than or equal to that of its displacement.	Its magnitude is less than or equal to that of its distance.

v. Different types of biomes and their subtypes include

(a) Land biome

- Tropical rainforests
- Grasslands
- Temperate–evergreen forests
- Deserts
- Tundra
- Taiga

(b) Aquatic biome

- Freshwater biomes
- Marine water biomes

vi.

(a) The falling of a body from a height towards the Earth under the gravitational force of the Earth (with no other forces acting on it) is called free fall.

(b) No, acceleration is independent of the mass of the body during free fall.

3.

i.

(a) The number of vibrations per second is called frequency.

The minimum distance in which a sound wave repeats itself is called its wavelength.

The distance travelled by a wave in one second is called the velocity of the wave.

Relation between velocity, frequency and wavelength of a wave:

Velocity of wave = frequency $\times$ wavelength

$v = f \times \lambda$

(b) Here,

Time period T = 1/260 s

Velocity v = 350 m/s

$$\text{Frequency} = \frac{1}{\text{Time period}} = 260 \text{ Hz}$$

$$\text{Wavelength, } \lambda = \frac{\text{Velocity of the wave}}{\text{Frequency}}$$

$$= \frac{350}{260} = 1.34 \text{ m}$$

ii. Area of the box = 4 m $\times$ 4 m = 16 m^2

Mass before reduction m_1 = 10 kg

Weight before reduction $W_1 = mg = 16 \times 10 = 160$ N

Pressure before reduction

$$P_1 = \frac{\text{Force}}{\text{Area}} = \frac{160}{16} = 10 \text{ Pa}$$

After reduction, area of the box = 2 m $\times$ 2 m = 4 m^2

Mass after reduction m_2 = 7 kg

Weight after reduction $W_2 = mg = 7 \times 10 = 70$ N

Pressure after reduction

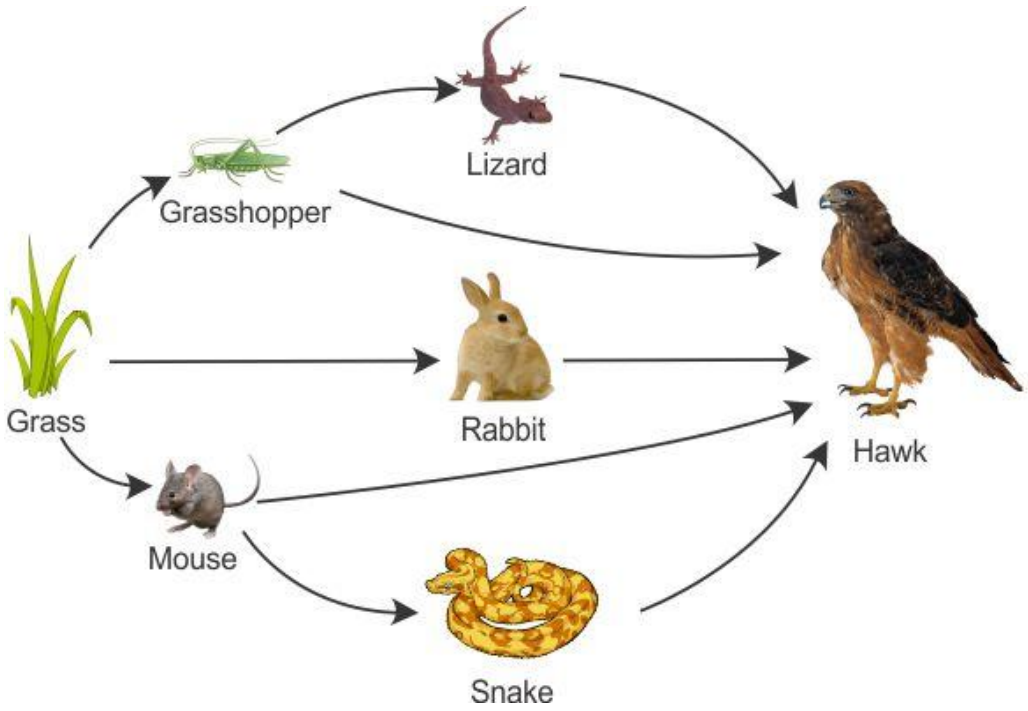
$$P_2 = \frac{\text{Force}}{\text{Area}} = \frac{70}{4} = 17.5 \text{ Pa}$$

Hence, ratio of the pressure exterted on the floor before and after the reduction of mass is

$$\frac{P_1}{P_2} = \frac{10}{17.5}$$

$$\text{or } \frac{P_1}{P_2} = \frac{4}{7}$$

iii.



Food web

iv.

Every object in the Universe attracts every other object with a force which is proportional to the product of their masses and inversely proportional to the square of the distance between their centres. The force is along the line joining the centres of two objects.

Consider two objects A and B of masses m_1 and m_2 lying at a distance r from each other.

Let the force of attraction between two objects be F.

According to the universal law of gravitation, the force between two objects is

$$F \propto m_1 m_2$$

$$F \propto \frac{1}{r^2}$$

Combining the two equations, we get

$$F \propto \frac{m_1 m_2}{r^2}$$

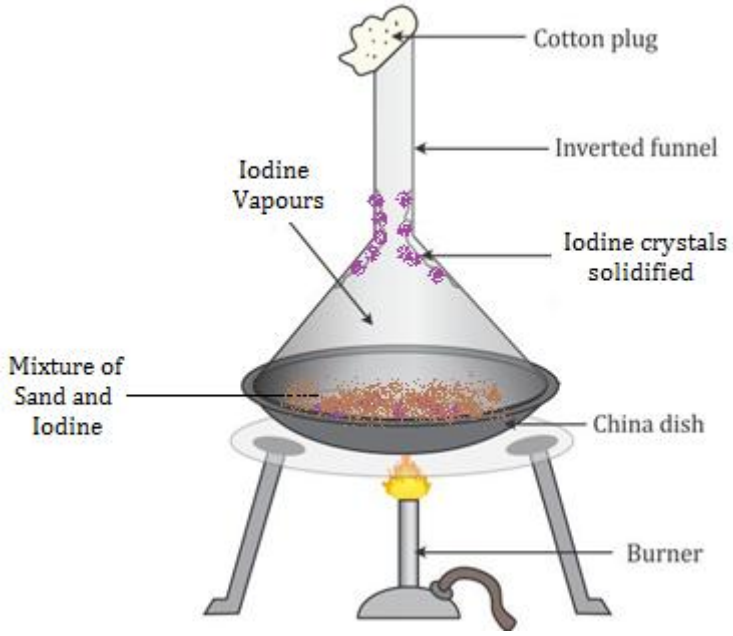
$$F = \frac{G m_1 m_2}{r^2}$$

where G is the constant of proportionality and is known as the universal constant of gravitation.

v. In nature, most nutrients are found in the soil in the elemental form or in the form of various compounds. These elements are absorbed by plants for their growth and development. When these plants are consumed by herbivores, the nutrients move on to these organisms and continue to flow through the food chain. When apex predators die, their bodies are decomposed by decomposers. This process releases the nutrients in the elemental form or in the form of its compounds in the soil where they are available for further use. Thus, nutrients in the soil and nutrients circulating through the food chain remain in balance.

vi. Procedure:

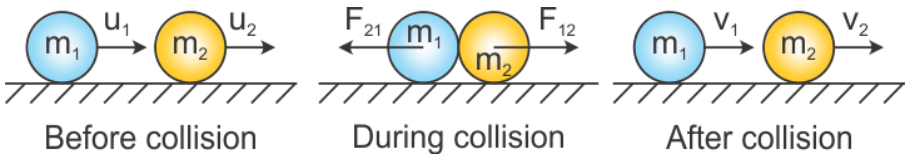
- Take a mixture of sand and iodine crystals in an evaporating dish or China dish.



- Put an inverted glass funnel over it and close its stem with a cotton plug.
- Heat the evaporating dish with a burner.
- Iodine being volatile in nature changes to vapour which condenses on the cooler inner surface of the inverted funnel in the form of crystals, whereas sand is left behind.

4.

i. Law of conservation of linear momentum: Total momentum of the system is always conserved if no external force acts on an object or system of objects.
Consider a collision between two balls wherein there occurs no energy losses during the collision.



Momentum of the two balls before collision,

$p_{1i} = m_1u_1$
$p_{2i} = m_2u_2$
Total momentum of the system of the two balls before collision,

$p_i = p_{1i} + p_{2i} = m_1u_1 + m_2u_2$
During the collision, m_1 exerts an action force F_{12} on m_2.
In response, from Newton's third law, m_2 exerts a reaction on m_1, i.e. F_{21}, such that, $F_{12} = -F_{21}$

The negative sign implies that the two forces are directed in opposite directions.

After the collision, they undergo change in velocity and a corresponding change in momentum. The momentum of the two balls after collision $p_{1f} = m_1v_1$

$p_{2f} = m_2v_2$

Total momentum of the system of two balls after collision,

$p_f = p_{1f} + p_{2f} = m_1v_1 + m_2v_2$

Also, from Newton's second law,

$$\text{Force} = \frac{\text{Change in momentum}}{\text{Time interval}}$$

$$\rightarrow F_{12} = \frac{\text{Change in momentum produced in } m_2}{\text{Collision time}}$$

$$\rightarrow F_{12} = \frac{m_2v_2 - m_2u_2}{t}$$

Similarly,

$$F_{21} = \frac{m_1v_1 - m_1u_1}{t}$$

From Newton's third law,

$$F_{12} = -F_{21}$$

$$\frac{m_2v_2 - m_2u_2}{t} = -\frac{(m_1v_1 - m_1u_1)}{t}$$

$$\Rightarrow m_1u_1 + m_2u_2 = m_1v_1 - m_2v_2$$

Total momentum before collision = Total momentum after collision

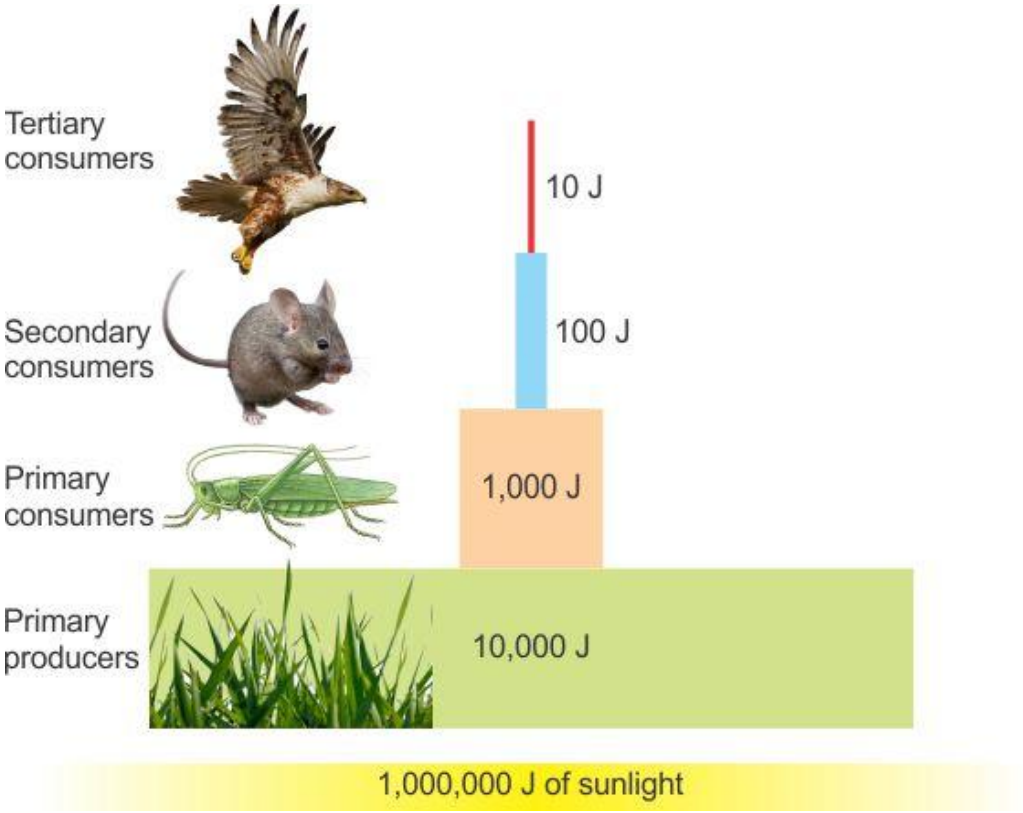
Hence, this equation implies that if no external force acts on the system of two colliding balls, the total momentum is conserved.

ii. A pyramid of energy is constructed on the basis of the amount of energy passed on from the organisms from one tropic level to the other.

The amount of energy that the Earth receives from the Sun in the form of sunlight is very large. Plants use solar energy to produce food; however, plants cannot harvest all the solar energy and some of it is lost in the environment in the form of heat.

The plants prepare food to obtain energy and some energy which is produced is used up for growth and reproduction, while some of it is lost in the form of heat into the surrounding. Thus, the stored energy which is passed on to the next tropic level is less and not the actual amount of energy initially produced.

All organisms thus use up some amount of energy and some of it is lost in the form of heat; hence, only a small portion of the energy obtained is passed on.


Tertiary consumers
Secondary consumers
Primary consumers
Primary producers
10 J
100 J
1,000 J
10,000 J
1,000,000 J of sunlight

SECTION B

5.

(A)

(a)

i. Hydrogen
Hydrogen is an element, while the others are compounds.

ii. Glandular epithelium
Glandular epithelium is simple tissue, while the rest are complex tissues.

(b)

Scientist	Contribution to the study of cells
i. Robert Brown	(c) Demonstrated the presence of a nucleus in a cell
ii. Johannes Purkinje	(a) Named the fluid content of a cell as protoplasm
iii. Zacharias Jansen	(d) Discovered the first microscope

(B)

i. **(c)** Based on location, simple squamous epithelium differs from stratified squamous epithelium as simple squamous epithelium is found in the lung alveoli, while stratified squamous epithelium is found in the outer layer of the skin.

ii. **(b)** Unicellular, prokaryotic cells without a distinct nucleus and cytoplasm.
Organisms of Kingdom Monera are characterised by unicellular, prokaryotic cells without a distinct nucleus and cytoplasm.

iii. **(c)** Departure from the normal state either physically or physiologically along with signs and symptoms specific to the disease
A diseased state is associated with the departure from the normal state either physically or physiologically along with signs and symptoms specific to the disease.

iv. **(b)** iron, zinc, boron, molybdenum, copper, chlorine, manganese
Nutrients are important for the growth of plants. The nutrients which plants take up from the surrounding are broadly classified into macro and micronutrients. The micronutrients include iron, zinc, boron, molybdenum, copper, chlorine and manganese.

v. **(c)** Filtration
The mixture of sand and water is first dissolved in water, and then it is filtered with the help of a filter paper in the funnel. The sand particles get collected in the funnel. The filtrate containing dissolved salt can later be extracted by evaporation.

[Please note that the explanation provided is to help you in learning. You may not be required to write an explanation in your answers to these questions.]

6.

i. Cricketers wear white clothes while playing a test match because
- White clothes reflect most of the radiant heat falling on them.
- Therefore, cricketers do not feel much warmth even though it is hot outside.

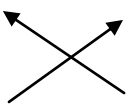
ii. Feed provided to cattle must be rich in basic nutrients such as carbohydrates, proteins, fats, minerals and vitamins. The feed should also contain adequate roughage and equal amounts of water. It should provide the essential micronutrients.

iii. Vermicompost is a type of manure or compost which is obtained by the technique of vermicomposting. Vermicomposting involves the management of biodegradable solid waste using earthworms.

iv. Postulates of the modern cell theory:
- All organisms are composed of cells.
- The cell is the structural and functional unit of life.
- All cells arise from pre-existing cells.
- All organisms start life from a single cell.

v. **Formula of ammonium sulphate**

Symbols	NH_4	SO_4
Valency	1+	2-
Formula	$\mathbf{(NH_4)_2SO_4}$	

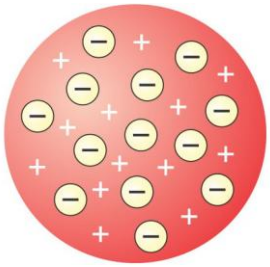


As we know that if a group of atoms receives a valency number more than 1, we enclose it within brackets. Therefore, the molecular formula of ammonium sulphate is $\mathbf{(NH_4)_2SO_4}$.

vi. Ligament:
- It connects the bones and holds them together.
- It is highly elastic and has considerable strength.
- It keeps the bones stable and in their place.
- They contain very less matrix within them.

7.

i. **Thomson's model of an atom**
- Thomson's model of an atom is popularly known as the plum pudding or Christmas pudding model of an atom.



Thomson's model of an atom

- According to Thomson's plum pudding model, an atom is a positively charged sphere in which the electrons are embedded.

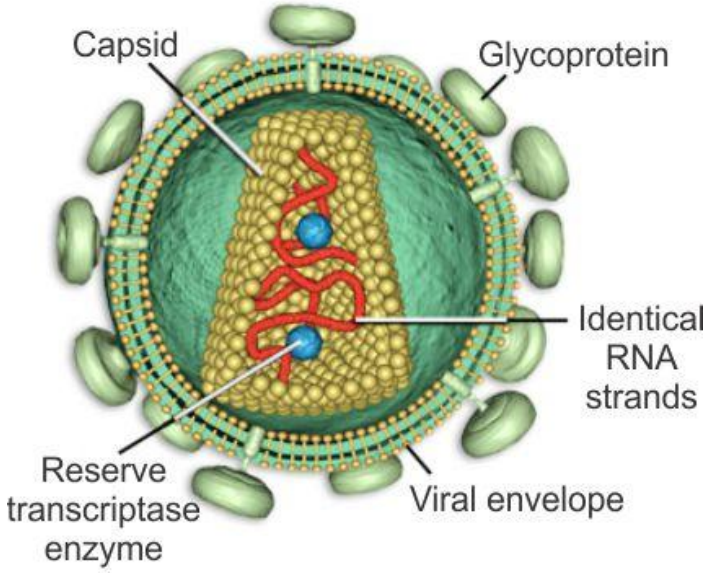
Limitations of Thomson's atomic model

- Although Thomson's atomic model explained why an atom is electrically neutral, it could not explain the distribution of electrons in the atom.
- If we accept that electrons are embedded in the positive charge, then the opposite electric charges should cancel each other out and the charged sphere would become chargeless.
- Thomson's model could not explain why different elements have different chemical properties.

ii. The cells formed from the meristematic tissue of the plant which lose the ability to divide and take up a specific function are known as permanent tissues. Permanent tissues are of two main types—simple permanent tissue and complex permanent tissue.
The simple permanent tissue is further classified into six types depending on the function which the cells perform. These include
- Parenchyma tissue – packaging tissue
- Chlorenchyma – chloroplast-containing tissue
- Aerenchyma – tissue-containing air spaces
- Collenchyma – imparts flexibility to the plant parts
- Sclerenchyma – makes the plant parts stiff and protects them
- Surface tissue – present on the surface of the plant

The complex permanent tissue is divided into two types based on its function—xylem and phloem. The xylem functions in the transport of water, salts and minerals. The phloem functions in the transport of food materials in the plant.

iii.



Structure of HIV virus

iv. Characters of Phylum Nematoda:

- The body is triploblastic and bilaterally symmetrical.
- The body is cylindrical.
- Organisms are generally parasitic.
- Sexes are separate.
- A false body cavity is present known as pseudocoelom.
- The digestive system is straight and starts from the mouth and ends in the anus.
- Most of the worms of this phylum cause diseases in humans.

v. Effects of improper solid waste management:

- Waste if discarded in an improper manner can lead to decomposition in the open and can release foul odour.
- Waste from industries and sewage can sometimes produce toxic gases. If these gases are unchecked, then they can pollute the air and can cause various diseases.
- Improperly discarded waste can spoil the aesthetic beauty of a place.
- Waste discarded improperly can cause various diseases in humans and animals.

vi.

(a) Air provides carbon and oxygen.
(b) Water provides hydrogen and oxygen.
(c) Soil provides both micronutrients and macronutrients.
   - Micronutrients are iron, magnesium, boron, zinc, copper, molybdenum and chlorine.
   - Macronutrients include nitrogen, phosphorus, potassium, calcium, magnesium and sulphur.

8.

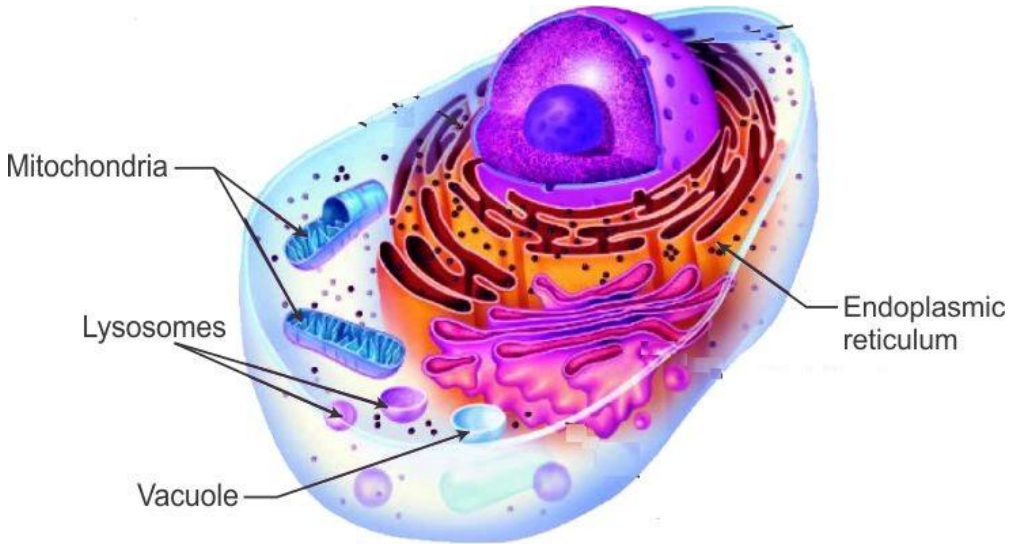
i.

(a) Lysosomes

(b) Mitochondria

(c) Endoplasmic reticulum

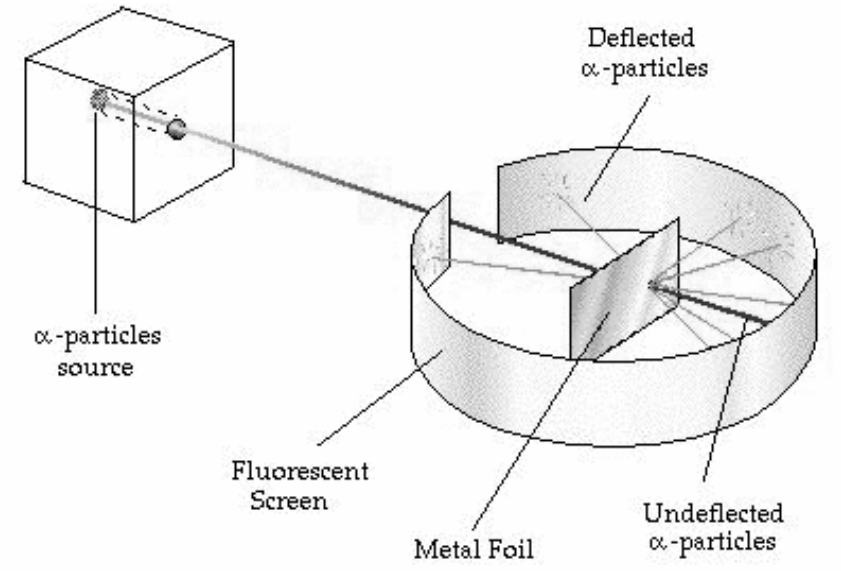
(d) Vacuoles



ii. **Rutherford's scattering experiment**

In 1911, Earnest Rutherford, a scientist from New Zealand, overturned Thomson's atomic model by his gold foil experiment.

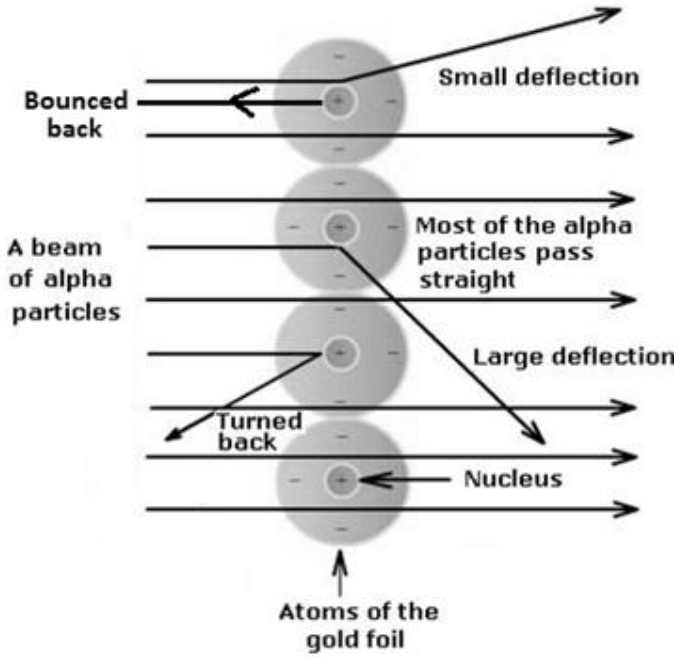
- Rutherford selected a gold foil as he wanted a very thin layer.
- The gold foil used by Rutherford was 0.004 millimetres in thickness, i.e. the foil was about 1000 atoms thick.
- In his experiment, fast-moving α-particles (alpha particles) were made to fall on a thin gold foil.
- The α-particles are helium ions with a +2 charge. Their atomic mass is 4 u. Hence, a high velocity beam of α-particles has a lot of energy.
- These particles were studied by the flashes of light they produced on striking a zinc sulphide screen.
- The α-particles are much heavier than the subatomic particles present in gold atoms.
- Hence, he expected the α-particles to pass through the gold foil with little deflection and strike the fluorescent screen.



Rutherford's α-Particle Scattering Experiment

However, the observations he made were quite unexpected.

Explanation of the results of Rutherford's gold foil experiment



Deflection of α-particles from the Gold foil

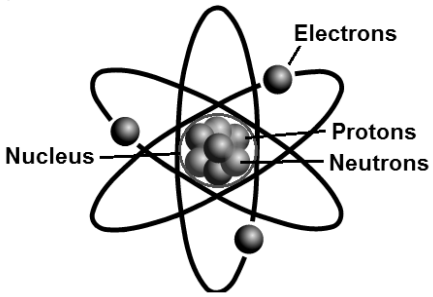
- Rutherford postulated that the atom must contain large empty spaces as most α-particles passed through it without getting deflected.
- Some α-particles were deflected by the foil through small angles, while some were deflected through very large angles. Thus, Rutherford concluded that the positively charged particles in an atom must be concentrated in a very small space.
- One out of every 12,000 particles was deflected through 180° showing a full rebound. Thus, Rutherford concluded that all the positive charges of the atom,

and most mass of the atom is concentrated in a very small volume within the atom.

- Rutherford named this small space inside the atom as the nucleus of the atom or the atomic nucleus.
- On the basis of these observations, Rutherford calculated that the atomic nucleus is 10^5 times smaller than the total area of the atom.
- The radius of the atom is 10^{-8} centimetres, while the radius of the nucleus is 10^{-13} centimetres.
- Thus, we can say that the atom is relatively hollow with a heavy nucleus at its centre. The electrons arranged around the nucleus possess negligible mass.
- Based on his observations, he formulated the theory of atom.

Rutherford's atomic model

- Based on the results of the α-particle scattering experiments, Rutherford put forth his atomic model.
- An atom contains a positively charged centre called the nucleus of the atom. Almost all the mass of the atom is concentrated in the nucleus.
- The electrons of the atom revolve around the nucleus in fixed, circular orbits.
- The size of the nucleus is many times smaller than the size of the atom. The nucleus of an atom is 10,000 times smaller than the atom.



Rutherford's Atomic Model

Drawbacks of Rutherford's model of an atom

- Rutherford's atomic model could not explain how moving electrons could remain in their orbits.
- Any charged particle during acceleration would radiate energy, and while revolving, it would lose its energy and eventually fall into the nucleus.
- This means that the atom would be highly unstable.
- However, matter is composed of stable atoms.
- Thus, the major drawback of Rutherford's atomic model was that it could not explain the stability of atoms.

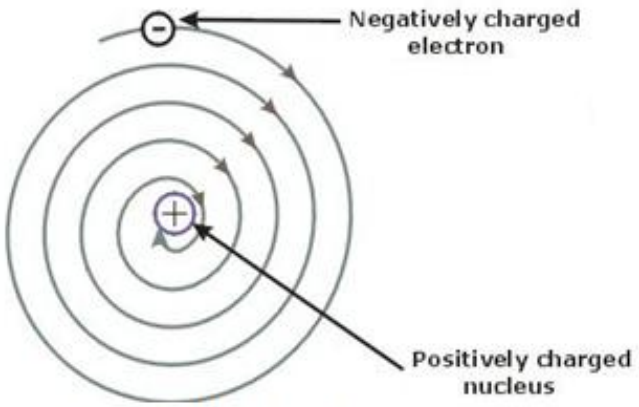


Diagram showing the atom losing energy