CHAPTERWISE SOLUTION

Based on **NCERT** Textbook

SCIENCE

Class 9

Student Advisor
(Editorial Team)

INDEX

1 Matter in Our Surroundings

Intext Questions

Q.1. Which of the following are matter ?
Chair, air, love, smell, hate, almonds, thought, cold, lemon water, smell of perfume.

Ans. Matter : Anything which occupies space, have mass and can be felt by any one of our five senses is known as matter.

The following substances are matter : chair, air, smell, almonds, lemon water, smell of perfume.

Q.2. Give reasons for the following observation: The smell of hot sizzling food reaches you several metres away, but to get the smell from cold food you have to go close.

Ans. The smell of food reaches us due to the phenomenon of diffusion. As the rate of diffusion of gases is very high so the particles of gas travel with high speed. The rate of diffusion of gas further increases on increasing temperature because the kinetic energy of particles of gases increases. Hence, the particles of hot vapour coming from hot sizzling food reaches to us from several metres away at faster speed. On the other hand, the particles of vapours coming from cold food can not diffuse faster and they travel slowly due to which, to get the smell of cold food we have to go closer to the food.

Q.3. A diver is able to cut through water in a swimming pool. Which property of matter does this observation show ?

Ans. A diver is able to cut through water in a swimming pool. This observation explains the following property of water i.e., liquid state :

(i) The inter particle forces of attraction in liquid state is not very strong.

(ii) Liquids have somewhat larger inter particle spaces.

(iii) Liquids have nature of fluidity i.e., the particles of liquid have freedom to move easily.

Q.4. What are the characteristics of the particles of matter ?

Ans. The main characteristics of the particles of matter are as follows :

(i) The particles of matter are very-very small.

(ii) The particles of matter have inter-particle spaces between them.

(iii) The particles of matter moves constantly.

(iv) The particles of matter have inter-particle forces of attraction.

(v) As the particles of matter are very small so they cannot be seen with the naked eyes.

Q.5. The mass per unit volume of a substance is called density (density = mass/volume). Arrange the following in order of increasing density :
air, exhaust from chimneys, honey, water, chalk, cotton and iron.

Ans. Air < exhaust from chimneys < cotton < water < honey < chalk < iron

Q.6. (a) Tabulate the differences in the characteristics of states of matter.
(b) Comment upon the following : rigidity, compressibility, fluidity, filling a gas container, shape, kinetic energy and density.

Ans. (a) The differences between solids, liquids and gases are as follows :

	Property	Solid	Liquid	Gas
1.	Shape and volume	Definite shape and volume	Indefinite shape but definite volume	Indefinite shape as well as volume
2.	Inter-particle forces of attraction	very strong	weak	very weak
3.	Density (mass/volume)	High	lesser than solid while greater than gas	very low density
4.	Inter-particle spaces	very small, particles are closely packed	comparatively large, particles are loosely packed	very large, particles are very loosely packed.

5.	Compressibility	negligible	very small	high
6.	Rigidity and fluidity	very hard and rigid but not fluid	less rigid but have fluidity	compressible, least rigid but highly fluid
7.	Diffusion	negligible	slow	very fast
8.	Molecular motion or kinetic energy	very low	comparatively high	very high
9.	Surface	many number of surfaces	only one upper surface	no surface
10.	Particle motion	Particle only vibrate about its position	Particles show transi-tional, rotational and vibrational motion.	Particles have maximum freedom. It shows transitional, vibrational and rotational motion

(b)(i) Rigidity–It is the tendency to maintain the shape, when some outward force is applied. The rigidity is highest in solids. Any matter is said to be rigid when it has very small inter-particle spaces and very strong inter-particle force of attraction.

(ii) Compressibility–It is the tendency to decrease the volume on application of force. The compressibility is highest in gases because of the largest inter-particle spaces.

(iii) Fluidity–It is the tendency to flow. The fluidity is highest in gases due to very weak inter-particle force of attraction. Liquids also have tendency to flow but their fluidity is smaller than gases due to comparatively smaller inter-particle distances and larger inter-particle force of attraction.

(iv) Filling of a gas container–The gases can be compressed into very small volumes by applying large pressures. Due to its high compressibility,fairly large mass of a gas can be filled in a small metal cylinders by compression. Such cylinders can be transported conveniently from one place to another. The cooking gas (L.P.G.) is also a form of compressed gas. The oxygen gas supplied to hospitals in cylinders is also a type of compressed form.

(v) Shape–Any sample of matter takes up a shape depending upon the intermolecular forces and intermolecular volume. Liquids take the shape of the containers, they are poured in.

(vi) Kinetic energy–It is the energy present in moving particle. In gases the inter particle spaces are large while inter particle force of attraction is small. Due to this reason, the particles of gases move with high speed hence, have highest kinetic energy. Kinetic energy of liquids is lesser than gases, while it is least in solids at room temperature.

(vii) Density–It is the mass occupied by a matter per unit volume. It can be obtained by dividing the mass of a particular solid by the volume occupied by that mass of the solid. The unit of density is kg/l or kg/dm^3 or g/ml or g/cm^3.

Q.7. Give reasons :

(i) A gas fills completely fill the vessel in which it is kept.

(ii) A gas exerts pressure on the walls of the container.

(iii) A wooden table should be called a solid.

(iv) We can easily move our hand in air but to do the same through a solid block of wood we need a 'karate expert '.

Ans.(i) A gas in the vessel completely fills it in which it is kept due to the phenomenon of diffusion. There is low force of attraction between gas particles, Hence, they move freely in all directions and occupy all space available to them.

(ii) Force per unit area is called pressure. The particles of gas moving with high speed strike the wall of the container and exerts force on it Hence, we can say that the gas exerts pressure.

(iii) A wooden table should be called a solid because it has definite shape, fixed volume, incompressible nature, rigidity and no movement of the constituent particles present in them.

(iv) The inter-particle spaces in air are very large while inter-particle force of attraction is very weak. This force is so weak that it can be overcome easily. It is the reason that our hand can move, in air. But the inter-particle spaces in solid are very small and inter-particle force of attraction is very strong. As a result this space cannot be easily overcome by the movement of our hand and thus only a 'karate expert' with high power can separate the particles of solid.

Q.8. Liquids generally have lower density as compared to solids but you must have observed that ice floats on water. Find out why ?

Ans. Liquids generally have lower density as compared to solids. But the solid form of water i.e., ice floats on the surface of liquid water. It indicates that the density of solid form of water is lower than liquid form of water. This is due to open cage like structure of ice. It means, in ice some vacant spaces are left when H_2O molecules get linked in ice. In water (liquid form) these vacant spaces are less. Therefore due to larger vacant spaces the volume of ice increases hence, density decreases. Thus, it floats over the surface of water.

Q.9. Convert the following temperature to celsius scale. (a) 300K (b) 573K

Ans. The relation between kelvin scale and celsius scale is as follows :

$$T(K) = t(°C) + 273$$

hence,

(a) $300K = t(°C) + 273$

$t(°C) = 300 - 273$

$t = 27°C.$

(b) $573K = t(°C) + 273$

$t(°C) = 573 - 273$

$t = 300°C.$

Q.10. What is the physical state of water at (a) 250°C (b) 100°C

Ans.(a) Water vapour or steam.

(b) At 100°C, which is the boiling point of water, water exists both as a liquid as well as a gas.

Q.11. For any substance, why does the temperature remain constant during the change of state ?

Ans. This is because, the heat supplied to the substance is used up (absorbed) during the change of state in overcoming the intermolecular forces between the particles without increasing its kinetic energy.

Q.12. Suggest a method to liquefy atmospheric gases ?

Ans. When a gas is compressed too much by applying high pressure, a lot of heat is produced. So, while applying pressure to liquefy gases, it is necessary to lower their temperature to take away the heat.

Q.13. Why does a desert cooler cool better on a hot dry day ?

Ans. In a desert cooler, hot and dry air passes through wet pads of wood– shavings, water takes heat from the hot air and evaporates. The evaporation of water cools the pads and the circulating water. As a result, the incoming air also gets cooled down.

Q.14. How does the water kept in an earthen pot (*matka*) become cool during summer ?

Ans. The water is kept in an earthen pot (*Matka*) become cool during summer due to the following reasons :

(i) The particles of water with high kinetic energy escapes through the pores of earthen pot (*matka*) and evaporates, since evaporation causes cooling, thus, the water cools.

(ii) In summer, the temperature is high so the rate of evaporation increases hence, cooling increases.

Q.15. Why does our palm feel cold when we put some acetone or petrol or perfume on it ?

Ans. Acetone or petrol or perfumes are volatile liquids with low boiling points, when they are put on palm they quickly evaporate. The energy needed for evaporation is taken from the palm. As a result, the palm feels cold.

Q.16. Why are we able to sip hot tea or milk faster from a saucer rather than a cup ?

Ans. When hot tea or milk is poured in a saucer than the surface area increases due to which rate of evaporation increases and tea or milk becomes a little cooler more quickly. Thus it becomes easier to sip hot tea or milk from a saucer rather than a cup. In cup the surface area of liquid is small therefore, evaporation occurs slowly hence, the liquid in the cup remains hot for a sufficient long time and we cannot sip tea or milk faster from cup.

Q.17. What type of clothes should we wear in summer ?

Ans. In summer, we should wear cotton clothes because during summer we perspire more and cotton have tendency to absorb sweat more quickly and expose it to the atmosphere. As cotton clothes evaporate sweat which produce cooling and we feel comfort. Therefore, in summer cotton clothes help us in keeping cool.

NCERT Exercises

Q.1. Convert the following temperatures to the celsius scale : (a) 293 K (b) 470 K

Ans.(a) 293 K

$t\ (°C) = T(K) - 273 = 293 - 273 = 20°C$

(b) 470 K

t (°C) = T(K) – 273 = 470 – 273 = 197°C

Q.2. Convert the following temperatures to the kelvin scale : (a) 25°C (b) 373° C

Ans.(a) 25° C

T(K) = t (°C) + 273 = 25 + 273 = 298 K

(b) 373° C

T(K) = t (°C) + 273 = 373 + 273 = 646 K

Q.3. Give reasons for the following observations:
(a) Naphthalene balls disappear with time without leaving any solid.
(b) We can get the smell of perfume sitting several metres away.

Ans.(a) Naphthalene is a volatile solid which show sublimation at room temperature. As a result it gets converted into gaseous state. Therefore, Naphthalene balls disappear with time without leaving any solid.

(b) We can get the smell of perfumes sitting several metres away because of diffusion process. Perfume is a volatile liquid, it quickly changes into vapours. The perfume vapours move rapidly in all directions in air,mix up with air particles and spread in air by diffusion. When this air reaches several metres away, we can smell perfume.

Q.4. Arrange the following substances in increasing order of forces of attraction between the particles—water, sugar, oxygen.

Ans. Oxygen (gas) < Water (liquid) < Sugar (Solid)

Q.5. What is the physical state of water at :
(a) 25°C (b) 0°C (c) 100°C

Ans.(a) liquid.

(b) solid (ice) or liquid (transition state)

(c) gas (steam) or a liquid.

Q.6. Give two reasons to justify :
(a) Water at room temperature is a liquid.
(b) An iron almirah is a solid at room temperature.

Ans.(a) Water is liquid at room temperature due to the following reasons : (i) Water takes the shape of the vessel in which it is kept. So water does not have fixed shape, so it is a liquid. (ii) Water can be poured from one vessel into another vessel. so water has fluidity i.e. it can flow as a liquid.

(b) An iron almirah is a solid at room temperature due to the following reasons : (i) An iron almirah is hard and incompressible in nature that is, it has fixed shape, so it is a solid. (ii) An iron almirah cannot diffuse on itself through air i.e., it can not diffuse so it is solid.

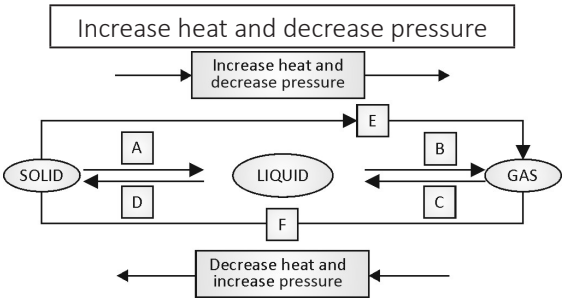
Q.7. Why is ice at 273 K more effective in cooling than water at the same temperature.

Ans. Ice (solid water) has extra energy in the form of latent heat of fusion (3.35×10^5 J/kg) as compared to water. Due to absorption of energy the temperature of surroundings gets lowered or cooling is caused. Since water is already present in a liquid state so it does not absorb energy from the surroundings. Thus, ice at 273K (or 0°C) becauses more cooling than water at the same temperature.

Q.8. What produces more severe burns, boiling water or steam ?

Ans. Steam produces more severe burns than boiling water because it can release 22.6×10^5 Jkg^{-1} of heat more than the same quantity of boiling water (due to its high latent heat of vaporisation).

Q.9. Name A, B,C, D, E and F in the following diagram showing change in its state :



Ans. A = Fusion (melting),
B = Vaporisation
C = Condensation (Liquefaction)
D = Solidification (freezing)
E = Sublimation
F = Sublimation (solidification of gaseous state)

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2 Is Matter Around Us Pure?

Intext Questions

Q.1. What is meant by a substance ?

Ans. A substance is a kind of matter that cannot be separated into other kinds of matter by any physical process.

Q.2. List the points of differences between homogeneous and heterogeneous mixtures.

Or

Differentiate between homogeneous and heterogeneous mixtures with examples.

Ans. Homogeneous mixture – A mixture which is perfectly uniform in its composition and properties throughout the mixture is called a homogeneous mixture.

Homogeneous mixtures are also called solutions. Kerosene is a homogeneous mixture of many hydrocarbons, solution of common salt or sugar in water is also a homogeneous mixture. Some common alloys (e.g. brass) etc, are homogeneous mixtures.

Heterogeneous mixture – A mixture which has different composition and different properties at different locations in the mixture is called heterogeneous mixture.

For example, muddy water from a pond, a mixture containing sugar and sand are heterogeneous mixture.

Some other examples are :

- A mixture consisting of common salt and sulphur.
- A mixture consisting of oil and water.

Q.3. How are sol, solution and suspension different from each other ?

Ans.

S. No.	Sol	Solution	Suspension
1.	A sol is a homogeneous looking but heterogeneous mixture.	A solution is a homogeneous mixture of two or more substances.	A suspension is a heterogeneous mixture of a solid dispersed in a liquid or a gas.
2.	Size of solute particles lies between 10^{-7} and 10^{-5} cm.	Size of solute particles is of 10^{-8} cm.	Size of solute particles is 10^{-5} cm.
3.	Stable	Stable	Unstable
4.	Sol scatters a beam of light.	Solution does not scatter light.	Suspension scatters beam of light.
5.	Solute particles pass through filter paper.	Solute particles easily pass through filter paper.	In suspension, solute particles do not pass through filter paper.

Q.4. To make a saturated solution, 36 g of sodium chloride is dissolved in 100 g of water at 293 K. Find its concentration at this temperature.

Ans. Given,

Mass of solute = 36 g

Mass of solvent = 100 g

Mass of solution = Mass of solute + Mass of solvent

= 36 g + 100 g = 136 g

$$\text{Concentration} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

$$= \frac{36}{136} \times 100 = 26{\cdot}47\%$$

Q.5. Classify the following as chemical or physical changes :

- Cutting of trees.
- Melting of butter in a pan.
- Rusting of almirah.
- Boiling of water to form steam.
- Passing of electric current, through water and the water breaking down into hydrogen and oxygen gases.
- Dissolving common salt in water.
- Making a fruit salad with raw fruits, and
- Burning of paper and wood.

Ans. Physical change

- Cutting of trees.
- Melting of butter in a pan.
- Boiling of water to form steam.
- Dissolving common salt in water.

- Making a fruit salad with raw fruits.

Chemical change

- Rusting of almirah.
- Passing of electric current through water and the water breaking down into hydrogen and oxygen gases.
- Burning of paper and wood.

Q.6. Try segregating the things around you as pure substances or mixtures :

Ans. Pure substances : 1. Distilled water, 2. Bread, 3. Diamond, 4. Graphite 5. Sugar, 6. Gold

Mixtures : 1. Ice-cream, 2. Steel, 3. Paper, 4. Talc, 5. Kerosene oil, 6. Solder wire, 7. Curd, 8. Air

NCERT Exercises

Q.1. Which separation techniques will you apply for the separation of the following :

(a) Sodium chloride from its solution in water.

(b) Ammonium chloride from a mixture of sodium chloride and ammonium chloride.

(c) Small pieces of metal in the engine oil of a car.

(d) Different pigment from an extract of flower petals.

(e) Butter from curd.

(f) Oil from water.

(g) Tea leaves from tea.

(h) Iron pins from sand.

(i) Wheat grains from husk.

(j) Fine mud particles suspended in water.

Ans. (a) Evaporation (b) Sublimation

(c) Magnetic Separation method

(d) Chromatography (e) Centrifugation

(f) Separating funnel (g) Filtration

(h) Magnetic separation (i) Sieving/Winnowing

(j) Sedimentation and then filtration.

Q.2. Write the steps you would use for making tea. Use the words solution, solvent, solute, dissolve, soluble, insoluble, filtrate and residue.

Ans. First Water is taken as a solvent in a saucer pan. This water (solvent) is allowed to boil. During heating, milk and tea leaves are added to the solvent as solutes. They form a solution. Then, the solution is poured through a strainer. The insoluble part of the solution remains on the strainer as residue. Sugar is added to the filtrate, which dissolves in the filtrate. The resulting solution is the required tea.

Q.3. Pragya tested the solubility of four different substances at different temperatures and collected the data as given below. (Results are given in the following table, as grams of substance dissolved in 100 grams of water to form a saturated solution.)

	Temperature in K				
Substance Dissolved	283	293	313	333	353
	Solubility				
Potassium nitrate	21	32	62	106	167
Sodium chloride	36	36	36	37	37
Potassium chloride	35	35	40	46	54
Ammonium chloride	24	37	41	55	66

(a) What mass of potassium nitrate would be needed to produce a saturated solution of potassium nitrate in 50 grams of water at 313 K.

(b) Pragya makes a saturated solution of potassium chloride in water at 353 K and leaves the solution to cool at room temperature. What would she observe as the solution cools ? Explain.

(c) Find the solubility of each salt at 293 K. Which salt has the highest solubility at this temperature?

(d) What is the effect of change of temperature on the solubility of a salt ?

Ans. (a) At 313 K, the mass of potassium nitrate dissolved in 100 g of water = 62g

$\therefore$ At 313 K, the mass of potassium nitrate dissolved in 50 g of water at

$$313K = \frac{62g}{100} \times 50g = 31\ g.$$

(b) On cooling the solution at room temperature, the crystals of potassium chloride will be obtained. This is because of decrease in the solubility of potassium chloride with a fall in temperature (or cooling).

(c) Solubility at 293 K.

(i) Potassium nitrate = 32 g per 100 g of water

(ii) Sodium chloride = 36 g per 100 g of water

(iii) Potassium chloride = 35 g per 100 g of water

(iv) Ammonium chloride = 37 g per 100 g of water

This shows that the ammonium chloride has the maximum solubility (37 g per 100g of water) at 293K.

(d) With increase in temperature, the solubility of all salts in water increases and when the temperature is decreased, the solubility of these salts in water decreases.

Q.4. Explain the following by giving examples :
(a) saturated solution (b) pure substance
(c) colloid (d) suspension.

Ans. (a) **Saturated Solution :** A saturated solution is a solution in which the maximum amount of solute has been dissolved at a given temperature. The solution cannot dissolve beyond that amount of solute at that temperature. Any more solute added will settle down at the bottom of the container as a precipitate.

Suppose 500g of a solvent can dissolve a maximum of 150g of a particular solute at 40°C. Then, the solution obtained by dissolving 150g of that solute in 500g of that solvent at 40°C is said to be a saturated solution at 40°C.

(b) **Pure substance :** A pure substance is a substance consisting of a single type of particles, i.e., all constituent particles of the substance have the same chemical properties.

For example : salt, sugar, water are pure substances.

(c) **Colloid :** A colloid is a heterogeneous mixture. The size of the solutes in this mixture is so small that they cannot be seen individually with naked eyes, and seems to be distributed uniformly throughout the mixture. The solute particles do not settle down when the mixture is left undisturbed. This means that colloids are quite stable. Colloids cannot be separated by the process of filtration. They can be separated by centrifugation. Colloids show the Tyndall effect. For example : milk, butter, foam, fog, smoke, clouds.

(d) **Suspension :** Suspensions are heterogeneous mixtures. The solute particles in this mixture remain suspended throughout the bulk of the medium. The particles can be seen with naked eyes. Suspension shows the Tyndall effect. The solute particles settle down when the mixture is left undisturbed. This means that suspensions are unstable. Suspensions can be separated by the method of filtration. For example : mixtures of chalk powder and water, wheat flour and water.

Q.5. Classify each of the following as a homogeneous or heterogeneous mixture : soda water, wood, air, soil, vinegar, filtered tea.

Ans. Homogeneous mixture : Soda water, air, vinegar, filtered tea.

Heterogeneous mixture : Wood, soil.

Air is a homogeneous mixture of different gases. If some dust or other particles are present, then air becomes a heterogeneous mixture.

Q.6. How would you confirm that a colourless liquid given to you is a pure water?

Ans. Every liquid has a characteristic boiling point. Pure water has a boiling point of 100°C (373K) at 1 atmospheric pressure. If the given colourless liquid boils at even slightly above or below 100°C, then the given liquid is not pure water. It must boil at sharp 100°C, Thus by observing the boiling point, we can confirm whether a given colourless liquid is pure water or not.

Q.7. Which of the following materials fall in the category of a 'pure substance' :

(a) Ice (b) Milk
(c) Iron (d) Hydrochloric acid
(e) Calcium oxide (f) Mercury
(g) Brick (h) Wood
(i) Air

Ans. Pure substances—

(a) Ice (b) Iron
(c) Hydrochloric acid (d) Calcium oxide
(e) Mercury.

Q.8. Identify the solutions among the following mixtures :

(a) Soil (b) Sea water
(c) Air (d) Coal
(e) Soda water.

Ans. The following mixtures are solutions—

(b) Sea water, (c) Air, (e) Soda water.

Q.9. Which of the following will show 'Tyndall effect' :

(a) Salt solution (b) Milk
(c) Copper sulphate solution
(d) Starch solution.

Ans. Milk and starch solution will show the 'Tyndall effect'.

Q.10. Classify the following into elements, compounds and mixtures :

(a) Sodium (b) Soil
(c) Sugar solution (d) Silver

(e) Calcium carbonate (f) Tin
(g) Silicon (h) Coal
(i) Air (j) Soap
(k) Methane (l) Carbon dioxide
(m) Blood.

Ans. Elements—
(a) Sodium (d) Silver
(f) Tin (g) Silicon
Compounds—
(e) Calcium carbonate
(k) Methane (l) Carbon dioxide
Mixtures—
(b) Soil (c) Sugar solution
(h) Coal (i) Air
(j) Soap (m) Blood.

Q.11. Which of the following are chemical changes:
(a) Growth of a plant
(b) Rusting of iron
(c) Mixing of iron filings and sand
(d) Cooking of food
(e) Digestion of food
(f) Freezing of water
(g) Burning of a candle.

Ans. The following changes are chemical changes—
(a) Growth of a plant
(b) Rusting of iron
(d) Cooking of food
(e) Digestion of food
(g) Burning of candle.

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3 Atoms and Molecules

Intext Questions

Q.1. In a reaction, 5·3 g of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2·2 g of carbon dioxide, 0·9 g water and 8·2 g of sodium acetate. Show that these observations are in agreement with the law of conservation of mass.

Ans. Sodium Carbonate + ethanoic acid $\rightarrow$ Sodium acetate + Carbon dioxide + Water

$$5{\cdot}3\ g + 6\ g \rightarrow 8{\cdot}2\ g + 2{\cdot}2\ g + 0{\cdot}9\ g$$

Mass of L.H.S. = 5·3 g + 6 g
= 11·3 g
Mass of R.H.S. = 8·2 g + 2·2 g + 0·9 g
= 11·3 g

$\Rightarrow$ Mass of Reactant = Mass of Product
Thus, law of conservation of mass is proved.

Q.2. Hydrogen and oxygen combine in the ratio of 1 : 8 by mass to form water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas ?

Ans. (Hydrogen : Oxygen) forms water (H_2O)
1 : 8
As 1 g of Hydrogen combines with 8 g of oxygen,
$\therefore$ 3 g of hydrogen will react with oxygen
= 8 × 3g = 24 g

Q.3. Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?

Ans. The postulate that, "the atoms cannot be created, divided or destroyed during any chemical reaction or physical change," is the result of the law of conservation of mass.

Q.4. Which postulate of Dalton's atomic theory can explain the law of definite proportions ?

Ans. The postulate which can explain the law of definite proportions is,
(a) All atoms of a given element have the same fixed mass.
(b) The atoms combine with each other in simple whole number ratios to form compounds.

Q.5. Define the atomic mass unit.

Ans. One atomic mass unit is equal to exactly one twelfth (1/12)th the mass of one atom of C-12.

Q.6. Why is it not possible to see an atom with naked eyes ?

Ans. Atoms are very small to be seen with naked eyes. Their size is measured in nanometers.
(1 nm = 10^{-9} m).

Q.7. Write down the formulae of :
(i) Sodium oxide
(ii) Aluminium chloride
(iii) Sodium sulphide
(iv) Magnesium hydroxide.

Ans.

	Ions present	Formula
(i) Sodium oxide	Na^+ O^{2-} (1, 2)	Na_2O
(ii) Aluminium chloride	Al^{3+} Cl^- (3, 1)	$AlCl_3$
(iii) Sodium sulphide	N^{+1} S^{2-} (1, 2)	Na_2S
(iv) Magnesium hydroxide	Mg^{2+} OH^- (2, 1)	$Mg(OH)_2$

Q.8. Write down the names of compounds represented by the following formulae :
(i) $Al_2(SO_4)_3$ (ii) $CaCl_2$
(iii) K_2SO_4 (iv) KNO_3
(v) $CaCO_3$.

Ans. (i) Aluminium Sulphate
(ii) Calcium Chloride
(iii) Potassium Sulphate
(iv) Potassium Nitrate
(v) Calcium Carbonate.

Q.9. What is meant by the term chemical formula?

Ans. The shorthand notation of any substance in terms of symbolic and numbers of various elements present in it is called its chemical formula.

Q.10. How many atoms are present in a
(i) H_2S molecule and (ii) PO_4^{3-} ion ?

Ans. (i) $H_2S \rightarrow$ 3 atoms are present,
(ii) $PO_4^{3-} \rightarrow$ 5 atoms are present.

Q.11. Calculate the molecular masses of H_2, O_2, Cl_2, CO_2, CH_4, C_2H_6, C_2H_4, NH_3, CH_3OH.

Ans.

H_2	$2 \times 1{\cdot}08 = 2{\cdot}16$ u
O_2	$2 \times 16 = Q.32$ u
Cl_2	$2 \times 35{\cdot}5 = 71$ u
CO_2	$12 + 2 \times 16 = 44$ u
CH_4	$12 + 4 \times 1{\cdot}08 = 16{\cdot}32$ u
C_2H_6	$2 \times 12 + 6 \times 1{\cdot}08 = 30{\cdot}48$ u
C_2H_4	$2 \times 12 + 4 \times 1{\cdot}08 = 28{\cdot}32$ u
NH_3	$14 + 3 \times 1{\cdot}08 = 17{\cdot}24$ u
CH_3OH	$12 + 3 \times 1{\cdot}08 + 1 \times 16 + 1.08 = 32{\cdot}32$ u

Q.12. Calculate the formula unit masses of ZnO, Na_2O, and K_2CO_3 (Given atomic mass : Zn = 65u, Na = 23u, K = 39u, C = 12u and O = 16u)

Ans. Formula unit mass of ZnO
= atomic mass of Zn + atomic mass of O
= 65 u + 16 u = 81 u
Formula unit mass of Na_2O
= (2 × atomic mass of Na) + atomic mass of O
= 2 × 23 u + 16 u
= 46 u + 16 u = 62 u
Formula unit mass of K_2CO_3
= (2 × atomic mass of K) + atomic mass of C + (3 × atomic mass of O)
= 2 × 39 u + 1×12 u + 3 × 16 u
= 78 u + 12 u + 48 u = 138 u

NCERT Exercise

Q.1. A 0.24g sample of compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g of oxygen. Calculate the percentage composition of the compound by mass.

Ans. Percentage of boron

$$= \frac{\text{Mass of Boron}}{\text{Mass of the compound}} \times 100$$

$$= \frac{0.096\text{ g} \times 100}{0.24\text{ g}} = 40.0$$

Percentage of oxygen

$$= \frac{\text{Mass of Oxygen}}{\text{Mass of the compound}} \times 100$$

$$= \frac{0.144\text{ g} \times 100}{0.24\text{ g}} = 60.0$$

Hence, the mass percentage of boron and oxygen in the given compound are 40% and 60% respectively.

Q.2. When 3.0 g of carbon is burnt in 8.0 g of oxygen, 11.0 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.0 g of carbon is burnt in 50.0 g of oxygen?

Which law of chemical combination will govern your answer?

Ans. Carbon + Oxygen $\rightarrow$ Carbon dioxide

3.0 g + 8.0g $\rightarrow$ 11.0 g

$\Rightarrow$ 11 g = 11 g

For first case :

3.0 g of carbon is burnt in 8.0 g of oxygen to form 11.0 g of CO_2.

For second case :

3.0 g of carbon must also combine with 8.0 g of oxygen only. This means that (50 – 8) = 42 g of oxygen will remain unreacted.

The mass of CO_2 in this case must also be 11 g. So, law of constant proportion is valid here.

Q.3. What are polyatomic ions ? Give examples.

Ans. The ions which contain more than one atoms and behave as a single unit are called polyatomic ions e.g., OH^-, PO_4^{2-}, CO_3^{2-}, SO_4^{2-} etc.

Q.4. Write the chemical formulae of the following:

(a) Magnesium chloride
(b) Calcium oxide
(c) Copper nitrate
(d) Aluminium chloride.
(e) Calcium carbonate.

Ans.(a) Symbol Mg Cl
Charge 2 + 1–
Formula $MgCl_2$

(b) Symbol Ca O
Charge 2 + 2 –
Formula Ca_2O_2 or CaO

(c) Symbol Cu (NO_3)
Charge 2 + 1 –
Formula $Cu(NO_3)_2$

(d) Symbol Al Cl
Charge 3 + 1 –
Formula $AlCl_3$

(e) Symbol Ca CO_3
Charge 2 + 2 –
Formula $Ca_2(CO_3)_2$ or $CaCO_3$

Q.5. Give the names of the elements present in the following compounds :

(a) Quick lime
(b) Hydrogen bromide
(c) Baking powder
(d) Potassium sulphate.

Ans.(a) Quick lime is calcium oxide (CaO)

Elements – Calcium and oxygen.

(b) Hydrogen bromide (HBr)

Elements – Hydrogen and bromine.

(c) Baking powder is sodium hydrogen carbonate ($NaHCO_3$)

Elements – Sodium, hydrogen, carbon and oxygen.

(d) Potassium sulphate (K_2SO_4)

Elements – Potassium, sulphur, oxygen.

Q.6. Calculate the molar mass of the following substances :

(a) Ethyne, C_2H_2
(b) Sulphur molecule, S_8
(c) Phosphorus molecule, P_4 (Atomic mass of phosphorus = 31)
(d) Hydrochloric acid, HCl
(e) Nitric acid, HNO_3.

Ans.(a) Molar mass of Ethyne, C_2H_2

$= 2 \times 12 + 2 \times 1 = 24 + 2 = 26$ g

(b) Sulphur molecule, $S_8 = 8 \times 32 = 256$ g

(c) Phosphorus molecule, $P_4 = 4 \times 31 = 124$ g

(d) Hydrochloric acid, $HCl = 1 \times 1 + 1 \times 35.5$

$= 1 + 35.5 = 36.5$ g

(e) Nitric acid, $HNO_3 = 1 \times 1 + 1 \times 14 + 3 \times 16$

$= 1 + 14 + 48 = 63$ g

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4 Structure of the Atom

Intext Questions

Q.1. What are canal rays ?

Ans. Canal rays (or anode rays) are streams of positively charged particles which move towards the negative electrode (cathode) in a discharge tube when high voltage electricity is passed through a gas at very low pressure taken in a discharge tube.

Q.2. If an atom contains one electron and one proton, will it carry any charge or not ?

Ans. The atom will be electrically neutral as one negative charge balances one positive charge.

Q.3. On the basis of Thomson's model of an atom, how the atom is neutral as a whole?

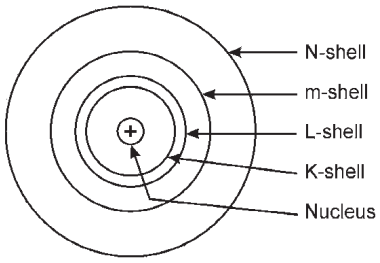
Ans. On the basis of Thomson's model of atom it is clear that an atom consists of a positively charged sphere and the electrons are embedded in it. As the negative and positive charges are equal in magnitude, so the atom is electrically neutral.

Q.4. On the basis of Rutherford's model of an atom, which subatomic particle is present in the nucleus of an atom ?

Ans. Protons.

Q.5. Draw a sketch of Bohr's model of an atom with three shells.

Ans.



Q.6. What do you think would be the observation if the α-particle scattering experiment is carried out using a foil of a metal other than gold.

Ans. Gold is highly ductile and a heavier metal. If the particle scattering experiment is carried out using a foil of any other metal, most of the α-particles will be absorbed by the metal foil and a very poor scattering of α-particles will occur.

Q.7. Name the three sub-atomic particles of an atom.

Ans. Electrons, protons and neutrons.

Q.8. Helium atom has an atomic mass of 4 u and two protons in its nucleus. How many neutrons does it have ?

Ans. Atomic mass = Number of protons + Number of neutrons

4 = 2 + Number of neutrons

Number of neutrons = 4 –2 = 2

Q.9. Write the distribution of electrons in carbon and sodium atoms.

Ans. For Carbon—

Atomic number = 6

Number of protons = 6

Number of protons = Number of electrons = 6

Electronic Distribution = K L

2 4

For Sodium—

Atomic number = 11

Number of protons = 11 = Number of electrons

Electronic Distribution = K L M

2 8 1

Q.10. If k and L shells of an atom are full, then what would be the total number of electrons in the atom.

Ans. K shell can hold 2 electrons

While L shell can hold 8 electrons

When both the shells are full, there will be (8 + 2) = 10 electrons in the atom.

Q.11. How will you find the valency of chlorine, sulphur and magnesium ?

Ans. For Chlorine—

Atomic number = 17

Number of Protons = 17

Number of electrons = 17

Electronic distribution = K L M

2 8 7

Chlorine needs 1 electron to complete its outermost shell

∴ Its valency is 1.

For sulphur—

Atomic number = 16

Number of protons = 16

Number of electrons = 16

Electronic distribution = K L M

2 8 6

Sulphur needs 2 electrons to complete its outermost shell

∴ Its valency is 2.

Magnesium—

Atomic number = 12

Number of Protons = 12

Number of electrons = 12

Electronic distribution = K L M

2 8 2

Magnesium will donate its 2 electrons from the outermost shell to become stable.

∴ Its valency is 2.

Q.12. If the number of electrons in an atom is 8 and number of protons is also 8, then

(i) What is the atomic number of the atom ? and

(ii) What is the charge on the atom ?

Ans. (i) Atomic number = Number of protons = 8
(ii) As number of electrons = number of protons, atom will be neutral. There is no charge on the atom.

Q.13. With the help of the table given below find out the mass number of oxygen and sulphur atom.

Table : Composition of Atoms of the First Eighteen Elements

Name of Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Number of Electrons	Distribution of Electrons				Valency
						K	L	M	N	
Hydrogen	H	1	1	-	1	1	-	-	-	1
Helium	He	2	2	2	2	2	-	-	-	0
Lithium	Li	3	3	4	3	2	-	-	-	1
Beryllium	Be	4	4	5	4	2	1	-	-	2
Boron	B	5	5	6	5	2	2	-	-	3
Carbon	C	6	6	6	6	2	3	-	-	4
Nitrogen	N	7	7	7	7	2	4	-	-	3
Oxygen	O	8	8	8	8	2	5	-	-	2
Fluorine	F	9	9	10	9	2	6	-	-	1
Neon	Ne	10	10	10	10	2	7	-	-	0
Sodium	Na	11	11	12	11	2	8	1	-	1
Magnesium	Mg	12	12	12	12	2	8	2	-	2
Aluminium	Al	13	13	14	13	2	8	3	-	3
Silicon	Si	14	14	14	14	2	8	4	-	4
Phosphorus	P	15	15	16	15	2	8	5	-	3.5
Sulphur	S	16	16	16	16	2	8	6	-	2
Chlorine	Cl	17	17	18	17	2	8	7	-	1
Argon	Ar	18	18	22	18	2	8	8	-	0

Ans. For oxygen –
Number of Protons = 8
Number of Neutrons = 8
Atomic number = Number of protons
= 8
∴ Atomic mass number = p + n = 8 + 8 = 16
For Sulphur—
Number of Protons = 16
Atomic number = Number of protons = 16
Number of Neutrons = 16
∴ Atomic mass number = p + n
= 16 + 16 = 32.

Q.14. For the symbol H, D, and T tabulate three sub-atomic particles found in each of them.
Ans.

Isotope	Symbol	Number of electrons	Number of Protons	Number of Neutrons
Hydrogen	$_1H^1$	1	1	0
Deuterium	$_1D^2$	1	1	1
Tritium	$_1T^3$	1	1	2

Q.15. Write the electronic configuration of any one pair of isotopes and isobars.
Ans. Isotopes—
Isotopes of carbon—

	$^{12}_{6}C$,		$^{14}_{6}C$	
Electronic configuration	K	L	K	L
	2	4	2	4

Isobars	$^{40}_{20}Ca$,				$^{40}_{18}Ar$		
Electronic configuration	K	L	M	N	K	L	M
	2	8	8	2	2	8	8

NCERT Exercises

Q.1. Compare the properties of electrons, protons and neutrons.

Ans. Comparison between properties of Electron, Proton and Neutron

Properties	Electron	Proton	Neutron
Mass	9.109×10^{-28} g	1.673×10^{-24} g	1.676×10^{-24}g
Relative mass	$\frac{1}{1840}u$	1 u	1 u
Relative charge	– 1	+ 1	0
Location in the atom	Outside the Nucleus	In the Nucleus	In the Nucleus

Q.2. What are the limitations of J.J. Thomson's model of the atom ?

Ans. Limitations of J.J. Thomson's model of an atom :

(i) Thomson's model failed to explain the results of the alpha particle scattering experiment that was given by Rutherford.

(ii) One of the major drawbacks of his model is that there were no experimental pieces of evidence provided by him.

(iii) He failed to explain the stability of atoms.

Q.3. What are the limitation of Rutherford's model of the atom.

Ans. (i) His model failed to explain the stability of atoms.

(ii) The arrangement of electrons in a circular path was not defined.

(iii) Any particle that is moving in a circular path would undergo acceleration and radiates energy. Thus, the revolving electron would lose energy and finally fall into the nucleus.

(iv) Another drawbacks of the Rutherford's model was its inability to explain the relationship between the atomic mass and atomic number (the number of protons).

Q.4. Describe Bohr's model of the atom.

Ans. Bohr's model of Atom—In 1913 Niels Bohr, a student of Rutherford proposed a model to account for the shortcomings of Rutherford's model. Bohr's model can be understood in terms of two postulates proposed by him. The postulates are :

Postulate 1. The electrons move in definite circular paths of fixed energy around a central nucleus; just like our solar system in which different planets revolve around the sun in definite trajectory. Similar to the planets, only certain circular paths around the nucleus are allowed for the electrons to move. These paths are called orbits, or energy levels.

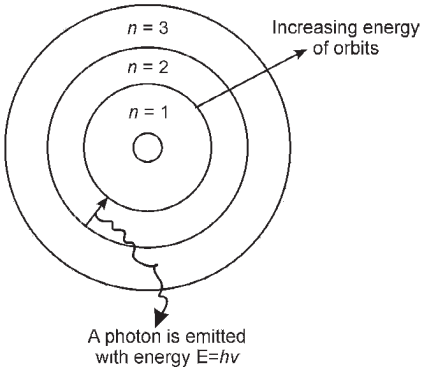


Fig. The electrons in an atom can change their energy level by absorbing suitable amounts of energy or by emitting energy.

The electron moving in the orbit does not radiate. In other words, it does not lose energy, therefore, these orbits are called **stationary orbits** or **stationary states**. The bold concept of stationary state could answer the problem of stability of atom faced by Rutherford's model.

It was later realised that the concept of circular orbit as proposed by Bohr was not adequate and it was modified to energy shells with definite energy, while a circular orbit is two dimensional, a shell is a three dimensional region. The shells of definite energy are represented by letters (K, L, M, N etc.) or by positive integers (1, 2, 3.... etc). The energies of the shells increase with the number n, n = 1, level is of the lowest energy, Further, the maximum number of electrons that can be accommodated in each shell is given by $2n_2$, where n is the number of the level. Thus, the first shell (n = 1) can have a maximum of two electrons whereas the second shell can have 8 electrons and so on. Each shell is further divided into various sub levels called sub shells.

Postulate 2. The electron can change its shells or energy level by absorbing or releasing energy. An electron at a lower state of energy E_i can go to a final higher state of energy E_f by absorbing a single photon of energy given by.

$$E = h\nu = E_f - E_i$$

Similarly, when electron changes its shell from a higher initial level of energy E_g to a lower final level of energy E_i a single photon of energy hv is released.

Q.5. Compare all the proposed models of an atom given in this chapter.

Ans. Comparison of all the proposed models of an atom :

	Thomson's model of an atom	Rutherford's model of an atom	Bohr's model of an atom
(i)	An atom consists of sphere of positive charge with negatively charged electrons embedded in it.	An atom consists of a very small positively charged nucleus at its centre with negatively charged electrons revolving around it in circular paths with high speeds.	An atom is made up of three particles, electrons, protons and neutrons. Electrons have negative charge, protons have positive charge and neutrons have no charge, they are neutral.
(ii)	The total positive charge on the sphere is equal to the total negative charge on the electrons due to which an atom is electrically neutral. It has no overall positive or negative electric charge.	The electrostatic attraction between the positively charged nucleus and the negatively charged electrons holds the atom together.	Due to presence of equal number of negative electrons and positive protons the atom on the whole is electrically neutral.
(iii)	Limitation : This model could not explain the results of alpha particle scattering experiment carried out by Rutherford.	The number of positive protons is equal to the number of negative electrons due to which an atom is electrically neutral.	The protons and neutrons are located in a small nucleus at the centre of atom. Due to the presence of photons, nucleus is positively charged.
(iv)		Almost the entire mass of an atom is concentrated in the nucleus.	The electrons revolve rapidly around the nucleus in fixed circular paths called energy levels or shells (denoted either by number 1, 2, 3, 4, 5 or by letters K,L, M,N, O) counted from the centre outwards.
(v)		Most of the part of atom is empty space. Limitation : Rutherford's model of an atom could not explain the stability of the atom.	Each energy level is associated with a fixed amount of energy.
(vi)			There is no change in the energy of electrons as long as they keep revolving in the same energy level.

Q.6. Summarise the rules for writing of distribution of electrons in various shells for the first eighteen elements.

Ans. (i) The maximum number of electrons that can be accommodated in a shell is given by the formula : $2n^2$, where n = 1, 2, 3 .....

(ii) The maximum number of electrons in different shells are :

K shell – $n = 1; 2n^2 = 2(1)^2 = 2$

L shell – $n = 2; 2n^2 = 2(2)^2 = 8$

M shell – $n = 3; 2n^2 = 2(3)^2 = 18$

N shell – $n = 4; 2n^2 = 2(4)^2 = 32$

(iii) The outermost orbit can be accommodated with 8 electrons at the maximum.

(iv) The electrons are not taken in unless the inner shells are filled, which are filled stepwise; hence, the highest element has K – 2, L – 8, M – 18, N – 32 distribution of electrons.

Q.7. Define valency by taking examples of silicon and oxygen.

Ans. The valency of an element is defined as the number of electrons lost, gained or shared by one atom of the element to achieve the nearest inert gas electron configuration.

(i) Silicon

Atomic number of silicon = 14

Number of electrons present = 14

Electronic configuration = K L M

= 2 8 4

Its outermost shell has 4 electrons which it can

share with other atoms to complete its orbit, hence its valency = 4.

(ii) Oxygen

Atomic number of oxygen = 8

Number of electrons present = 8

Electronic configuration = K L

2 6

Its outermost shell has 6 electrons. It will gain 2 electrons to complete its octet. Hence, its valency = 2.

Q.8. Explain with examples (i) Atomic number (ii) Mass number (iii) Isotopes and (iv) Isobars. Give any two uses of isotopes.

Ans. (i) Atomic number : The number of protons in one atom of an element is known as atomic number of that element. It is represented by Z. For example : One atom of carbon has 6 protons in it, so the atomic number of carbon is 6.

(ii) Mass number : The total number of protons and neutrons present in one atom of an element is known as its mass number. It is represented by A. For example : one atom of carbon has 6 protons and 6 neutrons, so the mass number of carbon is 6+6 = 12.

(iii) Isotopes : Isotopes are atoms of the same element having the same atomic number but different mass number. As they have same number of protons but a different number of neutrons. For example : Carbon molecule which exists as $_6C^{12}$ and $_6C^{14}$.

(iv) Isobars : Isobars are atoms which have the same mass number but differ in atomic number.

For example : $_{20}Ca^{40}$ and $_{18}Ar^{40}$.

Uses of Isotopes :

(i) The isotopes of the iodine atom is used to tret goitre, an iodine- deficient disease.

(ii) In the treatment of cancer, an isotope of cobalt is used.

(iii) Fuel for nuclear reactors is derived from the isotopes of the uranium atom.

Q.9. Na^+ has completely filled K and L shells. Explain.

Ans. Atomic number of sodium is 11 and its electronic configuration is 2, 8, 1. sodium ion (Na+) is formed by the loss of one electron from sodium atom.

$$\begin{array}{lcl} & Na & \longrightarrow & Na^+ + e^- \\ & 2, 8, 1 & & 2, 8 \\ \Rightarrow & K\ L\ M & & K\ L \end{array}$$

K and L shells of sodium ion have 2 and 8 electrons respectively and are completely filled.

Q.10. 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.

Ans. Percentage of Br isotope with mass number 79 = 49.7

Percentage of Br isotope with mass number 81 = 50.3

$\therefore$ Average atomic mass of Br

$$= \frac{49.7\times 79 + 50.3\times 81}{100} = \frac{3926.3 + 4074.3}{100}$$

$= 39.263 + 40.743 = 80.006\ u$.

Q.11. 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 ?

Ans. Let the percentage of the isotope $^{16}_{8}X$ be x. Hence, the percentage of the isotope $^{18}_{8}X$ is $(100 - x)$

Average atomic mass of X

$$= \frac{(\text{Percentage of } ^{16}_{8}X \times 16u) + (100 - \%\text{ of } ^{16}_{8}X) \times 18u}{100}$$

$$\text{or} \quad 16{\cdot}2u = \frac{(x \times 16u) + (100 - X) \times 18u}{100}$$

$$\text{or} \quad 2xu = 180\ u$$

$$\text{or} \quad x = \frac{180}{2} = 90$$

$\therefore$ Percentage of $^{16}_{8}X$ = 90% and percentage of $^{18}_{8}X$ = 100 – 90 = 10%

Q.12. If Z = 3, what would be the valency of the element? Also, name the element.

Ans. For Z = 3, the element is lithium (Li)

Electronic configuration of lithium

Z = 3 = K L

2 1

As the outermost shell has 1 electron. It loses one electron to complete its octet. Hence its valency is 1.

Q.13. Compositions 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 number of X and Y, what is the relation between the two species ?

Ans. Mass number of :

X = Number of Protons + Number of Neutrons
6 + 6 = 12

Y = Number of Protons + Number of neutrons
6 + 8 = 14

Both X and Y contain equal number of protons but different number of neutrons. Hence, X and Y are isotopes.

Q.14. For the following statements write 'T' for true and 'F' for False :

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

(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 1/2000 times that of proton.

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

Ans. (a) False, (b) False, (c) True, (d) False.

Q.15. Rutherford's alpha-particle scattering experiment was responsible for the discovery of

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

Ans.(a) Atomic nucleus.

Q.16. Isotopes of an element have :

(a) Same physical properties
(b) Different chemical properties
(c) Different number of neutrons
(d) Different atomic numbers.

Ans.(c).

Q.17. Number of valence electrons in Cl^- ion are:

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

Ans. As the electronic configuration of chlorine Cl (Z = 17) is

K	L	M
2	8	7

It gains 1 electron in the outermost shell to complete its octet. Hence, valency is 1.

Q.18. Which one of the following is a correct configuration of sodium :

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

Ans.(d) Atomic number of sodium = 11
Its electronic configuration is :

K	L	M
2	8	1

Q.19. 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	—

Ans. We can use the following formulae

- Mass Number = Atomic Number + Number of New Mass
- Number of electrons = Number of protons
- Number of Neutrons = Mass Number – Atomic Number
- Atomic Number = Number of Protons

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	Protium

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5 The Fundamental Unit of Life

Intext Questions

Q.1. Who discovered cells, and how ?

Ans. Robert Hooke (1665) discovered the cell. He examined a fine slice of a cork under a self-manufactured primitive microscope and observed that the slice of cork resembled the structure of a honey comb. These were actually dead cell walls observed by Robert Hooke. He named these tiny compartments cellulae now termed as cells. Cellula (plu. cellulae) is a Latin word which means 'a little room'.

Q.2. Why is the cell called the structural and functional unit of life.

Ans. Cell is the structural unit of life because, all living organisms are made up of cells. Cell is functional unit of life because functions of life like nutrition, respiration, excretion and reproduction etc. are basically performed by cell only.

Q.3. How do substances like CO_2 and water move in and out of the cell ? Discuss.

Ans. Carbon dioxide (CO_2) moves in and out of the cells by the process of diffusion. It is movement of particles of various substances from the region of the higher concentration to the region of the lower concentration.

Water moves in and out of the cells by osmosis. Osmosis is movement of water from the region of its higher concentration to the region of its lower concentration, when the both are separated by a semipermeable membrane.

Diffusion and osmosis are physical or mechanical phenomenon and do not require energy for their performance by the cells.

Q.4. Why is plasma membrane called a selectively permeable membrane ?

Ans. Plasma membrane allows the movement of only selected molecules across it and not all of them, so it is called selectively permeable membrane. For instance, It permits the entry of gases through diffusion and water through osmosis. Larger molecules may pass through the plasma membrane by an active process. Plasma membrane is impermeable to certain other materials. Therefore, it is selectively permeable.

Q.5. Fill in the gapes in the following table illustrating differences between prokaryotic and eukaryotic cells.

	Prokaryotic cell	Eukaryotic Cell
1.	Size : generally small (1-10 μm), 1 μm = 10^{-6} m	**Size :** generally large (5-100 μm)
2.	**Nuclear region** ..... and known as	**Nuclear region :** well defined and surrounded by a nuclear membrane.
3.	**Chromosomes.** single	**Chromosomes:** more than one chromosome.
4.	**Membrane bound cell organelles Absent**	....

Ans. 2. Prokaryotic cell—(i) Poorly defined due to absence of nuclear envelope (ii) Nucleoid

4. Eukaryotic cell—Membrane bound cell organelles are absent.

Q.6. Can you name the two organelles, we have studied that contain their own genetic material ?

Ans. Yes, mitochondria and chloroplast.

Q.7. If the organisation of a cell is destroyed due to some physical or chemical influence, what will happen ?

Ans. If organisation of a cell is destroyed or plasma membrane is disrupted, the cell would not be able to maintain the internal environment and chemical uniqueness. It will lead to death of the cell. Lysosomes would cause autolysis of the cell.

Q.8. Why are lysosomes known as suicide bags?

Ans. Lysosomes are membrane-bound sacs which contain hydrolytic enzymes. If lysosomes burst, enzymes are released and digest other organelles of the same cell. Therefore, they are known as 'suicide bags'.

Q.9. Where are proteins synthesized inside the cell ?

Ans. Proteins are synthesized over the ribosomes.

NCERT Exercises

Q.1. Make a comparison and write down ways in which plant cells are different from animal cell.

Ans. Differences between plant Cells and Animal Cells

	Plant cell	Animal cell
1.	Plant cells are generally larger than animal cells.	Animal cells are smaller than plant cells.
2.	A plant cell has a rigid cell wall on the outside.	A cell wall is absent.
3.	Plastids are found in plant cell.	Plastids are absent (except Euglena)
4.	A mature plant cell contains large central vacuole.	In animal cell vacuoles are either absent or they may have few small vacuoles.
5.	Centrioles are usually absent except in lower plants.	Centrioles are found in animal cells.
6.	Golgi apparatus consists of a number of distinct or unconnected unit called dictyosomes.	Golgi apparatus is either localised or consists of a wall connecting single x.
7.	Plant cells exposed to sunlight possess chlorophyll containing plastids called chloroplat.	Chlorophyll is absent.
8.	Reserve food is generally starch and fat.	Reserve food is usually glycogen and fat.

Q.2. How is a prokaryotic cell different from a eukaryotic cell ?

Ans. Differences between Prokaryotic cells and Eukaryotic cells

	Prokaryotic cells	Eukaryotic cells
1.	Generally these are smaller in size (1-10 μm).	These are generally larger in size (5-100 μm).
2.	True nucleus absent (Genetic material or nucleoid is not bounded by a nuclear membrane.	True nucleus present (Nuclear material is bounded by a nuclear membrane).
3.	These cells contain single chromosome.	These cells contain more than one chromosome.
4.	Chromosome lacks histones.	Chromosomes have histones.
5.	Nucleolus is absent.	Nucleolus is present in nucleoplasm.
6.	Membrane bounded cell organelles are absent.	Membrane bounded organelles are present.
7.	Ribosomes are of 70s type.	Ribosomes are of 70s and 80s types.
8.	Cell division takes place by fission or budding.	Cell division takes place by mitotic or meiotic cell division.

Q.3. What would happen if the plasma membrane ruptures or breaks down ?

Ans. If plasma membrane is ruptured, the cell would not be able to maintain the internal environment and chemical uniqueness. It will lead to death of the cell. Lysosomes would cause autolysis of the cell.

Q.4. What would happen to the life of a cell if there was no Golgi apparatus ?

Ans. Golgi apparatus packages and dispatach enzymes, hormones and other essential lipids and proteins secreted by ER to the target inside and outside of the cell.

Moreover, the digestive enzymes which remain concealed in lysosome will remain free in the cytoplasm killing the other cell content. Over all, in absence of Golgi apparatus, cell would die.

Q.5. Which organelle is known as the powerhouse of the cell ? Why.

Ans. Mitochondria is known as the powerhouse of the cell because the energy required for various life activities is released by mitochondria in the term of ATP molecule. Mitochondria contain enzymes that are needed for stepwise oxidation of food present in the cells to CO_2 and water. Oxidation of food releases energy which is used to form high energy ATP molecules. ATP are known as energy currency of the cell and these are used as cellular fuel.

Q.6. Where do the lipids and proteins constituting the cell membrane get synthesized ?

Ans. Proteins are synthesized over ribosome which are attached to rough endoplasmic reticulum while lipids are synthesized over smooth endoplasmic reticulum.

Q.7. How does an Amoeba obtain its food ?

Ans. Amoeba is unicellular organism. It acquires its food by the process of endocytosis. Plasma membrane of Amoeba is flexible which helps it to engulf food particles. The engulfed food particles pass into the body of Amoeba as a phagosome. Phagosome combine with lysosome to produce digestive or food vacuole. Digestion occurs in food vacuole. The digested food passes into surrounding cytoplasm. The undigested residue is thrown out of the cell.

Q.8. What is osmosis ?

Ans. Osmosis : Diffusion of water from the region of its higher concentration (pure water or dilute solution) to the region of its lower concentration through a semipermeable membrane is called osmosis.

Q.9. Carry out the following osmosis experiment: **Take four peeled potato halves and hollow each one out to make potato cups. One of these potato cups should be made from boiled potato. Put each potato cup in a trough containing water. Now-(a) keep cup A empty. (b) Put one teaspoon sugar in cup B (c) Put one teaspoon salt in cup C (d) Put one teaspoon sugar in boiled potato cup D. Keep this set up for two hours. Then observe the four potato cups and answer the following :**

(i) Explain why water gathers in the hollowed portion of B and C.

(ii) Why is potato A necessary for this experiment.

(iii) Explain why water does not gather in the hollowed out portions of A and D.

Ans. (i) Water gathers in the hollowed portion of B and C because living plasma membrane of potato cup acts as semipermeable membrane. There is higher concentration of water in trough than the sugar solution of B and salt solution of C potato cup respectively. So, by process of osmosis water moves into potato cups B and C.

(ii) Potato A functions as control experiment which indicates that the cavity does not induce movement of water.

(iii) Water does not gather in the potato cup A because it does not possess higher osmotic concentration than the cell of potato.

Potato cup D is boiled cup. It does not have living cell and the membrane of the potato cells have lost their permeability. As a result, when teaspoon of sugar is added into hollowed portion of boiled potato cup D, water does not come out from within the potato cells into the hollowed portion.

Q.10. Which type of cell division is required for growth and repair of body and which type is involved in formation of gamates ?

Ans. The form of cell division known as mitosis is responsible for body's expansion and repair. Gametes are created as a result of cell division process known as meiosis.

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6 Tissues

Intext Questions

Q.1. What is a tissue ?

Ans. Tissue is a group of related cells that have a common origin and perform a common function.

Q.2. What is the utility of tissues in multicellular organisms ?

Ans. In multicellular organisms, the different type of tissues perform different functions. Since a particular group of cells called tissue carry out only a particular function, they do it very efficiently. Thus, multicellular organisms possess a definite division of labour.

Q.3. Name types of simple tissue.

Ans. There are three types of simple tissue—

1. Parenchyma, 2. Collenchyma, 3. Sclerenchyma

Q.4. Where is apical meristem found ?

Ans. Apical meristem is found at root and stem apex.

Q.5. Which tissue makes up the husk of coconut?

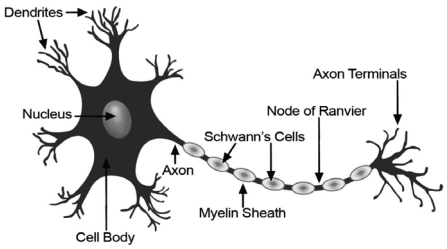
Ans. Sclerenchymatous fibres.

Q.6. What are the constituents of phloem ?
Ans. The four constituents of phloem are—
(a) Sieve tube (b) companion cells (c) phloem parenchyma and (d) phloem fibres.

Q.7. Name the tissue responsible for movement in our body ?
Ans. Muscular tissue.

Q.8. What does a neuron look like ?
Ans. A neuron is a nerve cell consisting of the cell body with a nucleus and cytoplasm from which a nucleus and cytoplasm from which a long and thin hair- like structure emerges. Every neuron has one elongated part known as the axon, and several short and small branched structures known as dendrites. A single neuron can be a meter long.

Structure of Neuron



Q.9. Give three features of cardiac muscles.
Ans. (i) The cells of cardiac muscles are cylindrical, branched and uninucleate. (ii) These are involuntary. (iii) These muscles show rythmic contraction and relaxation throughout the life.

Q.10. What are the functions of areolar tissue ?
Ans. Areolar tissue support internal organs and helps in repair of the tissues.

NCERT Exercises

Q.1. Define the term ''tissue''.
Ans. Tissue is a group of related cells that have a common origin and perform a common function.

Q.2. How many types of elements together make up the xylem tissue ? Name them.
Ans. There are four types of elements together make up the xylem tissue : 1. Tracheids, 2. Vessels, 3. Xylem parenchyma and 4. Xylem fibres.

Q.3. How are simple tissues different from complex tissues in plants ?
Ans. Differences between simple and complex tissue :

	Simple tissue	Complex tissue
1.	It is formed of only one type of cells.	It is formed of more than one type of cells.
2.	All the cells perform the same function.	The different cells perform different fraction of a function.
3.	They form primary structure of the plant.	They form transport system of the plant.

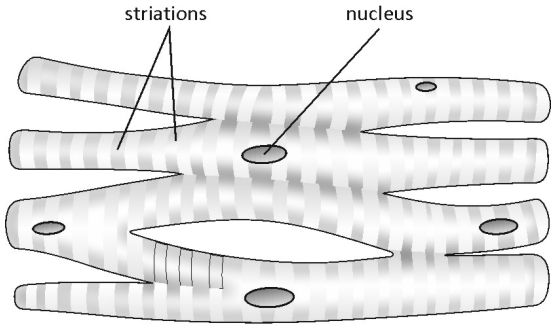
Q.4. Differentiate between paranchyma, collenchyma and sclerenchyma on the basis of the cell wall.
Ans. Differences between parenchyma, collenchyma and sclerenchyma :

	Parenchyma	Collenchyma	Sclerenechyma
1.	The cell wall is thin.	The cell wall is thickened at corners.	The cell wall is thickened.
2.	The cell wall is smooth.	The cell wall is unevenly thickened.	The cell wall is uniformly thickened.
3.	The cell wall is formed of cellulose.	The cell wall is pectocellulosic.	The cell wall is cellulosic but thickening is lignified.

Q.5. What are the functions of stomata ?
Ans. Functions of stomata :
(i) Stomata are sites where exchange of gases occurs between the plant interior and external environment.
(ii) Major part of transpiration occurs through stomata.
(iii) They regulate both gaseous exchange and transpiration.

Q.6. Diagrammatically show the difference between the three types of muscle fibres.
Ans. There are three types of muscle fibres, they are :

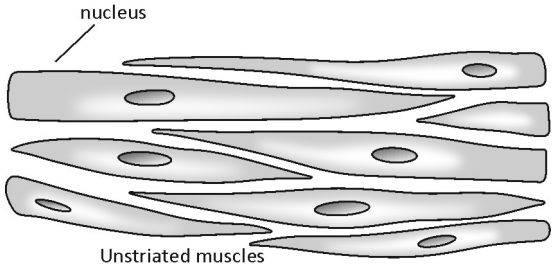
1. **Cardiac muscles**
   - Present in the heart.
   - Involuntary in nature.
   - The muscle fibres are branched.
   - They have 1 nucleus.



Cardiac muscles

Cardiac muscles

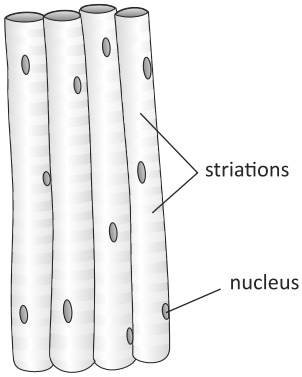
2. **Smooth Muscles**
   - Found in lungs and alimentary canal.
   - They are spindle-shaped.
   - Involuntary in nature.
   - They have 1 nucleus.



Unstriated muscles

Smooth muscles

3. **Striated Muscles**
   - They are connected with bones.
   - Voluntary in nature.
   - They are long and cylindrical muscle fibres.
   - They possess many nuclei.
   - Striated muscles are unbranched.



Striated Muscles

Q.7. What is the specific function of the cardiac muscle?

Ans. Cardiac muscle contracts and relaxes rapidly and continuously with a rhythm, but it never gets fatigued.

Q.8. Differentiate between striated, unstriated and cardiac muscles on the basis of their structure and site/location in the body.

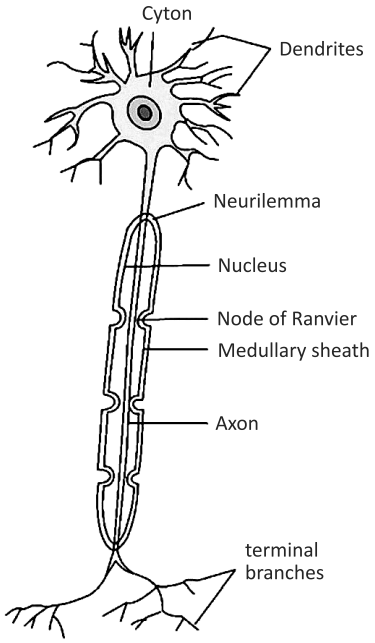
Ans. Differences amongst Striated, Smooth and Cardic Muscles

	Straited muscles	Smooth muscles	Cardiac muscles
1.	These muscle fibres are long, cylindrical.	These muscle fibres are elongated and spindle shaped.	These muscle fibres are small and cylindrical.
2.	The fibres have blunt ends.	The fibres have pointed ends.	The fibres have broad ends.
3.	They are striated.	They are not striated.	They are striated.
4.	They are not branched.	Not branched.	They are banched.
5.	Intercalated discs and cross connect-ions are absent in muscle fibres.	Intercalated discs and cross connections are absent.	Intercalated discs and cross connections are present.
6.	The muscle fibres are multinucleate. They occur peripherally below the sarcolemma.	The muscle fibres are uninucleate. Nuclei are centrally placed.	The cells are uninucleate. nucleus is centrally placed.
7.	The muscle fibres are found in bundles.	Muscle Fibres occur in sheets.	Muscle fibres form a network.

8.	They are voluntary.	They are involuntary.	They are involuntary.
9.	They are able to perform fast and powerful, contractions.	They perform slow but prolonged contractions.	They perform powerful and rhythmic contractions.
10.	They get fatigued soon.	Fatigue is rare.	They never get fatigued.
11.	Found in hands, legs and skeletal muscles.	Found in wall of stomach, intestine, ureter and bronchi.	Found in heart.

Q.9. Draw a labelled diagram of a neuron.

Ans.



A neuron–a unit of nervous tissue

Q.10. Name the following :

(a) Tissue that forms the inner lining of our mouth.

(b) Tissue that connects muscle to bone in humans.

(c) Tissue that transports food in plants.

(d) Tissue that stores fat in our body.

(e) Connective tissue with a fluid matrix.

(f) Tissue present in the brain.

Ans. (a) Stratified squamous epithelium.

(b) Tendon (c) Phloem

(d) Adipose tissue (e) Blood

(f) Nervous tissue

Q.11. Identify the type of tissue in the following: skin bark of tree, bone, lining of kidney tubule, vascular bundle.

Ans. Skin : Epithelial tissue.

Bark of tree : Cork (Protective tissue)

Bone : Connective tissue with solid matrix.

Vascular bundle : Complex or vascular tissue (xylem and phloem).

Q.12. Name the regions in which parenchyma tissue is present.

Ans. Parenchyma occurs in almost all nonwoody parts of the plant such as-cortex, pith, medullary rays of stem, cortex and pith of roots, leaf flowers, pith of fruits etc.

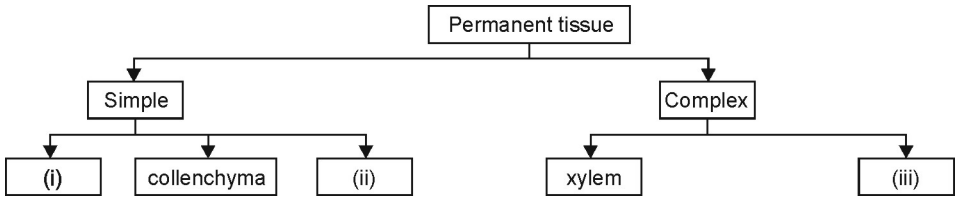
Q.13. What is the role of epidermis in plants.

Ans. Epidermis acts as a protective tissue in plants and protects underlying tissues. Epidermis helps in absorption, secretion, excretion, gaseous exchange and transpiration. It protects the entry of pathogens.

Q.14. How does the cork act as a protective tissue?

Ans. Cork acts as a protective layer because its cells are dead, filled with tannins, resin and air.

Q.15. Complete the table—



Ans.(i) Parenchyma (ii) Sclerenchyma (iii) Phloem

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7 Motion

Intext Questions

Q.1. An object has moved through a distance. Can it have zero displacement? If yes, support your answer with an example.

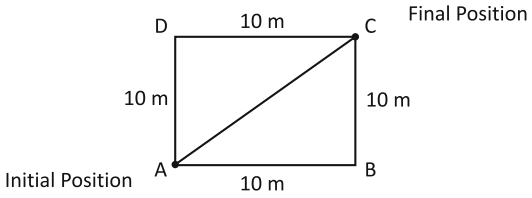
Ans. Yes. an object which has moved through a distance can have zero displacement if it comes back to its initial position. Example: An object moves from a position O.

Q.2. A farmer moves along the boundary of a square field of side 10 m in 40 s. What will be the magnitude of displacement of the farmer at the end of 2 minutes 20 seconds?

Ans. Given side of square = 10 m, thus perimeter (P) = 40 m

Time taken to cover the boundary of 40 m = 40 s

Thus in 1 second, the farmer covers a distance of 1 m



Total time given = 2 m 20 s

$= 2 \times 60 + 20 = 120 + 20 = 140$ sec.

Round covered in 140 sec.

$= 140 \text{ m} \div 40 \text{ m} = 3\frac{1}{2}$ m

In 3 round he returns back to initial point A and in next ½ round he reach at point C.

∴ Required displacement

$= AC = \sqrt{AB^2 + BC^2}$

$= \sqrt{10^2 + 10^2} = \sqrt{2 \times 10^2}$

$= 10\sqrt{2} = 10 \times 1.414 = 14.14$ m

Q.3. Which of the following is true for displacement?

(a) It cannot be zero.

(b) Its magnitude is less than the distance travelled by the object.

Ans.(b) Its magnitude is less than the distance travelled by the object because displacement can be zero also if an object comes back to its original position.

Q.4. Distinguish between speed and velocity.

Ans. Speed : The distance travelled by the object in unit time is referred to as speed. It is a scalar quantity.

– The average speed of an object is obtained by dividing the total distance travelled by the total time taken.

Velocity: Velocity is the speed of an object moving in a definite direction. The velocity of an object can be uniform or variable.

– Average velocity is given by the arithmetic mean of initial velocity and final velocity for a given period of time. It is vector quantity.

Q.5. Under what condition(s) is the magnitude of average velocity of an object equal to its average speed?

Ans. The magnitude of average speed and average velocity are equal when the total distance covered is equal to the displacement.

Q.6. What does the odometer of an automobile measure?

Ans. Total distance travelled by an automobile.

Q.7. What does the path of an object look like when it is in uniform motion?

Ans. The path of an object in uniform motion is a straight line.

Q.8. During an experiment, a signal from a spaceship reached the ground station in five minutes. What was the distance of the spaceship from the ground station? The signal travels at the speed of light, that is, 3×10^8 ms^{-1}.

Ans. Let the distance of the spaceship from the ground station be S

5 minutes = 5 × 60 seconds = 300 seconds.

Speed of the signal = 3×10^8 m/s.

Therefore, total distance = $3 \times 10^8 \times 300$

$= 9 \times 10^{10}$ meters.

Q.9. When will you say a body is in (i) uniform acceleration? (ii) non- uniform acceleration?

Ans. (i) A body has a uniform acceleration if its velocity changes by equal amounts in equal intervals of time.

(ii) A body has a non-uniform acceleration if its velocity changes by unequal intervals of time.

Q.10. A bus decreases its speed from 80 km h^{-1} to 60 km h^{-1} in 5 s. Find the acceleration of the bus.

Ans. Given: Initial velocity (u) = 80 km/hr = 80 × 5/18 = 400/18 = 22.2 m/sec

Final velocity (v) = 60 km/hr = 60 × 5/18
= 300/18 = 16.6 m/sec

Acceleration a = (v – u) / t
= (16.6 – 22.2)/5
= –5.6/5 = –1.12 m/s^2

Negative sign indicates that the velocity is decreasing.

Q.11. A train starting from a railway station and moving with uniform acceleration attains a speed 40 km h^{-1} in 10 minutes. Find its acceleration.

Ans. Given parameters

Initial velocity (u) = 0

Final velocity (v) = 40 km/h
v = 40 × (5/18)
= 11.1111 m/s

Time (t) = 10 minute
t = 60 x 10 = 600 s

Acceleration (a) = ?

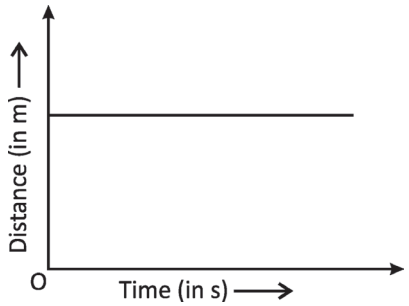
Consider the formula
v = u + at
11.11 = 0 + a × 600
11,11 = 600 a
a = 11.11/600 = 0.0185 ms^{-2}

Q.12. What is the nature of the distance-time graphs for uniform and non-uniform motion of an object?

Ans. The distance-time graph for an uniform motion is a straight line. The distance-time graph for a non-uniform motion is a curve.

Q.13. What can you say about the motion of an object whose distance-time graph is a straight line parallel to the time axis?

Ans. When the graph of a distance-time graph is a straight line parallel to time axis, It means that distance remains same at any time. So, the object does not move at any time.



Q.14. What can you say about the motion of an object if its speed-time graph is a straight line parallel to the time axis ?

Ans. Object is moving with constant speed.

Q.15. What is the quantity which is measured by the area occupied below the velocity-time graph?

Ans. The area occupied under the velocity-time graph is the displacement.

Q.16. A bus starting from rest moves with a uniform acceleration of 0.1 m s^{-2} for 2 minutes. Find (a) the speed acquired, (b) the distance travelled.

Ans. (a) Initial velocity (u) = 0 m/s

Acceleration (a) = 0.1 $m.s^{-2}$

Time = 2 minutes = 120 s

Therefore, terminal velocity (v) = u + at
= 0 $m.s^{-1}$ + (0.1 $m.s^{-2}$ x 120 s)
= 12 $m.s^{-1}$

(b) a = 0.1 ms^{-2}, v = 12 ms^{-1}, u = 0 ms^{-1}, and t = 120 s,

Then, the distance,
s = $(v^2 – u^2)/2a$
= $(12^2 – 0^2)/2(0.1)$ = 720 m

Therefore, s = 720 m.

Q.17. A train is travelling at a speed of 90 km h^{-1}. Brakes are applied so as to produce a uniform acceleration of – 0.5 m s^{-2}. Find how far the train will go before it is brought to rest.

Ans. Given that

Initial velocity (u) = 90 km/hour = 25 $m.s^{-1}$

Terminal velocity (v) = 0 $m.s^{-1}$

Acceleration (a) = –0.5 $m.s^{-2}$

As per the third equation of motion, $v^2 – u^2 = 2as$

Therefore,

The distance travelled by train (s) = $(v^2–u^2)/2a$

On substituting the known values we get
s = $(0^2 –25^2)/2(–0.5)$ meters = 625 meters

Q.18. A trolley, while going down an inclined plane, has an acceleration of 2 cm s^{-2}. What will be its velocity 3 s after the start?

Ans. Here, Initial velocity, u = 0
Final velocity, v = ?
Acceleration, a = 2 cm s^{-2}
And, Time, t = 3 s
Now, $v = u + at = 0 + 2 \times 3 = 6$ cms^{-1}
Thus, the velocity of trolley after 3 s will be 6 centimetres per second.

Q.19. A racing car has a uniform acceleration of 4 ms^{-2}. What distance will it cover in 10 s after start?

Ans. The car is initially at rest;
initial velocity (u) = 0 ms^{-1}
Acceleration (a) = 4 ms^{-2}
Time period (t) = 10 s
As per the second motion equation, $s = ut+1/2\ at^2$
Therefore, the total distance covered by the car (s)
$= 0 \times 10$ m + 1/2 (4 ms^{-2})(10 s)^2
= 200 meters
Therefore, the car will cover a distance of 200 meters after 10 seconds.

Q.20. A stone is thrown in a vertically upward direction with a velocity of 5 m s^{-1}. If the acceleration of the stone during its motion is 10 m s^{-2} in the downward direction, what will be the height attained by the stone and how much time will it take to reach there?

Ans. Given that Initial velocity (u) = 5 m/s
Terminal velocity (v) = 0 m/s (since the stone will reach a position of rest at the point of maximum height)
Acceleration = 10 ms^{-2} in the direction opposite to the trajectory of the stone = –10 ms^{-2}.
As per the third motion equation,
$s = (v^2 - u^2)/2a$
Therefore, the distance travelled by the stone is
$(s) = (0^2 - 5^2)/\ 2(10)$
Distance (s) = 1.25 meters
As per the first motion equation,
$v = u + at$
Therefore, time is taken by the stone to reach a position of rest (maximum height)
$= (v - u)\ /a = (0 - 5)/(-10)$ s
Time taken = 0.5 seconds
Therefore, the stone reaches a maximum height of 1.25 meters in a timeframe of 0.5 seconds.

NCERT Exercises

Q.1. An athlete completes one round of a circular track of diameter 200 m in 40 s. What will be the distance covered and the displacement at the end of 2 minutes 20 s?

Ans. Given: The diameter of the circular track = 200 m
Radius (r) = 200/2 = 100 m
Time taken to complete one round = 40 seconds.
Displacement = ?
Speed = Distance/Time
Total time athlete moves = 2 min 20 seconds
$= 2 \times 60 + 20 = 140$ seconds
Distance covered in one round
= Circumference of a circle.
Distance covered in one round = $2\pi r$
Distance covered in one round = $2 \times \pi \times 100$
Distance covered in one round = 200π
Time taken to complete one round = 40 seconds.
Number of rounds completed in 140s
= 140/40 = 3.5
Distance covered = 3.5 × circumference
$= 3.5 \times 2\pi r$
$= 3.5 \times 2 \times 3.14 \times 100$
$= 2198 \approx 2200$ m
Displacement = shortest path between the initial position and the final position
$= 2r = 2 \times 100 = 200$ m

Q.2. Joseph jogs from one end A to the other end B of a straight 300 m road in 2 minutes 30 seconds and then turns around and jogs 100 m back to point C in another 1 minute. What are Joseph's average speeds and velocities in jogging (a) from A to B and (b) from A to C?

Ans.(a) Total Distance covered from AB = 300 m
Total time taken = 2 x 60 + 30 s = 150 s
Therefore, Average speed
= Total Distance/ Total Time
= 300/150 m s^{-1} = 2 ms^{-1}
Therefore, velocity = Displacement / Time
= 300 /150 ms^{-1} = 2 ms^{-1}
(b) Total Distance covered from AC = AB + BC
= 300 + 100 m
Total time is taken from A to C
= Time taken for AB + Time taken for BC
$= (2 \times 60 + 30) + 60$ s = 210 s
Therefore, Average Speed from AC

= Total Distance/Total Time
= 400/210 ms^{-1} = 1.9 ms^{-1}
Displacement (s) from A to C
= AB – BC = 300 – 100 m = 200 m
Time (t) taken for displacement from AC = 210 s
Therefore, velocity
= Displacement / Time = 200/210 ms^{-1}
= 0.952 m s^{-1}

Q.3. Abdul, while driving to school, computes the average speed for his trip to be 20 km h^{-1}. On his return trip along the same route, there is less traffic and the average speed is 30 km h^{-1}. What is the average speed for Abdul's trip?

Ans. Case I : While driving to school
Average speed of Abdul's trip = 20 km/h
Total distance = d
Let total time taken = t_1
Speed = Distance / time
$20 = d / t_1$
$t_1 = d / 20$ ...(i)

Case II : While returning from school
Total distance = d
Speed = 30 km/h
Now, total time taken = t_2
Speed = distance / time
$30 = d / t_2$
$t_2 = d / 30$ ... (ii)

$\therefore$ Average speed = $\frac{2d}{t_1 + t_2}$

From equations (i) and (ii),

$$\text{Average Speed} = \frac{2d}{\frac{d}{20} + \frac{d}{30}} = \frac{2}{\frac{3+2}{30}}$$

Average Speed = 120/5 = 24 km/h

Hence, the average speed for Abdul's trip is 24 km/h.

Q.4. A motorboat starting from rest on a lake accelerates in a straight line at a constant rate of 3.0 m s^{-2} for 8.0 s. How far does the boat travel during this time?

Ans. Initial velocity, u = 0
Acceleration of the motorboat, a = 3 m/s^2
Time taken, t = 8 s
According to equation of motion:

$$s = ut + \frac{1}{2}at^2$$

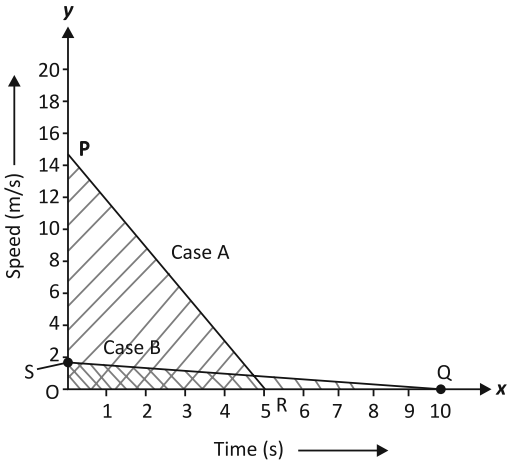
Distance covered by the motorboat, s

$$s = 0 + \frac{1}{2} \times 3 \times (8)^2 = 96 \text{ m}$$

Hence, the boat travels a distance of 96 m

Q.5. A driver of a car travelling at 52 km h^{-1} applies the brakes and accelerates uniformly in the opposite direction. The car stops in 5 s. Another driver going at 3 km h^{-1} in another car applies his brakes slowly and stops in 10 s. On the same graph paper, plot the speed versus time graphs for the two cars. Which of the two cars travelled farther after the brakes were applied?

Ans. Case A :
Initial speed of the car, u_1 = 52 km/h
= 52 × (5 / 18) = 14.44 m/s
Time taken, t_1 = 5 s
Final speed = 0 m/s
Case B :
Initial speed of the car, u_2 = 3 km/h
= 3 × (5 / 18) = 0.83 m/s
Time taken, t_2 = 10 s
Final speed = 0 m/s
Plot of the two cars on a speed–time graph is shown in the following figure:



Distance covered by each car is equal to the area under the speed-time graph.
Distance covered in case A,

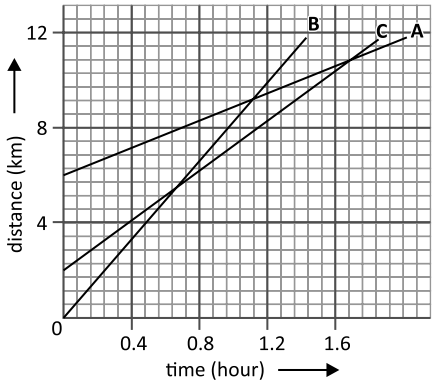
$$S_1 = \frac{1}{2} \times OP \times OR = \frac{1}{2} \times 14.4 \times 5 = 36 \text{ m}$$

Distance covered in case B,

$$S_2 = \frac{1}{2} \times OS \times OQ = \frac{1}{2} \times 0.83 \times 10 = 4.15 \text{ m}$$

Then, the car A travelling with a speed of 52 km/h travels farther after brakes were applied.

Q.6. Fig shows the distance-time graph of three objects A, B and C. Study the graph and answer the following questions:



(a) Which of the three is travelling the fastest?

(b) Are all three ever at the same point on the road?

(c) How far has C travelled when B passes A?

(d) How far has B travelled by the time it passes C?

Ans. (a) Object B

(b) All three objects A, B and C never come at the same point

(c) On the distance axis:

7 small boxes = 4 km

1 small box = 4 / 7 km

Initially, object C is 4 blocks away from the origin.

Initial distance of object C from origin = 16 / 7

Distance of object C from origin when B passes A = 8 km

$$= 8 - \frac{16}{7} = \frac{56-16}{7} = \frac{40}{7} = 5.714 \text{ km}$$

Distance covered by C

Hence, C has travelled a distance of 5.714 km when B passes A.

(d) Distance covered by B at the time it passes C = 9 boxes

$$= \frac{4}{7} \times 9 = \frac{36}{7} = 5.143 \text{ km}$$

Hence, B has travelled a distance of 5.143 km when B passes C.

Q.7. A ball is gently dropped from a height of 20 m. If its velocity increases uniformly at the rate of 10 m s^{-2}, with what velocity will it strike the ground? After what time will it strike the ground?

Ans. Distance covered by the ball, s = 20 m

Acceleration, a = 10 m/s^2

Initially, velocity, u = 0

Final velocity, v = ?

Time, t = ?

According to the third equation of motion:

$v^2 = u^2 + 2as = 0 + 2(10)(20)$

$v = 20$ m/s

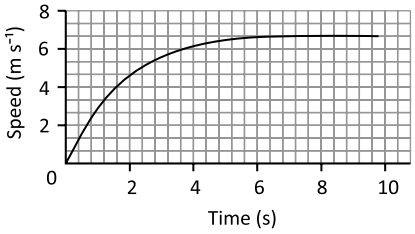
According to the first equation of motion:

$v = u + at$

$20 = 0 + 10\,(t) = t = 2$ s

Hence, time taken to reach at the ground is 2 seconds.

Q.8. The speed-time graph for a car is shown is Fig.



(a) Find how far does the car travel in the first 4 seconds. Shade the area on the graph that represents the distance travelled by the car during the period.

(b) Which part of the graph represents uniform motion of the car?

Ans. (a) Shaded area = $\frac{1}{2} \times 4 \times 6 = 12$ m

The distance covered by the car in first 4 seconds is 12 m.

(b) For uniform motion, the speed-time graph is a straight line parallel to the time axis. So, the straight part parallel to time axis represent the uniform motion of the car.

Q.9. State which of the following situations are possible and give an example for each of these:

(a) an object with a constant acceleration but with zero velocity

(b) An object moving with an acceletation but with uniform speed.

(c) an object moving in a certain direction with an acceleration in the perpendicular direction.

Ans. (a) **Possible:** When an object is thrown up at maximum height, it has zero velocity, although it will have constant acceleration due to gravity, which is equal to 9.8 m/s^2.

(b) **Possible:** Circular motion

(c) **Possible:** When an object is moving in a circular track, its acceleration is perpendicular to its direction

Q.10. An artificial satellite is moving in a circular orbit of radius 42250 km. Calculate its speed if it takes 24 hours to revolve around the earth.

Ans. Speed = Distance /Time

Distance covered by satellite in 24 hours,

$s = 2\pi r$

= 2 × 3.14 × 42250 = 265330 km
Time = 24 h
Speed = 265330 / 24
= 11055.4 km/h
= 11055.4 / 3600 = 3.07 km/s

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8 Force and Laws of Motion

Intext Questions

Q.1. Which of the following has more inertia :

(a) a rubber ball and a stone of the same size ?
(b) a bicycle and a train ?
(c) a five rupee coin and a one rupee coin?
Give reasons for your answer.

Ans.(a) Stone has more inertia than the rubber ball as the mass of the stone is more than the mass of the ball.

(b) A train has more inertia than a bicycle because it has more mass than a bicycle.

(c) A five rupee coin has more inertia than a one-rupee coin because it has more mass than a one-rupee coin.

Q.2. In the following example try to identify the number of times the velocity of the ball changes :
"A football player kicks a football to another player of his team who kicks the football towards the goal. The goalkeeper of the opposite team collects the football and kicks it towards a player of his own team."
Also identify the agent supplying the force in each case.

Ans.(i) Velocity of the football changes when first player kicks the balls towards another player of his team.

(ii) Velocity of the football also changes when another player kicks the football towards the goal.

(iii) Velocity of the football also changes when the goalkeeper of the opposite team stops the football by collecting it.

(iv) Velocity of the football changes when the goalkeeper kicks it towards a player of his team. Thus, the velocity of the ball changes four times in this case.

In first and second case, the force is supplied by the foot of players. In third case, force is supplied by the hands of the goalkeeper. In fourth case, as the goalkeeper hits the football with his foot, so the foot of the goalkeeper supplies the force.

Q.3. Explain why some of the leaves may get detached from a tree if we vigorously shake its branch?

Ans. Before shaking the branches, leaves are at rest. When branches are shaken, they come in motion while the leaves tend to remain at rest due to inertia of rest. As a result, leaves get detached from the branches and fall down.

Q.4. Why do you fall in the forward direction when a moving bus brakes to stop and fall backwards when it accelerates from rest ?

Ans.(i) When a moving bus brakes to stop, the lower portion of our body also comes to rest but the upper part of our body remain in motion due to inertia of motion. Hence, we fall in forward direction.

(ii) When a bus accelerates from rest, the lower portion of our body also comes in motion with the bus but the upper part of our body remain at rest due to inertia of rest. Hence, we fall backwards.

NCERT Exercises

Q.1. An object experiences a net zero external unbalanced force. Is it possible for the object to be travelling with a non-zero velocity ? If yes, state the conditions that must be placed on the magnitude and direction of the velocity. If no, provide a reason.

Ans. Yes, An object may travel with a non-zero velocity even when the net external force on it is zero.

Conditions are :

(i) If any object already moving with a uniform speed along a straight line.

(ii) Magnitude of velocity and direction of motion should not be altered.

(iii) There should be no friction between the object and the ground.

(iv) Air resistance must be zero.

If any of the four conditions is not fulfil the answer will be 'No'. The reason is that external unbalanced force is needed for initiating the motion and also for any change in its velocity.

Q.2. When a carpet is beaten with a stick, dust comes out of it. Explain.

Ans. When we beat the carpet with a stick, it comes into motion. But the dust particles continue to be at rest due to inertia of rest and get detached from the carpet.

Q.3. Why is it advised to tie any luggage kept on the roof of a bus with a rope ?

Ans. The luggage placed on the roof is not fixed to the bus. When the bus starts suddenly, the luggage tends to remain in the state of rest due to inertia of rest. As a result, the luggage might fall towards the backside of the bus. When a moving bus stops suddenly, the luggage continues to remain in the state of motion due to the inertia of motion. As a result, the luggage might slide towards the front side of the bus and fall. To prevent fall of the luggage from the roof of the bus, it is advised to tie the luggage with a rope.

Q.4. A batsman hits a cricket ball which then rolls on a level ground. After covering a short distance, the ball comes to rest. The ball slows to a stop because :

(a) the batsman did not hit the ball hard enough,

(b) velocity is proportional to the force exerted on the ball,

(c) there is a force on the ball opposing the motion,

(d) there is no unbalanced force on the ball, so the ball would want to come to rest.

Ans.(c) The moving ball stops after some time due to the action of the frictional force. The frictional force opposes the motion of the body. So, the correct answer is (c).

Q.5. A truck starts from rest and rolls down a hill with a constant acceleration. It travels a distance of 400 m in 20s. Find its acceleration. Find the force acting on it if its mass is 7 metric tonnes.

Ans. Given, $u = 0, s = 400$ m, $t = 20$ s

Find : $a = ?$, F = ?

$\because \quad s = ut + \frac{1}{2}at^2$

$$400 = 0 + \frac{1}{2}a(20)^2$$

$$a = \frac{400 \times 2}{400} = 2 \text{ ms}^{-2}$$

Now mass (m) = 7 metric tonnes

= 7 × 1000 kg = 7000 kg

F = ma = 7000 × 2

= 14,000 kg ms^{-2}

= 14,000 N.

Q.6. A stone of 1 kg is thrown with a velocity of 20 ms^{-1} across the frozen surface of a lake and comes to rest after travelling a distance of 50 m. What is the force of friction between the stone and the ice ?

Ans. Given, $m = 1$ kg, $u = 20$ ms^{-1}, $v = 0$, $s = 50$ m

F (Force of friction) = ?

$\because \quad v^2 - u^2 = 2as$

$(0)^2 - (20)^2 = 2a \times 50$

$$a = \frac{-400}{100} = -4 \text{ ms}^{-2}$$

F = $ma = 1 \times (-4) = -4$N

Q.7. A 8000 kg engine pulls a train of 5 wagons, each of 2000 kg along a horizontal track. If the engine exerts a force of 40,000 N and the track offers a friction force of 5000 N, then calculate:

(a) the net accelerating force and

(b) the acceleration of the train

Ans. Total mass of 5 wagons = 5 × 2000

= 10,000 kg

Force exerted by the engine = 40,000 N

Force exerted by the track = –5000 N

(a) The net accelerating force

F = Engine force – Friction force

= 40,000 – 5,000 = 35,000 N

(b) The acceleration of the train

$$a = \frac{35,000}{10,000} = 3.5 \text{ ms}^{-2}$$

Q.8. An automobile vehicle has a mass of 1500 kg. What must be the force between the vehicle and the road if the vehicle is to be stopped with a negative acceleration of 1·7 ms^{-2} ?

Ans. Given, $m = 1500$ kg

$a = -1{\cdot}7$ ms^{-2}

Find : F = ?

$\because \quad$ F = $ma = 1500 \times (-1{\cdot}7)$

$= -2550$ N

Negative sign shows that the direction of the

force is opposite to the direction of motion of the vehicle.

Q.9. What is the momentum of an object of mass m, moving with velocity v ?

(a) $(mv)^2$ (b) mv^2 (c) mv^2 (d) mv.

Ans. (d) mv.

Q.10. Using a horizontal force of 200 N, we intend to move a wooden cabinet across a floor at a constant velocity. What is the frictional force that will be exerted on the cabinet ?

Ans. The cabinet will move with constant velocity only when the net force on it is zero.

$\therefore$ Force of friction on the cabinet = 200 N, in a direction opposite to the direction of motion of the cabinet.

Q.11. According to the third law of motion when we push an object, the object pushes back on us with an equal and opposite force. If the object is a massive truck parked along the roadside, it will probably not move. A student justifies this by answering that the two opposite and equal forces cancel each other. Comment on this logic and explain why the truck does not move?

Ans. Student's justification is not correct. Two equal and opposite forces cancel each other if they act on the same body. According to the third law of motion, action and reaction forces are equal and opposite but they both act on different bodies. Hence, they cannot cancel each other.

When we push a massive truck, then the applied force on the truck is not sufficient to overcome the force of friction between the tyres of truck and ground, hence, truck does not move.

The truck will move if the force applied on it is greater than the frictional force.

Q.12. A hockey ball of mass 200 g travelling at 10 ms^{-1} is struck by a hockey stick so as to return it along its original path with a velocity of 5 ms^{-1}. Calculate the change of momentum occurred in the motion of the hockey ball by the force applied by the hockey stick.

Ans. Given, m = 200, g = 0·2 kg, u = 10 ms^{-1}

$v = -5\ ms^{-1}$

Change of momentum $= m(v-u)$

$= 0{\cdot}2(-5-10)$

$= -3\ kg\ ms^{-1}$.

Q.13. A bullet of mass 10g travelling horizontally with a velocity of 150 ms^{-1} strikes a stationary wooden block and comes to rest in 0·03 s. Calculate the distance of penetration of the bullet into the block. Also calculate the magnitude of the force exerted by the wooden block on the bullet.

Ans. Given : m = 10 g = 0·01 kg, u = 150 ms^{-1}

v = 0, t = 0·03 s

To find : a = ?

s = ?

F = ?

$v = u + at$

$v - u = at$

$$a = \frac{v-u}{t} = \frac{0-150}{0.03}$$

$= -5{,}000\ ms^{-2}$.

The distance of penetration of the bullet into the block.

$$s = ut + \frac{1}{2}at^2$$

We know that :

$$= 150 \times 0{\cdot}03 + \frac{1}{2} \times (-5{,}000) \times (0{\cdot}03)^2$$

$= 4{\cdot}5 - 2{\cdot}25 = 2{\cdot}25$ m.

The magnitude of the force exerted by the wooden block on the bullet = ma = 0·01 × 5,000

$\Rightarrow$ F = 50 N.

Q.14. An object of mass 1kg travelling in a straight line with a velocity of 10 ms^{-1} collides with and sticks to a stationary wooden block of mass 5 kg, then they both move off together in the same straight line. Calculate the total momentum just before the impact and just after the impact. Also, calculate the velocity of the combined object.

Ans. Mass of object m_1 = 1 kg

Velocity of object before collision,

$u_1 = 10\ ms^{-1}$

Mass of wooden block, m_2 = 5 kg

According to the law of conservation of momentum

Now, momentum of combined object

= Total momentum after the impact

Initial Momentum = Final Momentum

$\Rightarrow \quad M_1u_1 + M_2u_2 = [M_1 + M_2]v$

$\Rightarrow \quad 1 \times 10 + 5 \times 0 = [1 + 5]v$

$\Rightarrow \quad 10 = 6v$

$$v = \frac{10}{6} = 1{\cdot}67\ ms^{-1}.$$

Velocity of wooden block before collision,

$u_2 = 0$

Total momentum before the impact

$= m_1u_1 + m_2u_2$

$= 1 \times 10 + 5 \times 0$
$= 10 \text{ kg ms}^{-1}$

Q.15. An object of mass 100 kg is accelerated uniformly from a velocity of 5 ms^{-1} to 8 ms^{-1} in 6 s. Calculate the initial and final momentum of the object. Also, find the magnitude of the force exerted on the object.

Ans. Mass of object, $m = 100$ kg
Initial velocity, $u = 5 \text{ ms}^{-1}$
Final velocity, $v = 8 \text{ ms}^{-1}$
Time, $t = 6$ s
Initial momentum of the object = mu
$= 100 \times 5 = 500 \text{ kg ms}^{-1}$
Final momentum of the object = mv
$= 100 \times 8 = 800 \text{ kg ms}^{-1}$

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

$$= \frac{(800 - 500)}{6} = 50 \text{ N.}$$

Q.16. Akhtar, Kiran and Rahul were riding in a motorcar that was moving with a high velocity. On an expressway when an insect hit the windshield and got stuck on the wind screen, Akhtar and Kiran started pondering over the situation. Kiran suggested that the insect suffered a greater change in momentum as compared to the change in momentum of the motor car (because the change in the velocity of the insect was much more than that of the motorcar). Akhtar said that since the motorcar was moving with a larger velocity, it exerted a larger force on the insect and as a result, the insect died. Rahul while putting an entirely new explanation said that both the motorcar and the insect experienced the same force and change in their momentum. Comment on these suggestions.

Ans. Both the motorcar and insect experience the equal force and hence, a same change in their momentum. So we agreed with Rahul.
The insect died because it could not bear the larger force and larger change in momentum.

Q.17. How much momentum will a dumb-bell of mass 10 kg transfer to the floor if it falls from a height of 80 cm ? Take its downward acceleration to be 10 ms^{-2}.

Ans. $u = 0$, $m = 10$ kg, $s = 80$ cm $= 0{\cdot}8$ m
$a = 10 \text{ ms}^{-2}$
Using : $v^2 - u^2 = 2as$
$v^2 - 0 = 2 \times 10 \times 0{\cdot}8$
$v = \sqrt{16} \Rightarrow v = 4 \text{ ms}^{-1}$

Momentum of the dumb-bell just before it touches the floor
$= mv = 10 \times 4 = 40 \text{ kg ms}^{-1}$.
The momentum of the dumb-bell become zero as it touches the floor and the entire momentum of it transferred to the floor.
$\therefore$ Momentum transferred to the floor = 40 kg ms^{-1}.

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9 Gravitation

Intext Questions

Q.1. State the universal law of gravitation.

Ans. The force of attraction between two particles or objects is : (i) Directly proportional to the product of the masses of the objects. (ii) Inversely proportional to the square of the distance between them.
The direction of force is along the time joining the centres of the two bodies.

Q.2. Write the formula to find the magnitude of the gravitational force between the earth and an object on the surface of the earth.

Ans.

$$F = \frac{GMm}{R^2}$$

where G = Gravitational constant, M = mass of the earth, m = mass of object, R = radius of the earth.

Q.3. What do you mean by free fall ?

Ans. When an object falls towards the earth under the influence of gravitational force alone, then the object is in free fall.

Q.4. What do you mean by acceleration due to gravity?

Ans. The uniform acceleration with which an

object falls freely towards the earth due to gravitational force is known as acceleration due to gravity. It is denoted by 'g'. It is taken to be 9.8 m/s^2.

Q.5. What are the differences between the mass of an object and its weight ?

Ans. Differences between Mass and Weight :

S. No.	Mass	Weight
1	Mass of a body is defined as the quantity of matter contained in the body	The force with which a body is attracted by the earth is known as the weight of the body.
2	Mass of the body remains the same at all places.	The weight of the body changes from place to place.

Q.6. Why is the weight of an object on the moon $\frac{1}{6}^{th}$ its weight on the earth ?

Ans. The mass and radius of moon are less than that of earth due to which the moon exerts a lesser gravitational force on object (which is $\frac{1}{6}^{th}$ of that exerted by the earth). Since the gravitational force of the moon is $\frac{1}{6}^{th}$ that of the earth, therefore, the weight of an object on the moon is $\frac{1}{6}^{th}$ of its weight on the earth.

Q.7. Why is it difficult to hold a school bag having a strap made of a thin and strong string?

Ans. When we hold a heavy bag having strap made of a strong and thin string, then the area under the strap is small. Hence, large pressure is exerted by the strap on our fingers. Due to this large pressure. The strap tends to cut the skin and hence pain is caused.

Q.8. What do you mean by buoyancy ?

Ans. The tendency of a fluid to exert an upward force on a object placed in it is called buoyancy.

Q.9. Why does an object float or sink when placed on the surface of water ?

Ans. Floating Bodies : When an object is placed in water (or any other liquid), the two forces acting on it are :

m Weight (W) of the object acting vertically downwards.

m Buoyant force or upthrust FB (or B) outing on the object vertically upwards.

The object will move in the direction of the force which is greater.

The object will float on the surface of water, if the upthrust is greater than the weight of object. The object will sink, if the weight of the object is more than the upthrust of water.

Q.10. You find your mass to be 42 kg on a weighing machine. Is your mass more or less than 42 kg ?

Ans. On standing at the weighing machine, our weight acts vertically downwards whereas the buoyancy due to air on our body acts vertically upwards. Due to this, our apparent weight is less than the actual weight. Since the weighing machine measures the apparent weight, our actual weight is more than 42 kg.

Q.11. You have a bag of cotton and an iron bar, each indicating a mass of 100 kg when measured on a weighing machine. In reality, one is heavier than other. Can you say which one is heavier and why ?

Ans. Cotton bag is heavier as the buoyant force acting on the cotton bag is more as its surface area is more than that of iron-piece.

NCERT Exercises

Q.1. How does the force of gravitation between two objects change when distance between them is reduced to half ?

Ans. As we know, $F = \frac{Gm_1m_2}{r_1}$

when $r_1 = \frac{r}{2}$

then $F_1 = \frac{Gm_1m_2}{\left(\frac{r}{2}\right)^2} = \frac{Gm_1m_2}{\frac{r^2}{4}}$

$F_1 = \frac{4Gm_1m_2}{r^2} = 4\,F$

Thus, the force of gravitation becomes 4 times its original value.

Q.2. Gravitational force acts on all objects in proportion to their masses. Why, then, a heavy objects does not fall faster than a light object ?

Ans. The acceleration with which a body falls towards the earth is constant (= 9.8 ms^{-2}) and independent of the mass of the body. Thus, all bodies fall with the same acceleration irrespective

of their masses. That is why, a heavy body does not fall faster than the light body.

Q.3. What is the magnitude of the gravitational force between the earth and a 1 kg object on its surface? Mass of earth is 6×10^{24} kg and radius of earth is 6.4×10^6 m.

Ans. $$F = \frac{GMm}{R^2}$$

$$= \frac{6.67\times10^{-11}\times6\times10^{24}\times1}{(6.4\times10^6)^2}$$

$$= 77 \text{ N} = 9{\cdot}8 \text{ N}.$$

Q.4. The earth and the moon are attracted to each other by gravitational force. Does the earth attract the moon with a force that is greater or smaller or the same as the force with which the moon attracts the earth ? Why ?

Ans. Gravitational force with which a body A attracts another body B is equal in magnitude and opposite in direction to the gravitational force with which a body B attracts the body A. Thus, the magnitude of force with which the earth attracts the moon is equal to the magnitude of the force with which the moon attracts the earth. Thus, both the earth and the moon attract each other with equal forces.

Q.5. If the moon attracts the earth, why does the earth not move towards the moon ?

Ans. From Newton's second law of motion, it can be concluded that the acceleration produced in a body is inversely proportional to the mass of the body $\left(\because a = \frac{F}{m}\right)$. Now, due to the very large mass (m) of the earth, the gravitational force (F) between the moon and the earth produces very small acceleration (a) in the earth. Actually, the acceleration produced in the earth (by the attraction of moon) is so small that it cannot be observed. And hence we do not see the earth move towards the moon.

Q.6. What happens to the force between two objects, if :

(i) the mass of one object is doubled ?

(ii) the distance between the objects is doubled and tripled ?

(iii) the masses of both the objects are doubled ?

Ans. (i) The gravitational force between two objects is directly proportional to product of mass of two objects. So, if the mass of one object is doubled, then the force also gets doubled.

(ii) The gravitational force between two objects is inversely proportional to square of distance between them.

If the distance between objects is doubled, the force becomes $(\frac{1}{2})^2$ or $\frac{1}{4}$ (one-fourth).

If the distance between objects is tripled, the force becomes $(\frac{1}{3})^2$ or $\frac{1}{9}$ (one-ninth).

(iii) The gravitational force between two objects is directly proportional to the product of both object are doubled, the force becomes 2×2 = 4 times.

Q.7. What is the importance of universal law of gravitation ?

Ans. The universal law of gravitation explains many phenomena given below :

(1) The motion of moon around the sun.

(2) The responsibility of gravity on the weight of the body which keeps us on the ground.

(3) The motion of planets around the sun.

(4) Motion of artificial satellites around the earth.

(5) Rainfall, snowfall and flow of water in rivers on the earth.

Q.8. What is the acceleration of free fall ?

Ans. The falling of an object from a height towards the earth under the gravitational force of earth is called free fall. The gravitational force of earth produces a uniform acceleration in the freely falling object due to which its speed goes on increasing. This is called the acceleration of free fall, which is commonly known as acceleration due to gravity. The value of acceleration of free fall is 9.8 m/s^2.

Q.9. What do we call the gravitational force between the earth and an object ?

Ans. Force of gravity.

Q.10. Amit buys few grams of gold at the poles as per the instruction of one of his friends. He hands over the same when he meets him at the equator. Will the friend agree with weight of gold bought ? If not, why ?

Ans. Weight = *mg*

Since value of g is greater at the poles than at the equator, so the weight of gold at the poles will be greater than the weight of gold at the equator. Hence, his friend will say that the weight of gold is less than as told by Amit.

Q.11. Why will a sheet of paper fall slower than one that is crumpled into a ball ?

Ans. A sheet of paper has a larger area. Due to its large area, when a sheet of paper is dropped from a height, it experiences more resistance from air, its speed decreases and it falls at a slower rate.

On the other hand, a sheet of paper crumpled into a ball has smaller less resistance from air, its speed increases and it falls at a faster rate.

Q.12. Gravitational force on the surface of the moon is only $\frac{1}{6}$ as strong as gravitational force on the earth. What is the weight in Newtons of a 10 kg object on the moon and on the earth ?

Ans. Acceleration due to gravity on earth is 9.8 m/s^2. So, the acceleration due to gravity on moon will be $\frac{1}{6}$ of acceleration due to gravity on earth. that is, $9.8 \times \frac{1}{6}$ m/s^2.

Weight on earth :

$$V^2 = u^2 + 2gh$$
$$W = mg$$
$$= 10 \times 9.8 = 98 \text{ N}$$

Weight on moon :

$$W = mg$$
$$= 10 \times \frac{9.8 \times 1}{6} = 16.3 \text{ N}.$$

Q.13. A ball is thrown vertically upwards with a velocity of 49 m/s. Calculate : (i) the maximum height to which it rises (ii) the total time it takes to return to the surface of the earth.

Ans. Here, Initial velocity of ball, m = 49 m/s.

Final velocity of ball, V = 0 (at highest point)

Acceleration due to gravity, g = – 9.8.

(Here the ball is going up against the gravity, so the value of acceleration due to gravity (g) is to be taken as negative).

Height, h = ?

(i) using $V^2 = u^2 + 2gh$

$$h = \frac{v^2 - u^2}{2g}$$
$$= \frac{0 - 49 \times 49}{2 \times (-9.8)}$$
$$= 122.5 \text{ m}.$$

Thus, the maximum height to which the ball rises is 122.5 metres.

(ii) using, $v = u + gt$

$$t = \frac{v - u}{g}$$
$$= \frac{0 - 49}{-9.8} = 5 \text{ second}$$

Thus, the ball takes 5s to reach the highest point of its upward journey. The ball takes the same time to reach the ground from maximum height as time of ascent = time of descent

$\therefore$ Total time taken = 5s + 5s = 10 second.

Q.14. A stone is released from the top of a tower of height 19.6 m. Calculate its final velocity just before touching the ground.

Ans. Given : Initial Velocity, $u = 0$

Tower height = Total distance = 19.6 cm

$$g = 9.8 \text{ m/s}^2$$

Final velocity, V = ?

Using third equation of motion

$$V^2 = u^2 + 2gh$$
$$V^2 = 0 + 2 \times 9.8 \times 19.6$$
$$= 384.16$$
$$V = \sqrt{384.16}$$
$$= 19.6 \text{ m/s}$$

Q.15. A stone is thrown vertically upward with an initial velocity of 40 m/s. Taking g = 10 ms^{-2}, find the maximum height reached by the stone. What is the net displacement and the total distance covered by the stone ?

Ans. $u = 40$ m/s,

$g = -10$ ms^{-2}, (the stone goes up),

v = 0 (at the max. height)

Height h = ?

Using third equation of motion

$$V^2 = u^2 + 2gh$$
$$(0)^2 = (40)^2 + 2 \times (-10) \times h$$
$$0 = 1600 - 20h$$
$$20\,h = 1600$$
$$h = \frac{1600}{20} = 80 \text{ m}$$

Maximum height = 80 m

Total distance = 80 + 80 = 160 m

Total displacement = 0 (the first point is same as the last point.)

Q.16. Calculate the force of gravitation between the Earth and the Sun that the $M_e = 6 \times 10^{24}$ kg, $M_s = 2 \times 10^{30}$ kg. The average distance between the two is 1.5×10^{11} m.

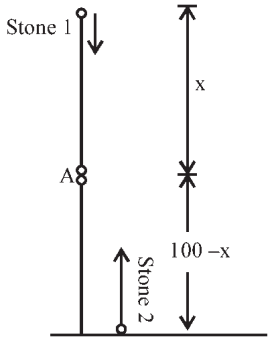
Ans. $F = \dfrac{GM_gM_e}{d^2} = \dfrac{6.67\times10^{-11}\times2\times10^{30}\times6\times10^{21}}{(1.5\times10^{11})^2}$

$= 3.6 \times 10^{22}$ N.

Q.17. A stone is allowed to fall from the top of a tower 100 m height and at the same time another stone is projected vertically upwards from the ground with a velocity of 25 m/s. Calculate when and where the two stones will meet ?

Ans. Given h = 100 m

Let two stones meet after t seconds at a point A at a distance x from the top.



For stone (1) :

Initial velocity, u = 0

$g = 9.8$ m/s^2 (stone falls down)

Height, $h = x$ m.

Time, $t = ?$

using second equation of motion

$$h = ut + \frac{1}{2} gt^2$$

$$x = 0 \times t + \frac{1}{2} \times 10 \times t^2$$

$$x = 5t^2 \quad ...(i)$$

For the stone projected upwards,

$$h' = ut - \frac{1}{2} gt^2$$

$$\Rightarrow \quad (100 - x) = 25\,t - \frac{1}{2} \times 10\,x\,t^2$$

$$\Rightarrow \quad 100 - x = 25\,t - 5t^2 \quad ...(ii)$$

On adding equations (i) and (ii), we get :

$$x + (100 - x) = 5\,t^2 + 25\,t - 5\,t^2$$

$$100 = 25t$$

$$t = \frac{100}{25} = 4$$

$$t = 4 \text{ s.}$$

So, the stones will meet after 4 s.

$$x = 5t^2 = 5 \times 4^2 = 80 \text{ m}$$

Q.18. A ball thrown up vertically returns to the thrower after 6 s. Find :

(a) velocity with which it was thrown up.
(b) the maximum height it reaches.
(c) its position after 4s.

Ans. Since the ball thrown up vertically returns to thrower's hand in 6s. it means the ball will take half of this time, that is $\frac{6}{2} = 3$. Second from thrower to maximum height and remaining 3 seconds to fall maximum height to thrower's hand.

$\Rightarrow \quad T_a = T_d = 3$ sec.

(a) Final velocity at maximum height, V = 0

From the first equation of motion

$$V = u - gt_a$$

$$u = v + gt_a$$

$$= 0 + 9.8 \times 3 = 29.4 \text{ m/s}$$

The velocity with which stone was thrown up is 29.4 m/s.

(b) From second equation of motion

$$s_1 = ut_a - \frac{1}{2} g\,(t_a)^2$$

$$= 29.4 \times 3 - \frac{1}{2} \times 9.8 \times 3 \times 3$$

$$= 88.2 - 44.1 = 44.1 \text{ m}$$

The maximum height reached by the ball is 44.1 metres.

(c) In 3 sec, it reaches the maximum height. Distance travelled in another 1 sec = s_2

$$s_1 = ut_a + \frac{1}{2} g\,(t_a)^2 = 0 + \frac{1}{2} \times 9.8 \times (1)^2$$

$$s_2 = 4.9 \text{ m}$$

The distance travelled in another one second = 4.9 m

Therefore in 4 sec, the position of point P is 44.1 – 4.9 = 39.2 m from the ground.

Q.19. In what direction does the buoyant force on an object immersed in a liquid act ?

Ans. Buoyant force acts in the upward direction on an object immersed in a liquid.

Q.20. Why does a block of plastic released under water come upto the surface of water ?

Ans. This is because upthrust or buoyant force acting on the block of plastic is greater than the gravitational force acting on the block in the downward direction.

Q.21. The volume of 50 g of substance is 20 cm^3. If the density of water is 1 g cm^{-3}. Will the substance float or sink ?

Ans. Volume = 20 cm^3, Mass = 50 g

$$\therefore \text{ Density of substance} = \frac{\text{Mass}}{\text{Volume}} = \frac{50g}{20cm^3}$$

$$= 2{\cdot}5\ gcm^{-3}$$

Since density of substance is more than the density of water, so the substance will sink.

Q.22. The volume of a 500 g sealed packet is 350 cm^3. Will the packet sink in water if density of water is 1 gcm^{-3} ? What will be the mass of the water displaced by the packet ?

Ans. Mass = 500 g, Volume = 350 cm^3

$$\therefore \text{ Density of packet} = \frac{\text{Mass}}{\text{Volume}} = \frac{50g}{350cm^3}$$

$$= 1.43\ gcm^{-3}$$

Since the density of the packet is greater than the density of water, so the packet will sink.

Mass of water displaced

= Volume of packet × density of water

= 350 cm^3 × 1 g/cm^3 = 350 g.

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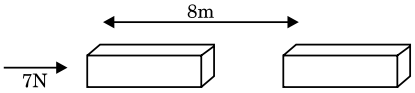
10 Work and Energy

Intext Questions

Q.1. A force of 7 N acts on an object. The displacement is say 8 m, in the direction of the force. Let us take it that the force acts on the object through out the displacement. What is the work done in this case?



F = 7 N

s = 8 m

Ans. Here, Work done = F × s = 7 × 8 = 56 J.

Q.2. When do we say that work is done?

Ans. Work is done, when following conditions are satisfied: (1) When force acts on an object. (2) The object is displaced from its initial position.

Q.3. Write an expression for the work done when a force is acting on an object in the direction of its displacement.

Ans. W = Fs.

Q.4. Define 1 J of work.

Ans. The amount of work done when a force of 1N moves a body through a distance of 1m in the direction of the force is called 1 joule.

Q.5. A pair of bullocks exerts a force of 140 N on a plough. The field being ploughed is 15 m long. How much work is done in ploughing the length of the field?

Ans. Force, F = 140 N

Displacement, s = 15 m

Work done = F × s = 140 × 15 = 2100 J.

Q.6. What is the kinetic energy of an object?

Ans. The energy possessed by a body by virtue of its motion is called kinetic energy (K.E).

Q.7. Write an expression for the kinetic energy of an object.

Ans. Kinetic energy of an object = $\frac{1}{2}mv^2$.

Q.8. The kinetic energy of an object of mass m moving with a velocity of 5 ms^{-1} is 25 J. What will be its kinetic energy when its velocity is doubled? What will be its kinetic energy when its velocity is increased three times?

Ans. Here kinetic energy = 25 J

Velocity of the object v = 5 ms^{-1}

since kinetic energy = $\frac{1}{2}mv^2$

$$m = \frac{2 \times E_k}{V^2} = \frac{2 \times 25}{25} = 2kg$$

(i) when $v' = 2v = 10\ ms^{-1}$

$$E_k = \frac{1}{2} mv'^2 = \frac{1}{2} \times 2 \times (10)^2 = 100 \text{ J}.$$

(ii) When $v' = 3v = 3 \times 5 = 15 \text{ ms}^{-1}$

$$E_k = \frac{1}{2} mv'^2 = \frac{1}{2} \times 2 \times 225 = 225 \text{ J}.$$

Q.9. What is Power?

Ans. The rate of doing work is called power.

$$\text{Thus, ower } P = \frac{\text{Total work done (W)}}{\text{Time taken (t)}}$$

Q.10. Define 1 watt of power.

Ans. When a body works at the rate of 1J per second, then its power is 1 Watt (=1W).

$$1 \text{ W} = 1 \text{ Js}^{-1}$$

Q.11. A lamp consumes 1000 J of electrical energy in 10s. What is its power ?

Ans. $P = \frac{\text{Work}}{\text{time}} = \frac{\text{Energy}}{\text{time}}$

$$= \frac{1000 \text{ J}}{10 \text{ s}} = 100 \text{ Js}^{-1} = 100 \text{ watt}.$$

Q.12. Define average power.

Ans. $\text{Average Power} = \frac{\text{Total Energy consumed}}{\text{Total Time taken}}$

NCERT Exercises

Q.1. Look at the activities listed below. Reason out whether or not work is done in the light of your understanding of the term 'work'.

(a) Suma is swimming in a pond.
(b) A donkey is carrying a load on its back.
(c) A wind mill is lifting water from a well.
(d) A green plant is carrying out photosynthesis.
(e) An engine is pulling a train.
(f) Food grains are getting dried in the sun.
(g) A sail boat is moving due to wind energy.

Ans.(a) Work is done by Reaction (force) of water on Suma during swimming displaces Suma in the forward direction].
(b) No work is done (force of gravity acting on the load is perpendicular to the displacement of the load).
(c) Work is done (force displaces water in the upward direction).
(d) No work is done (There is no force and no displacement during photosynthesis).
(e) Work is done (force displaces the train).
(f) No work is done (There is no external force and no displacement of the grains).
(g) Work is done (force acting on the sail boat displaces the boat).

Q.2. An object thrown at a certain angle to the ground moves in the curved path and falls back to the ground. The initial and final points of the path of the object lie on the same horizontal line.
What is the work done by the force of gravity on the object?

Ans. Work done by the force of gravity on the object = mgh
where h = difference in height of the initial and final position of the object.
Since initial and final position of the object are at the same level, so $h = 0$.
Work done = $mgh = mg \times 0 = 0$.

Q.3. A battery lights a bulb. Describe the energy changes involved in the process.

Ans. The chemical energy of the battery changes into electrical energy which is then converted into light and heat energy.

Q.4. Certain force acting on a 20 kg mass changes its velocity from 5 ms^{-1} to 2 ms^{-1}. Calculate the work done by the force.

Ans. Work done = Change in kinetic energy

$$= E_{kf} - E_{ki}$$
$$= \frac{1}{2} mv^2 - \frac{1}{2} mv^2$$
$$= \frac{1}{2} \times 20 \times 2 \times 2 - \frac{1}{2} \times 20 \times 25$$
$$= 40 - 250 = -210 \text{ J}.$$

Q.5. A mass of 10 kg is at a point A on a table. It is moved to a point B. If the line joining A and B is horizontal, what is the work done on the object by the gravitational force? Explain your answer.

Ans. Work done by gravitational force = mgh
$h = 0$ (because A and B are at the same height)
Therefore, Work done = 0.

Q.6. The potential energy of a freely falling body decreases progressively. Does this violate the law of conservation of energy? Why?

Ans. No, as the potential energy of a freely falling body decreases, the object acquires more and more speed. So, the kinetic energy, of the object increases at the cost of its potential energy.
However, total energy of the object remains the same at every point.

Q.7. What are the various energy transformations that occur when you are riding a bicycle ?

Ans. Our muscular energy is converted into the kinetic energy of the bicycle.

Q.8. Does the transfer of energy takes place when you push a huge rock with all your might fail to move it? Where is the energy you spend going?

Ans. When we push a huge rock, the rock also exerts a huge force on us. The muscular energy spent by us is used to oppose the huge force acting on us due to the potential energy of rock.

Q.9. A certain household has consumed 250 units of energy during a month. How much energy is this in joules?

Ans. Energy = 250 unit = 250 kWh

$= 250 \times 1000\ W \times 3600\ s.$

$= 250 \times 1000\ \frac{J}{s} \times 3600\ s.$

$= 9 \times 10^8\ J.$

Q.10. An object of mass 40 kg is raised to a height of 5 m above the ground. What is its potential energy ? If the object is allowed to fall, find its kinetic energy when it is half-way down.

Ans. (i) Potential energy = mgh

$= 40\ kg \times 10\ ms^{-2} \times 5\ m = 2000\ J.$

(ii) According to law of conservation of energy kinetic energy when it is half way down = potential energy when it halfway down

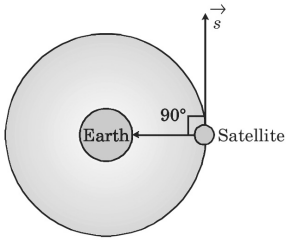
$$= mg\frac{h}{2} = \frac{40 \times 10 \times 5}{2} = 1000\ J$$

Q.11. What is the work done by the force of gravity on a satellite moving round the earth ? Justify your answer.

Ans. The force of gravity acts at right angle to the displacement of the satellite No work done.

$W = Fs \cos 90^\circ$

$W = 0.$



Q.12. Can there be displacement of an object in the absence of any force acting on it? Think, Discuss this question with your friends and teacher.

Ans. Yes, when an object moves with a constant velocity, then no force acts on the object. However, the object is displaced from one position to another position.

Q.13. A person holds a bundle of hay over his head for 30 minutes and gets tired. Has he done some work or not? Justify your answer.

Ans. W = Force × displacement Since the person is at rest, so displacement = 0. Hence, no work is done by the person.

Q.14. An electric heater is rated 1500 W. How much energy does it use in 10 h?

Ans. Power = 1500 W

Time = 10 h.

$$\text{Power} = \frac{\text{Energy}}{\text{Time}}$$

Energy = Power × Time = 1500 × 10

= 15000 Wh = 15 kWh

$= 15 \times 3.6 \times 10^6\ J$

$= 5.4 \times 10^7\ J$

Q.15. Illustrate the law of conservation of energy by discussing the energy changes which occur when we draw a pendulum bob to one side and allow it to oscillate. Why does the bob eventually come to rest? What happens to its energy eventually? Is it a violation of law of conservation of energy?

Ans. When the bob of a simple pendulum oscillates in air, the air friction opposes its motion. The kinetic energy of oscillating bob is used to overcome the air friction which tries to oppose the motion of the bob of the pendulum.

As the oscillating bob strikes the air molecules, the kinetic energy of the bob of the pendulum is converted into heat energy. This heat energy is transferred to the atmosphere. Ultimately, the entire kinetic energy of the bob of the pendulum is converted into heat energy and hence, the oscillating bob comes to rest.

The potential energy is converted into kinetic energy and vice-versa during the motion of the pendulum. But the total energy remains constant.

When the pendulum oscillates in air, the air friction opposes its motion. So, some part of kinetic energy of pendulum is used to overcome this friction. With the passage of time, energy of the pendulum goes on decreasing and finally becomes zero.

The energy of the pendulum is transferred to the atmosphere. So, energy is being transferred, i.e. is converted from one form to another. So, no violation of law of conservation of energy takes place.

In this case, the law of conservation of energy is not violated as one form of energy is converted into another form of energy.

Q.16. An object of mass m is moving with a constant velocity, v. How much work should be done on the object in order to bring the object to rest?

Ans. Work done = Change in kinetic energy

$$\text{Work done} = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

Here $u = v$ and $v = 0$

So $$\text{Work done} = 0 - \frac{1}{2}mv^2 = -\frac{1}{2}mv^2.$$

Q.17. Calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 km/h.

Ans. Here m = 1500 kg

$$u = 60 \text{ km/h} = 60 \times \frac{5}{18} = 16.67 \text{ ms}^{-1}$$

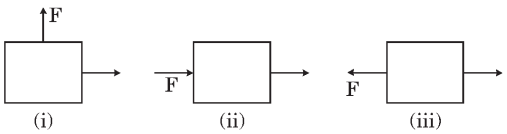
$$v = 0$$

$$\text{work done} = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$= 0 - \frac{1}{2} \times 1500 \times (16.67)^2$$

$$= -208416.675 \text{ J}.$$

Q.18. In each of the following, a force F is acting on an object of mass, m. The direction of displacement is from west to east shown by the longer arrow. Observe the diagrams carefully and state whether the work done by the force is negative, positive or zero.



Ans. First case, θ = 90°

Work done = Fs cos θ = Fs cos 90° = 0

(cos 90° = 0°)

Second case, θ = 0°

Work done = Fs cos θ = Fs cos 0 = Fs (positive work)

(cos 0° = 1)

Third case, θ = 180°

Work done = Fs cos θ = Fs cos 180° = – Fs (negative work)

(cos 180° = –1)

Q.19. Soni says that the acceleration in an object could be zero even when several forces are acting on it. Do you agree with him? Why?

Ans. Yes, this is possible, provided the resultant force is zero.

$$a = \frac{F}{m} = \frac{0}{m} = 0$$

Q.20. Find the energy in kWh consumed 10 hours by four devices of power in 500 W each.

Ans. Total power = 500 W × 4 = 2000 W

Time t = 10 h.

Energy consumed = Power × time

= 2000 W × 10 h

= 20,000 Wh = 20 kWh

Q.21. A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy?

Ans. Kinetic energy is converted into sound energy and heat energy.

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11 Sound

Intext Questions

Q.1. How does the sound produced by a vibrating object in a medium reach your ear?

Ans. The vibrating object produces compression and rarefaction pulses, one after the other in the medium. These pulses travel one behind the other as the sound wave. When this sound wave reaches our ear, it forces the tympanic membrane to vibrate and thus causing the sensation of hearing.

Q.2. Explain how sound is produced by your school bell?

Ans. When the school bell is hit by a hammer, it begins to vibrate and produces sound. If we touch the bell gently just after hitting it, we will feel vibrations. We can say that sound is produced by a vibrating body.

Q.3. Why are sound waves called mechanical waves?

Ans. Sound needs a material medium like air, water, steel etc. for its propagation; it is characterised by the motion of the particles of the medium. So, sound waves are called mechanical waves.

Q.4. Suppose you and your friend are on the moon. Will you be able to hear any sound produced by your friend?

Ans. No, the moon has no atmosphere or material medium through which sound can travel.

Q.5. Which wave property determines (a) loudness (b) pitch?

Ans. (a) Intensity of the wave determines the loudness.

(b) Frequency of the wave determines the pitch.

Q.6. Guess which sound has a higher pitch: guitar or car horn?

Ans. Guitar has a sound of higher pitch.

Q.7. What are the wavelength, frequency, time period and amplitude of a sound wave?

Ans.(a) Wavelength : The distance between the two nearest points on the wave which are in the same phase is called its wavelength.

(b) Frequency : The number of waves (or waves cycles) produced per second is called its frequency.

(c) Time Period : The time required to produce one complete wave (or wave cycle) is called the time period of the wave.

(d) Amplitude : The maximum displacement of the particles of a medium from their mean positions during the propagation of a wave is called amplitude of the wave.

Q.8. How are the wavelength and frequency of a sound wave related to its speed?

Ans. Speed of sound wave = wavelength of the sound wave × Frequency of the sound or $v = \lambda \times n$

Q.9. Calculate the wavelength of a sound wave whose frequency is 220 Hz and the speed is 440 m/s in a given medium.

Ans. Wavelength = $\frac{\text{wave speed}}{\text{frequency}} = \frac{440\,\text{ms}^{-1}}{220\,\text{s}} = 2\,\text{m}$

Q.10. A person is listening to a tone of 500 Hz sitting at a distance of 450 m from the source of sound. What is the time interval between successive compressions from the source?

Ans. Time interval between two successive compressions

$$T = \frac{1}{v} = \frac{1}{500\,\text{Hz}} = \frac{1}{500\,\text{S}^{-1}} = 0.002\,\text{s}$$

Q.11. Distinguish between loudness and intensity of sound.

Ans. (1) Sound intensity is a property of the sound source but loudness depends on the sound source, the medium and the receiver, as well.

(2) Sound intensity holds a small significance in problems involving human hearing system, but loudness is a very important property to consider in such problems.

(3) Sound intensity is measured in Watt per square meter whereas loudness is measured in Decibels.

Q.12. In which of the three media: air, water and iron, does sound travel the fastest at a particular temperature?

Ans.. Sound travels the fastest through iron.

Q.13. An echo returned in 3 s. What is the distance of the reflecting surface from the source, given that the speed of sound is 342 ms^{-1}?

Ans. Speed of sound, v = 342 ms^{-1}

Time taken for hearing the echo, t = 3 s

Distance travelled by the sound = v × t

= 342 × 3 = 1026 m.

Q.14. Why are the ceilings of concerts hall curved?

Ans. The ceilings of concert halls are made curved so that the sound after reflection could reach all the corners of the hall.

Q.15. What is the audible range of the average human ear?

Ans. 20 Hz to 20,000 Hz.

Q.16. What is the range of the frequencies associated with (a) Infrasound (b) Ultrasound.

Ans.(a) Infrasound-less than 20 Hz.

(b) Ultrasound- higher than 20 kHz.

NCERT Exercises

Q.1. What is sound and how is it produced?

Ans. Sound is a form of energy that produces sensation of hearing in our ears. It is produced by a vibrating body.

Q.2. Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound.

Ans. When a vibrating object moves forward, it pushes the air infront of it creating a region of high pressure. This region is called **compression**. This compression starts to move away from the vibrating object. When the vibrating object moves backward, it creates a region of low pressure called rarefaction. As the object moves back and forth rapidly, a series of compressions and rarefactions is created. These make the sound wave that propagates through the medium.

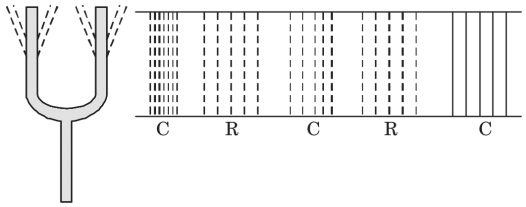


Fig. : A vibrating object creating a series of compressions (C) and rarefactions (R) in the medium

Q.3. Why is sound wave called a longitudinal wave?

Ans. Sound waves travel through a medium in the form of alternate compressions and rarefactions. The particles of the medium thus move to and fro along the direction of propagation of the sound wave. That is why; the sound waves are called longitudinal waves.

Q.4. Which characteristic of the sound helps you to identify your friend by his voice while sitting with others in a dark room?

Ans. The quality or timbre of sound is the characteristic which helps us to identify our friends voice.

Q.5. Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen, why?

Ans. The speed of sound is much smaller than the speed of light. So thunder is heard a few seconds after the flash is seen.

Q.6. A person has a hearing range from 20 Hz to 20 kHz. What are the typical wavelengths of sound waves in air corresponding to these two frequencies? Take the speed of sound in air as 344 ms^{-1}.

Ans. Speed of sound, v = 344 ms^{-1}

Frequency, v_1 = 20 Hz and

v_2 = 20 kHz = 20,000 Hz

Wavelength of sound waves corresponding to 20 Hz,

$$\lambda_1 = \frac{v}{v_1} = \frac{344}{20} = 17.2 \text{ m}$$

Wavelength of sound waves corresponding to 20 kHz

$$\lambda_2 = \frac{v}{v_2} = \frac{344}{20,000} = 0.0172 \text{ m}$$

Q.7. Two children are at opposite ends of an aluminium rod. One strikes the end of the rod with a stone. Find the ratio of times taken by the sound wave in air and in aluminium to reach the second child.

Ans. Let length of the aluminium rod = d metre

Speed of sound in air = 346 ms^{-1}

Time taken by sound in air, t(air) = $\frac{d}{346}$ s

Speed of sound in aluminium = 6420 ms^{-1}

Time taken by sound in aluminium rod,

$$t \text{ (aluminium)} = \frac{d}{6420} \text{ s}$$

Ratio of times taken by sound wave in air and aluminium,

$$\frac{t \text{ (air)}}{r \text{ (aluminimum)}} = \frac{d}{346} \times \frac{6420}{d}$$

$$= \frac{6420}{346} = 18.55$$

Q.8. The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?

Ans. Frequency of source = 100 Hz = 100 s^{-1}

Number of vibrations in 1 s = 100

Number of vibrations in 1 minute (or 60 s)

= 100 × 60 = 6000.

Q.9. Does sound follow the same laws of reflection as light does? Explain.

Ans. Yes, sound follows the same laws of reflection as light does. The directions in which sound is incident and reflected make equal angles with the normal to the reflecting surface and thus all lie in the same plane.

Q.10. When a sound is reflected from a distant object, an echo is produced. Let the distance between the reflecting surface and the source of sound production remains the same. Do you hear echo sound on a hotter day?

Ans. On the hotter day, the speed of sound increases. So the reflected sound returns to source

earlier than 0.1 s. Hence, a distinct echo can not be heard.

Q.11. Give two practical applications of reflection of sound waves.

Ans. (i) In a stethoscope, the sound of a patients heartbeat is guided along the tube of the stethoscope to the doctor's ears by multiple reflections of sound.

(ii) Sound boards are also used in a big hall to direct the sound to the people.

Q.12. A stone is dropped from the top of a tower 500 m high into a pond of water at the base of the tower. When is the splash heard at the top? Given, g = 10 ms^{-2} and speed of sound = 340 ms^{-1}.

Ans.. First we find the time taken by the stone to reach the base of the tower. We use the relation,

$$s = ut + \frac{1}{2} gt^2$$

But $s = 500$ m, $u = 0$, $g = 10\ ms^{-2}$

$$\therefore \quad 500 = 0 + \frac{1}{2} \times 10 \times t^2$$

$$\text{or} \quad t^2 = \frac{500}{5} = 100 \quad \text{or} \quad t = 10\text{s}$$

Time taken by sound to travel from base of the tower to its top,

$$t' = \frac{\text{Distance}}{\text{Speed of sound}} = \frac{500}{340\ ms^{-1}}$$

Total time after which the splash is heard

$$= t + t' = 10 + 1.47 = 11.47 \text{ s.}$$

Q.13. A sound wave travels at a speed of 339 ms^{-1}. If its wavelength is 1.5 cm, what is the frequency of the wave? Will it be audible?

Ans. Speed of sound wave, $v = 339\ m^{-1}$.

Wavelength, $\lambda = 1.5$ cm $= 0.015$ m

Frequency, $n = \frac{v}{\lambda} = \frac{339}{0.015} = 22{,}600$ Hz

As this frequency is higher than 20,000 Hz so it is not audible.

Q.14. What is reverberation? How can it be reduced?

Ans. The persistence of a sound in a big hall due to repeated reflections from the walls, ceiling and floor of the wall is known as reverberation. It can be reduced by covering the roofs and walls of the hall by sound absorbing materials.

Q.15. What is loudness of sound? What factors does it depend on?

Ans. Loudness of a sound is a subjective quantity, it is the measure of the sound energy reaching the ear per second.

Loudness depends on

(i) the amplitude of the vibrating body.

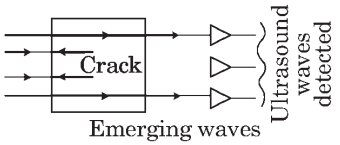
(ii) and the sensitivity of human ear.

Q.16. How is ultrasound used for cleaning?

Ans. The object to be cleaned is placed in a cleaning solution and ultrasonic waves are sent into the Solution : Due to the high frequency, the particles of dust, grease and dirt get detached and the object gets thoroughly washed.

Q.17. Explain how defects in a metal block can be detected using ultrasound.

Ans. Detection of cracks in metal blocks: When ultrasonic waves are sent in the metal block, the waves get partly reflected from a crack and therefore the intensity of emerging wave from the metal block is less in the portion of crack. Detectors are used to detect the transmitted waves.



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12 Improvement in Food Resources

Intext Questions

Q.1. What do we get from cereals, pulses, fruits and vegetables?

Ans. The cereals provide us carbohydrates. The pulses give us protein. Fruits and vegetables give us a range of vitamins and mineral. In addition the fruits and vegetables give carbohydrates, proteins fat and lots of fibres.

Q.2. How do biotic and abiotic factors affect crop production?

Ans. Biotic factors are living organisms that reduce crop productivity due to either directly feeding on them (e.g. insects, rodent) or causing disease (e.g.viruses, bacteria, fungi, my-coplasms etc).

Abiotic factors are non-living components of environment that affect growth of crop plants like scarcity of water (draught), excess of water (water logging), salinity, heat, cold or frost. Water logging reduces aeration of soil which is harmful to growth and functioning of roots. In drought, water is not available to meet the requirement of the plants for transpiration, growth and photo-synthesis. Frost, cold and heat reduce metabolic activities and are, therefore, harmful. These fac-tors are also responsible for spoilage of food grains during storage.

Q.3. What are the desirable agronomic characteristics improvements?

Ans. The desirable agronomic characteristics for crop improvement are :

(i) Tallness and profuse branching for fodder crops.

(ii) Dwarfness in cereals, pulses etc.

(iii) Number of flowers size of leaves and flowers etc.

Q.4. What are macronutrients and why are they called macronutrients?

Ans. Macronutrients are essential for plant growth and good state. Because these are required in large quantities.

Q.5. How do plants get nutrients?

Ans. Plants get nutrients from air, water, and soil. Air is the source of carbon and oxygen. Hydrogen is obtained from water. The remaining 13 elements are obtained directly from soil through root absorption.

Q.6. Compare the use of manure and fertilizers in maintaining soil fertility.

Ans. Manures help in enriching soil with nutrients and organic matter and increase soil fertility. The bulk of organic matter in manures helps in improving the soil texture. This increases the water holding capacity in sandy soil. In clayey soils, the large quantities of organic matter help in drainage and in avoiding water logging. Fertilizers are nutrient specific and concentrated source of nutrients. But continuous use of chemical fertilizers in an area can destroy soil fertility because the organic matter in the soil is not replenished and micro-organisms in the soil are harmed by the fertilizers used.

Q.7. Which of the following conditions will give the most benefits? Why?

(a) Farmers use high-quality seeds, do not adopt irrigation or use fertilizers.

(b) Farmers use ordinary seeds, adopt irrigation and use fertilizer.

(c) Farmers use quality seeds, adopt irrigation, use fertilizer and use crop protection measures.

Ans.(c) will give the maximum benefits because good quality seeds, proper irrigation and use of fertilisers is very helpful for the plants growth and crop protection measures are essential for the high yielding of the crop.

Q.8. Why should preventive measures and biological control methods be preferred for protecting crops?

Ans. Prevention in always better than cure. Plants are harmed if attacked by pests. Preventive measures and biological control methods are preferred for protecting crop plants because they not only prevent the stored food materials from getting, spoiled, getting infested by insects, bacteria and microorganisms. These methods prevents crops from chemicals which are some times added to control the pests attacking stored food grains. These chemicals are toxic, some pesticide lead to biomagnification. Biological methods are ecofriendly.

Q.9. What factors may be responsible for losses of grains during storage?

Ans. The factors responsible for losses of grains during storage are:

(i) Abiotic factors like moisture (present in food grains), humidity (of air) and temperature.

(ii) Biotic factors like insects, rodents, birds, mites, bacteria and fungi.

Q.10. Which method is commonly used for improving cattle breeds and why?

Ans. Cross-breeding method is commonly used for improving cattle breeds. Cross-breeding between two good varieties of cattle will produce a new improved variety.

Q.11. Discuss the implications of the following statement.

"It is interesting to note that poultry is India's most efficient converter of low fibre food stuff (which is unfit for human consumption) into highly nutritious animal protein food."

Ans. It is interesting to note that poultry is India's most efficient converter of low fibre food stuff (which is unfit for human consumption) into highly nutritious animals protein food.íí The low fibre food stuff (unfit for human consumption) is the feed of fowl. They convert this nutrient poor feed into nutrient rich food. When these fowls are consumed by humans as meat then it provides high nutritious animal protein.

Q.12. What management practices are common in dairy and poultry farming ?

Ans. The principles of feeding, breeding and weeding are same in both.

(i) Proper shelter, its hygiene aeration and lighting.

(ii) Proper feed and feed additives.

(iii) Proper drinking water.

(iv) Health care including vaccination.

(v) Selective breeding

Q.13. What are the differences between broilers and layers and in their management?

Ans. Difference between broilers and layers.

	Broilers	Layers
1.	Broilers are chickens used for meat.	Layers are chickens used to produce eggs.
2.	The feed for broilers is protein rich with adequate amount of fat. Level of vitamins A and K is kept high.	Layers are feed with vitamins, minerals especially calcium and micronutrients.
3.	They have fast growth and are ready to be used for meat after 6–7 weeks.	They lay egg at the age of 20 weeks.
4.	They have low mortality.	They have high mortality as compared to broilers.
5.	They do not require much space and lighting.	They requir enough space and proper lighting to grow.

Q.14. How are fish obtained?

Ans. Here are two ways of obtaining fish. One is from natural resources, which is called capture fishing. The other way is by fish farming, which is called culture fishery

Q.15. What are the advantages of composite fish culture?

Ans. The advantages of composite fish culture are:

(i) The species of fishes do not compete for food among them because they have different types of food habits.

(ii) Food available in all the parts/zones of the pond is utilized due to their food habits.

(iii) The fish yield is high as many types of fish are grown simultaneously.

Q.16. What are the desirable characters of bee varieties suitable for honey production?

Ans. The desirable characters of bee varieties suitable for honey production

(i) High honey collection capacity.

(ii) Sting less.

(iii) They stay in a given beehive for long periods, and breed very well.

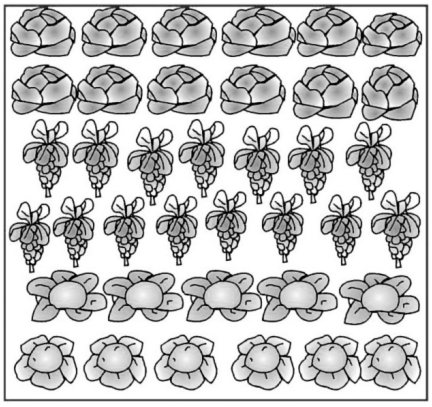
Q.17. What is pasturage and how is it related to honey production?

Ans. Pasturage is the availability of flowers from which bees collect nectar and pollen. It is related to the production of honey as it determines the taste and quantity of honey.

NCERT Exercises

Q.1. Explain any one method of crop production which ensures high yield.

Ans. One method of crop production which ensures high yield is inter-cropping. Inter-cropping is growing two or more crops simultaneously on the same field in a definite pattern. A few rows of one crop alternate with a few rows of a second crop, for example, soyabean + maize, or finger millet (bajra) + cowpea (lobia). The crops are selected such that their nutrient requirements are different. This ensures maximum utilisation of the nutrients supplied, and also prevents pests and diseases from spreading to all the plants belonging to one crop in a field. This way, both crops can give better returns.



Inter-cropping

Q.2. Why are manure and fertilizers used in fields?

Ans. Manure and fertilizers used in fields to enrich the soil quality and improve the yield. They help in controlling diseases and also provide various nutrients to the plants.

Q.3. What are the advantages of inter-cropping and crop rotation?

Ans. Some of the advantages of inter-cropping and crop rotation:

(i) Reduces risk and gives some insurance against failure of one of the crops.

(ii) This ensures maximum utilisation of the nutrients supplied, and also prevents pests and diseases from spreading to all the plants belonging to one crop in a field

(iii) Better yield.

Q.4. What is genetic manipulation? How is it useful in agricultural practices?

Ans. Genetic manipulation is a process of introducing genes of desirable characters from one plant to another plant by the technique of hybridization. Genetic manipulation helps in obtaining desirable agronomic characters liked Dwarfness in cereals and tallness and profuse branching in fodder crops.

Q.5. How do storage grain losses occur?

Ans. Factors responsible for such losses and biotic insects, rodents, fungi, mites and bacteria and abiotic inappropriate moisture and temperatures in the place of storage. These factors cause degradation in quality, less in weight, poor germinability, discolouration of in quality, loss in weight, poor germinability, discolouration of product, all leading to poor marketability. These factors can be controlled by proper treatment and by systematic management of warehouses.

Q.6. How do good animal husbandry practices benefit farmers?

Ans. The benefits of animal husbandry practices to farmers are the improvement of breeds, increases in yields such as milk, meat, eggs. It helps the farmers for proper management of animals like providing them good food, shelter, and protection against a variety of diseases.

Q.7. What are the benefits of cattle farming?

Ans. The cattle farmers are benefited in following ways:

(i) They get milk from cattle.

(ii) They use cattle for various draught purposes in a agricultural operations like ploughing, harrowing etc.

(iii) They are used in driving cart for transportation of men and materials.

(iv) They provide manure and fuel. Agriculture and cattle farming is complementary to each other.

(v) Provide extra income

Q.8. For increasing production, what is common in poultry, fisheries and bee-keeping?

Ans. For increasing production, common in poultry, fisheries and bee-keeping are :

(i) Proper supply of balanced and hygienic food.

(ii) Proper cleaning, sanitation, and spraying of disinfectants at regular intervals.

(iii) Appropriate vaccination at right time.

(iv) Maintenance of temperature and prevention and cure of diseases is also required to in-crease the number of animals.

Q.9. How do you differentiate between capture fishing, mariculture and aquaculture?

Ans.

Capture fisheries	Marinculture	Aquaculture
Catching fishes from natural resources is called capture fisheries e.g. from rivers or seas.	Production of marine fishes is called inland marinculture.	Production of aquatic animals and plants in any resources like lagoon is called aquaculture.

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