केन्द्रीय विद्यालय संगठन
KENDRIYA VIDYALAYA SANGATHAN

शिक्षा एवं प्रशिक्षण का आंचलिक संस्थान, चंडीगढ़
ZONAL INSTITUTE OF EDUCATION AND TRAINING, CHANDIGARH

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निदेशक महोदय का संदेश

विद्यार्थियों की शैक्षिक प्रगति को ध्यान में रखते हुए उपयोगी अध्ययन सामग्री उपलब्ध कराना हमारा महत्त्वपूर्ण उद्देश्य है। इससे न केवल उन्हें अपने लक्ष्य को प्राप्त करने में सरलता एवं सुविधा होगी बल्कि वे अपने आंतरिक गुणों एवं अभिरुचियों को पहचानने में सक्षम होंगे। बोर्ड परीक्षा में अधिकतम अंक प्राप्त करना हर एक विद्यार्थी का सपना होता है। इस संबंध में तीन प्रमुख आधार स्तंभों को एक कड़ी के रूप में देखा जाना चाहिए- अवधारणात्मक स्पष्टता, प्रासंगिक परिचितता एवं आनुप्रयोगिक विशेषज्ञता।

राष्ट्रीय शिक्षा नीति 2020 के उद्देश्यों की मूलभूत बातों को गौर करने पर यह तथ्य स्पष्ट है कि विद्यार्थियों की सोच को सकारात्मक दिशा देने के लिए उन्हें तकनीकी आधारित समेकित शिक्षा के समान अवसर उपलब्ध कराया जाए। बोर्ड की परीक्षाओं के तनाव और दबाव को कम करने के उद्देश्य को प्रमुखता देना अति आवश्यक है।

यह सर्वमान्य है कि छात्र-छात्राओं का भविष्य उनके द्वारा वर्तमान कक्षा में किए गए प्रदर्शन पर ही निर्भर करता है। इस तथ्य को समझते हुए यह अध्ययन सामग्री तैयार की गई है। उम्मीद है कि प्रस्तुत अध्ययन सामग्री के माध्यम से वे अपनी विषय संबंधी जानकारी को समृद्ध करने में अवश्य सफल होंगे।

शुभकामनाओं सहित।

मुकेश कुमार
उपायुक्त एवं निदेशक

अनुक्रमणिका / INDEX

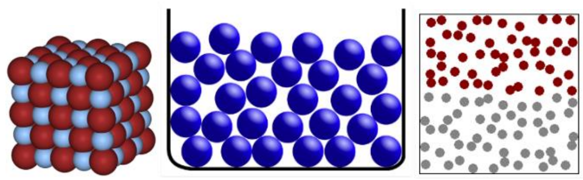
CLASS IX- SCIENCE 2022-23

CHAPTER 1

MATTER IN OUR SURROUNDINGS

<u>Definition of matter</u>: Matter is anything that has mass and occupies space.

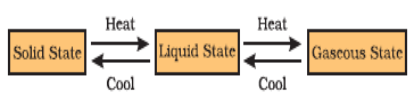
- Matter can be classified as solid, liquid and gas on the basis of interparticle forces and the arrangement of particles.
- These three forms of matter are interconvertible by increasing or decreasing pressure and temperature. For example, ice can be converted from solid to a liquid by increasing the temperature.

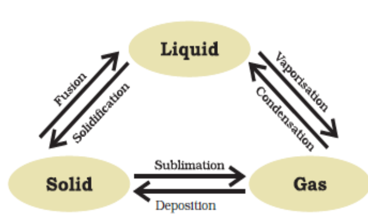


SOLID LIQUID GAS

Property	Solid	Liquid	Gas
Shape and volume	Fixed shape and volume	No fixed shape but has volume	Neither definite shape nor volume
Arrangement of molecules	Regular and closely arranged	Random and little sparsely arranged	Random and more sparsely arranged
Interparticle space	Very less	More	Large
Movement	Negligible	Depends on interparticle attraction	Free, constant and random
Fluidity	Cannot flow	Flows from higher to lower level	Flows in all directions

Change of state Matter: Flowchart for inter-conversion of the three states of matter:





EFFECT OF CHANGE OF TEMPERATURE:
(a) Conversion of ice to water,
(b) Conversion of water to water vapour

Change of state melting (absorption of heat):

Melting point: The melting point of a solid is defined as the temperature at which solid melts to become liquid at the atmospheric pressure.
At melting point, these two phases, i.e., solid and liquid are in equilibrium, i.e., at this point both solid state and liquid state exist simultaneously.
The melting point at which ice a solid turns to water a liquid is 32°F (0°C).

Fusion: When two atoms collide to create a heavier atom, such as when two hydrogen atoms combine to create one helium atom, this process is known as fusion.

Boiling point: The boiling point of a liquid is defined as the temperature at which the vapour pressure of the liquid is equal to the atmospheric pressure.

The boiling point for any material is the temperature point at which the material transforms into the gas phase in the liquid phase. This happens at 100 degrees centigrade for water. The Celsius scale was in fact created on the basis of the ice/water melting point and the liquid water/vapor boiling point.

For water this temperature is 373 K (100^0C = 273 + 100 = 373 K).

Latent heat of fusion: It is the amount of heat energy that is required to change 1 kg of a solid into liquid at atmospheric pressure at its melting point.

Latent heat of vaporization: It is the amount of heat energy that is required to change 1 kg of a liquid into gas at atmospheric pressure at its boiling point.

Effect of change in pressure on state of matter
By applying pressure, the interparticle spaces between particles of matter decreases. Thus, by applying pressure and reducing temperature we can convert a solid to liquid and a liquid to gas.

Evaporation: The phenomenon by which molecules in liquid state undergo a spontaneous transition to the gaseous phase at any temperature below its boiling point is called evaporation.

- For example, the gradual drying of damp clothes is caused by the evaporation of water to water vapour.

Factors affecting evaporation

- **Temperature:** The rate of evaporation increases with an increase in temperature.
- **Surface area:** The rate of evaporation increases with an increase in surface area.
- **Humidity:** The rate of evaporation decreases with an increase in humidity.

- **Wind speed:** The rate of evaporation increases with an increase in wind speed.

Cooling due to evaporation: During evaporation, the particles of a liquid absorb energy from the surroundings to overcome the inter-particle forces of attraction and undergo the phase change. The absorption of heat from the surrounding makes the surrounding cool.

For example, sweating cools down our body.

Applications of Evaporative Cooling

- To keep water cool, it is kept in earthenware containers. Similar to the pores in cotton fabric, the pores in the earthen pot's surface area allow for more evaporation.
- To keep our body cool, we sweat a lot. Evaporation is what transpiration ultimately is. Our body's water evaporates, using energy in the process and lowering our body temperature as a result.
- We dress in cotton during the summer. Since cotton is a powerful water absorbent, it allows more perspiration to come into touch with the air, promoting more evaporation. We have a cooling effect when wearing cotton clothing because of this.

Condensation

Condensation is the process where water vapour is changed into liquid form. This change is brought about by a change in the pressure and temperature of the substance.

When the water is present in the gaseous form in the air, it is called water vapour.

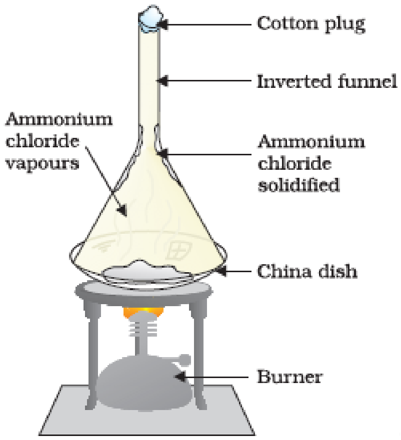
It is the process through which water vapour in the air is converted into liquid water. This is called condensation.

Explanation:

The boiling point and the condensation point of water are the same. It occurs at 212 degrees Fahrenheit or 100 degrees Celsius. Water tends to evaporate once the temperature increases from the boiling point which is beyond 100 degrees Celsius. The water boils and evaporates into the air forming water vapour. If the process is reversed, that is the water-cooled down to below 10 degrees Celsius; the water vapour will condense and turn back into its original liquid form.

This temperature of condensation occurs between 32 Fahrenheit or 0 Celsius and 212 F or 100 Celsius. It is most noticeable when there is a greater temperature difference between the object and the atmosphere. When droplets of water form on an ice candy when the temperature is hot.

Sublimation: The transition of a substance directly from its solid phase to gaseous phase without changing into the liquid phase (or vice versa) is called **sublimation.**



Sublimation of Ammonium chloride

Assignments:

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

Ans. Chair, Air, Almonds, Lemon water and Smell of perfume.

2. Convert the following temperature to Celsius scale:
   a. 300 K b. 573 K.

Ans. a. 27 ^{0}C b. 300 ^{0}C

3. What is the physical state of water at:
   a. 250ºC b. 100ºC?

Ans. (a) At 250°C – Gaseous state since it is beyond its boiling point.

(b) At 100°C – It is at the transition state as the water is at its boiling point.

4. Give reasons
   (a) A gas fills completely the vessel in which it is kept.
   (b) A gas exerts pressure on the walls of the container.
   (c) A wooden table should be called a solid.
   (d) 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. (a) There is a low force of attraction between gas particles. The particles in the filled vessel are free to move about.

(b) Gaseous particles have the weakest attraction force. They are always moving in a haphazard manner. When a gas particle collides with the container’s walls, it exerts force and thus pressure on the wall.

(c) There is a distinct contour and volume to the hardwood table. The wood particles are tightly packed. They do not conform to the container’s shape. As a result, the solid features of a hardwood table are satisfied.

(d) The boundaries between air particles are quite loose. They are a long way apart and have a lot of space between them. As a result, we may move our hands freely in the air. The particles in a solid block, on the other hand, are bound together by a strong force of attraction. As a result, there is either some or no space between them. As a result, we’ll require a karate expert.

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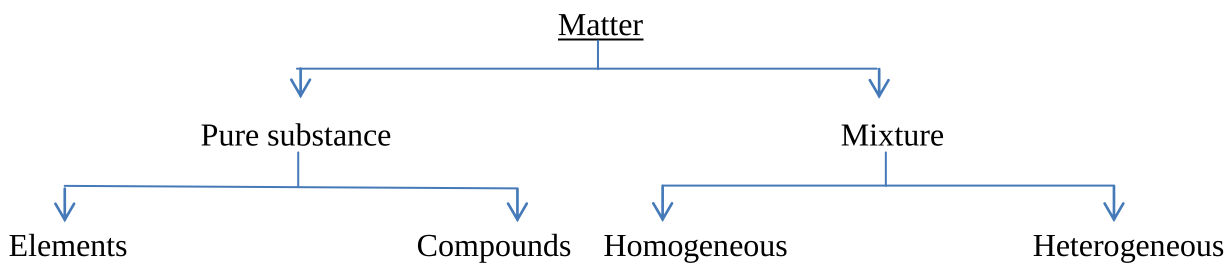
CHAPTER 2
IS MATTER AROUND US PURE

Nature of matter:



Element: It is a basic form of matter that cannot be broken down into simpler substances by chemical reactions. Elements can be normally divided into metals, non-metals and metalloids.

Metals:
- They have lustre (shine).
- They have silvery-grey or golden-yellow colour.
- They conduct heat and electricity.
- They are ductile (can be drawn into wires).
- They are malleable (can be hammered into thin sheets).
- They are sonorous (make a ringing sound when hit).

Examples of metals are gold, silver, copper, iron, sodium, potassium etc.
Mercury is the only metal that is liquid at room temperature.

Non-metals:
- They display a variety of colours.
- They are poor conductors of heat and electricity.
- They are not lustrous, sonorous or malleable.

Examples of non-metals are hydrogen, oxygen, iodine, carbon (coal, coke), bromine, chlorine etc.

Metalloids: Some elements have intermediate properties between those of metals and non-metals, they are called metalloids; examples are boron, silicon, germanium etc.

Compound: A compound is a substance composed of two or more elements, chemically combined with one another in a fixed proportion.
Compounds can be of three types:
1. Covalent compounds
2. Metallic compounds
3. Ionic compounds.

Compounds can also be classified as organic compounds or inorganic compounds depending on the presence of carbon in the molecular structure.
For examples, Water, salt, baking soda, etc.

Mixtures are substances that are formed by physically mixing two or more substances. A mixture can have a variable composition of the substances forming it.
For examples, Oil and water, sand and water, smog (smoke + fog), etc.

Mixtures are mainly of two types:

1. **Homogenous mixtures:** These are the types of mixtures in which the components mixed are uniformly distributed throughout the mixture.
   Example: rainwater, vinegar, etc.
2. **Heterogeneous mixtures:** This is a type of mixture in which all the components are completely mixed and all the particles can be seen under a microscope.
   Example: seawater, pizza, etc.

Difference Between Compound and Mixture:

S.NO.	Compounds	Mixtures
1.	Elements react to form new compounds.	Elements or compounds just mix together to form a mixture and no new compound is formed.
2.	The composition of each new substance is always fixed.	A mixture has a variable composition.
3.	The new substance has totally different properties.	A mixture shows the properties of the constituent substances.
4.	The constituents can be separated only by chemical or electrochemical reactions.	The constituents can be separated fairly easily by physical methods.

Physical and Chemical Changes-

The interconversion of states is a physical change because these changes occur without a change in composition and no change in the chemical nature of the substance.
Although ice, water and water vapour all look different and display different physical properties, they are chemically the same.
Both water and cooking oil are liquid but their chemical characteristics are different.

They differ in odour and inflammability. We know that oil burns in air whereas water extinguishes fire. It is this chemical property of oil that makes it different from water.
Burning is a chemical change. During this process one substance reacts with another to undergo a change in chemical composition.
Chemical change brings change in the chemical properties of matter and we get new substances. A chemical change is also called a chemical reaction.

Suspension: A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium.

Properties of a Suspension
Suspension is a heterogeneous mixture.
The particles of a suspension can be seen by the naked eye.
The particles of a suspension scatter a beam of light passing through it and make its path visible.
The solute particles settle down when a suspension is left undisturbed, that is, a suspension is unstable. They can be separated from the mixture by the process of filtration. When the particles settle down, the suspension breaks and it does not scatter light any more.

Colloids:
A colloid is a kind of solution in which the size of the solute particles is intermediate between those in true solution and those in suspension.
Examples of colloids are mayonnaise, milk, butter, gelatin, and jelly.

Properties of colloids:
A colloid is a heterogeneous mixture.
The size of particles of a colloid is too small to be individually seen by naked eyes.
Colloids are big enough to scatter a beam of light passing through it and make its path visible.
They do not settle down when left undisturbed, that is, a colloid is quite stable.
They cannot be separated from the mixture by the process of filtration. But, a special technique of separation known as centrifugation can be used to separate the colloidal particles.

The components of a colloidal solution are the dispersed phase and the dispersion medium. The solute-like component or the dispersed particles in a colloid form the dispersed phase, and the component in which the dispersed phase is suspended is known as the dispersing medium.
Colloids are classified according to the state (solid, liquid or gas) of the dispersing medium and the dispersed phase.
A few common examples of colloids are given below:

Dispersed phase	Dispersion medium	Type	Example
Solid	Solid	Solid sol	Coloured gemstone, milky glass
Liquid	Solid	Gel	Jelly, cheese, butter
Gas	Solid	Foam	Foam rubber, sponge, pumice
Solid	Liquid	Sol	Milk of magnesia, mud

Liquid	Liquid	Emulsion	Milk, face cream
Gas	Liquid	Foam	Shaving cream
Solid	Gas	Aerosol	Smoke
Liquid	Gas	Aerosol	Fog, cloud, mist

Colloidal solution: A colloidal solution is a heterogeneous mixture, for example, milk. Because of the small size of colloidal particles, we cannot see them with naked eyes. But, these particles can easily scatter a beam of visible light. This scattering of a beam of light is called the Tyndall effect.
Tyndall effect can also be observed when a fine beam of light enters a room through a small hole. This happens due to the scattering of light by the particles of dust and smoke in the air. Tyndall effect can be observed when sunlight passes through the canopy of a dense forest. In the forest, mist contains tiny droplets of water, which act as particles of colloid dispersed in air.

Assignments:

1. List the points of differences between homogeneous and heterogeneous mixtures.

Classify each of the following as a homogeneous or heterogeneous mixture.

soda water, wood, air, soil, vinegar, filtered tea.

Ans. Difference between homogeneous and heterogeneous mixtures

Homogeneous mixtures- soda water, air, vinegar, filtered tea.

Heterogeneous mixtures- wood, soil.

2. A solution contains 40 g of common salt in 320 g of water. Calculate the concentration in terms of mass-by-mass percentage of the solution.

Ans. Mass of solute (salt) = 40 g

Mass of solvent (water) = 320 g

Mass of solution = Mass of solute + Mass of solvent = 40 g + 320 g = 360 g

Mass percentage of solution = (Mass of solute / Mass of solution) ×100

= (40 /360) ×100 = 11.1%

3. 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 changes: 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 changes: rusting of almirah, passing of electric current, through water and the water breaking down into hydrogen and oxygen gases and burning of paper and wood.

4. Explain the following giving examples.

(a) saturated solution

(b) pure substance

(c) colloid

(d) suspension

Ans. (a) Saturated solution: It is that state in a solution at a specific temperature when a solvent is no more soluble without an increase in the temperature. Example: Excess carbon leaves off as bubbles from a carbonated water solution saturated with carbon.

(b) Pure substance: A substance is said to be pure when it comprises of only one kind of molecules, atoms or compounds without adulteration with any other substance or any divergence in the structural arrangement. Example: Sulphur, diamonds

(c) Colloid: A Colloid is an intermediate between solution and suspension. It has particles of various sizes, that ranges between 2 to 1000 nanometres. Colloids can be distinguished from solutions using the Tyndall effect. Tyndall effect is defined as the scattering of light (light beam) through a colloidal solution. Example: Milk, gelatin.

(d) Suspension: It is a heterogeneous mixture that comprises of solute particles that are insoluble but are suspended in the medium. These particles that are suspended are not microscopic but visible to bare eyes and are large enough (usually larger than a micrometre) to undergo sedimentation.

5. Which of the following will show “Tyndall effect”?

(a) Salt solution

(b) Milk

(c) Copper sulphate solution

(d) Starch solution.

Ans. Tyndall effect is exhibited by only milk and starch solution from the above-mentioned list of solutions.

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CHAPTER 3
ATOM NAND MOLECULES

Particle nature and their basic units:

Atoms and molecules:

Atoms: Atoms are the smallest particles of an element which can take reaction.
Size of an atom: Atomic radius is measured in nanometers.
1nm = 10^{-9}m
Atomic radii of hydrogen atom = 1×10^{-10} m.
Symbols of atoms:

Name of the element	Atomic Number	Symbol
Hydrogen	1	H
Helium	2	He
Lithium	3	Li
Beryllium	4	Be
Boron	5	B
Carbon	6	C
Nitrogen	7	N
Oxygen	8	O
Fluorine	9	F
Neon	10	Ne
Sodium	11	Na
Magnesium	12	Mg
Aluminium	13	Al
Silicon	14	Si
Phosphorous	15	P

Sulphur	16	S
Chlorine	17	Cl
Argon	18	Ar
Potassium	19	K
Calcium	20	Ca

Molecules: Molecules are the smallest particle of an element or a compound which can exist independently. Molecules may be monoatomic, di-atomic or polyatomic.
Atomicity: The number of atoms constituting a Molecule is known as its atomicity.

Name of the element	Atomicity	Molecules formula
Helium	Diatomic	He
Neon	Monoatomic	Ne
Argon	Monoatomic	Ar
Sodium	Monoatomic	Na
Aluminium	Monoatomic	Al
Hydrogen	Diatomic	H_2
Nitrogen	Diatomic	N_2
Oxygen	Diatomic	O_2
Chlorine	Diatomic	Cl_2
Phosphorous	Polyatomic	P_4
Sulphur	Polyatomic	S_8

<u>Law of Chemical Combination:</u>
(i) Law of conservation of mass: Mass can neither be created nor destroyed in a chemical reaction. For example,

$$A+B \longrightarrow C+D$$

Reactants Products
Mass of reactants = Mass of products

(ii) Law of constant proportion: In a chemical substance the elements are always present in definite proportions by mass. For example in water,
The ratio of the mass of hydrogen to the mass of oxygen is always 1: 8 respectively.

Chemical Formulae:

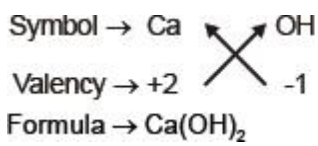
(i) The valencies or charges on the ion must balance.

(ii) A metal and non-metal compound should show the name or symbols of the metal first. For example, $Na^+ \ Cl^- \rightarrow NaCl$

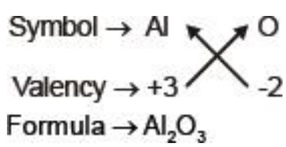
(iii) If a compound consist of polyatomic ions. The ion before writing the number to indicate the ratio. For example, $[H]^+[SO_4]^{2-} \rightarrow H^+ \ SO_4^{2-} \rightarrow H_2SO_4$.

Chemical formula of some simple compounds

(a) Calcium hydroxide



(b) Aluminum oxide



Atomic mass: Atom - Atomic mass
Molecular Mass: Molecule - Molecular Mass

Molecular Mass: It is the sum of the atomic masses of all the atoms in a molecule of the substance. It is expressed in atomic mass unit (u). For example,

$2H^+ + O_2 \longrightarrow 2H_2O$

$H_2O = 1 \times 2 + 16 = 18$ u

Formula Unit Mass: It is the sum of the atomic masses of all atoms in a formula unit of a compound. The constituent particles are ions. For example,

$Na^+ + Cl– \rightarrow NaCl$

$1 \times 23 + 1 \times 35.5 = 58.5$ u

Assignments:

1. In a reaction, 5.3 g of sodium carbonate reacted with 6 g of acetic 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.
   sodium carbonate + acetic acid → sodium acetate + carbon dioxide + water

Ans. Sodium carbonate + acetic acid → Sodium acetate + carbon dioxide + water

5.3g 6g 8.2g 2.2g 0.9g

As per the law of conservation of mass, the total mass of reactants must be equal to the total mass of products

As per the above reaction, LHS = RHS i.e., 5.3g + 6g = 2.2g + 0.9 g + 8.2 g = 11.3 g

Hence the observations are in agreement with the law of conservation of mass.

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. We know hydrogen and water mix in the ratio 1: 8.

For every 1g of hydrogen, it is 8g of oxygen.

Therefore, for 3g of hydrogen, the quantity of oxygen = 3 x 8 = 24g

Hence, 24g of oxygen would be required for the complete reaction with 3g of hydrogen gas.

3. **<u>Define the atomic mass unit.</u>**

Ans. An atomic mass unit is a unit of mass used to express weights of atoms and molecules where one atomic mass is equal to 1/12th the mass of one carbon-12 atom.

4. Write down the formulae of

(i) sodium oxide

(ii) aluminium chloride

(iii) sodium sulphide

(iv) magnesium hydroxide

Ans. The following are the formulae:

(i) sodium oxide – Na_2O

(ii) aluminium chloride – $AlCl_3$

(iii) sodium sulphide – Na_2S

(iv) magnesium hydroxide – $Mg(OH)_2$

5. Write down the names of compounds represented by the following formulae:

(i) $Al_2 (SO_4)$

(ii) $CaCl_2$

(iii) $K_2 SO_4$

(iv) KNO_3

(v) $CaCO_3$.

Ans. (i) $Al_2(SO_4)_3$ – Aluminium sulphate

(ii) $CaCl_2$ – Calcium chloride

(iii) K_2SO_4 – Potassium sulphate

(iv) KNO_3 – Potassium nitrate

(v) $CaCO_3$ – Calcium carbonate

6. 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. The molecular mass of H_2 – 2u

The molecular mass of O_2 = 2 x 16u = 32u

The molecular mass of Cl_2 = 2 x 35.5u = 71u

The molecular mass of CO_2 = 12 + (2 ×16) u = 44u

The molecular mass of CH_4 = 12 + (4 x 1) u = 16u

The molecular mass of C_2H_6 = (2 x 12) + (6 x 1) u=24+6=30u

The molecular mass of C_2H_4 = (2 x 12) + (4 x 1) u=24+4=28u

The molecular mass of NH_3 = (14 + 3 x 1) u= 17u

The molecular mass of CH_3OH = (12 + 3×1+16+1) u = 32u

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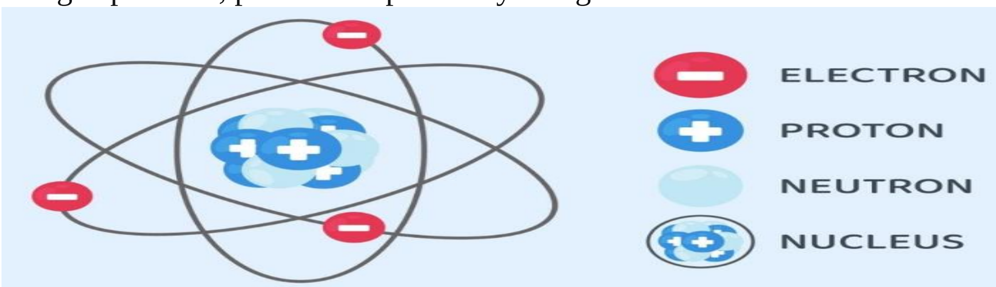
CHAPTER 4
STRUCTURE OF ATOM

Structure of atoms: An atom contains three basic particles namely electrons, protons and neutrons.
The nucleus of the atom contains electrons, protons and neutrons where electrons are negatively charged particles, protons are positively charged and neutrons are neutral.



The electrons are located at the outermost regions called the electron shell.

Electron: J. J. Thomson, in 1897, discovered negatively charged particles emitted by the cathode towards the anode in a cathode ray experiment. These **negatively charged** particles are Electrons.
Protons: Ernest Goldstein, in 1886, discovered that with a different condition in the same chamber, anode emitted **positively charged** particles known as Canal rays or later named as Protons.
Neutrons: J. Chadwick discovered a subatomic particle with **no charge** and a mass equivalent to protons in the nucleus of all atoms. These neutrally charged particles are Neutrons.

The properties of electrons, protons, and neutrons:

Property	**Electrons**	**Protons**	**Neutrons**
Charge	Negatively Charged	Positively Charged	No Charge
Affinity	Attracts to positively charged	Attracts to negatively charged	Get attracted neither to positive nor negative
Mass	Mass is negligible	1 a.m.u	1 a.m.u
Location	Outside the nucleus	Within the nucleus	Inside the nucleus

Ions: The charged particles (atoms) are called ions, they charge or negative charge on it:
Negatively charged ion is called anion ($C1^-$).
Positively charge ion is called cation (Na^+).
Valency: The combining capacity of an element is known as its valency.
Valency is used to form a chemical compound.

Name of the element	**Atomic Number**	**Symbol**	Valency
Hydrogen	1	H	1

Helium	2	He	0
Lithium	3	Li	1
Beryllium	4	Be	2
Boron	5	B	3
Carbon	6	C	4
Nitrogen	7	N	3
Oxygen	8	O	2

Atomic Number (Z): The atomic number is equal to the number of protons present in one atom of an element. As the atom is electrically neutral, the number of protons and electrons are the same. The notation *Z* denotes an Atomic number. The atomic number of Hydrogen is one as it has only one proton.

Number of Protons present in an atom **= Atomic number (Z)**

Number of Electrons present in an atom**= Atomic number (Z)**

Number of Neutrons **= Mass number (A) - Atomic number (Z)**

Mass Number (A): The mass number is the measure of the total **number of protons and neutrons** in the nucleus of an atom. The notation *A* indicates the **Mass number**. The notation *n* signifies the total **number of neutrons**.

Mass Number = Atomic Number + Number of Neutrons in the Nucleus

$$A = Z + n$$

Isotopes and Isobars:

Isotopes: The atoms of the same elements with the same atomic number and different mass numbers. For Examples,

Hydrogen has three isotopes: *Protium* ($_1H^1$), *Deuterium* ($_1H^2$), *and Tritium* ($_1H^3$)**.**

Isobars: The atoms of different molecules with the same mass number.

For Example, in Argon, atomic number 18, Calcium, atomic number 20, the mass number of both these elements is 40.

$_{18}Ar^{40}$, $_{20}Ca^{40}$

Assignments:

1. If 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?
   (ii) what is the charge on the atom?

Ans. (i) The atomic number of an atom is the same as the number of protons in that atom, hence its atomic number is 8.

(ii) In an atom, the number of protons is equal to the number of electrons. Hence both the charges – positive and negative neutralize each other. Therefore, the atom does not possess any charge.

2. Explain with examples
   (i) Atomic number,
   (ii) Mass number,
   (iii) Isotopes
   (iv) Isobars.

Ans. (i) The number of positively charged protons present in the nucleus of an atom is defined as the atomic number and is denoted by Z. Example: Hydrogen has one proton in its nucleus; hence its atomic number is one.

(ii) The total number of protons and neutrons present in the nucleus of an atom is known as the mass number. It is denoted by A. $_{20}Ca^{40}$. Mass number is 40. Atomic number is 20.

(iii) The atoms which have the same number of protons but different number of neutrons are referred to as isotopes. Hence the mass number varies.

Example: The simplest example is the Carbon molecule which exists as $_6C^{12}$ and $_6C^{14}$

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

Examples are, $_{20}Ca^{40}$and $_{18}Ar^{40}$

3. Number of valence electrons in Cl– ion is:
   (a) 16 (b) 8 (c) 17 (d) 18
4. Which one of the following is a correct electronic configuration of sodium?
   - 2,8 (b) 8,2,1 (c) 2,1,8 (d) 2,8,1
5. 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.

Atomic Number	Mass Number	Number of Neutrons	Number of Protons	Number of Electrons	Name of the atomic species
9	19	10	9	9	Fluorine
16	32	16	16	16	Sulphur
12	24	12	12	12	Magnesium
1	2	1	1	1	Deuterium
1	1	0	1	0	Hydrogen

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CLASS 9- 2022-23

Chapter-5

FUNDAMENTAL OF UNIT OF LIFE

CELL

- Cell is the fundamental structural and functional unit of all living organisms.

Anton Von Leeuwenhoek	**First saw and described a live cell.**
Robert Hook (1665)	Discovered cell in cork slice with the help of primitive microscope.
Robert Brown (1831)	Discover nucleus.
Schleiden and Schwan	Proposed cell theory
Purkinje (1839)	Coined the term protoplasm
Rudolf Virchow (1855)	"Omnis cellula-e cellula"

CELL THEORY

Proposed by Matthias Schleiden and Theodore Schwann and modified by Rudolf Virchow.

Cell theory states that:-

(i) All living organisms are composed of cells and products of cells.

(ii) All cells arise from pre-existing cells.

TYPES OF CELLS

Based on number	**Unicellular and Multicellular**
Based on nucleus structure	Prokaryotic cell and Eukaryotic cell
Also classified as	Plant cell and animal cell

Essential components of cell

- Outer envelope (Plasma Membrane)
- Genetic material (DNA/ RNA)
- Cytoplasm (semi fluid matrix contain cell organelles)

UNICELLULAR AND MULTICELLULAR ORGANSIMS

UNICELLULAR ORGANSIMS	MULTICELLULAR ORGANSIMS
Composed of single cell	Composed of many cells
All function occur in single cell	Different cells perform different function
Example: Bacteria	Example: Plant, Animals

PROKARYOTIC CELL AND EUKARYOTIC CELL

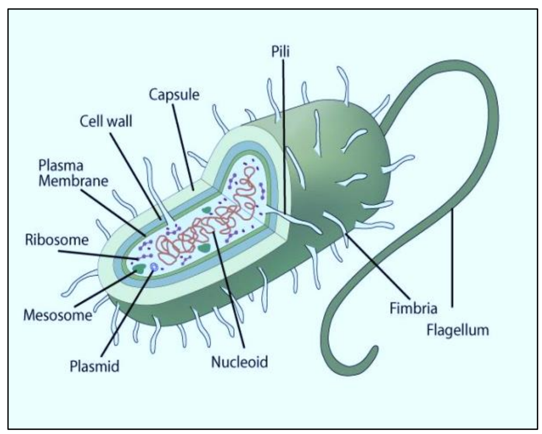
PROKARYOTIC CELL	EUKARYOTIC CELL
Smaller in size	Larger in size
Nuclear membrane is absent	Nuclear membrane is present

DNA is circular	DNA is linear
Ribosome 70 S type	Ribosome 80 S type
Double membrane cell organelles absent like, Mitochondria, Golgi body, Endoplasmic reticulum	Present
Extrachromosomal DNA (plasmid) may occur	Absent
Example: bacteria, blue-green algae, mycoplasma and PPLO (Pleuro Pneumonia Like Organisms)	Example: Plant cell, Animal cell

PLANT CELL AND ANIMAL CELL

PLANT CELL	ANIIMAL CEL
Cell wall present	Cell wall absent
Plastids are present	Absent
Single large vacuole present	Many small vacuole present
Lysosome rare	Lysosome present
Reserve food is starch	Reserve food is glycogen

PROKARYOTIC CELL



- Prokaryotes have a cell wall (except in mycoplasma).
- The nuclear membrane is absent and DNA scattered in cytoplasm. Such nuclear structure is known as nucleoid.
- Many bacteria have plasmids (Extra chromosomal genetic material). The plasmid DNA has specific properties like antibiotic resistant.
- Ribosome are of 70 S types (50 S + 30 S). Ribosome are the site of protein synthesis.
- Polysome: Several ribosome may attach to a single mRNA.

  Basic shapes of bacteria
- Bacillus (rod like), Coccus (spherical), Vibrio (comma shaped) and Spirillum (spiral)
- Cell Envelope and its Modifications
- In bacteria cell envelop is glycocalyx (outermost layer) followed by the cell wall and then the plasma membrane. It may be thick (capsule) or loose (slime layer).
- Gram had classified bacteria into two groups based on staining property

Gram positive	**When stained with gram stain remain purple**

Gram negative	When stain with gram stain remain colourless

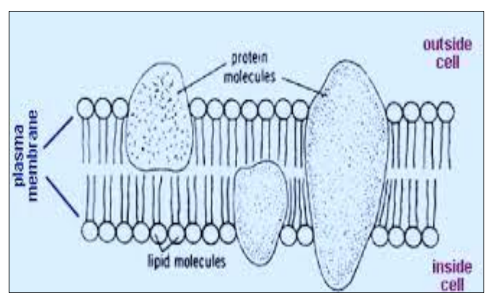
- Infolding of cell membrane forms mesosomes which are main site for energy production. it also helps in cell wall formation, DNA replication and distribution to daughter cells
- In some prokaryotes like cyanobacteria, chromatophores are present. These contain pigments.
- Some bacteria have flagella for locomotion and movement. It is made up of three parts – filament, hook and basal body.
- Bacteria also have Pili and Fimbriae.
- Pili- The pili are elongated tubular structures helps in reproduction of bacteria.
- Fimbriae- The fimbriae are small bristle like fibers helps in attachment.
- Reserve material in prokaryotic cells is stored in the cytoplasm in the form of inclusion bodies. e.g., phosphate granules, cyanophycean granules and glycogen granules.
- Gas vacuoles are found in blue green and purple and green photosynthetic bacteria.

EUKARYOTIC CELLS

- They are characterized by nuclear membrane.
- Membrane bound cell organelles are present.

CELL MEMBRANE

Singer and Nicolson (1972) proposed fluid and mosaic model of plasma membrane which is widely accepted.



- Cell membrane or plasma membrane is mainly composed of lipids and proteins.
- In human RBC (erythrocyte) protein: lipid proportion is 52:40.
- The lipid arranged in bilayer. The hydrophilic portion of lipid lies outside while hydrophilic portion toward inner side. This ensures protection of tail portion (nonpolar saturated hydrocarbons) from the aqueous environment. Lipids are mainly phospholipid type and also contain cholesterol.
- Proteins in cell membranes may of two types
  Peripheral: lie on the surface of membrane
  Integral: partially or totally buried in the membrane
- **Singer and Nicolson model**: Quasi-fluid nature of lipid enables lateral movement of proteins within the overall bilayer. This ability to move within the membrane is measured as its fluidity.

Function of cell membrane

- Protects the cell by acting as a barrier.
- Regulates the transport of substances in and out of the cell.
- Receives chemical messengers from other cell.
- Acts as a receptor.
- Cell mobility, secretions, and absorptions of substances.

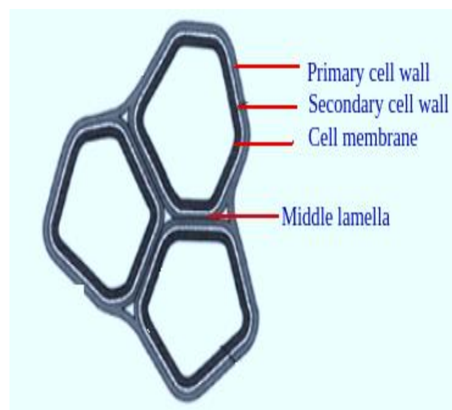
Transport across cell membrane

- The membrane is selectively permeable to some molecules present on either side of it.

Passive transport	**Movement of molecules across the membrane without any requirement of energy.**
Active transport	Movement of molecules across the membrane with the help of energy (ATP). This transport takes place against the concentration gradient, i.e., from lower to the higher concentration.
Simple diffusion	Movement of molecules from higher concentration to lower concentration area.
Osmosis	Movement of water higher to lower concentration area through semipermeable membrane

Cell Wall

- Outermost non-living rigid wall of a cell is called as cell wall.
- It is characteristic feature of plants and fungi.
- Cell wall provide shape to the cell
- It protects the cell from mechanical damage and infection.
- Cell wall also helps in cell-to-cell interaction



Organism	Cell wall composition
Bacteria	Peptidoglycans
Algae	cellulose, galactans, mannans
Fungi	Chitin
Plants	Cellulose, Pectin
Animal	Cell wall is absent

Components of cell wall

Primary wall	capable of growth, which gradually diminishes as the cell matures
Secondary wall	formed on the inner (towards membrane) side of the cell
Middle lamella	Made up of calcium pectate which holds or glues the different neighboring

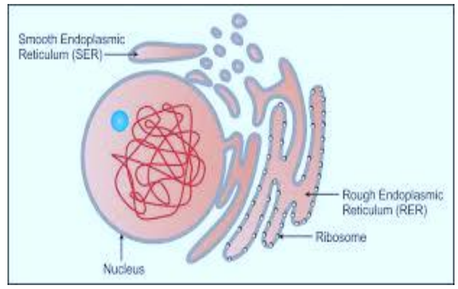
	cells together
Plasmodesmata	These are cytoplasmic threads in between cells and provide transport and communication between them.

ENDOMEMBRANE SYSTEM

The endomembrane system is a system of membranous components whose function is coordinated.

Example: Endoplasmic Reticulum (ER), Golgi apparatus, Lysosomes, Vacuoles

THE ENDOPLASMIC RETICULUM (ER)

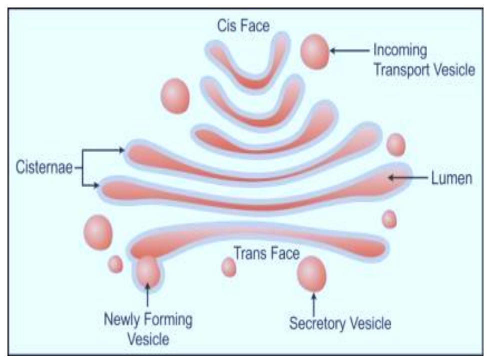


This is network tubular structures scattered in the cytoplasm. They divide the cytoplasm into two distinct compartments, luminal (inside ER) and extra luminal (cytoplasm).

ER is of two types-

- RER (rough endoplasmic reticulum) – contains ribosomes on it. It is major site of protein synthesis.
- SER (smooth endoplasmic reticulum) - ribosomes are not present. SER is involved in lipid and steroidal hormones (animals).

GOLGI APPARATUS



- It is first observed by Camillo Golgi (1898).
- They consist of many flat, disc-shaped sacs or cisternae (0.5µm to 1.0µm) stacked parallel to each other. The cisternae have interconnected - **cis** (convex or farming face) and **trans** (maturing face) faces.
- Golgi apparatus remains in close association with the endoplasmic reticulum.
- Golgi body is involved in packaging materials, modification of proteins, formation of glycoproteins and glycolipids.

LYSOSOMES

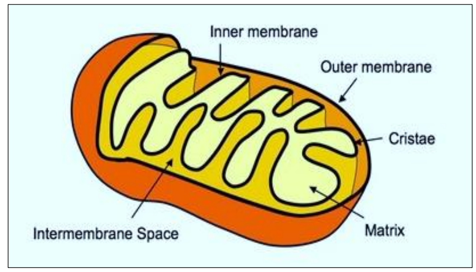
- These are membrane bound vesicular structures formed by the process of packaging in the Golgi apparatus.
- Lysosomes are known as suicide bags because it contains hydrolytic enzymes (hydrolases – lipases, proteases, carbohydrases). These enzymes are capable of digesting carbohydrates, proteins, lipids and nucleic acids.

VACUOLES

- A vacuole is a membrane-bound (**tonoplast**) cell organelle.
- In animal cells, vacuoles are generally small and help sequester waste products.
- In plant cells, vacuoles help maintain water balance and facilitate transport of ions.

- The vacuole is the membrane-bound space found in the cytoplasm.
- It contains water, sap, excretory product and other materials not useful for the cell.
- In Amoeba the contractile vacuole helps in osmoregulation and excretion.
- In Protista food vacuoles are present. These are formed engulfing the food particles.

MITOCHONDRIA



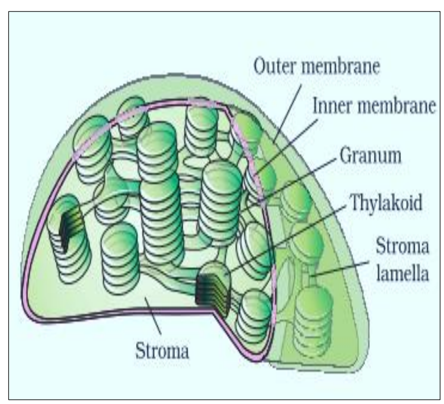
- Mitochondria are double membrane (outer and inner) bound cell organelles.
- These membranes encloses matrix.
- Matrix contains 70 S ribosome.
- The matrix also possesses single circular DNA molecule, a few RNA molecules.
- The mitochondria divide by fission.
- The Infolding of inner membrane form cristae. The cristae are projected in the matrix and increase surface area.
- It is called as powerhouse of the cell as it is the site for energy production.
- Mitochondria are the sites of aerobic respiration. These are known as power house of the cell as it is site of energy (ATP) production.

PLASTIDS

Plastids are pigment bearing organelles present in plants and euglenoides (like euglena).

Chloroplast	**chlorophyll and carotenoid pigments**	
Chromoplasts	fat soluble carotenoid pigments like carotene, xanthophylls	
Leucoplasts	colourless plastids	
	Amyloplasts	store carbohydrates (starch), e.g., potato
	Elaioplasts	store oils and fats
	Aleuroplasts	store proteins

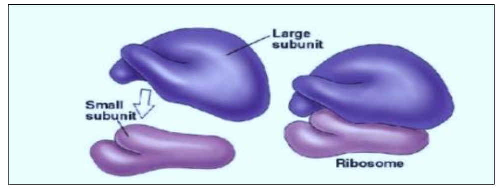
CHLOROPLASTS



- Occur in mesophyll cells of the leaves.
- Shape- lens-shaped, oval, spherical, discoid or even ribbon-like
- Number- 1 per cell (Chlamydomonas), 20-40 (green alga)
- Chloroplasts are also double membrane bound (outer and inner membrane).
- Membranes enclose stroma.
- In stroma many flattened structure (**thylakoids**) are present. It encloses a space called a lumen.
- Thylakoids are arranged in stacks like the piles of coins called **grana** or the intergranal thylakoids.

- Some thylakoids are connected by flat membranous tubules called the stroma lamellae.
- Chloroplast contains enzymes for photosynthesis, 70 S Ribosome and ds circular DNA.

RIBOSOMES



- Ribosomes are first observed by George Palade (1953)
- These are composed of rRNA (ribosomal RNA)) and proteins.
- These are not surrounded by any membrane.

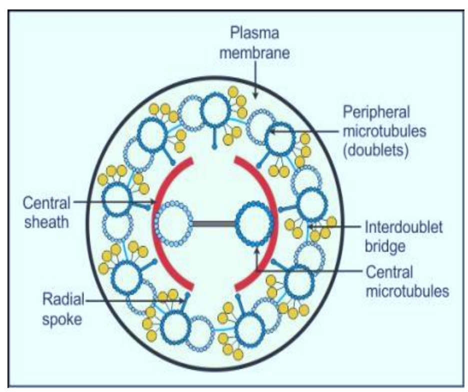
Type	Larger subunit	Smaller subunit	Example
80 S	50 S	30 S	Prokaryotes, Mitochondria, chloroplast
70 S	60 S	40 S	Eukaryotes

- <u>'S' (**Svedberg's Unit**) stands for the sedimentation coefficient.</u>

CYTOSKELETON

- These are network of filamentous proteinaceous structures consisting of microtubules, microfilaments and intermediate filaments present in the cytoplasm.
- The cytoskeleton in a cell is involved in many functions such as mechanical support, motility, maintenance of the shape of the cell.

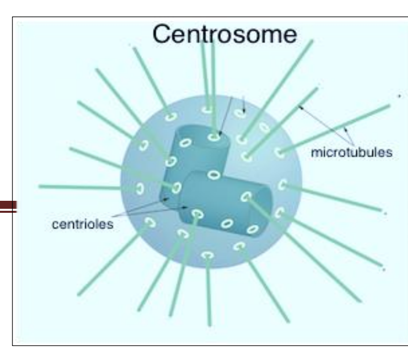
CILIA AND FLAGELLA



- These are hair like outgrowths of the cell membrane.
- Cilia are smaller and cause the movement of either the cell or the surrounding fluid.
- Flagella are comparatively longer and responsible for cell movement.
- In core axoneme is present which is covered with plasma membrane.
- The axoneme possesses a number of microtubules.
- The microtubules are arranged in **9+2** pattern.
- In flagella 9 radial spokes are also present.
- Both the cilium and flagellum emerge from centriole-like structure called the basal bodies.

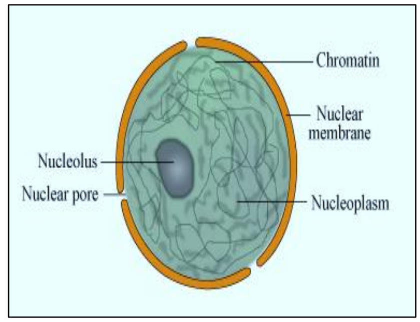
CENTROSOME AND CENTRIOLES

- Centrosome is an organelle that consists of two centrioles.



- Both the centrioles in a centrosome lie perpendicular to each other.
- Each centriole is made up of nine microtubule triplet arranged in 9+0 pattern.
- Microtubules are composed of protein tubulin and some lipids.
- A fine radial fibre (spoke) joins each microtubule to the central hub.
- The centrioles form the basal body of cilia or flagella, and spindle fibers that give rise to spindle apparatus during cell division in animal cells

NUCLEUS



- Nucleus is the membrane-enclosed organelle within a cell that contains the chromosomes.
- In eukaryotic organisms nucleus is surrounded by two membranes (outer and inner). In between membranes perinuclear space (10-50 nm) is present.
- The outer nuclear membrane usually remains continuous with the endoplasmic reticulum and also bears ribosomes on it.
- The nuclear membrane is not in continuous fashion, it contains very minute nuclear pores. These pores help in movement of RNA and protein molecules in between the nucleus and the cytoplasm.
- Nuclear membranes enclose nucleoplasm. In nucleoplasm nucleolus and chromatin are present.
- Nucleolus is a site for r RNA synthesis.

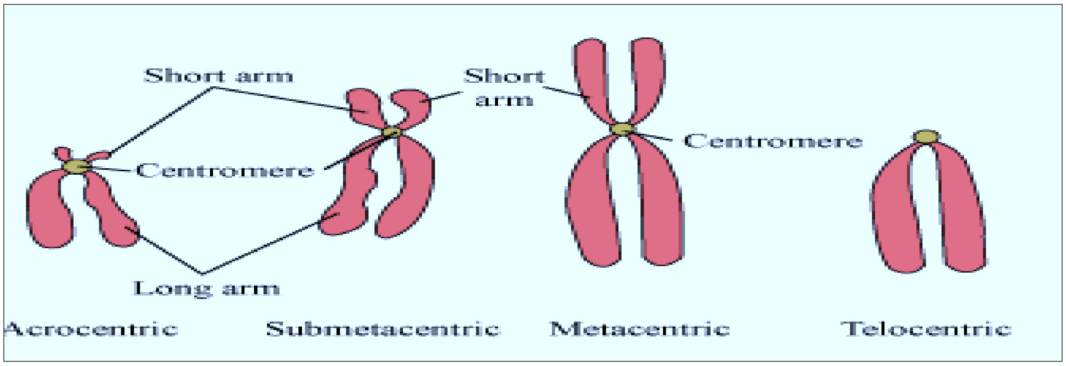
CHROMATIN AND CHROMOSOME

- Chromatin is a complex of DNA and some basic protein (**histone**), non-histone proteins and RNA.
- Chromosomes are thickened chromatins. In human cell 23 pairs of chromosome (46) are present.
- Every chromosome has a primary constriction (**centromer**e) on the sides of which disc shaped structures (kinetochores).
- Sometimes a few chromosomes have non-staining secondary constrictions (**satellite**) is present.
- Centromere holds two chromatids of a chromosome.

Based on the **position of the centromere**, the chromosomes can be classified into four types-

Metacentric	**It has middle centromere forming two equal arms of the chromosome.**
Sub-metacentric	It has centromere slightly away from the middle, resulting into one shorter arm and one longer arm.

Acrocentric	centromere is situated close to its end forming one extremely short and one very long arm
Telocentric	chromosome has a terminal centromere



IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **Name the single largest animal cell. Which cell is longest in human being?**
Ans: Ostrich egg is the largest cell
Neurons in human are longest cell

2- **Give two examples of prokaryotic cells other than bacteria and mycoplasma.**
Ans: Blue-green algae, PPLO (Pleuro Pneumonia like Organisms)

3- **What are plasmids? Give one importance of plasmids**.
Ans: plasmids are Extrachromosomal, circular DNA present in some bacteria.
They confer antibiotic resistant property to the bacteria.

4- **Write any two roles of mesosomes.**
Ans: Helps in cell division, site for energy production

5- **Compare role of pili and fimbriae.**
Ans: Pili: helps in sexual reproduction of bacteria
Fimbriae: helps in attachment to host cell

6- **Which type of ribosome is observed in bacteria? How it is different from human ribosome?**
Ans: In bacteria – 70 S
In human- 80 S

7- **Mention any two organisms that have gas vacuoles in their cells.**
Ans: blue green and purple and green photosynthetic bacteria

8- **How secondary cell wall is formed in cells?**
Ans: as the cell matures the primary cell wall diminishes and the secondary wall is formed on the inner side of the cell.

9- **What is composition of middle lamellae? Write its role in cell.**

Ans: The middle lamella is a layer mainly of calcium pectate which holds or glues the different neighbouring cells together.

10- **What are Plasmodesmata? Mention its significance.**

Ans: The cell wall and middle lamellae may be traversed by plasmodesmata which connect the cytoplasm of neighbouring cells.

Short Answer Type Questions

1- **Who modified cell theory? Explain the cell theory.**

Ans: Rudolf Virchow modified cell theory.

Cell theory states that:-

(i) All living organisms are composed of cells and products of cells.

(ii) All cells arise from pre-existing cells.

2- **What are two types of endoplasmic reticulum? Differentiate these on the basis of function.**

Ans: Types- Rough endoplasmic reticulum and Smooth endoplasmic reticulum

Function- Rough endoplasmic reticulum- is major site of protein synthesis.

Smooth endoplasmic reticulum is site for synthesis of lipid and steroidal hormones (animals).

3- **How active transport is different from passive transport?**

Ans: Passive transport -Movement of molecules across the membrane without any requirement of energy.

Active transport-Movement of molecules across the membrane with the help of energy (ATP).

4- **What term is given the cytoplasmic threads present in between two adjacent cells? Write their function.**

Ans: Plasmodesmata.

Provide transport and communication between them.

5- **Diagrammatically explain the internal structure of flagella and label any four parts of it.**

Ans: fig 8.10, page 137, NCERT

6- **"A cell is a building unit of an organism". Explain the statement.**

Ans: cell is the fundamental structural and functional unit of the cell. Unicellular organism performs all their function in single cell only but multicellular organisms have different organ systems. The organ systems are consists of various organs and latter is made up of tissues. Tissue is a group of cells performing the same function. So cells are the building unit of organisms.

7- **Write any two differences in between plasma membrane and cell wall.**

Ans: Plasma membrane: it is a limiting membrane present in all organisms semipermeable in nature. It is made up of lipid and protein.

Cell wall: it is not present in animal cells. Cell wall is made up of cellulose/ chitin/ hemicellulose/ peptidoglycans.

8- **Draw L.S. of mitochondrion and label it. Also justify why it is called as power house of the cell?**

Ans: fig 8.7, page 135, NCERT

Mitochondrion is supposed to as powerhouse of the cell as it is the site for energy (ATP) production.

9- **(i) How do substances like CO2 and water move in and out of cell?**
(ii) Which one essentially required semipermeable membrane?

Ans: (i) CO2 by diffusion and Water through osmosis.
(ii)Osmosis

10- **List any three functions performed by endoplasmic reticulum.**

Ans: Synthesis of lipids (SER) and proteins (RER).
It provides support to cytoplasm.
It helps in intracellular and intercellular transport of substances.

<u>Long Answer Type Questions</u>

1- **(i) Give a detailed account on plastids and its types present in cell.**
(ii) Draw labelled diagram of chloroplast.

Ans: (i) Plastids are pigment bearing organelles present in plants and euglenoides (like euglena).

Chloroplast- green pigment consists of chlorophyll and carotenoid pigments

Chromoplasts- fat soluble carotenoid pigments like carotene, xanthophylls

Leucoplasts - colourless storage plastids

Amyloplasts- store carbohydrates
Elaioplasts- store oils and fats
Aleuroplasts- store proteins

(ii) Fig 8.8, page 136, NCERT

2- **(i) What types of proteins are present in chromosomes?**
(ii)Describe different types of chromosomes that may occur in a cell.

Ans: (i) Basic histone proteins that helps in packaging of DNA

(ii) Metacentric chromosome- It has middle centromere forming two equal arms of the chromosome.

Sub-metacentric chromosomes- the centromere is situated slightly away from the middle, resulting into one shorter arm and one longer arm.

Acrocentric chromosomes- the centromere is situated close to its end forming one extremely short and one very long arm

Telocentric chromosome- they have terminal centromere

3- **Compare plant and animal cell only by giving suitable diagram.**

Ans: fig 8.3, page 130, NCERT

4- **Explain the structure of plasma membrane. Also mention its role in the cell. Also provide the diagram of plasma membrane.**

Ans: Cell membrane or plasma membrane is mainly composed of proteins and two layers of lipids. The hydrophilic portion of lipid lies outside while hydrophilic portion toward inner side. This ensures protection of tail portion (nonpolar saturated hydrocarbons) from the aqueous environment. Lipids are mainly phospholipid type and also contain cholesterol. Proteins in cell membranes may of two types Peripheral: lie on the surface of membrane, Integral: partially or totally buried in the membrane.

Fig 8.4, page 131, NCERT

5- Write any five differences between prokaryotic cell and eukaryotic cell.

Ans:

PROKARYOTIC CELL	EUKARYOTIC CELL
Smaller in size	Larger in size
Nuclear membrane is absent	Nuclear membrane is present
DNA is circular	DNA is linear
Ribosome 70 S type	Ribosome 80 S type
Double membrane cell organelles absent like, Mitochondria, Golgi body, Endoplasmic reticulum	Present
Plasmid may occur	Not present
Example: bacteria, blue-green algae, mycoplasma and PPLO	Example: Plant cell, Animal cell

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Chapter-6
TISSUES

The five levels of organization of life include cell, tissues, organs, organ system and organisms.

- Organisms are made up of organ system, organs system is composed of organs, organs are made from tissues and tissues are formed by Cells.

TISSUES

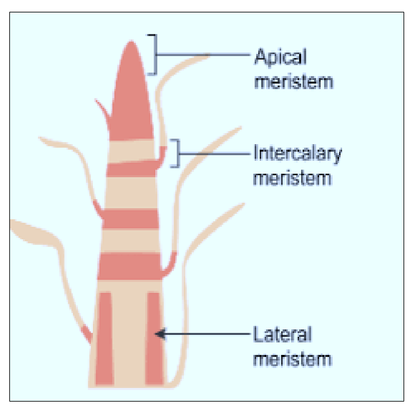
Tissue is a group of cells that have similar structure and that function together as a unit.

PLANT TISSUES

Meristematic tissue	These are simple tissues have ability to divide. Cells of meristmatic tissue are very active; they have dense cytoplasm, thin cellulose walls and prominent nuclei. They lack vacuoles.
Permanent tissue	These tissues lose the ability to divide.

Types of meristmatic tissues:

Based on the position the meristmatic tissues are classified as-



Apical meristem	This is present at the growing tips of stems and roots and increases the length of the stem and the root.
Intercalary meristem	These are responsible for increase in girth of the stem or root
Lateral meristem	Intercalary meristem is located near the node.

Types of permanent tissues

Simple permanent tissue	These are formed by one type of cells.	Parenchyma, Collenchyma, Sclerenchyma

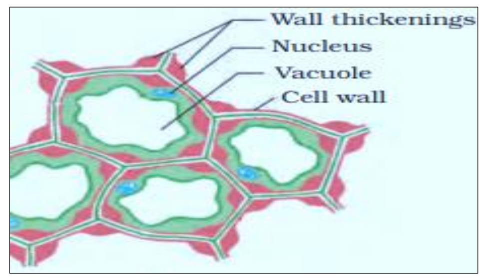
Complex tissue	permanent	These are composed of more than two types of cells	Xylem, Phloem

PARENCHYMA

- These are living cells with thin cell wall.
- The cells are loosely arranged with large intercellular spaces.
- They may be chlorenchyma (contains chlorophyll) or aerenchyma (large air cavities in aquatic plants)
- Parenchyma may store food, water (succulent and xerophytic plants), helps in buoyancy etc.

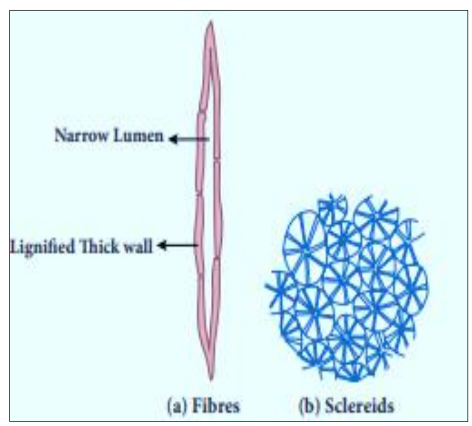
COLLENCHYMA

- The cells are living with very little intercellular space.
- These are characterized by thickened corners.
- It provides mechanical support to the plant.



SCLERENCHYMA

- The tissue contains dead cells.
- The walls are long and narrow as the walls are thickened due to lignin.
- Sclerenchyma may be in the form of fibres and sclereids.
- Fibres- elongated with pointed ends
- Sclereids- Isodiametric, broad
- This tissue is present in stems, around vascular bundles, in the veins of leaves and in the hard covering of seeds and nuts.
- It provides strength to the plant parts

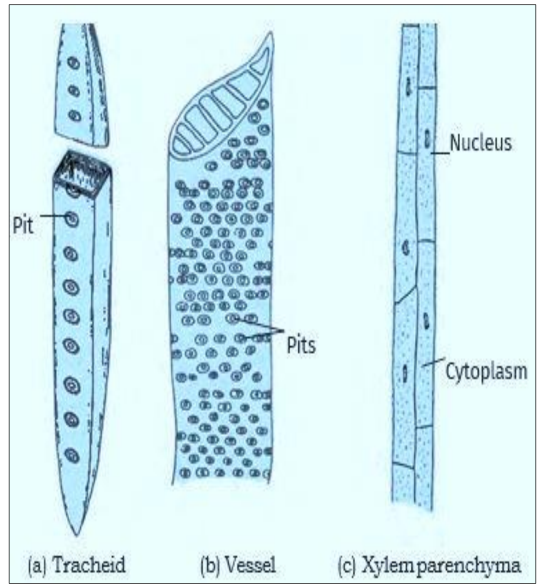


XYLEM

- Xylem is a conducting tissue which conducts water, mineral nutrients from root to aerial part of plant.

- It also provides mechanical support to the plant body.
- Xylem is composed

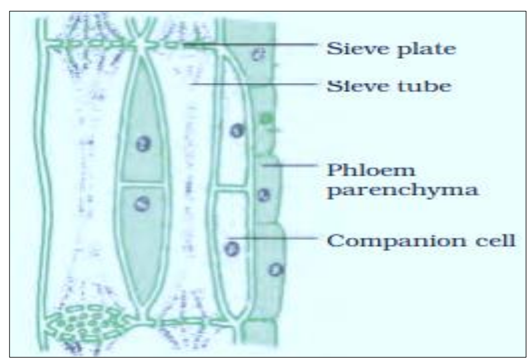
Xylem tracheids	Thick walled, tubular, Conduct water , provide mechanical support
Xylem fibres	Provide mechanical support
Xylem vessels	Thick walled , tubular, Transport of water and provide mechanical strength
Xylem parenchyma	Storage



PHLOEM

Phloem is a complex tissue translocates food from leave to other part of plants.

Sieve elements	Living tubular cells with perforated walls.
	Translocation of food, from leaves to the storage organs
Companion cells	Living, help in food transport
Phloem fibres	Dead cells, help in food transport
Phloem parenchyma	living cells , Storage



ANIMAL TISSUES

EPITHELIAL TISSUE

- It is the simplest tissue.
- It is composed of one or more layers of cells.

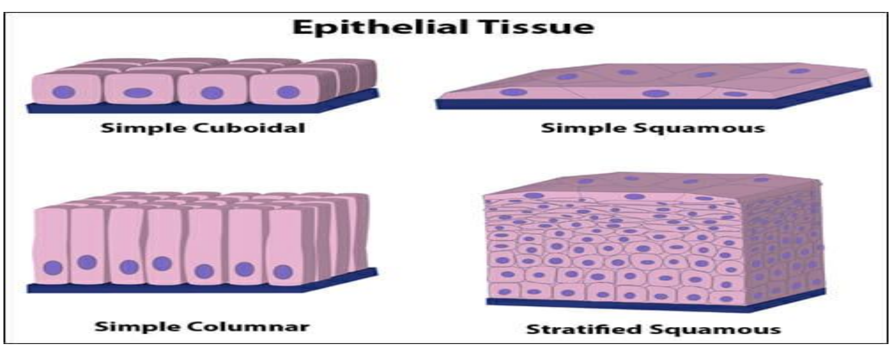
- The cells are tightly packed with almost no intercellular spaces
- It covers external surface as well as internal organs.

Functions of epithelial tissues

- Protects the body cells from drying, injury and microbial infections.
- They help in absorption of water and nutrients.
- They are involved in elimination of waste products.
- Some perform function of Secretion of sweat, saliva, mucus and enzymes.

Types:

Types	Features	Location	Function
Simple squamous	Cells are extremely thin & flat and form a delicate lining.	Skin, lining blood vessels, lung alveoli, oesophagus, mouth	Protection from mechanical injury, and invasion of germs.
Stratified squamous	arranged in a pattern of layers	Skin, salivary glands, sweat glands	Secretion / absorption
Columnar	Pillar like	inner lining of the intestine, respiratory tract, some are ciliated	Secretion/ absorption and movement
Cuboidal	cube-shaped cells	lining of kidney tubules and ducts of salivary glands	Secretion/ absorption
Glandular	specialized gland	gastric glands, pancreatic tubules and intestinal glands	Secrete digestive juices



CONNECTIVE TISSUE

The cells of connective tissue are loosely spaced and embedded in an intercellular matrix.

Blood It is fluid connective tissue. It has fluid matrix called plasma, in

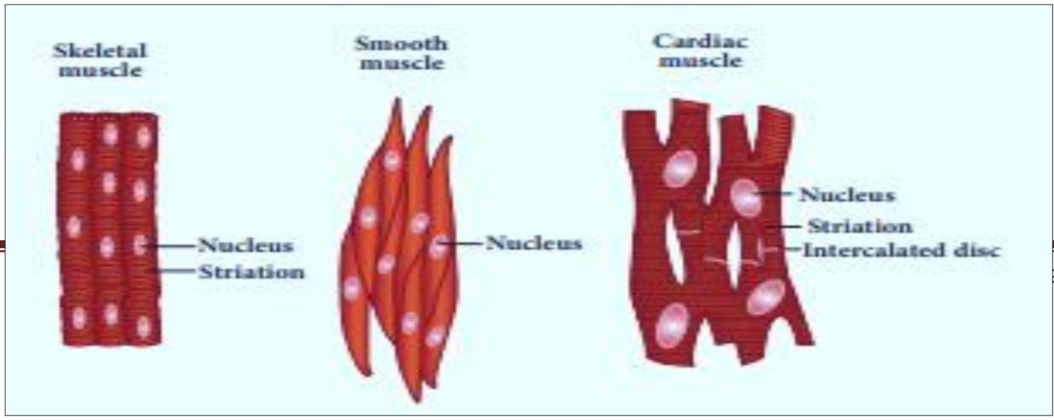
	which RBS, WBC, platelets are suspended.
Bone	Bone cells are embedded in a hard matrix that is composed of calcium and phosphorus compounds.
Ligaments	It connects bone to bone.
Tendons	It connects muscles to bones
Cartilage	They are soft, semi-rigid, and flexible and are less vascular in nature. They are present in the tip of the nose, trachea and larynx
Areolar connective tissue	It occurs between the skin and muscles, around blood vessels and nerves and in the bone marrow. It fills the space inside the organs, supports internal organs and helps in repair of tissues.

MUSCULAR TISSUE

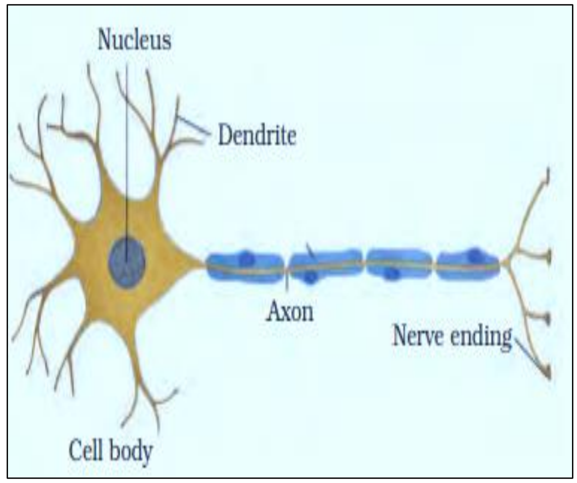
- Muscular tissue consists of elongated cells, also called muscle fibres (myofibrils).
- They are responsible for movement in our body.
- Muscles contain special proteins called contractile proteins (actin and myosin), which contract and relax to cause movement.

Types

Skeletal muscle/ striated /	Shows alternate dark and light bands, Unbranched, multinucleate
(voluntary)	These muscles are attached.These are responsible for the body movements.
Smooth muscle/ Non striated/ (involuntary)	Do not show dark and light band. Cells are spindle shaped, uninucleate. Non- striated. Present in internal organs (blood vessels, gastric glands, intestinal villi and urinary bladder)
Cardiac muscle	cylindrical, branched and uninucleate present in heart



NERVOUS TISSUE



- These are composed of neurons.
- Neurons are the longest cells of the body.
- Each neuron consists of a cell body (cyton), axon and branched dendrites.
- The signal that passes along the nerve fibre is called a nerve impulse.
- It enables animals to move rapidly in response to stimuli.

IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **What is the utility of tissues in multi-cellular organisms?**
Ans: In multicellular organism tissues provides structural and mechanical strength and enables division of labour.

2- **Where is apical meristem present in plants?**
Ans: shoot apical meristem, root apical meristem

3- **Mention one significant difference between growth of plant and animals.**
Ans: Growth continues throughout the life of the plant. Growth takes place for definite periods before maturity.

4- **Why growth in plant does localize at certain area?**
Ans: This is because the meristmatic tissue (dividing tissue) is located only at specific area.

5- **Name the connective tissue which helps is the repair of tissues. State where this tissue is found. Mention one more function.**
Ans: Areolar connective tissue is found between the skin and muscles, around blood vessels and nerves and in the bone marrow.
It fills the space inside the organs, supports internal organs and helps in repair of tissues.

6- **Write an adaptation by which desert plants minimizes water loss.**
Ans: on outer side of epidermis a layer of cuticle is present is some desert plants. The cuticle reduces the rate of loss of water.

7- **Which type of tissues shows irregularly thickened at the corners?**
Ans: Collenchyma

8- **Which tissue makes up the husk of coconut?**

Ans: Sclerenchyma

9- **What are the various types of blood cells?**
Ans: RBC, WBS, Platelets

10- **Write any two characteristic of meristematic tissue.**
Ans: Thin-walled compactly arranged cells
Ability to divide

Short Answer Type Questions

1- **What is guard cell? Where these are found. Write the role of these cells.**
Ans: Guard cell are bean shaped cells encloses the stomata. They help in closing and opening of stomata.

2- **Epidermis is outermost layer. Specify the one modificat6ion of epidermis in root and also mention its role.**
Ans: some epidermal cells of the roots elongate to form root hairs. They perform water absorption.

3- **What are the constituents of water conduction complex tissue in the plants?**
Ans: phloem: Sieve elements, Companion cells, Phloem fibres, Phloem parenchyma

4- **Compare areolar tissue and adipose tissue.**
Ans: Areolar tissue fills the spaces between internal organs and facilitates transportation.
Adipose tissue serves as a fat reservoir and heat insulator.

5- **Write any four characteristic features of sclerenchyma.**
Ans: The cells are dead, long and narrow.
Thickened wall is due to lignin.
This tissue is present in stems, around vascular bundles, in the veins of leaves and in the hard covering of seeds and nuts.
It provides strength to the plant parts

6- **Identify the tissues present in the following cases-**
(a) lining of blood vessels, (b) lining of small intestine
Ans: (a) Squamous epithelium (b) Columnar epithelium

7- **From which category of animal tissue ligament and tendons belong. How these are different from each other?**
Ans: Connective tissue
Ligament: it connects bone to bone.
Tendon: it connects muscles to bones.

8- **Write any two properties of bones and cartilage.**
Ans: bone – hard, porous
Cartilage- flexible, non-porous

9- **Differentiate between parenchyma, collenchyma and sclerenchyma on the basis of their cell wall.**

Ans: Parenchyma: The cells have thin cell walls made up of cellulose. Collenchyma: The cells have cell walls thickened at the corners due to pectin deposition. Sclerenchyma: Their walls are thickened due to lignin deposition.

10- Draw labelled structure of longest human cell.

<u>Long Answer Type Questions-</u>

1- Explain different types of meristems present in plat cell? Also draw suitable diagram of meristems.

Ans: Apical meristem- This is present at the growing tips of stems and roots and increases the length of the stem and the root.

Intercalary meristem- These are responsible for increase in girth of the stem or root

Lateral meristem- Intercalary meristem is located near the node.

2- (i) Draw section of a stem and label it's any six parts.

(ii)Mention the role of any two parts.

Ans:

Labeling- cuticle, epidermis, collenchyma, parenchyma, xylem, phloem, vascular bundle.

Role of any two – xylem- water conducting tissue, phloem- food conducting tissue

3- Explain different types of skeletal muscles by providing suitable diagram.

Ans: Skeletal muscle/ striated / (voluntary) - shows alternate dark and light bands Unbranched, multinucleate, these muscles are attached, these are responsible for the body movements.

Smooth muscle/ Non striated/ (involuntary)- do not show dark and light band, Cells are spindle shaped, uninucleate, Non- striated., Present in internal organs (blood vessels, gastric glands, intestinal villi and urinary bladder)

Cardiac muscle- cylindrical, branched and uninucleate, present in heart, involuntary

4- What are connective tissues? Explain the different types of connective tissue and their role.

Ans: The cells of connective tissue are loosely spaced and embedded in an intercellular matrix.

Blood- It is fluid connective tissue. It has fluid matrix called plasma, in which RBS, WBC, platelets are suspended. Blood flows all over the body and helps in the transport of gases, digested food, hormones and waste material to different parts of the body.

Bone- Bone cells are embedded in a hard matrix that is composed of calcium and phosphorus compounds.

Ligaments- It connects bone to bone.

Tendons- It connects muscles to bones

Cartilage- It is soft, semi-rigid, and flexible and is less vascular in nature. They are present in the tip of the nose, trachea and larynx

Areolar connective tissue- It occurs between the skin and muscles, around blood vessels and nerves and in the bone marrow. It fills the space inside the organs, supports internal organs and helps in repair of tissues.

5- **Write a brief note on epithelial tissue. Describe the functions of different types of epithelium tissue.**

Ans: It is the simplest tissue and composed of one or more layers of cells.

The cells are tightly packed with almost no intercellular spaces

It covers external surface as well as internal organs.

Some perform function of Secretion of sweat, saliva, mucus and enzymes.

Types:

Simple squamous epithelium- Cells are extremely thin & flat and form a delicate lining. Skin, lining blood vessels, lung alveoli, oesophagus, mouth, it provide protection from mechanical injury, and invasion of germs.

Stratified squamous epithelium- cells are arranged in a pattern of layers, present in Skin, salivary glands, sweat glands , helps in Secretion / absorption

Columnar epithelium- cells are pillar like, present in inner lining of the intestine, respiratory tract; some are ciliated, helps in secretion/ absorption and movement

Cuboidal epithelium- cube-shaped cells, lining of kidney tubules and ducts of salivary glands, helps in Secretion/ absorption

Glandular epithelium- these are specialized gland like gastric glands, pancreatic tubules and intestinal glands, they secrete digestive juices.

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CLASS 9, SCIENCE-2022-23

Chapter-8-Motion

Understanding Motion

Reference point and reference frame

- To describe the position of an object we need a reference point or origin. An object may seem to be moving to one observer and stationary to another.
- Example: A passenger inside a bus sees the other passengers to be at rest, whereas an observer outside the bus sees the passengers to be in motion.
- In order to make observations easy, a convention or a common reference point or frame is needed. All objects must be in the same reference frame.

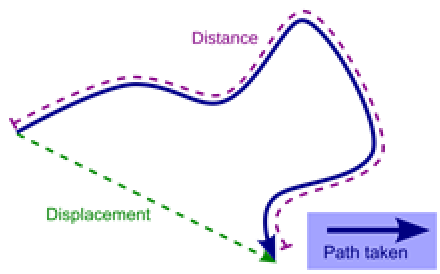
Distance and Displacement

The magnitude of the length covered by a moving object is called distance. It has no direction.

Displacement is the shortest distance between two points or the distance between the starting and final positions with respect to time. It has magnitude as well as direction.

Displacement can be zero, but distance cannot.

Distance VS Displacement



Magnitude

Magnitude is the size or extent of a physical quantity. In physics, we have scalar and vector quantities.
Scalar quantities are only expressed as magnitude. E.g: time, distance, mass, temperature, area, volume
Vector quantities are expressed in magnitude as well as the direction of the object. E.g: Velocity, displacement, weight, momentum, force, acceleration, etc.

Time and speed

Time is the duration of an event that is expressed in seconds. Most physical phenomena occur with respect to time. It is a scalar quantity.
Speed is the rate of change of distance. If a body covers a certain distance in a certain amount of time, its speed is given by
The instantaneous speed is the speed of an object at a particular moment in time.
Average speed is stated as the distance covered by the object within a period of time.

Average speed = Total distance travelled / Total time taken

The below table lists the difference between Average Speed and Instantaneous Speed.

Average Speed	Instantaneous Speed
It is defined as the total distance travelled divided by the total time elapsed.	It is defined as the speed at a particular instant of time.
It is constant	It is not constant
Measured by calculating the speed for an entire journey	It is measured by a speedometer
Example: A car travelling with a speed of 60 kmph. Thus, the average speed of the car is 60 km an hour	Example: A car travelling at a certain speed at an instant of time can be given by a speedometer.

Uniform motion and Non-uniform motion

When an object covers equal distances in equal intervals of time it is in uniform motion.
Examples of Uniform Motion

- Movement of the ceiling fan’s blades.
- Motion of earth around the sun
- Pendulum with equivalent amplitude on either side

When an object covers unequal distances in equal intervals of time it is said to be in non-uniform motion.

- Bouncing ball
- Running horse
- Moving train

To know more about Uniform Motion and Non-Uniform Motion, visit here.

Velocity

The Rate of change of displacement is velocity. It is a vector quantity. Here the direction of motion is specified.
Instantaneous velocity is the rate of change of position for a time interval which is very small i.e. almost zero. In more simple words, the velocity of an object at a given instant of time is known as instantaneous velocity.
Average velocity is defined as the displacement (Δx) divided by the time intervals (Δt) in which the displacement occurs.

Average Velocity	Instantaneous Velocity

Average velocity is defined as the displacement (Δx) divided by the time intervals (Δt) in which the displacement occurs.	Instantaneous velocity is the rate of change of position for a time interval which is very small i.e. almost zero.
Average velocity is calculated by dividing the rate of displacement by the time elapsed.	Instantaneous velocity is calculated by dividing displacement by time at that instant.
If Jack took a total of 1 hour to travel 10 km from his house to school then his average velocity will be 10 km/hr	In Jack's case on his way to school, while he is sitting and waiting for the train to pass his instantaneous velocity will be zero. Though the instantaneous velocity was zero for a small part of the journey, the average velocity will not be zero.

Acceleration

The rate of change of velocity is called acceleration. It is a vector quantity. In non-uniform motion, velocity varies with time, i.e., change in velocity is not 0. It is denoted by "a"

Acceleration = Change in Velocity / Time

(OR)

Where, t (time taken), v (final velocity) and u (initial velocity).

constant retardation

Equations of Motion

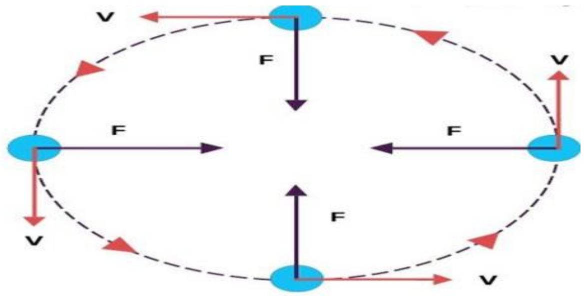
The motion of an object moving at uniform acceleration can be described with the help of three equations, namely

(i) $v = u + at$
(ii) $v^2 - u^2 = 2as$
(iii) $s = ut + (1/2)at^2$

where u is the initial velocity, v is the final velocity, t is the time, a is the acceleration and s is the displacement.

Uniform circular motion

- If an object moves in a circular path with uniform speed, its motion is called uniform circular motion.
- Velocity is changing as direction keeps changing.
- Acceleration is constant
- The uniform circular velocity is given by the following formula:



Uniform Circular Motion Examples

- Motion of artificial satellites around the earth is an example of uniform circular motion.
- The motion of electrons around its nucleus.
- The motion of blades of the windmills.
- The tip of second's hand of a watch with circular dial shows uniform circular motion.

SOME QUESTIONS

1. (a) Identify the kind of motion in the following cases:

(i) A car moving with constant speed turning around a curve.

(ii) An electron orbitting around nucleus.

(b) An artificial satellite is moving in a circular orbit of radius 36,000 km. Calculate its speed if it takes 24 hours to revolve around the earth.

2. (a) Define average speed.

(b) A bus travels a distance of 120 km with a speed of 40 km/h and returns with a speed of 30 km/h. Calculate the average speed for the entire journey.

3. Define uniform and non-uniform motion. Write one example for each.

4. What does the odometer of an automobile measure? Which of the following is moving faster? Justify your answer.

(i) A scooter moving with a speed of 300 m per I minute.

(ii) A car moving with a speed of 36 km per hour.

5. A car travels from stop A to stop B with a speed of 30 km/h and then returns back to A with a speed of 50 km/h. Find

(i) displacement of the car.

(ii) distance travelled by the car.

(iii) average speed of the car.

6. (a) Define uniform acceleration. What is the acceleration of a body moving with uniform velocity?

(b) A particle moves over three quarters of a circle of radius r. What is the magnitude of its displacement?

7. A bus accelerates uniformly from 54 km/h to 72 km/h in 10 seconds Calculate

(i) acceleration in m/s^2

(ii) distance covered by the bus in metres during this interval.

8. A car moves with a speed of 30 km/h^{-1} for half an hour, 25 km/h^{-1} for one hour and 40 km/h^{-1} for two hours. Calculate the average speed of the car.

9. Derive the equation for velocity-time relation (v = u + at) by graphical method.

10. A car is travelling at 20 km/h, it speeds upto 60 km/h in 6 seconds. What is its acceleration?

11. A car accelerates from 6 ms^{-1} 16 ms^{-1} in 10 sec. Calculate

(a) the acceleration and

(b) the distance covered by the car in that time.

12. A circular track has a circumference of 3140 m with AB as one of its diameter. A scooterist moves from A to B alone the circular path with a uniform speed of 10 m/s. Find

(a) distance covered by the scooterist,

(b) displacement of the scooterist, and

(c) time taken by the scooterist in reaching from A to B.

13. (a) Differentiate between uniform linear and uniform circular motion.

(b) Write any four examples of uniform circular motion.

(c) Is uniform circular motion accelerated motion?

14. (a) Differentiate between speed and velocity.

(b) When is a body said to have uniform velocity?

(c) How can we describe the position of an object?

15. (a) Derive the equation of motion v = u +at, using graphical method.

(b) A train starting from rest attains a velocity of 72 km/h in 5 minutes. Assuming the acceleration is uniform, find

(i) the acceleration.

(ii) the distance travelled by the train for attaining this velocity.

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CLASS 9, SCIENCE-2022-23

Chapter-9

FORCE AND LAWS OF MOTION

Introduction to Force

A force is an effort that changes the state of an object at rest or at motion. It can change an object's direction and velocity. Force can also change the shape of an object.

Effects of Force

Some effects of force include the following:

- Force moves stationary objects
- Force stops objects from moving
- Force changes the shape of a body
- Force changes the direction of motion

Push is defined as an action of force which causes an object to move from its place. The following are the examples of push:

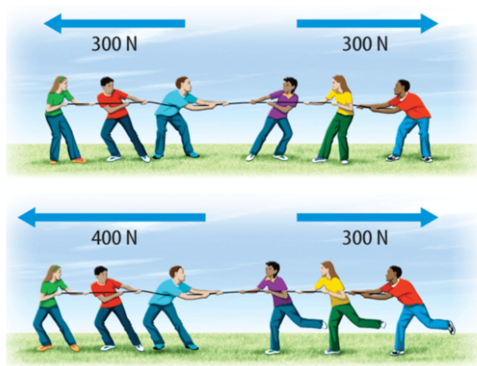
- Opening and closing of the door.
- Pushing the table.
- Pushing a car.
- Pushing of the thumb pins.
- Walking

Pull is defined as an action to make move by either tugging or dragging. The following are the examples of pull:

- Plucking the string of a guitar.
- Pulling ropes while playing tug of war.
- Opening the drawer.
- Pulling the window curtain.
- Opening and closing of the doors.

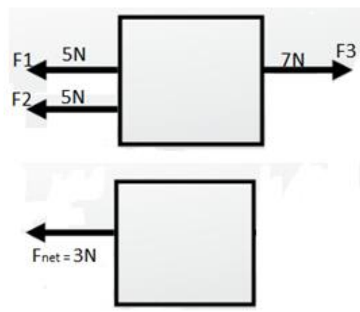
Balanced and Unbalanced Forces

When balanced forces are applied to an object, there will be no net effective force acting on the object. Balanced forces do not cause a change in motion.
Unbalanced forces acting on an object change its speed and/or direction of motion. It moves in the direction of the force with the highest magnitude.



Net force

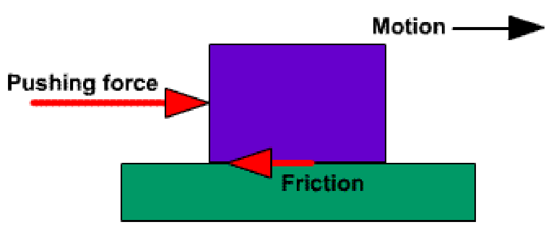
When multiple forces act on a body, they can be resolved into one component known as the net force acting on the object. The net force decides the direction of motion.



Frictional force

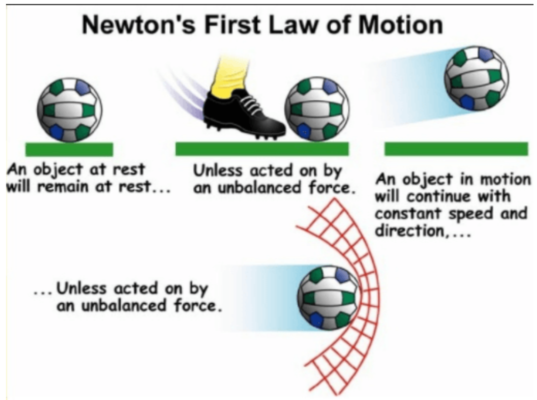
The force that opposes relative motion is called friction. It arises between the surfaces in contact.

Example: When we try to push a table and it does not move is because it is balanced by the frictional force.



First Law of Motion

A body continues to be in the state of rest or uniform motion in a straight line unless acted upon by an external unbalanced force. The First Law is also called the Law of Inertia.



Inertia-

Basically, all objects have a tendency to resist the change in the state of motion or rest. This tendency is called **inerti**a. All bodies do not have the same inertia. Inertia depends on the mass of a body. Mass of an object is the measure of its inertia.

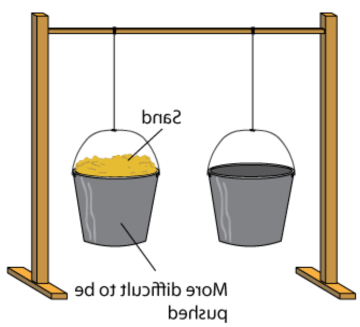
More the mass → more inertia and vice versa.

Inertia of Rest-

An object stays at rest, and it remains at rest until an external force affects it. Example: When a car accelerates, passengers may feel as though their bodies are moving backward. In reality, inertia is making their bodies stay in place as the car moves forward.

Inertia of Motion-

An object will continue to be in motion until a force acts on it. Example: A hockey puck will continue to slide across the ice until acted upon by an outside force.



Second Law of Motion

In order to understand second law, we need to first understand momentum.

Momentum

Impacts produced by objects depend on their mass and velocity. The momentum of an object is defined as the product of its mass and velocity. p = mv. Vector quantity, has direction and magnitude. Some examples of momentum include: A baseball flying through the air and a bullet fired from a gun.

Second Law of Motion

The rate of change of momentum of an object is directly proportional to the applied unbalanced force in the direction of the force.

$\Delta pt\ \alpha\ m(v-u)\ t$
Here, a [= (v – u)/t] is the acceleration, which is the rate of change in velocity.

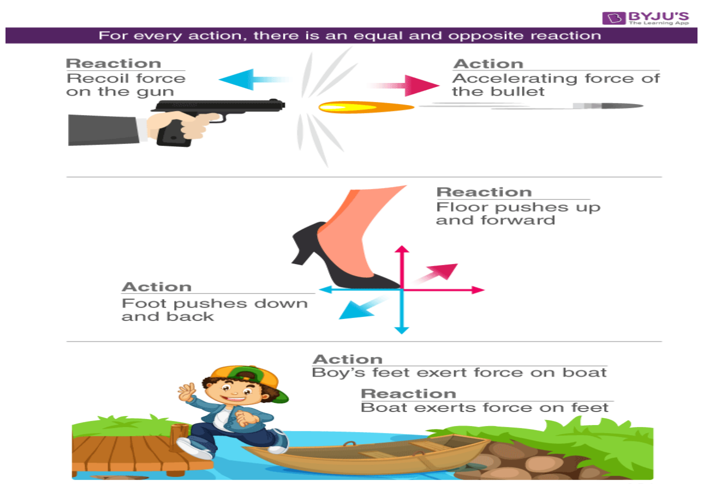
$\Delta pt\ \alpha\ ma$
$F\alpha\ ma$
$F = kma$

For 1 unit of force on 1 kg mass with the acceleration of 1m/s2, the value of k = 1.

Therefore, F = ma.

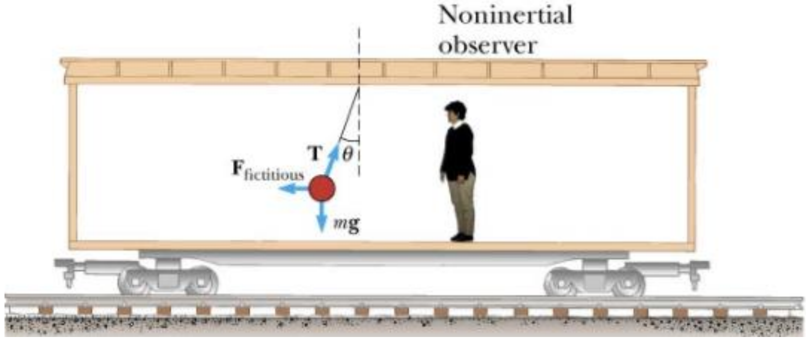
Third Law of Motion

Newton's 3rd law states that every action has an equal and opposite reaction. Action and reaction forces are equal, opposite and acting on different bodies.



Inertial and Non-inertial frames

- A non-inertial frame of reference is a frame of reference in which Newton's laws of motion do not hold. A non-inertial reference frame is a frame of reference that is undergoing acceleration with respect to an inertial frame. An accelerometer at rest in a non-inertial frame will, in general, detect a non-zero acceleration.

- A frame of reference where Newton’s Laws hold is known as an inertial frame of reference. 

SOME QUESTIONS

1. What do you mean by law of conservation of momentum?
2. Why do roads on mountains have inward inclination at sharp turns?
3. Why is it dangerous to jump out of a moving bus?
4. How do safety belts of cars help in preventing accidents?
5. Explain how momentum gets conserved in collision of two bodies?
6. How are Newton’s three laws of motion related?
7. Explain inertia and momentum in detail.
8. Define force and its various types. What is its unit?
9. Give three examples exhibiting inertia in our daily life
10. What change will a force bring in a body?
11. From a rifle of mass 5kg, a bullet of mass 50gram is fired with an initial velocity of 50m/s. Calculate the initial recoil velocity of the rifle.
12. Explain how Newton′s second law of motion is used in sports?
13. Why does one get hurt on jumping from a great height to the floor?
14. What is a balanced force?

SOME EXTRA QUESTIONS

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-rupees coin and a one-rupee coin?

Ans. (a) A stone of the same size
(b) a train

(c) a five-rupees coin

As the mass of an object is a measure of its inertia, objects with more mass have more inertia.

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.

Agent supplying the force	Change in velocity of ball
1. First player kicks a football.	Velocity from 'O' changes to 'u'
2. Second player kicks the football towards the goal.	Velocity changes again
3. The goalkeeper collects the football.	Velocity becomes O
4. Goalkeeper kicks it towards a player Of his team	Change in velocity takes place

The velocity of football changed four times.

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

Ans. When the tree's branch is shaken vigorously the branch attain motion but the leaves stay at rest.

Due to the inertia of rest, the leaves tend to remain in its position and hence detaches from the tree to fall down.

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

Ans. When a moving bus brakes to a stop: When the bus is moving, our body is also in motion, but due to sudden brakes, the lower part of our body comes to rest as soon as the bus stops. But the upper part of our body continues to be in motion and hence we fall in forward direction due to inertia of motion.

When the bus accelerates from rest we fall backwards: When the bus is stationary our body is at rest but when the bus accelerates, the lower part of our body being in contact with the floor of the bus comes in motion, but the upper part of our body remains at rest due to inertia of rest. Hence we fall in backward direction.

5. If action is always equal to the reaction, explain how a horse can pull a, cart?

Ans. The third law of motion states that action is always equal to the reaction but they act on two different bodies.

In this case the horse exerts a force on the ground with its feet while walking, the ground exerts an equal and opposite force on the feet of the horse, which enables the horse to move forward and the cart is pulled by the horse.

6. Explain, why is it difficult for a fireman to hold a hose, which ejects a large amount of water at a high velocity.

Ans. The water that is ejected out from the hose in the forward direction comes out with a large momentum and equal amount of momentum is developed in the hose in the opposite direction and hence the hose is pushed backward. It becomes difficult for a fireman to hold a hose which experiences this large momentum.

7. From a rifle of mass 4 kg, a bullet of mass 50 g is fired with an initial velocity of 35 m/s. Calculate the initial recoil velocity of the rifle.

Ans. (m_1) Mass of rifle = 4 kg

(m_2) Mass of bullet = 50 g = 0.05 kg

(v_2) Velocity of bullet = 35 m/s

(v_1) Recoil velocity of rifle = ?

According to the law of conservation of momentum

Momentum of rifle = momentum of bullet

8. Two objects of masses 100 g and, 200 g are moving along the same line and direction with velocities of 2 m/s and 1 m/s respectively.

They collide and after the collision the first object moves at a velocity of 1.67 m/s. Determine the velocity of the second object.

Ans. $m_1 = 100$ g = 0.1 kg

$m_2 = 200$ g = 0.2 kg

$u_1 = 2$ m/s

$u_2 = 1$ m/s

After collision

$v_1 = 1.67$ m/s

$v_2 = ?$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

Questions from NCERT Textbook

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. When an object experiences a net zero external unbalanced force, in accordance with second law of motion its acceleration is zero. If the object was initially in a state of motion, then in accordance with the first law of motion, the object will continue to move in same direction with same speed. It means that the object may be travelling with a non-zero velocity but the magnitude as well as direction of velocity must remain unchanged or constant throughout.

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

Ans. The carpet with dust is in state of rest. When it is beaten with a stick the carpet is set in motion, but the dust particles remain at rest. Due to inertia of rest the dust particles retain their position of rest and falls down due to gravity.

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

Ans. In moving vehicle like bus, the motion is not uniform, the speed of vehicle varies and it may apply brake suddenly or takes sudden turn. The luggage will resist any change in its state of rest or motion, due to inertia and this luggage has the tendency to fall sideways, forward or backward.

To avoid the fall of the luggage, it is tied with the rope.

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) there is a force on the ball opposing the motion.

5. A truck starts from rest and rolls down a hill with a constant acceleration. It travels a distance of 400 m in 20 s. Find its acceleration. Find the force acting on it if its mass is 7 tonnes (Hint : 1 tonne = 1000 kg).

Ans. u = 0 m/s　　　　m = 7 tonnes

s = 400 m　　　　= 7 x 1000 kg

t = 20 s　　　　= 7000 kg

a = ?

F = ?

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?

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 40000 N and the track offers a friction force of 5000 N, then calculate:

(a) the net accelerating force;

(b) the acceleration of the train; and

(c) the force of wagon 1 on wagon 2.

Ans. (a) The net accelerating force = Force exerted by the engine – friction force

= 40000 N – 5000 N = 35000 N

= 35000 N

(b) The acceleration of the train (a) = ?

F = 35000 N

Mass of 5 wagons pulled by engine

= 5 × 2000

= 10000 kg

F = ma

35000 = 10000 × a

(c) The force of wagon 1 on wagon 2

F = ?

Mass of wagon 2 → (2000 × 4)

a = 3.5 m/s^2

F = ma

= 8000 × 3.5

= 28000 N

8. An automobile vehicle has a mass of 1500 kg. What must be the force between the vehicle and road if the vehicle is to be stopped with a negative acceleration of 1.7 ms–2?

Ans. mass = 1500 kg

a = –1.7 m/s^2

F = ?

$F = m \times a$

$= 1500 \times (– 1.7)$

$= – 2550$ N

The force between the vehicle and road is – 2550 N.

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

(a) $(mv)^2$ (b) mv^2

(c) $1/2\ mv^2$ (d) mv

Ans. (d) mv

10. Using a horizontal force of 200 Ar. we intend to move.a wooden cabinet across a floor at a constant velocity, Wl.ot is the friction force that will be exerted on the cabinet?

Ans.

As the wooden cabinet moves across the floor at a constant velocity and the force applied is 200 . Hence the frictional force that will be exerted on the cabinet will be less than 200 N.

11. Two objects each of mass 1.5 kg, are moving in the same straight line but in opposite directions. The velocity of each object is 2.5 ms–1 before the collision during which they stick together. What will be the velocity of the combined object after collision?

Ans. Mass of the objects m1 = m2 = 1.5 kg

Velocity of first object $v_1 = 2.5$ m/s

Velocity of second object $v_2 = – 2.5$ m/s

Momentum before collision = $m_1v_1 = m_2v_2$

$= (1.5 \times 2.5) + (1.5 \times –2.5) = 0$

Momentum after collision = $m_1 + m_2 = 1.5 + 1.5 = 3.0$ kg

After collision v = ?

According to law of conservation of momentum

Momentum before collision = Momentum after collision

$0 = 3 \times v$

$v = 0$

12. According to the third law of motion when we push on 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. The mass of truck is too large and hence its inertia is too high. The small force exerted on the truck cannot move it and the truck remains at rest. For the truck to attain motion, an external large amount of unbalanced force need to be exerted on it.

13. 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 at 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. Mass of ball m = 200 g = 0.2 kg

Initial speed of ball u = 10 m/s

Final speed of ball v = – 5 m/s

Initial momentum of the ball = mu

= 0.2 kg x 10 m/s

= 2 kg m/s

Final momentum of the ball = mv

= 0.2 kg x (_ 5 m/s)

= – 1 kg m/s

Hence, change in momentum

= Difference in the momentum

=2 – (–1)

= 2 + 1 = 3kg m/s

14. A bullet of mass 10 g 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.

∴ The penetration distance of the bullet in the wooden block = 2.25 m.

Magnitude of force F = ma

15. An object of mass 1 kg travelling in a straight line with a velocity of 10 msr' 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. m_1 = 1 kg

v_1 = 10 m/s

Mass of wooden block = 5 kg

m_2 = 5 kg + 1 kg (combined object) = 6 kg

Velocity of combined object = v_2 = ?

p_1 and p_2 = ?

Momentum before impact p = m_1v_1

= 1 × 10 = 10 kg m/s

∴ Momentum before impact

= Momentum after impact

16. 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. m = 100 kg

u = 5 m/s

v = 8 m/s

t = 6s

p_1 = ?

p_2 = ?

F = ?

Initial momentum p_1 = mu

= 100 × 5 = 500 kg m/s

Final momentum p_2 = mv

= 100 × 8 = 800 kg m/s

Force exerted on the object F = ma

17. 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 windscreen. 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 motorcar (because the change in the velocity of 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 on entirely new explanation said that both the motorcar and the insect experienced the same force and a change in their momentum. Comment on these suggestions.

Ans. Rahul gave the correct reasoning and explanation that both the motorcar and the insect experienced the same force and a change in their momentum. As per the law of conservation of momentum.

When 2 bodies collide:

Initial momentum before collision = Final momentum after collision

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

The equal force is exerted on both the bodies but, because the mass of insect is every small it will suffer greater change in velocity.

18. 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. Mass of dumb-bell = 10 kg

Height, h = 80 cm = 0.8 m

$a = 10\ m/s^2$

$u = 0$

$v_2 - u_2 = 2\ as$

$v_2 - (0)^2 = 2 \times 10 \times 0.8$

$v_2 = 16$

$v = 4\ m/s$

Momentum $p = mv$

$= 10 \times 4$

$= 40$ kgm/s

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CLASS 9, SICENCE- 2022-23

Chapter-10

GRAVITATION

Introduction to Gravitation

This chapter discusses gravitation and the universal law of gravitation. The motion of objects under the influence of gravitational force on Earth is also examined closely. Students will also understand how weight varies from place to place and the conditions required for objects to float on water.

What is Gravitation?

Gravitation or just gravity is the force of attraction between any two bodies. All the objects in the universe attract each other with a certain amount of force, but in most cases, the force is too weak to be observed due to the very large distance of separation. Besides, gravity's range is infinite but the effect becomes weaker as objects move away.
Some examples of gravity are:

- The force that causes the ball to come down is known as gravity
- Gravity keeps the planets in orbit around the sun.
- Gravity is the force that causes a rock to roll downhill.

Type of forces

There are four fundamental forces in the universe and they are:

- Gravitational force
- Electromagnetic force
- Strong nuclear force
- Weak nuclear force

Gravitational Force

Gravitational force is the weakest force out of the four forces. When gravitational force is considered for massive objects, such as the sun, or giant planets, the gravitational force is considered to be strong as the masses of these objects are also large. On an atomic level, this force is considered weak.

Electromagnetic Force

The electromagnetic force is a type of physical interaction that occurs between electrically charged particles. It acts between charged particles and is the combination of magnetic and electrical forces. The electromagnetic force can be attractive or repulsive.

Strong Nuclear Force

The strong force holds together quarks, the fundamental particles that make up the protons and neutrons of the atomic nucleus, and further holds together protons and neutrons to form atomic nuclei.

Weak Nuclear Force

Weak force is the force existing between the elementary particles which are responsible for certain processes to take place at a low probability.

The Universal Law of Gravitation

Newton's Law of gravitation states that every object in the universe attracts every other object by a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

$\Rightarrow F \propto M * g$
$F \alpha 1d2$
$F = GMmr2$
where G is the universal gravitation constant.

Value of G = $6.673*10^{-11} Nm^2 Kg^{-2}$

Acceleration due to Gravity

$F = mg$
and also,

$F = GMmR2$
$g = GMmR2$
Plug the values of G ($6.673*10^{-11} Nm^2 Kg^{-2}$)

M(mass of Earth) = $6 * 10^{24}$ kg and R= $6 * 10^{6}$ m , to get the value of gas $\approx 9.8 ms^{-2}$

This is the acceleration due to gravity and the acceleration felt by any freely falling body towards the Earth.

The value of g keeps changing due to the variation of Earth's radius.

The Moon's Falling – Moon's revolution around Earth

The moon revolves around the Earth due to centripetal force, which is the force of gravity of the Earth. If the force of attraction between the Earth and the moon ceases, then the moon will continue to travel in a straight line path tangential to its orbit around the Earth.

Centripetal force

When a body undergoes circular motion, it experiences a force that acts towards the centre of the circle. This centre-seeking force is called a centripetal force. Centripetal force is given by the following equation:

$F = mv2r$

Free Fall and Motion

When an object is under free fall, acceleration due to gravity is constant at $g = 9.8ms^{-2}$.

Value of g does not depend on mass i.e any object big or small experiences the same acceleration due to gravity under free fall. All three equations of motion are valid for freely falling objects as it is under uniform motion.

The sign of convention → towards earth g is +ve / away from earth g is -ve.

Weight and Mass

The mass of an object is the measure of its inertia and is constant throughout the universe. The weight of an object keeps changing as the value of g changes. Weight is nothing but a force of attraction of the Earth on an object and is given by the following equation:
$W=mg$

The weight of an object on the Moon is 1/6 times the weight on Earth.

Thrust and Pressure

Force acting on an object perpendicular to the surface is called thrust. The effect of thrust depends on the area of contact. The pressure is thrust per unit area. SI unit is the pascal (Pa). Force acting on a smaller area applies more pressure than the same force acting on a larger area.

Pressure in fluids

The pressure exerted by a fluid in a container is transmitted undiminished in all directions on the walls of the container.

Archimedes' Principle – Why objects float or sink

The upward force exerted by a fluid on an object is known as upthrust or buoyant force.

The magnitude of buoyancy depends on the density of the fluid. If the density of an object is less than the fluid, it will float. If the density of the object is greater than the fluid, it will sink.

According to the Archimedes' principle, when a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by it.

- Kepler's first law – The law of orbits
- Kepler's second law – The law of equal areas
- Kepler's third law – The law of periods

The orbit of a planet is an ellipse with the sun as its foci. The line joining the planets and the sun sweeps equal areas in equal intervals of time.

Cube of a mean distance of a planet from the sun ∝ Square of orbital time period T.

SOME IMPORTANT QUESTIONS

1. State the universal law of gravitation.

Solution:

The universal law of gravitation states that every object in the universe attracts every other object with a force called the gravitational force. The force acting between two objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers.

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

Solution:

Consider F as the force of attraction between an object on the surface of earth and the earth

Also, consider 'm' as the mass of the object on the surface of earth and 'M' as the mass of earth

The distance between the earth's centre and object = Radius of the earth = R

Therefore, the formula for the magnitude of the gravitational force between the earth and an object on the surface is given as

$F = G\ Mm/R^2$

1. What do you mean by free fall?

Solution:

Earth's gravity attracts each object to its center. When an object is dropped from a certain height, under the influence of gravitational force it begins to fall to the surface of Earth. Such an object movement is called free fall.

2. What do you mean by acceleration due to gravity?

Solution:

When an object falls freely from a certain height towards the earth's surface, its velocity keeps changing. This velocity change produces acceleration in the object known as acceleration due to gravity and denoted by 'g'.

The value of the acceleration due to gravity on Earth is,

$$g = \frac{9.8m}{s^2}$$

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

Solution:

The differences between the mass of an object and its weight are tabulated below.

Mass	Weight
Mass is the quantity of matter contained in the body.	Weight is the force of gravity acting on the body.

It is the measure of inertia of the body.	It is the measure of gravity.
It only has magnitude.	It has magnitude as well as direction.
Mass is a constant quantity.	Weight is not a constant quantity. It is different at different places.
Its SI unit is kilogram (kg).	Its SI unit is the same as the SI unit of force, i.e., Newton (N).

4. Why is the weight of an object on the moon 1/6th its weight on the earth?

Solution:

The mass of the moon is 1/100 times and its radius 1/4 times that of earth. As a result, the gravitational attraction on the moon is about one-sixth when compared to earth. The moon's gravitation force is determined by the mass and the size of the moon. Hence, the weight of an object on the moon is 1/6th its weight on the earth. The moon is far less massive than the Earth and has a different radius(R) as well.

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

Solution:

It is tough to carry a school bag having a skinny strap because of the pressure that is being applied on the shoulders. The pressure is reciprocally proportional to the expanse on which the force acts. So, the smaller the surface area, the larger is going to be the pressure on the surface. In the case of a skinny strap, the contact expanse is quite small. Hence, the pressure exerted on the shoulder is extremely huge.

6. What do you mean by buoyancy?

Solution:

The upward force possessed by a liquid on an object that's immersed in it is referred to as buoyancy.

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

Solution:

An object floats or sinks when placed on the surface of water because of two reasons.

(i) If its density is greater than that of water, an object sinks in water.

(ii) If its density is less than that of water, an object floats in water.

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

Solution:

A weighing machine measures the body weight and is calibrated to indicate the mass. If we stand on a weighing machine, the weight acts downwards while the upthrust due to air acts upwards. So our apparent weight becomes less than the true weight. This apparent weight is measured by the weighing machine and therefore the mass indicated is less than the actual mass. So our actual mass will be more than 42 kg.

9. 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?

Solution:

The correct answer is the cotton bag is heavier than an iron bar. The bag of cotton is heavier than the bar of iron. The cotton bag experiences a larger air thrust than the iron bar. Therefore, the weighing machine indicates less weight than its actual weight for the cotton bag. The reason is

True weight = (apparent weight + up thrust)

The cotton bag's density is less than that of the iron bar, so the volume of the cotton bag is more compared to the iron bar. So the cotton bag experience more upthrust due to the presence of air.

Therefore, in the presence of air, the cotton bag's true weight is more compared to the true weight of the iron bar.

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

Solution:

Consider the Universal law of gravitation,

According to that law, the force of attraction between two bodies is

$$F = \frac{(Gm_1m_2)}{r^2}$$

Where,

m_1 and m_2 are the masses of the two bodies.

G is the gravitational constant.

r is the distance between the two bodies.

Given that the distance is reduced to half then,

r = 1/2 r

Therefore,

$$F = \frac{(Gm_1m_2)}{r^2}$$

$$F = \frac{(Gm_1m_2)}{(^r/_2)^2}$$

$$F = \frac{(4Gm_1m_2)}{(r)^2}$$

F = 4F

Therefore once the space between the objects is reduced to half, then the force of gravitation will increase by fourfold the first force.

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

Solution:

All objects fall from the top with a constant acceleration called acceleration due to gravity (g). This is constant on earth and therefore the value of 'g' doesn't depend on the mass of an object. Hence, heavier objects don't fall quicker than light-weight objects provided there's no air resistance.

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

Solution:

From Newton's law of gravitation, we know that the force of attraction between the bodies is given by

$$F = \frac{(Gm_1m_2)}{r^2}$$

Here

m_1 = mass of Earth = 6.0×10^{24}kg

m_2 = mass of the body = 1kg

r = distance between the two bodies

Radius of Earth = 6.4×10^6m

G = Universal gravitational constant = 6.67×10^{-11} Nm^2kg^{-2}

By substituting all the values in the equation

$$F = \frac{(Gm_1m_2)}{r^2}$$

$$F = \frac{6.67 \times 10^{-11} \quad (6.0 \times 10^{24} \times 1)}{(6.4 \times 10^6)^2}$$

F = 9.8 N

This shows that Earth exerts a force of 9.8 N on a body of mass 1 kg. The body will exert an equal force of attraction of 9.8 N on the Earth.

13. 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?

Solution:

The earth attracts the moon with a force same as the force with which the moon attracts the earth. However, these forces are in opposite directions. By universal law of gravitation, the force between moon and also the sun can be

$$F = \frac{(Gm_1m_2)}{d^2}$$ Where,

d = distance between the earth and moon.

m_1 and m_2 = masses of earth and moon respectively.

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

Solution:

According to the universal law of gravitation and Newton's third law, we all know that the force of attraction between two objects is the same, however in the opposite directions. So the earth attracts the moon with a force same as the moon attracts the earth but in opposite directions. Since earth is larger in mass compared to that of the moon, it accelerates at a rate lesser than the acceleration rate of the moon towards the Earth. Therefore, for this reason the earth does not move towards the moon.

15. 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 objects are doubled?

Solution:

(i)

According to universal law of gravitation, the force between 2 objects (m_1 and m_2) is proportional to their plenty and reciprocally proportional to the sq. of the distance(R) between them.

$$F = \frac{(G2m_1m_2)}{R^2}$$

If the mass is doubled for one object.

F = 2F, so the force is also doubled.

(ii)

If the distance between the objects is doubled and tripled

If it's doubled

Hence,

$F = (Gm_1m_2)/(2R)^2$

$F = 1/4\ (Gm_1m_2)/R^2$

$F = F/4$

Force thus becomes one-fourth of its initial force.

Now, if it's tripled

Hence,

$F = (Gm_1m_2)/(3R)^2$

$F = 1/9\ (Gm_1m_2)/R^2$

$F = F/9$

Force thus becomes one-ninth of its initial force.

(iii)

If masses of both the objects are doubled, then

$$F = \frac{(G2m_1 2m_2)}{R^2}$$

F = 4F, Force will therefore be four times greater than its actual value.

16. What is the importance of universal law of gravitation?

Solution:

The universal law of gravitation explains many phenomena that were believed to be unconnected:

(i) The motion of the moon round the earth

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

(iii) The tides because of the moon and therefore the Sun

(iv) The motion of planets round the Sun

17. What is the acceleration of free fall?

Solution:

Acceleration due to gravity is the acceleration gained by an object due to gravitational force. On Earth, all bodies experience a downward force of gravity which Earth's mass exerts on them. The Earth's gravity is measured by the acceleration of the freely falling objects. At Earth's surface, the acceleration of gravity is 9.8 ms^{-2} and it is denoted by 'g'. Thus, for every second an object is in free fall, its speed increases by about 9.8 metres per second.

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

Solution:

The gravitation force between the earth and an object is called weight. Weight is equal to the product of acceleration due to the gravity and mass of the object.

19. 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 the weight of gold bought? If not, why? [Hint: The value of g is greater at the poles than at the equator.]

Solution:

The weight of a body on the earth's surface;

W = mg (where m = mass of the body and g = acceleration due to gravity)

The value of g is larger at poles when compared to the equator. So gold can weigh less at the equator as compared to the poles.

Therefore, Amit's friend won't believe the load of the gold bought.

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

Solution:

A sheet of paper has a larger surface area when compared to a crumpled paper ball. A sheet of paper will face a lot of air resistance. Thus, a sheet of paper falls slower than the crumpled ball.

21. Gravitational force on the surface of the moon is only 1/6 as strong as gravitational force on the earth. What is the weight in newton's of a 10 kg object on the moon and on the earth?

Solution:

Given data:

Acceleration due to earth's gravity = g_e or g = 9.8 m/s^2

Object's mass, m = 10 kg

Acceleration due to moon gravity = g_m

Weight on the earth= W_e

Weight on the moon = W_m

Weight = mass x gravity

$g_m = (1/6)\ g_e$ (given)

So $W_m = m\ g_m = m \times (1/6)\ g_e$

$W_m = 10 \times (1/6) \times 9.8 = 16.34$ N

$W_e = m \times g_e = 10 \times 9.8$

$W_e = 98$N

22. 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.

Solution:

Given data:

Initial velocity u = 49 m/s

Final speed v at maximum height = 0

Acceleration due to earth gravity g = -9.8 m/s^2 (thus negative as ball is thrown up).

By third equation of motion,

$2gH = v^2 – u^2$

$2 × (- 9.8) × H = 0 – (49)^2$

$– 19.6 H = – 2401$

H = 122.5 m

Total time T = Time to ascend (T_a) + Time to descend (T_d)

v = u + gt

$0 = 49 + (-9.8) x T_a$

Ta = (49/9.8) = 5 s

Also, T_d = 5 s

Therefore $T = T_a + T_d$

T = 5 + 5

T = 10 s

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

Solution:

Given data:

Initial velocity

u = 0

Tower height = total distance = 19.6m

g = 9.8 m/s^2

Consider third equation of motion

$v^2 = u^2 + 2gs$

$v^2 = 0 + 2 × 9.8 × 19.6$

$v^2 = 384.16$

$v = \sqrt{(384.16)}$

v = 19.6m/s

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

Solution:

Given data:

Initial velocity u = 40m/s

g = 10 m/s^2

Max height final velocity = 0

Consider third equation of motion

$v^2 = u^2 – 2gs$ [negative as the object goes up]

$0 = (40)^2 – 2 \times 10 \times s$

s = (40 x 40) / 20

Maximum height s = 80m

Total Distance = s + s = 80 + 80

Total Distance = 160m

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

25. Calculate the force of gravitation between the earth and the Sun, given that the mass of the earth = 6 × 10^{24} kg and of the Sun = 2 × 10^{30} kg. The average distance between the two is 1.5 × 10^{11} m.

Solution:

Given data:

Mass of the sun $m_s = 2 \times 10^{30}$ kg

Mass of the earth $m_e = 6 \times 10^{24}$ kg

Gravitation constant $G = 6.67 \times 10^{-11}$ N m^2/ kg^2

Average distance $r = 1.5 \times 10^{11}$ m

Consider Universal law of Gravitation

$$F = \frac{(Gm_1m_2)}{d^2}$$

$$F = \frac{(6.67 \times 10^{-11} \times 6 \times 10^{24} \times 2 \times 10^{30})}{(1.5 \times 10^{11})^2}$$

$F = 3.56 \times 10^{22}$ N

26. A stone is allowed to fall from the top of a tower 100 m high 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.

Solution:

Given data:

(i) When the stone from the top of the tower is thrown,

Initial velocity u' = 0

Distance travelled = x

Time taken = t

Therefore,

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

$x = 0 + (1/2)\ gt^2$

$x = 5t^2$ ---------(a)

(ii) When the stone is thrown upwards,

Initial velocity u = 25 m/s

Distance travelled = (100 – x)

Time taken = t

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

$(100 - x) = 25t - (1/2) \times 10 \times t^2$

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

From equations (a) and (b)

$5t^2 = 100 - 25t + 5t^2$

t = (100/25) = 4sec.

After 4sec, two stones will meet

From (a)

$x = 5t^2 = 5 \times 4 \times 4 = 80$m.

Putting the value of x in (100-x)

= (100-80) = 20m.

This means that after 4sec, 2 stones meet a distance of 20 m from the ground.

27. A ball thrown up vertically returns to the thrower after 6 s. Find

(a) The velocity with which it was thrown up,

(b) The maximum height it reaches, and

(c) Its position after 4s.

Solution:

Given data:

$g = 10m/s^2$

Total time T = 6sec

$T_a = T_d = 3sec$

(a) Final velocity at maximum height v = 0

From first equation of motion:-

$v = u - gt_a$

$u = v + gt_a$

= 0 + 10 x 3

= 30m/s

The velocity with which stone was thrown up is 30m/s.

(b) From second equation of motion

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

$= 30 \times 3 - (1/2) \times 10 \times (3)^2$

= 90-45 = 45m

The maximum height stone reaches is 45m.

(c) In 3sec, it reaches the maximum height.

Distance travelled in another 1sec = s'

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

s = 0 + 10 x 1 x 1

s = 5m.

The distance travelled in another 1sec = 5m.

Therefore in 4sec, the position of point p (45 – 5)

= 40m from the ground.

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

Solution:

The buoyant force on an object that is immersed in a liquid will be in a vertically upward direction.

29. Why a block of plastic when released under water come up to the surface of water?

Solution:

The density of plastic is lesser than that of water. Therefore, the force of buoyancy on plastic block will be greater than the weight of plastic block. Hence, the acceleration of plastic block is going to be in the upward direction. So, the plastic block comes up to the surface of water.

30. The volume of 50 g of a substance is 20 cm^3. If the density of water is 1 g cm^{-3}, will the substance float or sink?

Solution:

To find the Density of the substance the formula is

Density = (Mass/Volume)

Density = (50/20) = 2.5g/cm^3

Density of water = 1g/cm^3

Density of the substance is greater than density of water. So the substance will sink.

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

Solution:

Density of sealed packet = 500/350 = 1.42 g/cm^3

Density of sealed packet is greater than density of water

Therefore the packet will sink.

Considering Archimedes Principle,

Displaced water volume = Force exerted on the sealed packet.

Volume of water displaced = 350cm^3

Therefore displaced water mass = ρ x V

= 1 × 350

Mass of displaced water = 350g.

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CLASS 9, SICENCE- 2022-23

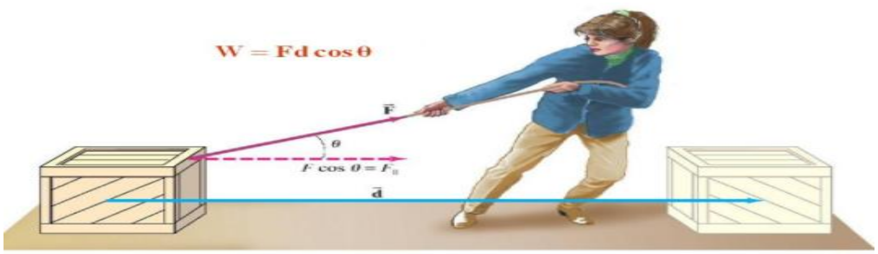
Chapter-11

WORK AND ENERGY

Work

Work done on an object is defined as the product of the magnitude of the force acting on the body and the displacement in the direction of the force. **W = F.s**. The SI unit of force is Newton.

If a force acting on a body causes no displacement, the work done is 0. For example, pushing a wall.



The force component F cos θ gives the component of force along the direction that the body is displaced. Cos θ is the angle between the force vector and displacement vector.

Energy

Energy is defined as the ability to do work. Its unit is the same as that of work. Energy is a scalar quantity.

SI unit of energy or work = Joule (Nm) or Kgm2s−2.

Forms of Energy

Energy has different forms: Light, heat, chemical, electrical or mechanical.
Mechanical energy is the sum of:
(i) Kinetic energy (K.E)
(ii) Potential energy (P.E)

Kinetic Energy

Objects in motion possess energy and can do work. This energy is called Kinetic Energy.
F=ma Also, W=Fs
From the second equation of motion, we know that
$v^2 = u^2 + 2as$ OR $v^2 - u^2 = 2as$
Rearranging the equation, we get
$s = \frac{v^2 - u^2}{2a}$
Substituting equation for work done by a moving body,
W= FXs OR $W=(m\times a)\left(\frac{v^2 - u^2}{2a}\right)$

Taking intial velocity as zero, we get

KE=½ m v^2

When two identical bodies are in motion, the body with a higher velocity has more K.E.

Work-energy theorem

The work-energy theorem states that the net work done by a moving body can be calculated by finding the change in KE.

⇒ W net = KE final − KE $_{\text{initial}}$

⇒ W net= ½.m[v^2 - u^2]

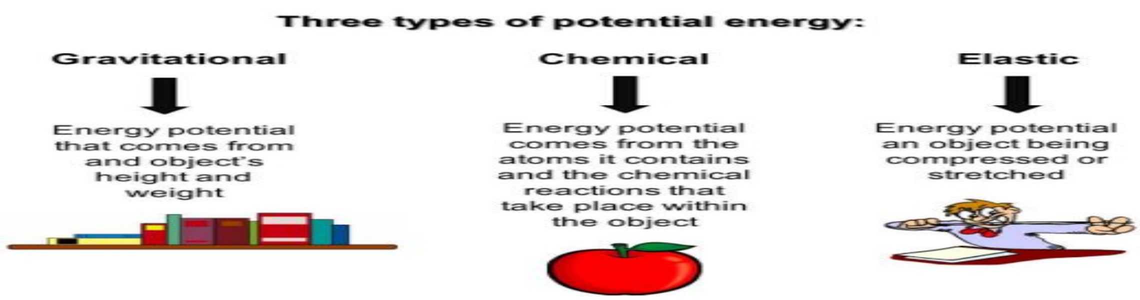
Factors affecting kinetic energy

- Mass
- Velocity
- Momentum

Potential Energy

Energy can get stored in an object when work is done on it.

For example, stretching a rubber string. The energy that is possessed by a body by virtue of its configuration or change in position is known as Potential Energy.



The potential energy of an object at a height.

When an object is raised to a certain height, work is done against gravity to change its position. This energy is stored as Potential Energy.

⇒W = F.s

⇒F = ma

In the case of increasing the height, F = mg

Therefore , **W (P.E) = m.g.h**

⇒ ΔPE=mg(h final−h initial)

Law of Conservation of Energy

Law of conservation of energy states that energy can neither be created nor destroyed, but can be transferred from one form to another. The total energy before and after the transformation remains constant.

Total energy = KE + PE
where, $\frac{1}{2}$ $mv^2 + mgh$ = constant
For example: consider a ball falling freely from a height. At height h, it has only PE = mgh.

By the time it is about to hit the ground, it has a velocity and therefore has KE= 12 mv2. Therefore, energy gets transferred from PE to KE, while the total energy remains the same.

Power

The rate of doing work or the rate of transfer of energy is called power. It is denoted by P
⇒ P =Wt

SI unit is Watt (Js−1).

Average power = Total energy consumed/Total time taken

SOME QUESTIONS

Question.1 Does work done depend upon the velocity of the body.
Answer. No.
Question.2 State the law of conservation of energy.
Answer. It states that energy can neither be created nor destroyed. It can only change its form.
Question.3 In a tug-of-war one team gives way to the other. What work is being done and by whom ?
Answer.
The winning team does work. The work is equal to the product of the resultant force and the displacement undergone by the losing team.
Question.4 What will cause greater change in kinetic energy of a body? Changing its mass or changing its velocity?
Answer. Changing its velocity.
Question.5 List two essential conditions for work to be done.
Answer. (i) A force must act and (ii) There should be displacement in the body.
Question.6 When is 1 joule of work said to be done?
Answer. When a force of 1 newton acting on a body displaces it in its own direction.
Question.7 What is the SI unit of work done and power ?
Answer. Joule and Watt.
Question.8 What is power? What is its SI unit ?
Answer. It is defined as the rate of doing work. Its unit is watt.
Question.9 Find the energy in kWh consumed in 10 hours by a machine of power 500 W.
Answer. W = P x t = 500 x 10 = 5000 Wh – 5 kWh.
Question.10. When is work said to be done against the force of gravity?
Answer. When a body lifted the work is done against the force of gravity.
Question.11 Write an expression for the work done in lifting a body of mass ‘m’ through a vertical height ‘h’.
Answer. Work done W = mgh, where g is acceleration due to gravity.

Question.12 When a book is lifted from a table, against which force work is done?
Answer. Work is done against the force of gravity.
Question.13 Will work be done by a man who pushes a wall?
Answer. No.
Question.14 What is the work done when the force acting on the body and the displacement produced in the body are at right angles to each other?
Answer. Zero.
Question.15 Is it possible that some force is acting on a body but still the work done is zero?
Answer. Yes, when force acts at an angle of 90° with the displacement.
Question.16 What is the work done on a body moving in a circular path?
Answer. Zero, because force and displacement are perpendicular to each other.
Question.17 Does every change in energy of the body involve work?
Answer. Yes.
Question.18 What is the work done in the situation shown below?
Answer. Zero.
Question.19 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 the displacement. What is the work done in this case?
Answer.
Given, displacement = 8 m,
Force = 7N
Now, Work done = Force x Displacement
= 7 x 8 = 56 J
Question.20 When do we say that work is done ? ~
Answer.
Work is said to be done when a force causes displacement of an object in the direction of applied force.
Question.21 Write an expression for the work done when a force is acting on an object in the direction of its displacement.
Answer.
Work done = Force x Displacement
Question.22 A pair of bullocks exert 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 ?
Answer.
Work done = Force x Displacement = 140 x 15 = 2100 J
Question.23 What is the kinetic energy of an object?
Answer.
The energy possessed by a body by virtue of its motion is called kinetic energy.
Question.24 Write an expression for the kinetic energy of an object.
Answer.
The expression is KE = 1/2 mv^2, where 'm' is the mass and V is the velocity of the body.
Question.25 Define 1 watt of power.
Answer.
When a work of 1 joule is done in 1s, the power is said to be one watt.
Question.26 A lamp consumes 1000 J of electrical energy in 10 s. What is its power ?
Answer.

Given, W = 1000 J, t = 10 s, R = ?
Using p = W/t = 1000/10 = 100 W
Question.27 Define average power.
Answer.
When a machine or person does different amounts of work or uses energy in different intervals of time, the ratio between the total work or energy consumed to the total time is average power.
Question.28 Define energy.
Answer.
Energy is the ability of a body to do work. It is also defined as the capacity to do work.
Question.29 A body performs no work. Does it imply that the body possesses no energy ?
Answer.
When a body does not perform any work, it never implies that the body has no energy. The body may have energy but still does not perform any work, e.g., a book placed on a table has potential energy but is not performing any work.
Question.30 What is the SI unit of energy?
Answer.The SI unit of energy is joule.
Question.31 Does a body at rest possess any kinetic energy ?
Answer.No.
Question.32 What will happen to the kinetic energy of a body if its mass is doubled ?
Answer. Its kinetic energy will be doubled.
Question.33 What will happen to the kinetic energy of a body if its velocity is halved?
Answer. The kinetic energy of the body will become one-fourth.
Question.34 By how much will the speed of a body, of fixed mass, increase if its kinetic energy becomes four times its initial kinetic energy ?
Answer. The speed is doubled.
Question.35 Can a body possess energy even if it is not in motion ?
Answer. Yes, it can possess potential energy.
Question.36 Define potential energy.
Answer. It is defined as the energy possessed by a body by virtue of its position or change in shape.
Question.37 Name the energy possessed by a stretched rubber band lying on the table.
Answer. Potential energy.

Question.38 Give the SI unit of potential energy.
Answer. The SI unit of potential energy is.joule.
Question.39 What do you mean by trans- formation of energy ?
Answer. It is the change of energy from one form of energy into another form of energy.
Question.40 Can energy be destroyed? Can energy be created ?
Answer. No,
Question.41 A cell converts one form of energy into another. Name the two forms.
Answer.
It converts chemical energy into electrical energy.
Question.42 Name one unit of power bigger than watt.
Answer. A unit bigger than watt is kilowatt.
Question.43 When an arrow is shot from its bow, it has kinetic energy. From where does it get the kinetic energy ?

Answer.
A stretched bow possesses potential energy on account of a change in its shape. To shoot an arrow; the bow is released. The potential energy of the bow is converted into the kinetic energy of the arrow.
Question.44 Name at least three commonly used units of energy.
Answer. (i) Joule (ii) Erg (iii) Kilowatt hour.
Question.45 Name the practical unit of power in engineering.
Answer. Horsepower.
Question.46 Name at least six forms of energy.
Answer.
(i) Chemical energy
(ii) Heat energy
(iii) Light energy
(iv) Electrical energy
(v) Sound energy
(vi)Solar energy
Question.47 How many watt are there in 1 horse – power ?
Answer. 746 watt.
Question.48 What is horsepower ?
Answer. It is a unit of power.
Question.49 A light and a heavy body have equal kinetic energy. Which one is moving fast ?
Answer. The lighter body is moving fast.

2 MARKS QUESTIONS

Question.1 State the relation between kW h and joule. Define 1 watt.
Answer.
1 kW h – 1000 W h = 1000 Js^{-1} x 60 x 60 s = 3.6 x 10^6 J
1 watt is the power of an agent which can do one joule of work in one second.
Question.2 Is it possible that a body be in accelerated motion under a force acting on the body, yet no work is being done by the force? Explain your answer giving a suitable example.
Answer. Yes, it is possible, when the force is perpendicular to the direction of motion. The moon revolving round the earth under the centripetal force of attraction of the earth but earth does not do any work on the motion of The moon.
Question.3 Define work. How is work measured ? When is work done by a force negative?
Answer. Work is said to be done if force acting on an object displaces it through a certain distance.
It is measured as the product of force and displacement.
Work done is negative if force and displacement are in the opposite direction.
Question.4 What is the work done by the force of gravity in the following cases ?
(a) Satellite moving around the earth in a circular orbit of radius 35000 km.
(b) A stone of mass 250 g is thrown up through a height of 2.5 m.
Answer.
(a) Zero, as the displacement in one complete revolution is zero.
(b) Given m = 250 g = 0.25 kg, h = 2.5 m, g = 10 ms^{-2}, W = ?
Now, W = FS = mg x h = 0.25 x 10 x 2.5 = 6.25 J

Question.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.
Answer. The work done is zero. This is because the gravitational force and displacement are perpendicular to each other.
Question.6 The potential energy of a freely falling object decreases progressively. Does this violate the law of conservation of energy? Why?
Answer. It does not violate the law of conservation of energy. Whatever, is the decrease in PE due to loss of height, same is the increase in the KE due to increase in velocity of the body.
Question.7 What are the various energy transformations that occur when you are riding a bicycle?
Answer. The chemical energy of the food changes into heat and then to muscular energy. On paddling, the muscular energy changes into mechanical energy.
Question.8 Does the transfer of energy take place when you push a huge rock with all your might and fail to move it? Where is the energy you spend going?
Answer. Energy transfer does not take place as no displacement takes place in the direction of applied force; the energy spent is used to overcome inertia of rest of the rock.
Question.9 An object thrown at a certain angle to the ground moves in a curved path and falls back to the ground. The initial and the 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 ?
Answer. Since the body returns to a point which is on the same horizontal line through the point of projection, no displacement has taken place against the force of gravity; therefore, no work is done by the force due to gravity.
Question.10 A battery lights a bulb. Describe the energy changes involved in the process.
Answer. Within the electric cell of the battery the chemical energy changes into electrical energy. The electric energy on flowing through the filament of the bulb, first changes into heat energy and then into the light energy.
Question.11 What is the work done by the force of gravity on a satellite moving round the earth? Justify your answer.
Answer. The work done by the force of gravity on the satellite is zero because the force of gravity acts at right angles to the direction of motion of the satellite. Therefore, no displacement is caused in the direction of applied force. The force of gravity only changes the direction of motion of the i satellite.
Question.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.
Answer. The answer is. both Yes and No. Yes, because when an object moves in deep space from one
point to another point in a straight line, the displacement takes place, without the application of force. No, because force cannot be zero for displacement on the surface of earth. Some force is i essential.
Question.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.
Answer. The person does not do work because no displacement takes place in the direction of applied force as the force acts in the vertically upward direction.

Question.14 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 ?
Answer. Work done to bring the object to rest is equal change in kinetic energy of the object.
Question.15 Soni says that the acceleration in an object could be zero even when several forces are acting on it. Do you agree with her ? Why ?
Answer. Yes, we do agree when the number of forces act on a body, such that they constitute balanced forces, then net force acting on the body is zero. In such a situation no acceleration acts on the object.
Question.16 A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy ?
Answer. The KE on reaching the ground changes into heat energy, sound energy etc. and, therefore, gets dissipated in air.
Question.17 What kinds of energy transformations take place at a thermal power station ?
Answer. At a thermal power station, the chemical energy of coal is changed into heat energy which is further changed into electrical energy with the help of an electric generator.
Question.18 Name the transformation of energy involved in the following cases :
(a) When a body is thrown upwards.
(b) When a body falls from the top of a hill.
(c) When coal burns.
(d) When a gas bums.
(e) When water falls from a height.
Answer.
(a) Kinetic energy into potential energy.
(fa) Potential energy into kinetic energy.
(c) Chemical energy into heat energy.
(cf) Chemical energy into heat energy.
(e) Potential energy into kinetic energy.
Question.19 What are the factors on which the work done depends ?
Answer.The work done by a force depends upon:
(i) The magnitude of the force.
(ii) The magnitude of the displacement and
(iii) The angle between force and displacement.
Question.20 How are kinetic energy and momentum related ?
Answer.
Question.21 What is the work done by a coolie walking on a horizontal platform with a load on his head ?
Answer. In order to balance the load on his head, the coolie applies a force on it in the upward direction, equal to its weight. His displacement is along the horizontal direction. Thus, the angle between force F and displacement is 90°. Therefore, work done $W = FS \cos \theta = FS \cos 90° = 0$.
Question.22 We wind our watch once a day, what happens to the energy ?
Answer. When we wind our watch, we wind the spring inside the watch. As a result, energy is stored in the spring in the form of elastic potential energy. This elastic potential energy is used to make the watch work the whole day. .
Question.23 What is the amount of work done by a force when a body moves in a circular path ?
Answer. Work done is given by the expression $W = FS \cos \theta$. When a body moves in a circular path, then the displacement (S) is zero. Therefore, work done is $W = F \times 0 = 0$.

3 MARKS QUESTIONS

Question.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'
(i) Suma is swimming in a pond.
(ii) A donkey is carrying a load on its back.
(iii) A wind-mill is filling water from a well.
(iv) A green plant is carrying out photosynthesis.
(v) An engine is pulling a train.
(vi)Food grains are getting dried in the sun.
(vii) A sailboat is moving due to wind energy.
Answer.
(i) Work is done because the displacement of swimmer takes place in the direction of applied force.
(ii) If the donkey is not moving, no work is done as the displacement of load does not take place in the direction of applied force.
(iii) Work is done, as the displacement takes place in the direction of force.
(iv) No work is done, because no displacement takes place.
(v) Work is done, because displacement takes place in the direction of applied force.
(vi)No work is done, because displacement does not take place.
(vii)Work is done because displacement takes place in the direction of the force.

Question.2 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 the law of conservation of energy ?
Answer. When the pendulum bob is pulled (say towards left), the energy supplied is stored in it is the form of PE on account of its higher position. When the pendulum is released so that it stars moving towards right, then its PE changes into KE, such that in mean position, it has maximum KE, and zero PE. As the pendulum moves towards extreme right, its -KE changes into PE such that at the extreme position, of has maximum PE and zero KE. When it moves from this extreme position to mean position, its PE again changes to KE. This illustrates the law of conservation of energy. Eventually, the bob comes to rest, because during each oscillation a part of the energy possessed by it transferred to air and- m overcoming friction at the point of suspension. Thus, the energy of the pendulum is dissipated in air.
The law of conservation of energy is not violated because the energy merely changes its form and is not destroyed.

Question.3 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.

Question.4 Distinguish between work, energy and power. State the SI units for each of these quantities.
Answer.
Work: It is defined as the product of force applied and the distance moved by the body on the application of the force. In SI it is measured in joule.
Energy : It is defined as the capacity of a body to do work. In SI it is measured in joule.
Power: It is defined as the rate of doing work. It measures how fast or slow the work is done. In SI it is measured in watt.

5 MARKS QUESTIONS

Question.1 Calculate the electricity bill amount for a month of 31 days, if the following devices are used as specified :
(a) 3 bulbs of 40 W for 6 hours.
(b) 4 tubelights of 50 W for 8 hours,
(c) A TV of 120 W fro 6 hours.
Give the rate of electricity is Rs 2.50 per unit.
Answer.
Question.2
(a) What is meant by mechanical energy ? State its two forms. State the law of conservation of energy. Give an example in which we observe a continuous change of one form of energy into another and vice-versa.
(b) Calculate the amount of work required to stop a car of 1000 kg moving with a speed of 72 km h”1.
Answer.
(a) It is the sum of KE and PE of an object. It states that energy can neither be created nor be destroyed. We observe a continuous change in energy in a simple pendulum and its : explanation. At the mean position, the energy is wholly kinetic while at the extreme position it is wholly potential. As the pendulum oscillates its energy continuously changes between kinetic and potential.
Question.3 State the law of conservation of energy? Show that when a body falls from a certain height the total mechanical energy remains conserved.
Question.4
(a)Derive an expression for kinetic energy of a body having mass m and moving with a velocity v.
(b)When velocity of a body is increased 5 times, what is the change in its kinetic energy ?
(c)Two masses m and 2m are dropped from heights h and 2h. On reaching the ground, which will have greater kinetic energy and why ?
Answer.
(a)For derivation see above questions.
(b)Kinetic energy is given by the expression
KE = 1/2 mv^2, therefore, if velocity is made 5 times KE will increase by 25 times.
(c)More the potential energy more will be the kinetic energy of the body when it falls. Hence, the body with mass 2m will have greater kinetic energy as it has more potential energy.

Question.5
(a)State the law of conservation of energy.
(b)What is the work done to increase the velocity of a car from 36 km h-1 to 72 km h~1 if the mass of the car is 1500 kg ? Does the work done by the force have a negative or a positive magnitude ?
(c)Where does an oscillating pendulum have maximum PE and KE ?

APPLICATION BASED QUESTIONS

Question.1 A light body and a heavy body have the same kinetic energy. Which one will have the greater momentum ?
Question.2 A light and a heavy body have the same momentum. Which one will have greater kinetic energy ?
Answer.
Question.3
(a) Can a body have energy without having momentum ? Explain.
(b) Can a body have momentum without having energy ? Explain.
Question.4 When an arrow is shot from its bow, it has kinetic energy. From where does it get the kinetic energy ?
Answer. A stretched bow possesses potential energy on account of a change in its shape. To shoot an arrow; the bow is released. The potential energy of the bow is converted into the kinetic energy of the arrow.

Question.5 A spring which has been kept compressed by tying its ends together is allowed to be dissolved in an acid. What happens to the potential energy of the spring ?
Answer. The PE of the spring gets converted into KE of acid molecules whose temperature rises.

Higher Order Thinking Skills (HOTS) Questions

Question.1 justify giving proper reasoning whether the work done in the following cases is positive or negative :
(a) Work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket.
(b) Work done by gravitational force in the above case.
(c) Work done by friction on a body sliding down an inclined plane.
(d) Work done by an applied force on a body moving on a rough horizontal plane with uniform velocity.
(e) Work done by resistive force of air on a vibrating pendulum in bringing it to rest.
Answer.
(a) Work done is positive as the bucket moves in the direction of force applied by the man.
(b) Work done by the gravitational force is negative, as the bucket moves upwards i.e., opposite to the gravitational force.
(c) Work done is negative, as frictional force acts opposite to the direction of motion of the body.
(d) Work done is positive because applied force acts along the same direction as the direction of motion of the body.

(e) Work done is negative because the resistive force of air always acts opposite of the direction of motion of the vibrating*pendulum.

Question.2 What is the work done by a coolie walking on a horizontal platform with a load on his head?
Answer. In order to balance the load on his head, the coolie applies a force on it in the upward direction, equal to its weight. His displacement is along the horizontal direction. Thus, the angle between force F and displacement is 90°. Therefore, work done $W = FS \cos \theta = FS \cos 90° = 0$
Question.3 The work done in lifting a box on to a platform does not depend upon how fast it is lifted up.
Explain your answer giving proper reasoning.
Answer. The work done (W) in lifting a box through a distance (S) against the gravitational force (F) is given by $W = FS$. Hence, it is obvious that it is independent of the rate at which the box is lifted.
Question.4 Is it possible that a body be in accelerated motion under a force acting on the body, yet no work is being done by the force ? Explain your answer giving a suitable example.
Answer. Yes, it is possible, when the force is perpendicular to the direction of motion. The moon revolving round the earth under the centripetal force of attraction of the earth, but earth does no work on the motion.
Question.5 A body moves along a circular path. How much work is done in doing so? Explain.
Answer. In case of a body moving along a circular path, the force (centripetal) is always along the radius while displacement is tangential. Hence, work done $W = FS \cos 90° = 0$ as angle between F and S is 90°.
Question.6 A man rowing a boat upstream is at rest with respect to the shore. Is he doing work ?
Answer. The man is doing work relative to the stream because he is applying force to produce relative motion between the boat and the stream. But he does zero work relative to the shore as the displacement relative to the shore is zero.
Question.7 What type of energy is stored in the spring of a watch?
Answer. When we wind a watch, the configuration of its spring is changed. The energy stored in the spring is obviously potential in nature (elastic potential energy to be more accurate).
Question.8 What happens to the kinetic energy when :
(i) the mass of the body is doubled at constant velocity?
(ii)the velocity of the body is doubled at constant mass?
(iii)the mass of the body is doubled but the velocity is reduced to half?
Answer.
Question.9 When a constant force is applied to a body moving with constant acceleration, is the power of the force constant? If not, how would force have to vary with speed for the power to be constant?
Answer.
Question.10 A spring which is kept compressed by tying its ends together is allowed to be dissolved in an acid. What happens to the potential energy of the spring?
Answer. The potential energy of the spring gets converted into heat energy (kinetic energy of acid molecules). Due to this heat, the temperature of the acid rises.
Question.1
(a) Define power. Give its SI unit.
(b) Taking the example of a simple pendulum, explain the variations in the forms of energy and

the; inter-conversions involved.
Answer.
(a) Power is defined as the rate of doing work. Its SI unit is watt.
(b) For a simple pendulum, the inter-conversion of energy is as shown in the table below :
Question.2
(a) How much work is done when a force of 1 N moves a body through a distance of 1 m in its direction?
(b) Is it possible that a force is acting on a body but still the work done is zero? Explain giving one example.
Answer.
(a) 1 J of work is done.
(b) Yes, it is possible when force acts at right angles to the direction of motion of the body. Example Gravitational force of earth acts on a satellite at right angles to its direction of motion.

Question.3
(a) What is meant by potential energy? Is potential energy vector or scalar quantity?
(b) Give one example of a body having potential energy.
Answer.
(a) The energy possessed by a body by virtue of its position or configuration. It is a scalar quantity.
(b) Stretched string of a bow.

Question.4 When is the work done by a force said to be negative? Give one situation in which one of the forces acting on the object is doing positive work and the other is doing negative work.
Answer. We know that work done W = FS cos 0, where 0 is the angle between F and S. Clearly, W will be -ve, if 0 is between 90° and 180° because then cos 0 will be -ve. Consider the case of a body falling under gravity. The body experiences an upward frictional force and downward force due to gravity. Since the body is moving downwards, the work done by force to gravity will be +ve but that is against the upward thrust will be -ve.

Question. 5
(a) Is it possible that a body be in accelerated motion under the action of a force, yet no work is being done by the force? Explain with an example.
(b) Two bodies of masses m, and m2 have equal kinetic energies. What is the ratio of their linear momenta?

(a) Yes, it is possible in the case of a body moving in a circular path with a speed v. The body has a centripetal acceleration directed along the radius of the circular path. The displacement is, however, tangential to the radius i.e., 0 = 90°. Thus, work done, W = FS cos 90° = 0.

Important Questions

Question.1 An object of mass m when raised To height h possess a potential energy of 1200 J. Find the new potential energy :
(a) if the same object is raised to height h/4.
(b) if the same object is raised to height 4h. Answer.
Question.2 Define 1 watt of power. A lamp consumes 1000 of electrical energy in 10 s. Calculate its power.
Question.3 Explain that the flying bird has; potential and kinetic energy and give their expressions.
Question.4
(a)An arrow moves forward when released from a stretched bow. Explain the transformation of energy in the process.
(b)A boy of mass 50 kg climbs up a vertical height of 100 m. Calculate the amount of potential energy he gains.
Question.5
(a)What is the commercial unit of energy ? Give its relationship with SI unit of energy.
(b)An electric bulb of 60 W is lighted for 10 hours everyday. How many units of electrical energy is consumed by this bulb in one day ?
Question.6 Define : (a) power (b) work done (c) kinetic energy. Give SI unit of each.
(a) The rate of doing work is called power. Its SI unit is watt.
(b) Work is the product of force and displacement. Its SI unit is joule.
(c) It is the energy possessed by a body by virtue of its motion. Its SI unit is joule.
Question.7 Define power. Write commercial unit and SI unit of electrical energy. An electrical geyser of 1.5 kW works for 2 hours. Find the electrical energy units consumed in a day.
Question.8 The masses of scooter and bike are in the ratio of 2 : 3 but moving with same speed of 108 km h~1. Compute the ratio of their kinetic energy.

NUMERICAL PROBLEMS

Question.1 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?
Question.2 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.
Question.3. A certain household has consumed 250 units of energy during a month. How much energy is this in joule?
Question.4 An electric heater is rated 1500 W. How much energy does it use in 10 hours?
Question.5 Calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 kmh-1?
Question.6 Find the energy in kWh consumed in 10 hours by four devices of power 500 W each.
Question.7 Two bodies of equal masses move with the uniform velocities v and 3v respectively. Find the , ratio of their kinetic energies.

Solution.Thus, the kinetic energy of the second body is nine times the kinetic energy of the first body.

Question.8 A man of mass 60 kg runs up a flight of 30 steps in 40 seconds. If each step is 20 cm high, calculate the power of the man.

Question.9 Calculate the amount of work done in moving a 50 kg block through a distance of 10 m by applying a force of 100 N.

Question.10 A block of mass 5 kg is lying bn a frictionless table. A force of 20 N is applied on it for 10 seconds. Calculate its kinetic energy.

Question.11 A girl of mass 40 kg climbs a rope 6 m long at constant speed in 15 seconds. What power she expands during the climb.

Question.12 A man weighing 70 kg carries a weight of 10 kg to the top 6f a tower 100 m high. Calculate the work done.

Solution.We know that work done is given by W = FS = mgh i.e., change in potential energy, therefore, we have W = mgh = (70 + 10) x 9.8 x100 = 78400 J

Question.13 Calculate the kinetic energy of a body of mass 2 kg moving with a velocity of 0.1 ms-1.

Question.14 Find the velocity of a body of mass 100 g having a kinetic energy of 20 J.

Question.15 A man drops a 10 kg rock from the top of a 5 m ladder. What is its kinetic energy when reaches the ground? What is its speed just before it hits the ground?

Question.16 Which would have greater effect on kinetic energy of an object – doubling the mass, or doubling the velocity?

Solution. We .know that KE$\propto$ m, KE $\propto$ v2

Therefore, by doubling the mass, the kinetic energy doubles, while by doubling the velocity, the kinetic energy increases four times. Therefore, doubling the velocity will have a greater effect on the kinetic energy of an object.

Question.17 A body of mass 4 kg initially at rest is subjected to a force of I6 N. What is the kinetic energy acquired by the body at the end of 10 s? [SAII-2010]

Solution.

Question.18 A crane pulls up a car weighing 500 kg to a vertical height of 4 m. Calculate the work done by the crane.

Solution.

In order to lift the car, the crane has to do work against the force of gravity.

Therefore, the force required = Mg = 500 x 9.8 = 4900 N

Now, displacement undergone by the car, S = 4 m

Hence, work done = FS = 4900 x 4 = 19600 J

Question.19 A force of 10 N displaces a body by a distance of 2 m at an angle 60° to its own direction. Find the amount of work done. [SAII-2012]

Solution.

By definition, Work = Force x Displacement in the direction of force = FD cos θ

Given, F = 10 N;S = 2m;θ = 60°. Therefore,

W = 10 x 2 x cos 60° = 10 x 2 x 1/2 =10J

Question.20 A boy of mass 40 kg runs up flight of 50 steps each 10 cm high in 5 seconds. Find: (i) the work done by the boy. (ii) the power developed, (g = 9.8 ms^{-2})

Solution.

Question.21 Calculate the power of an engine required to lift 10s kg of coal per hour from a mine 360 m deep, (Take g = 10ms^{-2}).
Question.22 A man whose mass is 50 kg climbs up 30 steps of a stair in 30 s. If each step is 20 cm high, calculate the power used in climbing the stairs. [Take g = 10 ms^{-2}]
Question.23 A mass of 10 kg is dropped from a height of 50 cm. Find its : (i) Kinetic energy (ii) Velocity just as it reaches the ground. Does the velocity depend upon the mass of the particle? Explain. [Take g = 10 ms^{-2}] [SAll-2012]
Question.24 If you apply 1 J of energy to lift a book of 0.5 kg, how high will it rise? [Take g = 10 ms^{-2}]
Solution.
We know that PE = mgh
1 = 0.5 x 10 x h
Therefore, h = 0.2 m = 20 cm

Question.25 A woman pulls a bucket of water of total mass 5 kg from a well which is 10 m in 10 s. Calculate the power used by her. [Take g = 10 ms^{-2}]
Question.26
(a) Define average power.
(b) A lamp consumes 1000 J of electrical energy in 10 s. What is its power?
(c) Give the commercial unit of energy in Joules. [SAll-2013]

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CLASS- 9 SCIENCE 2022-23

Chapter- 12

SOUND

Introduction to waves

A wave is a disturbance in a medium which moves from one point to another and carries energy without a net movement of particles. It may take the form of elastic deformation or a variation of pressure.

E.g: Rubber cork on the water that goes up and down when a rock falls in the water creates a ripple.

Particle motion of mechanical waves

(i) Transverse Waves

Particle motion is perpendicular to the direction of wave motion. This type of wave is a mechanical wave.

E.g: Light and Mexican wave in a stadium.

(ii) Longitudinal waves

Particles travel parallel to the direction of wave motion, by means of successive compressions or elongations. This is also a mechanical wave.

E.g: Sound waves in air.

Introduction to sound waves

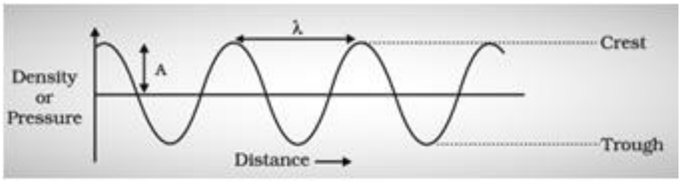
Sound needs a medium to propagate. The matter or material through which sound propagates is called a medium. When particles vibrate about their mean positions, it pushes a region of compressed air, creating a region of high pressure, followed by a region of low pressure as the particle retreats to its mean position. The sound wave propagates by compressions and rarefactions of particles in a medium. Sound propagation can be visualised as the propagation of pressure variations in the medium.

Characteristics of Sound Waves

Watch The Below Video to Know More On Characteristics of Sound Waves, :

Wavelength

The distance between two successive crests or troughs (or) successive compressions and rarefactions is called as wavelength (λ). The SI unit of wavelength is metre (m).



Time period

Time taken by two consecutive compressions or rarefactions to cross a fixed point is called a Time period (T). The SI unit of time in seconds (s).

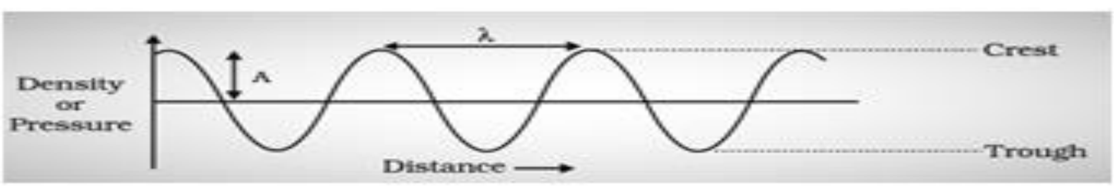
Frequency

The number of compressions or rarefactions per unit time is called frequency (**ν**).
The SI unit of frequency is Hertz. The SI unit is Hertz (s−1)

v=1T
Speed (v), wavelength (λ) and frequency (**ν**) are related as v=λ**ν**

Amplitude

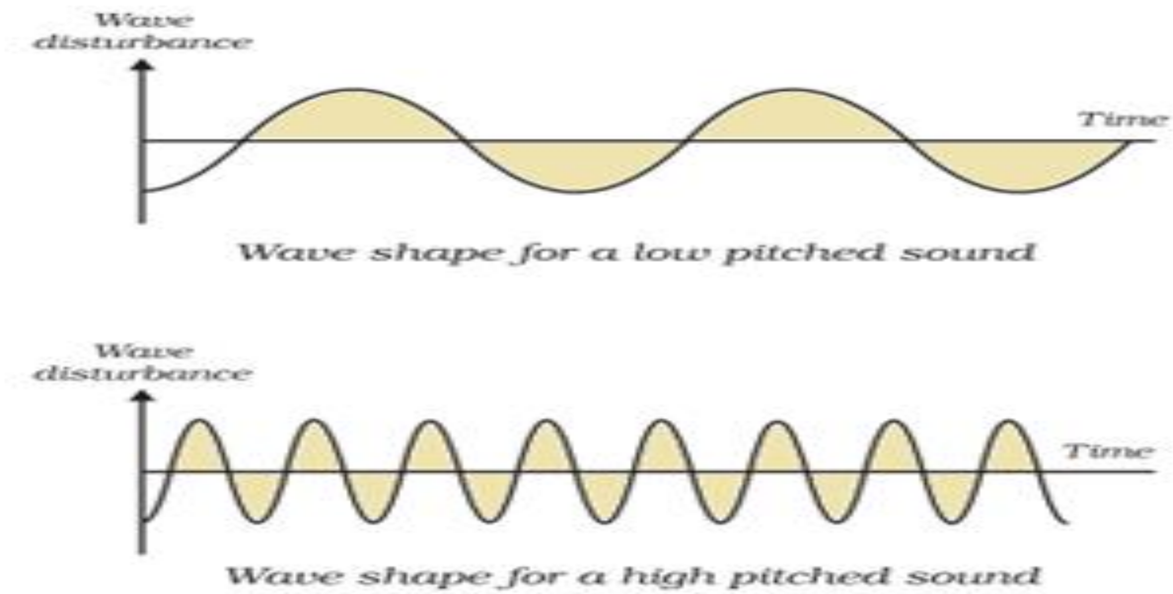
The magnitude of disturbance in a medium on either side of the mean value is called an amplitude (A).
As shown in the figure below, the unit of amplitude will be the density or pressure. Distance between mean position and crest (maximum displacement).



Amplitude (A)

Pitch

The number of compressions or rarefactions per unit time. Directly proportional to frequency.



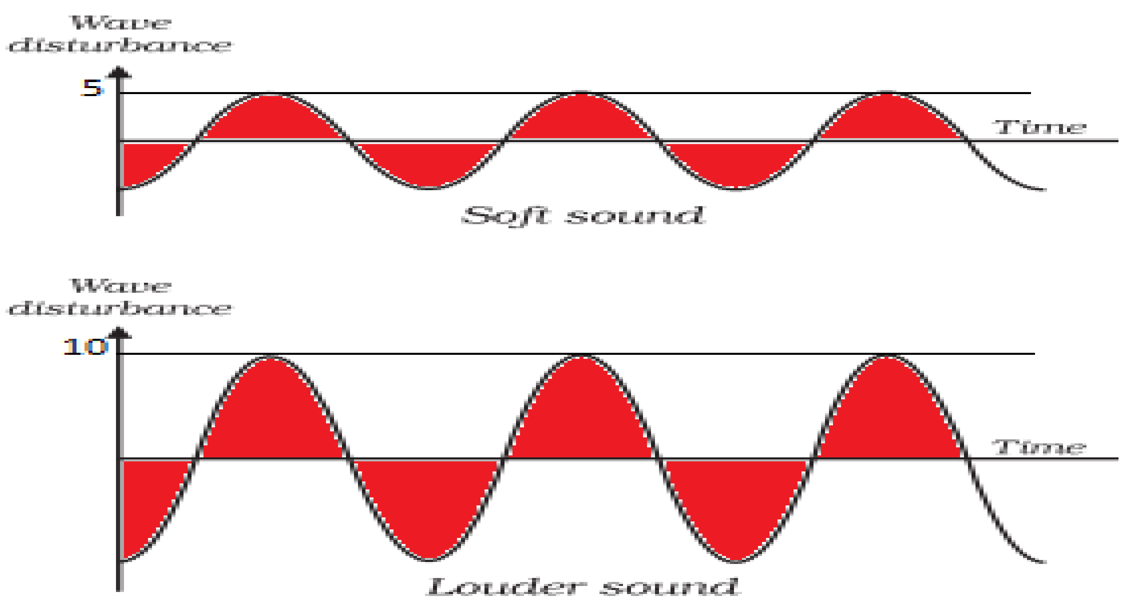
Representation of low and high pitch

<u>Volume</u>

Volume or loudness of a sound depends on the amplitude. The force with which an object is made to vibrate gives the loudness.

Higher force → higher amplitude → louder sound

The amount of sound energy flowing per unit time through a unit area is called the intensity of sound.



The Intensity of Sound

Note and Tone

A sound of a single frequency is called a tone. A sound produced with a mixture of several frequencies is called a note.

Quality of sound

The richness or timber of sound is called the quality. Sound with the same pitch and loudness can be distinguished based on the quality. Music is pleasant to the ears while noise is not. But they both can have the same loudness and pitch.

Speed of sound

Sound travels through different media with different speeds. Speed of sound depends on the properties of the medium: pressure, density and temperature

Speed of sound: Solids > Liquids > Gases

Speed of sound in air = 331 m/s at 0^0C and 344 m/s at 22∘ C

When a source emits sound with a speed greater than the speed of sound in air, it creates a sonic boom which produces shockwaves with lots of energy. They produce a very loud noise which is enough to shatter glass and damage buildings.

Reflection of Sound Waves

Like light, sound also follows laws of reflection, it bounces off the surface of solid and liquid.

Echo

The phenomenon where a sound produced is heard again due to reflection is called an echo.
E.g: Clapping or shouting near a tall building or a mountain.

To hear distinct echo sound, the time interval between original and reflected sound must be at least 0.1s. As sound persists in our brain for about 0.1s. Minimum distance for obstruction or reflective surface to hear an echo should be 17.2 m. Multiple echoes can be heard due to multiple reflections.

Applications of Ultrasound

(i) Scanning images of human organs
(ii) Detecting cracks in metal blocks
(iii) Cleaning parts that are hard to reach
(iv) Navigating, communicating or detecting objects on or under the surface of the water (SONAR).

Sonar consists of a transmitter and detector mounted on a boat or ship. The transmitter sends ultrasonic sound waves to the seabed which gets reflected back and picked up by the detector. Knowing the speed of sound in water, distance can be measured using: **$2d=v\times t$.** This method is called echo-location or echo ranging.

Reverberation

Persistence of sound because of multiple reflections is called reverberation. Examples: Auditorium and a big hall.

Excessive reverberation is undesirable and to reduce this, halls and auditoriums have sound-absorbing materials on the walls and roofs. E.g: Fibreboard and rough plaster.

<u>Doppler's effect</u>

If either the source of sound or observer is moving, then there will be a change in frequency and wavelength for the observer. The frequency will be higher when the observer moves towards the source and it decreases when the observer moves away from the source.

Example: If one is standing on a street corner and an ambulance approaches with its siren blaring, the sound of the siren steadily gains in pitch as it comes closer and then, as it passes, the pitch suddenly lowers.

SOME QUESTIONS

1. Explain how sound is produced by your school bell.

Solution: When the school bell is hit with a hammer, it moves forward and backwards producing compression and rarefaction due to vibrations. This is how sound is produced by the school bell.

2. Why are sound waves called mechanical waves?

Solution: Sound waves require a medium to propagate to interact with the particles present in it. Therefore, sound waves are called mechanical waves.

3. Suppose you and your friend are on the moon. Will you be able to hear any sound produced by your friend?

Solution: No. Sound waves require a medium to propagate. Due to the absence of atmosphere on the moon and since sound cannot travel in vacuum, I will not be able to hear any sound produced by my friend.

4. Which wave property determines (a) loudness, (b) pitch?

Solution:(a). Amplitude – The loudness of the sound and its amplitude is directly related to each other. Larger the amplitude, louder is the sound.

(b). Frequency – The pitch of the sound and its frequency is directly related to each other. If the pitch is high then the frequency of sound is also high.

5. Guess which sound has a higher pitch: guitar or car horn?

Solution: The pitch of a sound is directly proportional to its frequency. Therefore, the guitar has a higher pitch when compared to a car horn.

6. What are wavelength, frequency, time period and amplitude of a sound wave?

Solution:(a) Wavelength – Wavelength can be defined as the distance between two consecutive rarefactions or two consecutive compressions. The SI unit of wavelength is meter (m).

(b) Frequency – Frequency is defined as the number of oscillations per second. The SI unit of frequency is hertz (Hz).

(c) Amplitude – Amplitude can be defined as the maximum height reached by the trough or crest of a sound wave.

(d) Time period – The time period is defined as the time required to produce one complete cycle of a sound wave.

7. How are the wavelength and frequency of a sound wave related to its speed?

Solution: Wavelength, speed, and frequency are related in the following way:

Speed = Wavelength x Frequency

$v = \lambda \nu$

8. Calculate the wavelength of a sound wave whose frequency is 220 Hz and speed is 440 m/s in a given medium.

Solution: Given that,

Frequency of sound wave = 220 Hz.

Speed of sound wave = 440 m/s.

Calculate wavelength.

We know that,

Speed = Wavelength × Frequency

$v = \lambda \nu$

440 = Wavelength × 220

Wavelength = 440/220

Wavelength = 2

Therefore, the wavelength of the sound wave = 2 meters.

9. A person is listening to a tone of 500 Hz sitting at a distance of 450 m from the source of the sound. What is the time interval between successive compressions from the source?

Solution: The time interval between successive compressions from the source is equal to the time period and time period is reciprocal of the frequency. Therefore, it can be calculated as follows:

$T= 1/F$

$T= 1/500$

$T = 0.002$ s.

10. Distinguish between loudness and intensity of sound.

Solution: The amount of sound energy passing through an area every second is called intensity of a sound wave. Loudness is defined by its amplitude.

11. In which of the three media, air, water or iron, does sound travel the fastest at a particular temperature?

Solution: Sound travels faster in solids when compared to any other medium. Therefore, at a particular temperature, sound travels fastest in iron and slowest in gas.

12. An echo is heard in 3 s. What is the distance of the reflecting surface from the source, given that the speed of sound is 342 ms^{-1}?

Solution: Speed of sound (v) = 342 ms^{-1}

Echo returns in time (t) = 3 s

Distance travelled by sound = v × t = 342 × 3 = 1026 m

In the given interval of time, sound must travel a distance which is twice the distance of reflecting surface and source.

Therefore, the distance of reflecting surface from the source =1026/2 = 513 m.

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13. Why are the ceilings of concert halls curved?

Solution: Ceilings of concert halls are curved to uniformly spread sound in all directions after reflecting from the walls.

14. What is the audible range of the average human ear?

Solution: 20 Hz to 20,000 Hz. Any sound less than 20 Hz or greater than 20,000 Hz frequency is not audible to human ears.

15. What is the range of frequencies associated with (a) Infrasound? (b) Ultrasound?

Solution: (a). 20 Hz

(b). 20,000 Hz.

16. A submarine emits a sonar pulse, which returns from an underwater cliff in 1.02 s. If the speed of sound in salt water is 1531 m/s, how far away is the cliff?

Solution: Time (t) taken by the sonar pulse to return = 1.02 s

Speed (v) of sound in salt water = 1531 m s^{-1}

Distance travelled by sonar pulse = Speed of sound × Time taken

= 1531 x 1.02 = 1561.62 m

Distance of the cliff from the submarine = (Total distance travelled by sonar pulse) / 2

= 1561.62 / 2

= 780.81 m.

17. What is sound and how is it produced?

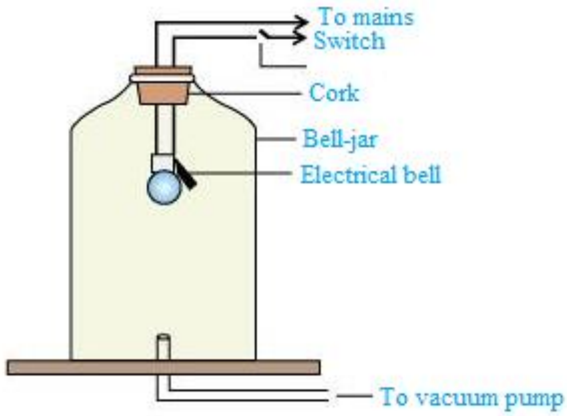
Solution: Sound is produced due to vibrations. When a body vibrates, it forces the adjacent particles of the medium to vibrate. This results in a disturbance in the medium, which travels as waves and reaches the ear. Hence, sound is produced.

18. Describe with the help of a diagram, how compressions and rarefactions are produced in the air near a source of sound.

Solution: When the school bell is hit with a hammer, it moves forward and backwards producing compression and rarefaction due to vibrations. When it moves forward, it creates high pressure in its surrounding area. This high-pressure region is known as compression. When it moves backwards, it creates a low-pressure region in its surrounding. This region is called rarefaction.

19. Cite an experiment to show that sound needs a material medium for its propagation.

Solution: Take an electric bell and hang it inside an empty bell-jar which is fitted with a vacuum pump (as shown in the figure below).



Initially, one can hear the sound of the ringing bell. Now, pump out some air from the bell-jar using the vacuum pump. You will realize that the sound of the ringing bell decreases. If you keep on pumping the air out of the bell-jar, then glass-jar will be devoid of any air after some time. Now try to ring the bell. No sound is heard but you can see bell prong is still vibrating. When there is no air present in the bell jar, a vacuum is produced. Sound cannot travel through vacuum. Therefore, this experiment shows that sound needs a material medium for its propagation.

20. Why is sound wave called a longitudinal wave?

Solution: The vibration of the medium that travels parallel to the direction of the wave or along in the direction of the wave, is called a longitudinal wave. The direction of particles of the medium vibrates parallel to the direction of the propagation of disturbance. Therefore, a sound wave is called a longitudinal wave.

21. Which characteristics of the sound help you to identify your friend by his voice while sitting with others in a dark room?

Solution: Quality of sound is a characteristic that helps us identify the voice of a particular person. Two people may have the same pitch and loudness, but their qualities will be different.

22. Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen, why?

Solution: The speed of sound is 344 m/s whereas the speed of light is 3×10^8 m/s. The speed of light is less when compared to that of light. Due to this reason, the thunder takes more time to reach the Earth as compared to the light speed which is faster. Hence, lightning is seen before whenever we hear the thunder.

23. 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 m s^{-1}.

Solution:

For sound waves,

Speed = Wavelength × frequency

$v = \lambda \times v$

Speed of sound wave in air = 344 m/s

(a) For v = 20 Hz

$\lambda_1 = v/v_1 = 344/20 = 17.2$ m

(b) For v_2 = 20,000 Hz

$\lambda_2 = v/v_2 = 344/20,000 = 0.0172$ m

Therefore, for human beings the hearing wavelength is in the range of 0.0172 m to 17.2 m.

24. Two children are at opposite ends of an aluminum rod. One strikes the end of the rod with a stone. Find the ratio of times taken by the sound wave in the air and in aluminum to reach the second child.

Solution:

Consider the length of aluminum rod = d

Speed of sound wave at 25° C, V Al = 6420 ms-1

Time taken to reach other end

T Al = d/ (V Al) = d/6420

Speed of sound in air, V air = 346 ms-1

Time taken by sound to each other end,

T air = d/ (V air) = d/346

Therefore, the ratio of time taken by sound in aluminum and air,

T air / t Al = 6420 / 346 = 18.55

25. The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?

Solution:

Frequency = (Number of oscillations) / Total time

Number of oscillations = Frequency × Total time

Given,

Frequency of sound = 100 Hz

Total time = 1 min (1 min = 60 s)

Number of oscillations or vibrations = 100 × 60 = 6000

The source vibrates 6000 times in a minute and produces a frequency of 100 Hz.

26. Does sound follow the same laws of reflection as light does? Explain.

Solution:

Yes. Sound follows the same laws of reflection as light. The reflected sound wave and the incident sound wave make an equal angle with the normal to the surface at the point of incidence. Also, the reflected sound wave, the normal to the point of incidence, and the incident sound wave all lie in the same plane.

27. 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?

Solution:

An echo is heard when time interval between the reflected sound and the original sound is at least 0.1 second. As the temperature increases, the speed of sound in a medium also increases. On a hotter day, the time interval between the reflected and original sound will decrease and an echo is audible only if the time interval between the reflected sound and the original sound is greater than 0.1 s.

28. Give two practical applications of reflection of sound waves.

Solution:

(i) Reflection of sound is used to measure the speed and distance of underwater objects. This method is called SONAR.

(ii) Working of a stethoscope – the sound of patient's heartbeat reaches the doctor's ear through multiple reflections of sound.

29. 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 m s^{-2} and speed of sound = 340 m s^{-1}.

Solution:

Height (s) of tower = 500 m

Velocity (v) of sound = 340 m s^{-1}

Acceleration (g) due to gravity = 10 m s^{-1}

Initial velocity (u) of the stone = 0

Time (t_1) taken by the stone to fall to tower base

As per second equation of motion:

$s = ut_1 + (½)\, g\, (t_1)^2$

$500 = 0 \times t_1 + (½)\, 10\, (t_1)^2$

$(t_1)^2 = 100$

$t_1 = 10$ s

Time (t_2) taken by sound to reach top from tower base = 500/340 = 1.47 s.

$t = t_1 + t_2$

t = 10 + 1.47

t = 11.47 s.

30. A sound wave travels at a speed of 339 m s^{-1}. If its wavelength is 1.5 cm, what is the frequency of the wave? Will it be audible?

Solution:

Speed (v) of sound = 339 m s^{-1}

Wavelength (λ) of sound = 1.5 cm = 0.015 m

Speed of sound = Wavelength × Frequency

$v = v = \lambda \text{ X } v$

$v = v / \lambda = 339 / 0.015 = 22600$ Hz.

The frequency of audible sound for human beings lies between the ranges of 20 Hz to 20,000 Hz. The frequency of the given sound is more than 20,000 Hz, therefore, it is not audible.

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31. What is reverberation? How can it be reduced?

Solution: The continuous multiple reflections of sound in a big enclosed space is reverberation. It can be reduced by covering walls and ceiling of enclosed space with the help of sound absorbing materials such as loose woollens, fibre boards.

32. What is loudness of sound? What factors does it depend on?

Solution: Loud sounds have high energy. Loudness directly depends on the amplitude of vibrations. It is proportional to the square of the amplitude of vibrations of sound.

33. Explain how bats use ultrasound to catch prey.

Solution: Bats have the ability to produce high-pitched ultrasonic squeaks. These squeaks get reflected by objects like preys and return to their ears. This helps a bat to know how far his prey is.

34. How is ultrasound used for cleaning?

Solution: Objects that need to be cleansed are put in a cleaning solution and ultrasonic sound waves are passed through the solution. The high frequency of ultrasound waves helps in detaching the dirt from the objects. In this way ultrasound is used for cleaning purposes.

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THEME: FOOD

Chapter-15

IMPROVEMENT IN FOOD RESOURCES

PLANT AND ANIMAL BREEDING

- Plant breeding is the manipulation to create plants with desired characters like better yield, disease resistant varieties etc.
- Animal husbandry is the scientific management of animal livestock. Its aim is producing improved breeds of domesticated animals by improving their genotypes through selective breeding.

These can be achieved by crossing plants/ animals with different characteristics or by gene manipulation (genetic engineering)

SELECTION FOR QUALITY IMPROVEMENT AND MANAGEMENT FOR PLANTS

- Crop variety improvement
- Crop production improvement
- Crop protection management

CROP VARIETY IMPROVEMENT

- A good variety of crops shows disease resistance, response to fertilizers, product quality and high yields.
- This can be achieved by hybridization of genetic engineering (creating GMOS; genetically modified organisms).

Hybridisation – It refers to crossing between genetically dissimilar plants.

This may be intervarietal (between different varieties)

Interspecific (between two different species of the same genus)

Intergeneric (between different genera).

Some of the factors for which variety improvement is done are:

Higher yield and improved quality	Improved quality like protein (pulses), baking quality (wheat), oil quality (oilseeds), preserving quality (fruits and vegetables).
Biotic & abiotic resistance	Production of resistant crops to biotic (diseases, insects and nematodes) and abiotic (drought/ salinity/ water-logging/ heat/ cold/ frost) stresses.

Less maturity duration	Producing crops with less duration of maturity period. This allows farmers to grow multiple rounds of crops in a year.
Wider adaptability	Developing verities which can be grown in different environmental situation and climate

Source	Nutrients
Air	carbon, oxygen
Water	hydrogen, oxygen
Soil	(i) *Macronutrients*: nitrogen, phosphorus, potassium, calcium, magnesium, sulphur (ii) *Micronutrients:* iron, manganese, boron, zinc, copper, molybdenum, chlorine

Desirable agronomic characteristics	Like Tallness and profuse branching are desirable characters for fodder crops. Dwarfness is desired in cereal.

CROP PRODUCTION MANAGEMENT

- Nutrient management: Manure, Fertilizer
- Irrigation: wells, canals, River Lift Systems, Tanks
- Cropping patterns: Mixed cropping, Inter-cropping, Crop rotation

NUTRIENT MANAGEMENT

- Nutrients are supplied to plants by air, water and soil.
- Some are required in large quantities known as macronutrients others are micronutrients.
- Deficiency of these nutrients affects growth and development of crops.

Manure

- Manure helps in enriching soil with nutrients and organic matter and increasing soil fertility and its quality.

Manures may be

- **Compost**: Compost is a mixture of ingredients used to improve the soil quality. It is commonly prepared by decomposing plant and food waste with the help of decomposers.
- In **vermicomposting** earthworm are used to convert organic matter manure

- **Green manure**: it refers to specific plants (sun hemp or guar) that are grown and turned into the soil, helping it improve its overall quality and enriching the soil in nitrogen and phosphorus

Fertilizer

Fertilizers are chemicals that are added to the soil to increase its fertility.

Fertilizers supply N, P and K to the soil.

Fertilizers may pollute the soil if used in excess.

Continuous use of 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. Short-term benefits of using fertilizers and long-term benefits of using manure for maintaining soil fertility have to be considered while aiming for optimum yields in crop production.

Organic farming is a farming system with minimal or no use of chemicals as fertilizers, herbicides, pesticides etc. and with a maximum input of organic manures.

Biological agents are used as biofertilizers (blue green algae) bio pesticides (neem leaves or turmeric) and healthy cropping systems [mixed cropping, inter-cropping and crop rotation) are used.

- Kharif crop: grown in rainy season (June to October). E.g. - Paddy, soyabean, pigeon pea, maize, cotton, green gram and black gram
- Rabi crop: grown in the winter season (November to April). E.g. - wheat, gram, peas, mustard, linseed

IRRIGATION

Irrigation is the artificial application of water to the soil through various systems of tubes, pumps, and sprays.

- **Wells**: (dug wells and tube wells) –
  In a dug well, water is collected from water bearing strata.
  Tube wells can tap water from the deeper strata.
- **Canals**: In this system canals receive water reservoirs/ rivers and distributed to field.
- **River Lift Systems**: In water deficient areas water is directly drawn from the rivers for supplying irrigation in areas close to rivers.
- **Tanks**: This is used to irrigate smaller area.

Rainwater harvesting and watershed management- This involves building small check-dams which lead to an increase in ground water levels. The check-dams stop the rainwater from flowing away and also reduce soil erosion.

CROPPING PATTERN

Mixed cropping	**Inter-cropping**	**Crop rotation**
It is growing two or more crops simultaneously on the same piece of land. e.g. wheat + gram wheat + mustard Groundnut + sunflower. This reduces risk against failure of one of the crops.	In this two or more crops with different nutrient requirement grown on the same field in a definite pattern. Different rows have different crops. e.g. soyabean + maize millet (bajra) + cowpea (lobia) This ensures maximum utilization of the nutrients.	The growing of different crops on a piece of land in a pre-planned succession is known as crop rotation.

CROP PROTECTION MANAGEMENT

Weeds	They are unwanted plants in the cultivated field, for example, Xanthium (gokhroo), Parthenium (gajar ghas), Cyperinus rotundus (motha). They compete for food, space and light. Weeds take up nutrients and reduce the growth of the crop.
Pest	Insect pests cut the root, stem and leaf, Bore into stem and fruits, Suck the cell sap
Pathogens	These are disease causing organisms like Bacteria, fungi and viruses and can be transmitted through the soil, water and air.
Pesticides	It includes herbicides, insecticides and fungicides. Pesticides are chemicals used to control weeds, pests and pathogens. These are toxic and cause pollution.

STORAGE OF GRAINS

- By proper storage techniques, losses (causes due insects, rodents, fungi, mites and bacteria, moisture and temperatures to) can be significantly reduced.

ANIMAL HUSBANDRY

CATTLE FARMING

- Cattle husbandry is done for two purposes— milk and draught labour for agricultural work.
- Indian cattle- Cow (Bos indicus), buffaloes (Bos bubalis)
- Milch animals: Milk-producing females.
- Exotic or foreign breeds (Jersey, Brown Swiss) have long lactation periods, while local breeds (Red Sindhi, Sahiwal) show excellent resistance to diseases.
- Draught animals: for farm labour are called.

POULTRY FARMING

- The aim of poultry farming is to rearing of birds for meat or eggs.
- For this improved breeds are developed and farmed to produce layers for eggs and broilers for meat.
- Broiler chickens are fed with fat and vitamin-rich supplementary feed for good growth rate.
- The level of vitamins A and K is kept high in the poultry feeds

The cross-breeding programmes between Indian (indigenous, for example, Aseel) and foreign (exotic, for example, Leghorn) breeds for variety improvement are focused on to develop new varieties for the following desirable traits—

- Better adaptation and low maintenance
- Dwarf broiler parent for commercial chick production;
- Reduction in the size of the egg-laying bird with ability to utilize more fibrous cheaper diets formulated using agricultural by-products.

FISH PRODUCTION

- Fish production includes the finned true fish as well as shellfish such as prawns and molluscs.
- Marine fishery- pomphret, mackerel, tuna, sardines, bombay duck, finned fishes (mullets, bhetki), prawns, mussels and oysters.
- Inland fisheries: Catla, Silver carp, Rohu, Grass, Mrigal, common Carp

BEE-KEEPING

For production of honey bee-keeping is carried out at large scale.

- Indian bee: Apis cerana indica
- Rock bee: A. dorsata
- Little bee: A. florae
- Italian bee : A. mellifera

IMPORTANT QUESTIONS

Very Short Answer Questions

1- **How do plants get nutrients?**

Ans: Plants gets nutrients through soil, water and air.

2- **Give example of two crops by which we can get carbohydrate.**
Ans: wheat, rice

3- **What collective name is given for herbicides, insecticides and fungicides?**
Ans: Pesticides

4- **Write any two natural manures which are widely used in agriculture.**
Ans: compost and vermicompost

5- **List any two method of irrigation used in India.**
Ans: Canal, River lift system

6- **Name scientific name of any two Indian cattle.**
Ans: Bos indicus – cows, Bos bubalis – buffaloes.

7- **Which nutrient is supplied by air to the crops?**
Ans: carbon, oxygen

8- **Sometimes exotic breeds are preferred to local breeds? Give reason.**
Ans: Exotic breeds have long lactation periods and more yield.

9- **Name any two marine fish varieties.**
Ans: Pomphret, mackerel

10- **Categories following as fresh water or marine water species.**
Macrobrachium rosenbergii, Peneaus monodon
Ans: Macrobrachium rosenbergii (fresh water) Peneaus monodon (marine)

Short Answer Questions

1- **Give two examples of each of micronutrients and macronutrients.**
Ans: (i) Macronutrients: nitrogen, phosphorus
(ii) Micronutrients: iron, manganese

2- **Which method is commonly used for improving cattle breeds and why?**
Ans: Cross-breeding is widely used to improve cattle breeds. Through these two good cattle varieties will lead to a new, improved variety.

3- **Mention any for varieties and scientific name of honey bees used in bee keeping.**
Ans: Indian bee (Apis cerana indica), Rock bee (Apis dorsata), Little bee (Apis florae), Italian bee (Apis mellifera)

4- **Describe hybridization and its types.**
Ans: Hybridisation – It is crossing between genetically dissimilar plants.
Types- intervarietal (between different varieties), Interspecific (between two different species of the same genus), Intergeneric (between different genera).

5- **Explain composite fish culture and write its advantage.**
Ans: Composite fish culture is a method in which 5-6 fish species are grown together in a single fish pond. By this survival rate of fish and their yield increases without affecting the other species.

6- **If there is low rainfall in a village throughout the year, what measures will you suggest to the farmers for better cropping?**

Ans: (i) using drought-resistant and early maturing varieties of crops.

(ii) add more humus to the soil as it increases the water-holding capacity and retains water for longer duration.

7- **Classify the crops on the basis of growing seasons. Also mention one example of each.**

Ans: Kharif crop: grown in rainy season (June to October). E.g. – Paddy

Rabi crop: grown in the winter season (November to April). E.g. - wheat

8- **What are fodder crops? Write two examples.**

Ans: fodder crops are used for feeding of cattle.

e.g. - berseem, oats

Long Answer Types Questions

1- **Write different ways by which insect damages the crops in the field? Suggest one method of their effective control.**

Ans: (i) they cut the root, stem and leaf

(ii) They suck the cell sap from various parts of the plant

(iii) They bore into stem and fruits.

The insect pest can be control by spray of insecticide.

2- **What are weeds? List any two ways by which they affect crop growth? Give two examples of weeds.**

Ans: weds are undesirable plants in the cultivated field.

They compete for food, space and light.

Weeds take up nutrients and reduce the growth of the crop.

Example: Xanthium (gokhroo), Parthenium (gajar ghas), Cyperinus rotundus (motha).

3- **Compare mixed cropping and inter cropping by giving suitable example. Illustrate their advantage too.**

Ans: Mixed cropping- It is growing two or more crops simultaneously on the same piece of land.

E.g. Wheat + gram, wheat + mustard, Groundnut + sunflower.

This reduces risk against failure of one of the crops.

Intercropping: In this two or more crops with different nutrient requirement grown on the same field in a definite pattern. Different rows have different crops.

e.g. soyabean + maize, millet (bajra) + cowpea (lobia)

This ensures maximum utilization of the nutrients.

4- **Explain any four factors on the basis of which crop production is done.**

Ans: Higher yield and improved quality Improved quality like protein (pulses), baking quality (wheat), oil quality (oilseeds), preserving quality (fruits and vegetables).

Biotic & abiotic resistance- Production of resistant crops to biotic (diseases, insects and nematodes) and abiotic (drought/ salinity/ water-logging/ heat/ cold/ frost) stresses.

Less maturity duration- Producing crops with less duration of maturity period. This allows farmers to grow multiple rounds of crops in a year.

Desirable agronomic characteristics- Like Tallness and profuse branching are desirable characters for fodder crops. Dwarfness is desired in cereal.

5- **Explain the differences between broilers and layers. What necessary steps have to be taken to prevent the occurrence of infectious diseases in poultry farms?**

Ans: Broilers birds are used for meat-production and egg-laying birds are called layers.

The requirement of the broilers is protein and fat-rich food. The level of vitamin A and vitamin K is kept high in their feed.

Care is taken to avoid mortality and to maintain the feathering and carcass quality. The layers require enough space, proper light, and hygienic conditions.

Necessary steps for prevention of infectious diseases are:

(i) Proper cleaning and sanitation

(ii) Effective vaccination to prevent infectious diseases.

(iii) Spraying of disinfectants at regular intervals

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