PARAMOUNT SCIENCE NOTES

PRIMARY SEVEN

TERM TWO

TOPIC ONE: MACHINES

FRICTION

- Friction is the force that opposes motion of an object
- ✓ It occurs in all the states of matter

FACTORS THAT DETERMINE FRICTION

- Weight of an object
- Nature (texture) of an object

PROPERTIES OF FRICTION

- There is more friction on rough surfaces than on smooth surfaces
- Friction increases with increase in weight
- Friction always produces heat

CAUSES OF FRICTION

- Roughness of surfaces
- Deformations of the objects
- Molecular adhesion (attractive forces between surfaces in contact)

TYPES OF FRICTION

- Static friction
- Dynamic friction
- Viscosity

1. STATIC FRICTION

- This is the type of friction that occurs between objects at rest (stationary objects)

Examples of objects with static friction

- A pen resting on a table
- A boy sitting on a desk
- A stone resting on ground

Why do objects with static friction possess potential energy?

- They are at rest

2. DYNAMIC (KINETIC) FRICTION

This is the type of friction that occurs in moving objects (objects in motion)

Examples of dynamic (kinetic) friction

- Sliding friction
- Rolling friction

Examples of objects with kinetic (dynamic) friction

- A book sliding over a table
- A ball rolling on ground
- A tyre of moving car on the road

Why do objects with dynamic friction possess kinetic energy?

- They are in motion

3. VISCOSITY FRICTION (FLUID FRICTION)

- This is the type of friction that occurs in liquids and gases
- ✓ It is found in all fluids (liquids and gases)
- ✓ **A fluid** is a substance that can flow easily

Examples of objects with viscosity (fluid friction)

- A fish swimming in water
- A bird flying in air

MERITS/ADVANTAGES/IMPORTANCE OF FRICTION

Why is friction regarded as a useful force?

- It helps us in lighting match sticks
- It helps us in getting static electricity
- It helps us in sharpening tools
- It helps us in braking vehicles
- It helps us in climbing trees
- It helps us in writing on papers
- It helps us in grinding grains and seeds
- It helps us in washing clothes
- It helps us in us walking

Name the force that enabled early man to discover fire.

- Friction

WAYS OF INCREASING FRICTION

- By putting treads on tyres and shoes
- By putting spikes on sports shoes
- By putting grips on bicycle handles and car steering wheels
- By putting tarmac on road surfaces
- By putting gravel/small stones on road surfaces
- By increasing the weight of moving objects
- By making smooth surfaces rough

Things used to increase friction (materials that make surfaces rough)

- Treads
- Spikes
- Grips
- Gravel/small stones
- Tarmac

Why should friction be increased on roads?

- To prevent vehicles from sliding
- To make braking of vehicles easy

How do road engineers increase friction on the roads?

- By putting murram/gravel/small stones on road surfaces
- By putting tarmac on road surfaces

How do vehicle drivers increase friction on the roads?

- By driving vehicles with treads on their tyres (cars with new tyres)
- By putting much weight in their vehicles

Why it is dangerous to drive a car without treads on its tyre?

- It can slide easily
- It cannot brake (stop) easily
- It can get punctures easily

Why should friction be increased on car steering wheels?

- To prevent hands of the driver from sliding off

State the importance of grips on bicycle handles and car steering wheels.

- To increase friction

How is friction increased on motorcycle handles?

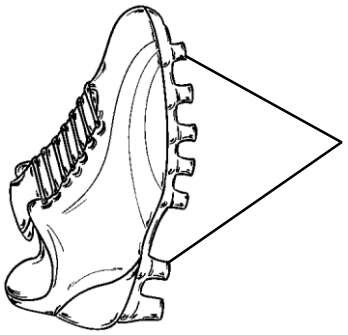
- By putting grips on motorcycle handles

Of what importance are the rough surfaces in palms of hands and soles of feet?

- To increase friction

DIAGRAMS SHOWING THINGS THAT INCREASE FRICTION

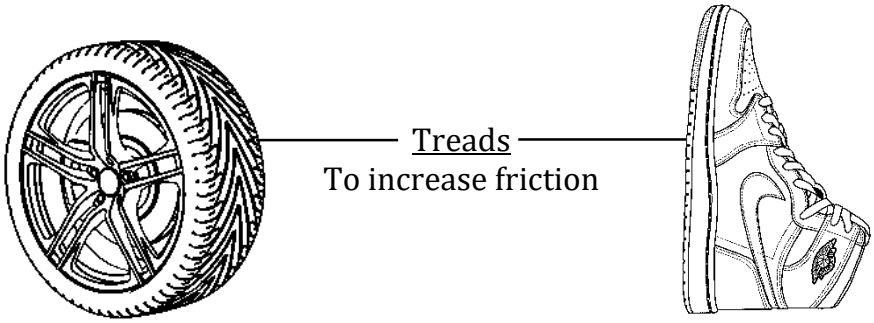
SPIKES ON SPORTS SHOE



Spikes

✓ To increase friction

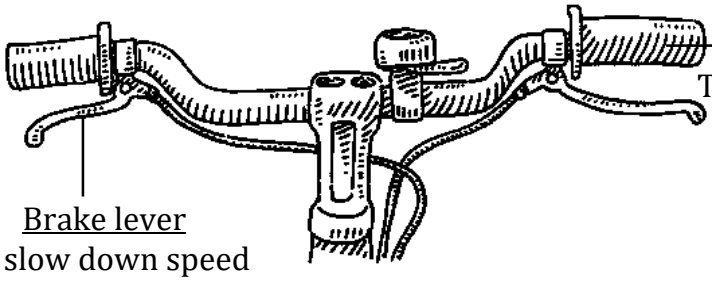
TREADS ON CAR TYRE AND SCHOOL SHOE



Treads

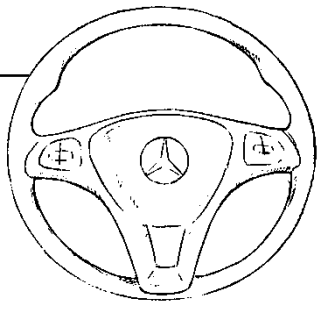
To increase friction

GRIPS ON CAR STEERING WHEEL AND BICYCLE HANDLES



Grips

To increase friction



Brake lever

To slow down speed

How do spikes on football shoes, treads on tyres and gravel put on road surfaces increase friction?

- They make surfaces rough

DEMERITS/DISADVANTAGES OF FRICTION

Why is friction regarded as a nuisance force?

- It causes unnecessary heat in machines
- It causes unnecessary noise in machines
- It reduces efficiency of machines
- It causes wear and tear of machines
- It delays work
- It makes us use a lot of effort to move machines

WAYS (METHODS) OF REDUCING FRICTION

- By lubricating (oiling or greasing)
- By using rollers
- By using ball bearings
- By polishing or varnishing surfaces
- By streamlining objects
- By making rough surfaces smooth

Things used to reduce friction

- Oil } Lubricants
- Grease }
- Rollers
- Ball bearings
- Polish
- Varnish

How does varnishing and polishing reduce friction?

- By making the surfaces smooth

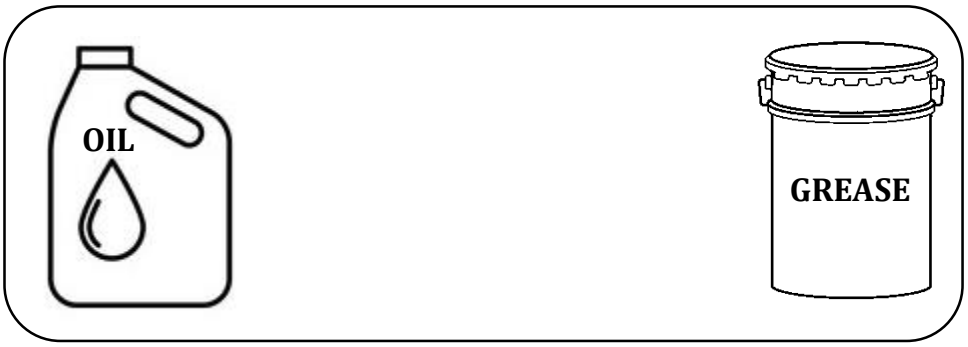
LUBRICANTS

- These are organic substances that reduce friction

Examples of lubricants

- Oil
- Grease

DIAGRAMS SHOWING LUBRICANTS



How do lubricants (oil and grease) reduce friction?

- They make surfaces (moving parts) smooth or slippery

Ways of lubrication

- Oiling
- Greasing

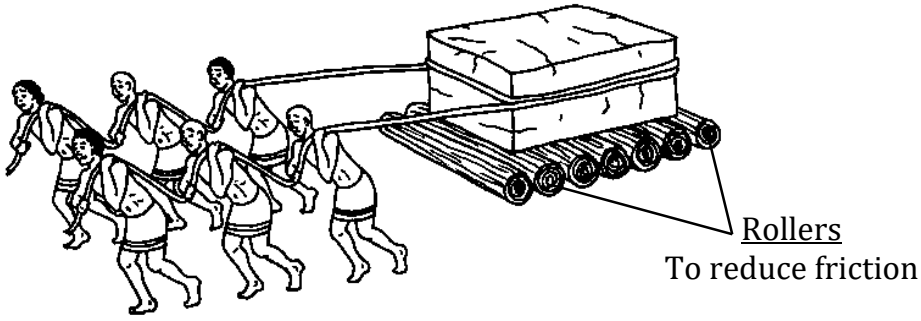
Besides reducing friction, give other reason why moving parts (e.g. door hinges) should be lubricated?

- To prevent rusting

Why is it bad to lubricate brake pads of bicycles?

- It reduces friction hence making braking of bicycle difficult.

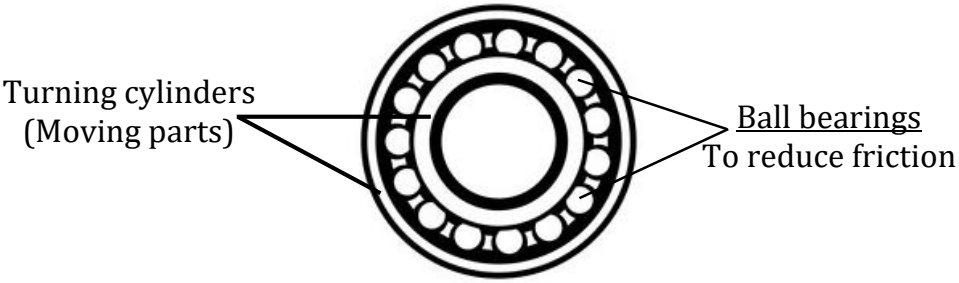
A DIAGRAM SHOWING ROLLERS



How do rollers reduce friction?

- They reduce the area of contact between moving parts

A DIAGRAM SHOWING BALL BEARINGS



How do ball bearings reduce friction?

- They keep the moving parts separate

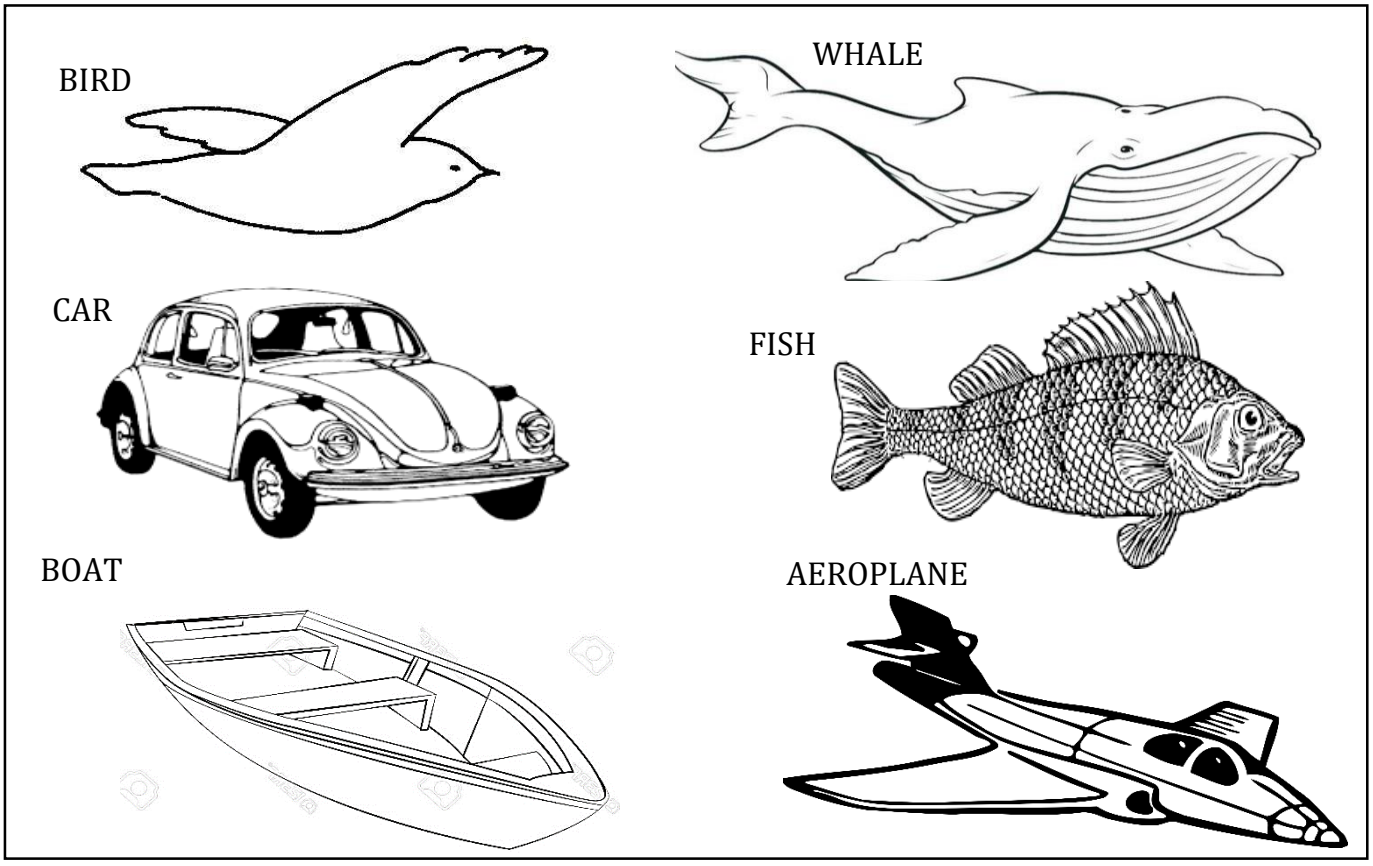
EXAMPLES OF STREAMLINED NON- LIVING OBJECTS

- Aeroplane
- Car
- Boat
- Ship
- Rocket
- Jet fighter

Examples of streamlined animals

- Fish
- Bird
- Bat
- Whale

DIAGRAMS SHOWING STREAMLINED ORGANISMS AND NON-LIVING OBJECTS



How does streamlining reduce friction?

- It reduces resistance to the flow of liquids and gases

Identify the type of friction minimized by streamlining objects

- Viscosity

HOW ARE THE FOLLOWING ABLE TO REDUCE FRICTION NATURALLY?

Birds, bats, fish and sea mammals

- They have streamlined bodies

Joints

- They have synovial fluid
- They have cartilage

Why should friction be reduced in moving parts of machines?

- To prevent unnecessary noise in machines
- To prevent unnecessary heat in machines
- To increase efficiency of a machine
- To prevent tear and wear of machines
- To make movement easy (to increase speed of movement)

INERTIA

- This is the tendency of an object to resist change in its state of motion
- ✓ It is determined by **mass**

Why do passengers seated in a car bend?

i) Backward when the driver starts it suddenly:
   - **Due to inertia at rest**

ii) Forward when the driver stops (brakes) it suddenly:
   - **Due to inertia in motion**

MACHINES

- A machine is a device (tool) that makes work easier
- A machine is a device (tool) that simplifies work

ADVANTAGES OF USING MACHINES

How do machines simplify work?

- Some machines multiply effort (reduce the effort needed to do work)
- Some machines change the direction of forces
- Some machines increase the speed of doing work
- Some machines change energy from one form to another

DISADVANTAGES OF USING MACHINES

- Some machines are expensive to buy and manage
- Some machines can cause accidents
- Some machines can cause laziness

TYPES (GROUPS) OF MACHINES

- Complex machines
- Simple machines

COMPLEX MACHINES

These are machines with many parts and difficult to use

- They need special training to use

Examples of complex machines

- Tractor
- Sewing machine: It consists of a pulley and a wedge
- Computer
- Car
- Aeroplane
- Tractor

Why is a tractor called a complex machine?

- It is made up of many parts and difficult to use

SIMPLE MACHINES

- These are machines with few parts and easy to use
- ✓ They do not need special training to use

Examples of simple machines

- Knife
- Panga
- Hoe
- Axe
- Ladder
- Broom
- Borehole
- Nut cracker
- Scissors

Why is an axe called a simple machine?

- It is made up of few parts and easy to use

TYPES (GROUPS OR CLASSES) OF SIMPLE MACHINES

- Levers
- Inclined planes (slopes)
- Wedges
- Screws
- Pulleys
- Wheel and axle

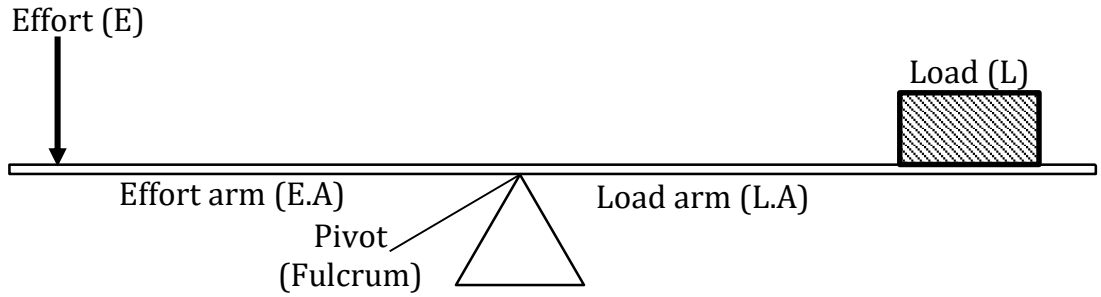
LEVERS

- A lever is a rigid bar that turns at a fixed point called pivot

Parts of a lever

- Load
- Effort
- Pivot (Fulcrum)

A DIAGRAM SHOWING A LEVER



PART OF A LEVER	DESCRIPTION
1. Effort (E)	▪ This is the force applied to move the load
2. Load (L)/Resistance	▪ This is the force (weight) to be moved
3. Pivot (P)/Fulcrum (F)	▪ This is a fixed turning point of a lever
4. Effort arm (EA)/Effort distance	▪ This is the distance from effort to the fulcrum (pivot)
5. Load arm (LA)/Load distance	▪ This is the distance from load to the fulcrum (pivot)

When does the lever work best?

- When the effort arm is longer than the load arm

CLASSES OF LEVERS

- First class lever
- Second class lever
- Third class lever

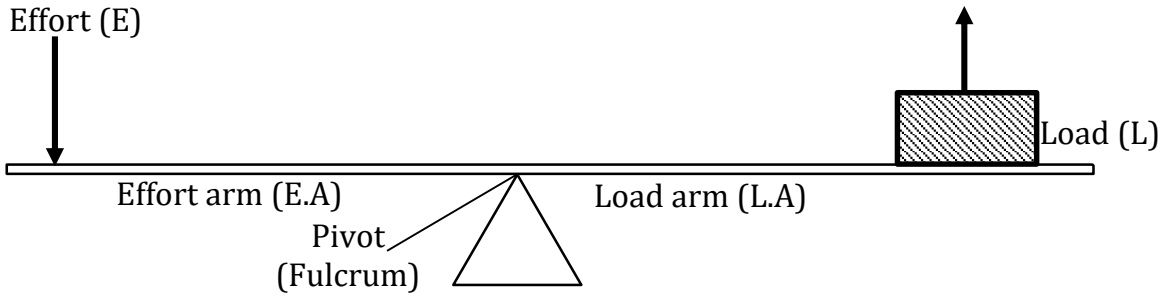
What factor determines the class of lever?

- The position of load, effort and pivot

FIRST CLASS LEVERS (EPL)

- This is the class of lever where the pivot is between the load and effort

AN ILLUSTRATION OF FIRST CLASS LEVER



- The load and effort move in opposite directions
- The longer the effort arm, the smaller the effort applied

EXAMPLES MACHINES IN THE FIRST CLASS LEVER

- See-saw
- Beam balance
- Scissors
- Pliers
- Crowbar
- Pincers
- Lid opener
- Shears
- Claw hammer
- Borehole
- Secateurs

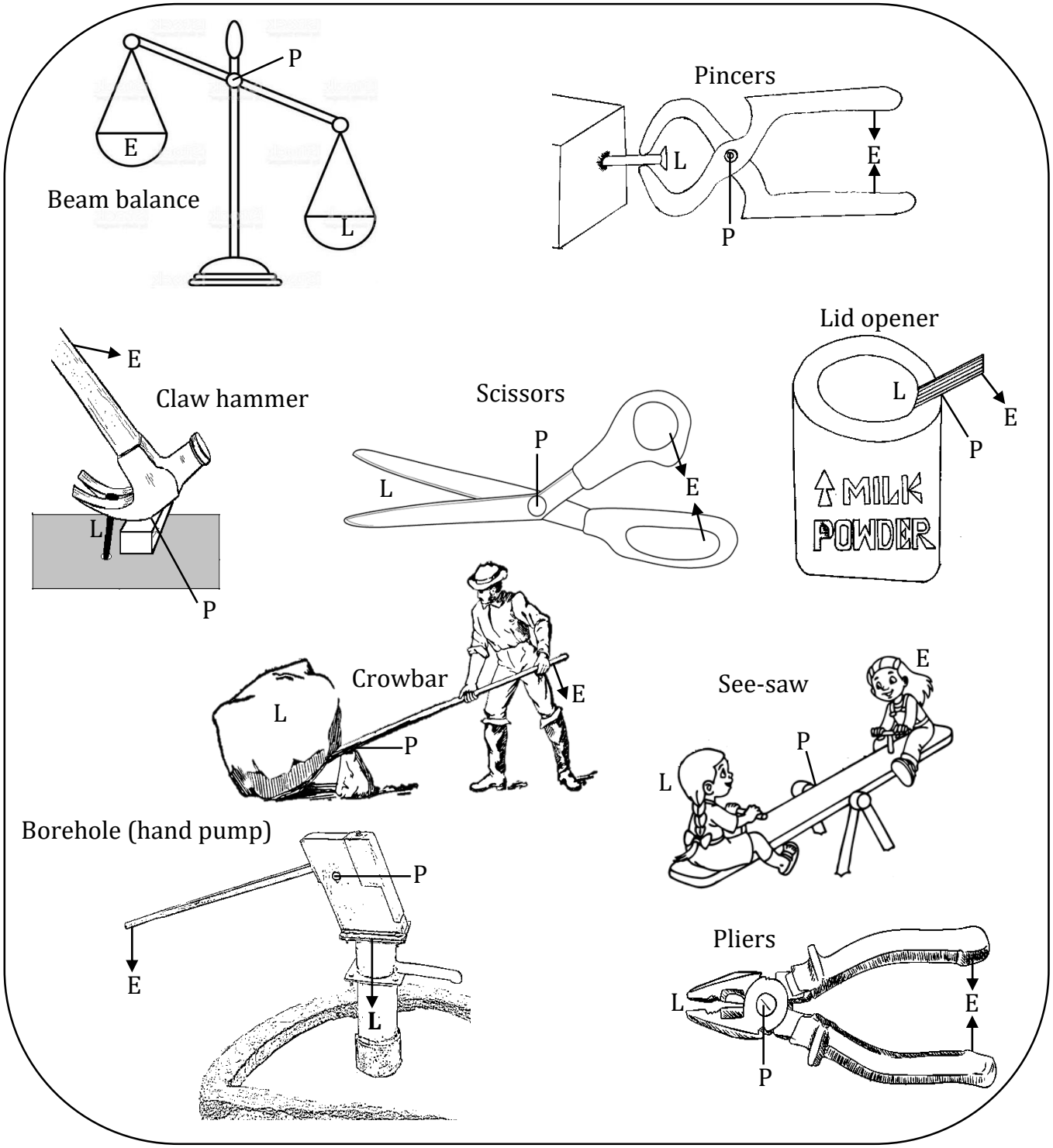
How do first class levers simplify work? (Advantages of using first class levers)

- They reduce the effort needed to do work (They use less effort)

How do first class levers reduce the effort needed to do work?

- By increasing effort arm (by making effort arm longer than load arm)

DIAGRAMS SHOWING FIRST CLASS LEVER MACHINES



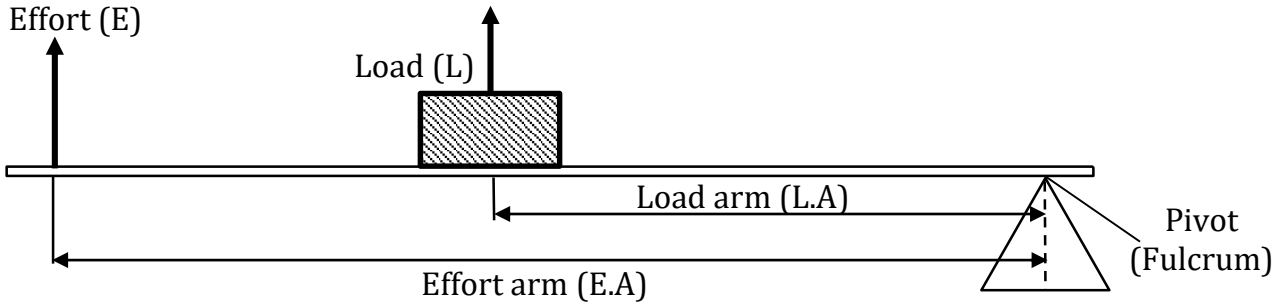
Uses of first class levers in our daily life

- A see-saw helps in playing balancing games
- A beam balance helps in measuring mass of items
- A claw hammer helps in removing iron nails from wood
- A lid opener helps in opening tins of paint
- A borehole helps in pumping water from underground
- A pair of scissors is used for cutting bandage when giving first aid
- Secateurs help in pruning
- Shears help in shearing (removing fleece/wool from sheep)

SECOND CLASS LEVERS (PLE)

- This is the class of lever where the load is between the pivot and effort

AN ILLUSTRATION OF SECOND CLASS LEVER



- The load and effort move in the same direction
- The effort arm is longer than the load arm hence using less effort

Examples of second class levers (class two levers)

- Wheelbarrow
- Bottle opener
- Spanner
- Nut cracker
- Paper cutter
- Human foot
- Door

How do second class levers simplify work? (Advantages of using second class levers)

- They reduce the effort needed to do work (They use less effort)

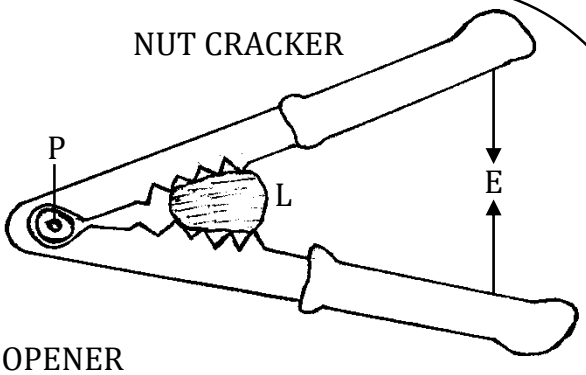
How do second class levers reduce the effort needed to do work?

- By increasing effort arm (By making effort arm longer than load arm)

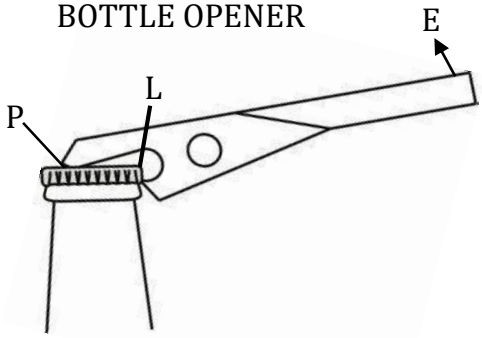
DIAGRAMS SHOWING SECOND CLASS LEVER MACHINES

WHEELBARROW

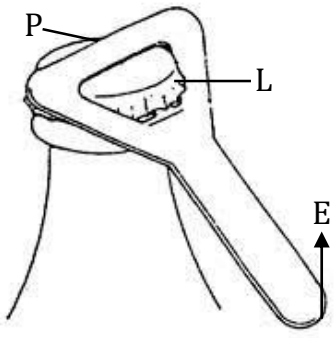
NUT CRACKER



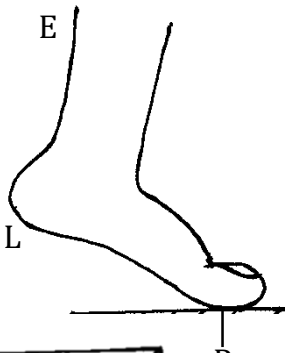
BOTTLE OPENER



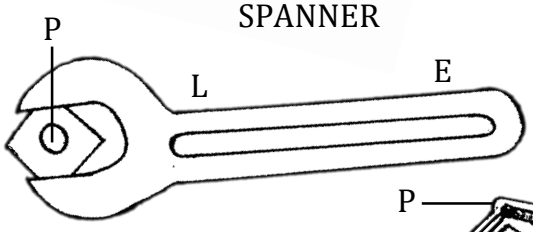
BOTTLE OPENER



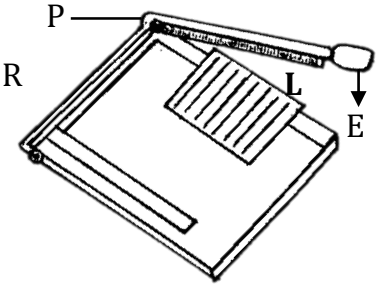
HUMAN FOOT



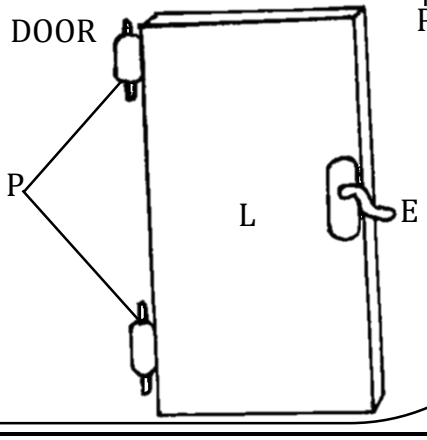
SPANNER



PAPER CUTTER



DOOR



USES OF SECOND CLASS LEVERS IN OUR DAILY LIFE

- A wheelbarrow is used to transport manure to the garden
- A nut cracker is used to break hard shelled seeds
- A bottle opener is used to open soda bottles
- A paper cutter is used to cut papers
- A door is used to promote privacy in buildings
- A spanner is used fasten or loosen nuts and bolts

Why are first and second class levers regarded as force multipliers?

- They reduce the effort needed to do work

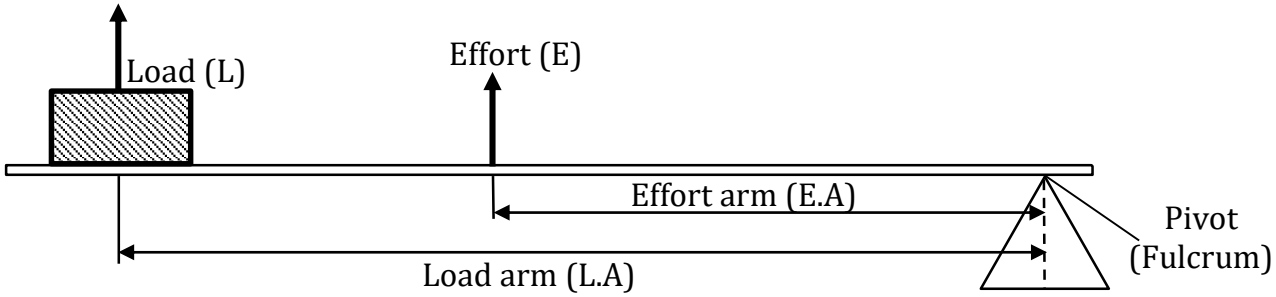
Why are scissors, pliers, pincers, shears, secateurs and nut crackers called double levers?

- They have two rigid bars with one pivot

THIRD CLASS LEVER (PEL)

- This is the class of lever where the effort is between the load and pivot

An illustration of a third class lever



✓ The load arm is always longer than the effort arm

EXAMPLES OF THIRD CLASS LEVERS MACHINES

- Fishing rod
- Broom
- Artificial arm
- Kitchen tongs (sugar tongs)
- Tweezers
- Human arm
- Cricket bat
- Chopstick
- Spade
- Shovel
- Hoe

How do third class levers simplify work? (Advantages of using third class levers)

- They increase the speed of doing work

How do third class levers simplify work? (Advantages of using third class levers)

- By reducing the effort arm (distance moved by effort)

Why third class lever regarded as distance multiplier?

- It reduces the effort arm (effort distance) and increases load distance

Why third class lever regarded as speed multiplier?

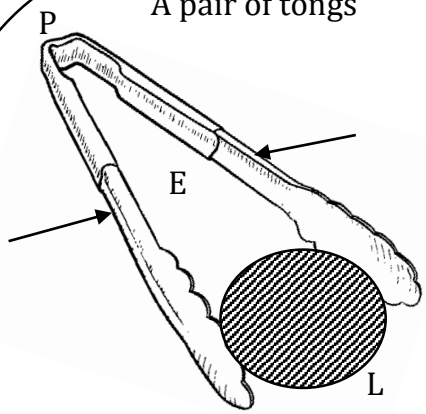
- It reduces the effort distance and increases load distance to increase the speed of doing work

Disadvantage of using third class levers

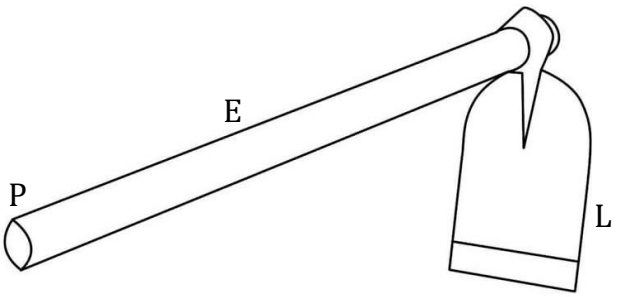
- They use much effort to do work

DIAGRAMS SHOWING THIRD CLASS LEVER MACHINES

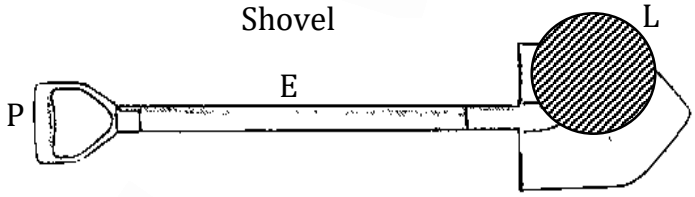
A pair of tongs



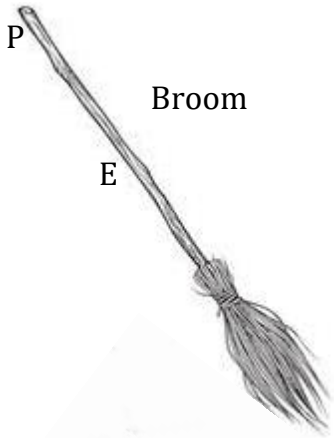
Hoe



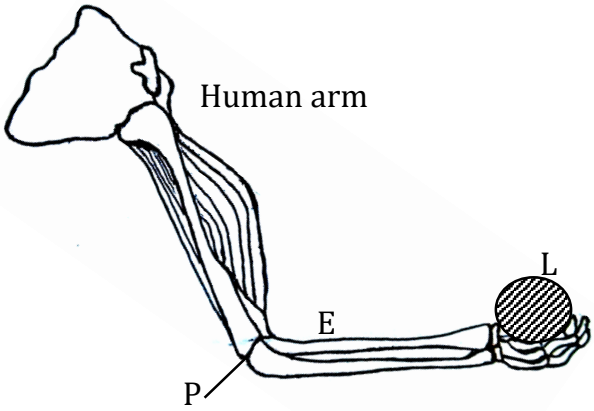
Shovel



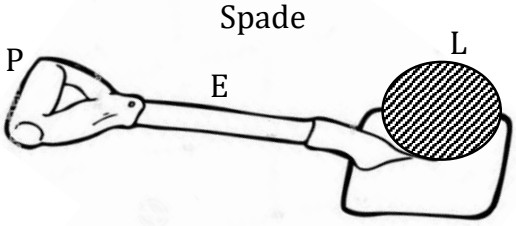
Broom



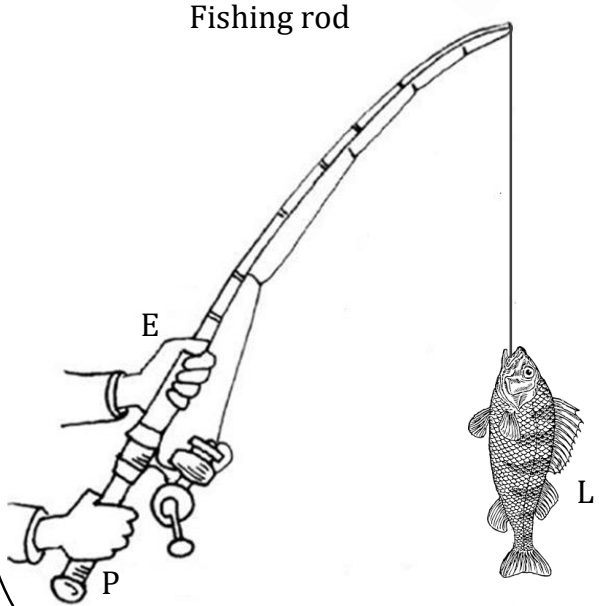
Human arm



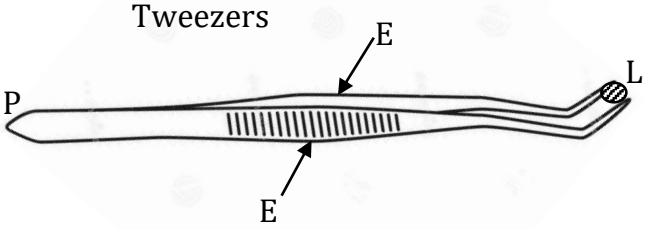
Spade



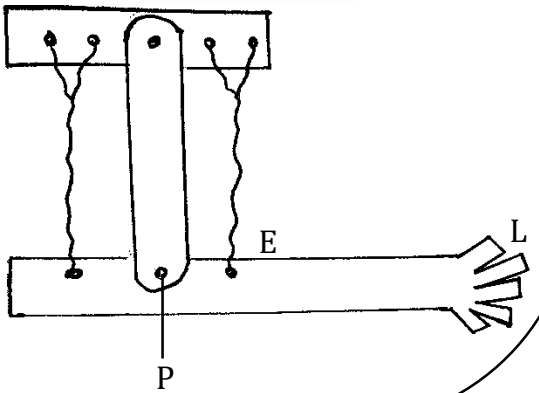
Fishing rod



Tweezers



Artificial arm



USES OF THIRD CLASS LEVERS IN OUR DAILY LIFE

- A fishing rod is used for harvesting fish from water bodies
- A broom is used for sweeping rubbish
- Artificial arm is used to replace the removed arm
- Kitchen tongs is used for lifting hot charcoal
- Tweezers help in removing insect stings from the skin
- A spade is used for loading manure
- A shovel is used for removing loose soil
- A hoe is used for digging

MOMENTS

- **A moment** is the turning effect of a force
- It is measured in **Newton metre (NM)**
- A force acting downwards on left of the pivot turns the lever in anticlockwise direction
- A force acting downwards on right of the pivot turns the lever in clockwise direction

PRINCIPLES OF MOMENTS (LAWS OF LEVERS)

- The sum of clockwise moments is equal to the sum of anticlockwise moments for a lever to balance
- The product of effort and effort arm is equal to the product of load and the load arm for a lever to balance

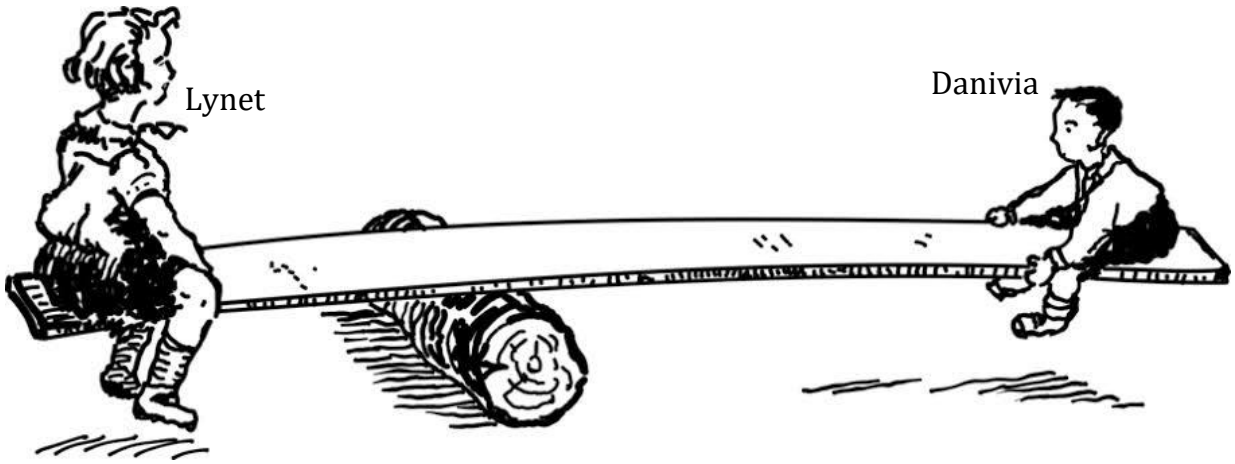
Effort x Effort arm = Load X Load arm

When is a lever said to be balancing (to be in equilibrium)?

- When the product of effort and effort arm is equal to the product of load and load arm

NOTE:

1. If a lever is to balance, the heavier body sits near the pivot.



Study the diagram above and answer questions about it.

i) **Who is heavier?**

- Lynet

ii) **Give a reason for your answer above.**

- Lynet is nearer the pivot than Danivia

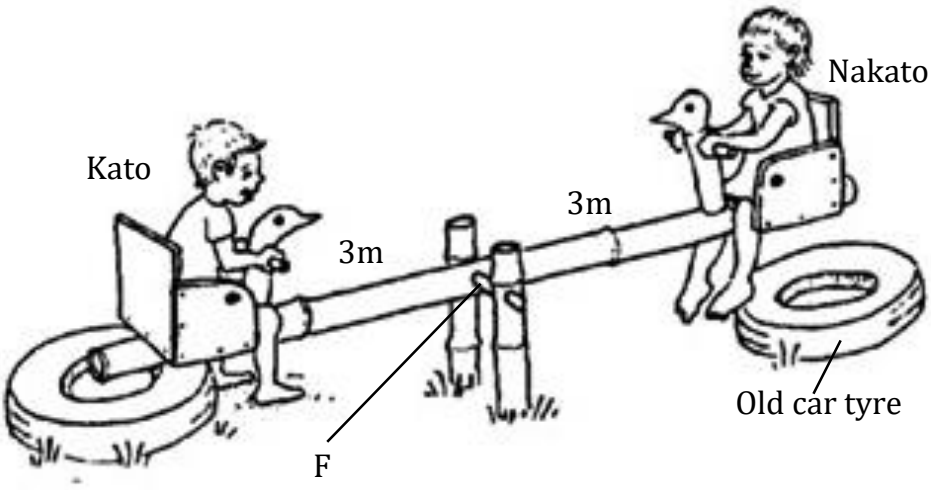
iii) **Who is lighter?**

- Danivia

iv) **Give a reason for your answer above.**

- Danivia is farther from the pivot than Lynet

2. It two bodies are at the same distance on opposite sides of the pivot, the heavier body lifts up the lighter one.



<u>Study the diagram of a seesaw shown above and answer questions that follow.</u>

i) <u>Of the twins on the seesaw above, who is heavier?</u>
- Kato

ii) <u>Give a reason for your answer above.</u>
- Kato has lifted up Nakato

iii) <u>What should Kato do in order to balance with Nakato?</u>
- Kato should sit nearer the pivot than Nakato

iv) <u>What should Nakato do in order to balance with Kato?</u>
- Nakato should sit farther from the pivot than Kato

v) <u>Name the part marked F</u>
- Pivot / Fulcrum

vi) <u>State the importance of the old car tyres put at the ends of a seesaw?</u>
- Old car tyres act as shock absorbers / To absorb shock

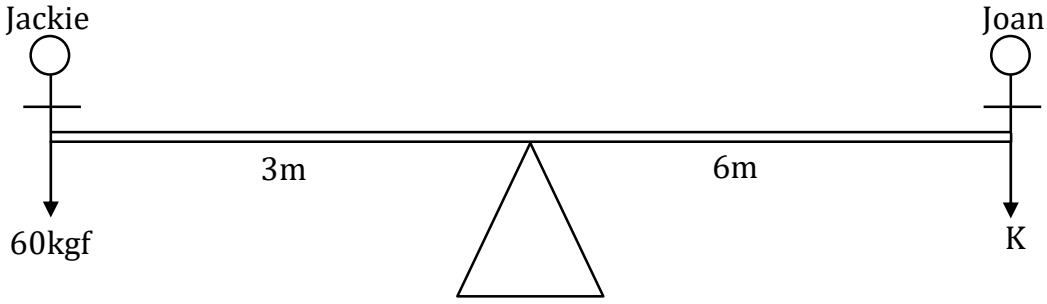
<u>CALCULATIONS ON MOMENTS</u>

<u>EXAMPLE I</u>

Jackie weighs 60kgf and sits 3 metres away from the fulcrum of the seesaw. Joan sits on the opposite side 6 metres away from the fulcrum and both girls balance.

Find Joan's weight

<u>Sketch</u>



- ✓ Let Joan's weight be K

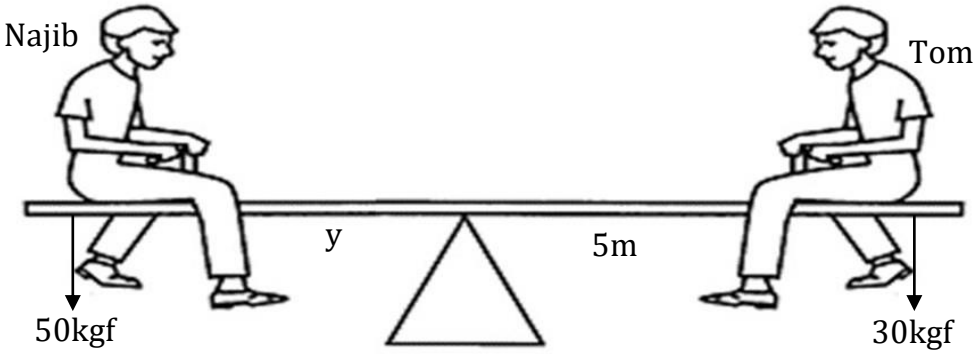
<u>Apply the law of levers</u>

L x LA	=	E x EA
(6 x K)	=	60 x 3
6K	=	180
<u>6K</u>	=	<u>180</u>
6		6
K	=	30Kgf

EXAMPLE II

Najib weighs 50kgf and is seated at a distance of y m from the pivot of a seesaw. Tom on other side is seated at a distance of 5m from the pivot weighs 30kgf. If the lever balances

i) Draw a sketch to show the position of Najib and Tom.



✓ Let Mukasa's distance from the pivot be y

ii) **Find Najib's distance from the pivot.**

Apply the law of levers

L x LA	=	E x EA
(50 x y)	=	30 x 5
50y	=	150
50y	=	150
50		50
y	=	3m

iii) **How far is Najib from Tom?**

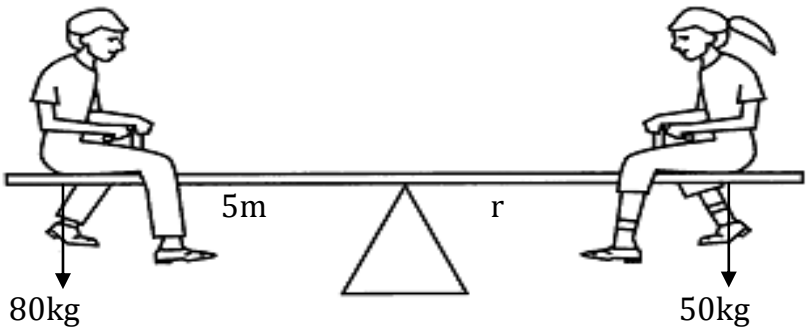
3m + 5m = 8m

EXAMPLE III

A man weighs 80kg and sits 5m away from the pivot of a seesaw.

i) **Where will his wife who weighs 50kg sit in order for them to balance?**

Sketch



✓ Let wife's distance from the pivot be r

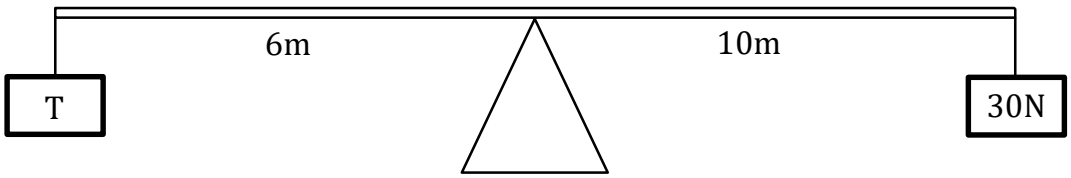
Apply the law of levers

E x EA	=	L x LA
(50 x r)	=	80 x 5
50r	=	400
50r	=	400
50		50
r	=	8m

ii) **How far is the man from his wife?**
8m + 5m = 11m

Example IV

Find the value of T in the figure below



Apply the law of levers

E x EA	=	L x LA
(T x 6)	=	10 x 3
6T	=	30
$\frac{6T}{6}$	=	$\frac{30}{6}$
T	=	5N

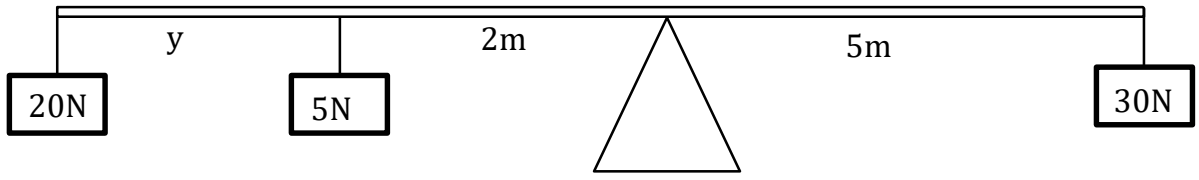
Activity

1. Wasswa weighs 80kgf and sits 3 m from the pivot of the see saw. Where will Kato who weighs 60kgf sit in order for them to balance?
2. Dan weighs 72kg sits 6metres from the pivot of a seesaw. Diana who weighs 36kk sits on the opposite side of the seesaw and they balance.
   i) Draw a sketch to show the position of Dan and Diana
   ii) How far is Diana from the pivot?
3. A man weighs 90kgf and sits 3m away from the fulcrum while his son weighing 30kgf sits in order to balance the man.
   i) Draw a sketch to represent the above information
   ii) How far is the man from the boy?
4. A man weighs 60kgf and sits 1.5 m from the turning point of the see saw. How far from the turning point will the boy whose weight is 30kgf sit in order to balance the man?

MORE CALCULATIONS ON MOMENTS

EXAMPLE I

In a lever below, calculate the value of **y** if two sides are to balance

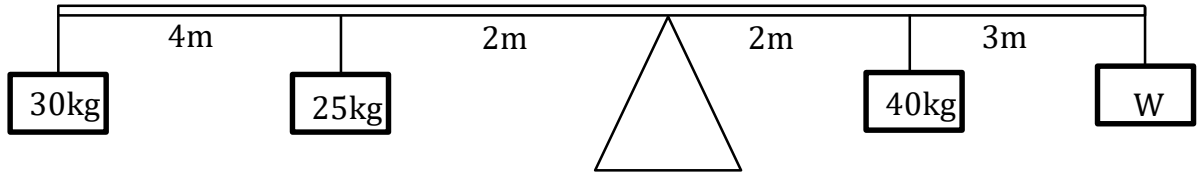


Apply the law of levers

E x EA	=	Lx LA
20(y + 2) + (5 x 2)	=	30 x 5
20y + 40 + 10	=	150
20y + 50	=	150
20y +50 – 50	=	150 - 50
20y	=	100
$\frac{20y}{20}$	=	$\frac{100}{20}$
y	=	5m

EXAMPLE II

Find the W in kg



Apply the law of levers

E x EA	=	L x LA
W(3 + 2) + (40 x 2)	=	30(4 + 2) + (25 x 2)
3W + 2W + 80	=	120 + 60 + 50
5W + 80	=	230
5W + 80 - 80	=	230 - 80
5W	=	150
5W / 5	=	150 / 5
W	=	30kg

TERMS USED WITH MACHINES

Mass

- This is the amount (quantity) of matter in an object
- ✓ The **basic unit** of mass is grams **(g)** and the **standard unit** is kilograms (Kg)

Weight

- This is the force of gravity acting on an object.
- ✓ It is measured in **Newton (N)**

FACTORS AFFECTING WEIGHT OF AN OBJECT

- Force of gravity
- Nature of an object
- Size of an object

Why do objects weigh less on moon than on earth?

- The moon's gravity is less than the earth's gravity
- There is less gravity on moon than on earth

DIFFERENCES BETWEEN MASS AND WEIGHT

- Mass is measured in kilograms while weight is measured in Newtons
- Mass is constant while weight changes
- Mass is a scalar quantity while weight is a vector quantity
- Mass can never be zero while weight can be zero
- Mass is the amount of matter in an object while weight is the force of gravity acting on an object

BUOYANCY (UPTHRUST)

- This is the upward force acting on an object put in a fluid (liquid or gas)

Why do objects weigh less when put (immersed) in water or other fluids?

- Due to upthrust (buoyancy)

How is buoyancy important to sailors?

- It enables their boats to float on water

Examples of objects that float due to upthrust (buoyancy)

- Boat
- Ferry
- Ship

SURFACE TENSION

- This is the force of attraction between molecules on the surface layer of the liquid

Application of surface tension

- It enables small insects to walk on water
- It enables small pins to float on water

Why do small sinking objects e.g. pins and small insects/water striders tend to float on water?

- Due to surface tension

COHESION

- This is the force of attraction between molecules of the same kind
- ✓ Cohesion is greatest in solids and weakest in gases

Why do solids have greatest cohesion?

- Solids have compact molecules / molecules in solids are closely packed together

Why do gases have no cohesion?

- Molecules in gases are farthest apart

Why do liquids flow?

- They have weak cohesion

ADHESION

- This is the force of attraction between molecules of different kind

Name the force that enables water droplets to stick on a glass surface.

- Adhesion

DISTANCE

This is the space between two points

- The basic unit of distance is **metre (m)** and the standard unit is **kilometre (km)**

FORCE

This is pull or push on an object

- It is measured in **Newton (N)**

  1kg = 10N

  1kgf = 1N

Note

Force = Mass x gravity

F = M x g

WORK

- This is the product of force and displacement

OR

- This is the product of force and distance moved in a specific direction
- Work done is measured in **joules (J)**

When is work said to be done?

- When an object moves along the direction of applied force

When is it said that there is no work done?

- When force is applied and an object does not move
- When the force is perpendicular to the motion of an object

CALCULATIONS ON WORK DONE

Work done = force x distance

W.d = F x d

Example I

Calculate the work done to push a wheelbarrow with an effort of 10N through a distance of 5m.

W = F x d
W = 10 x 5
= 50J

Example II

A block was moved using an effort of 7kg through a distance of 5m. Calculate the work done

1kg = 10N
70 kg = 7 x 10N
= 70N
W = F x d
W = 70 x 5
= 350J

Example III

Calculate the work done by a man who used 4N to push a wheel barrow through a distance of 2.5m

$$W = F \times d$$
$$W = 4 \times 2.5$$
$$= \frac{4 \times 25}{10}$$
$$= \frac{100}{10}$$
$$= 10J$$

Activity:

1. Calculate the measure of work done to put a sack of rice on a truck 3m above the ground using an effort of 50kg
2. An effort of 75N was applied to lift up a brick through a distance of 60m. Calculate the work done

MECHANICAL ADVANTAGE (M.A)

- This is the ratio of load to effort

OR

- This is the number of times a machine simplifies a given work.

$$\text{M.A} = \frac{\text{Load (L)}}{\text{Effort (E)}}$$

NOTE

- M.A has no units **because** it is a ratio of forces
- Less effort is used when M.A is greater than one
- Much effort is used when MA is less than one

Name the force that affects mechanical advantage of a machine

- Friction

Much friction reduces mechanical advantage and less friction increases mechanical advantage

CALCULATIONS ON MECHANICAL ADVANTAGE (MA)

An effort of 40N is applied to a lever to overcome a load of 200N.Calculate the MA of the machine.

$$MA = \frac{L}{E}$$

$$MA = \frac{200N}{40N}$$

$$= 5$$

What does the answer above mean?

- A machine simplifies the given work four times

Activity

1. Calculate the mechanical advantage (MA) if the cook uses a wheel barrow to push a 100kgf of maize flour with an effort of 25kgf.
2. Find the effort needed to lift a load of 300N if the MA is 3

Velocity Ratio (V.R)

- This is the ratio of effort arm to load arm

OR

- This is the ratio of effort distance to load distance

$$\textbf{V.R} = \frac{\textbf{Effort distance}}{\textbf{Load distance}}$$

CALCULATIONS ON VELOCITY RATIO

1. A crowbar moved a load of 800N to a height of 2m. If an effort of 200N was applied at a distance of 8m,
   i) Calculate the MA
   ii) Find the VR
2. A load of 100N was moved through a distance of 10m. If an effort of 2200N was applied at a distance of 50m from the fulcrum on the opposite side.
   i) Calculate the mechanical Advantage
   ii) Find the velocity ratio of the machine

EFFICIENCY OF A MACHINE (E)

- This is the ratio of the work output to work input of a machine expressed as a percentage

WORK OUTPUT

- This is the product of load and load distance
- This is the work done on the load by the machine

WORK INPUT

- This is the product of effort and effort distance
- This is the work done by the effort on the machine

$$\textbf{E} = \frac{\textbf{L x L.D}}{\textbf{E x E.D}} \textbf{ x 100\%}$$

REASONS WHY THE EFFICIENCY OF A MACHINE IS ALWAYS LESS THAN 100%

- Due to friction
- Due to gravity
- Due to rusting

WAYS OF IMPROVING THE EFFICIENCY OF A MACHINE

- By lubricating (oiling or greasing) to reduce friction
- By replacing/repairing worn out parts of a machine

Example

By using a machine, an effort of 30N was moved through a distance of 15m to raise a load of 120N to a height of 3m. Calculate the efficiency of the machine

Efficiency = Load x Load distance x 100%
Effort x Effort distance
= 120N x 3m x100%
30N x 15m
= 4 x 100%
5
= 80%

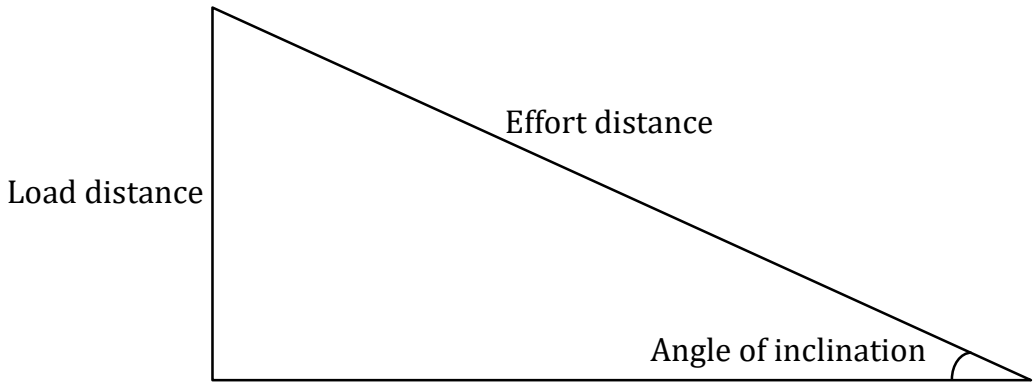
POWER

- This is the rate of doing work
- ✓ It is measured in **watts (w)** or **kilowatts (kw)**

INCLINED PLANES (SLOPES)

- These are slanting surfaces that join a lower level to a higher level
- These are simple machines with a slanting surface
- ✓ They are called inclined **because** they have a slanting surface and planes **because** they are flat

AN ILLUSTRATION SHOWING AN INCLINED PLANE (SLOPE)



- The vertical height **is the load distance (load arm)**
- The slanting surface **is the effort distance (effort arm)**

How do inclined planes/slopes simplify work? (Advantages of using inclined planes)

- They reduce the effort needed to raise heavy loads to higher levels

How do inclined planes/slopes reduce the effort needed to do work?

- By increasing the effort distance

How do inclined planes/slopes reduce the effort needed to do work?

- By increasing the effort distance

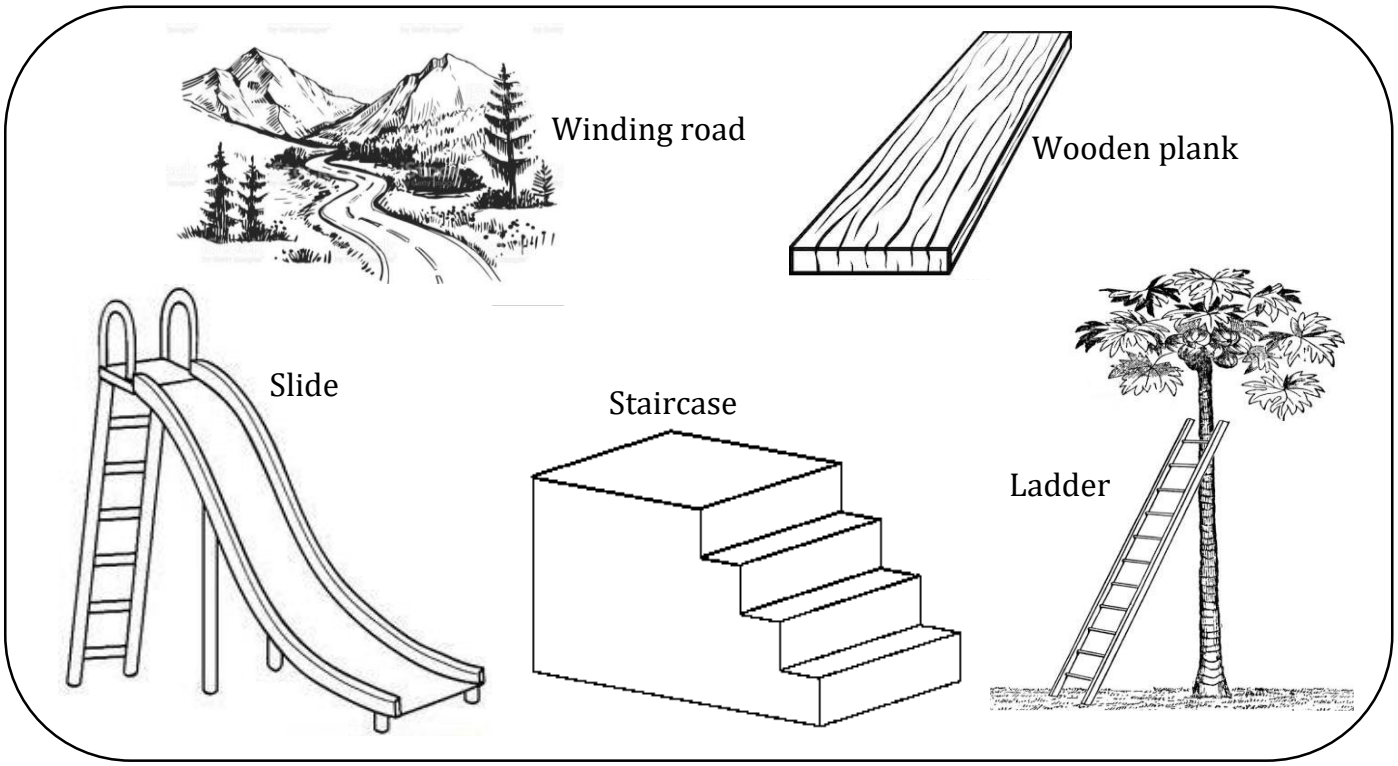
EXAMPLES OF INCLINED PLANES

- Staircase : this is a stepped slope
- Winding road (road going uphill)
- Ramp/Wheelchair ramp
- Ladder
- Slide
- Wooden plank (plank of wood)

USES OF INCLINED PLANES IN OUR DAILY LIFE

- A ladder helps in climbing trees
- Staircases help in climbing tall buildings
- A winding road helps in climbing steep hills
- A slide is used for playing sliding games
- A wooden plank helps in loading heavy goods on trucks

DIAGRAMS SHOWING SLOPES (INCLINED PLANES)



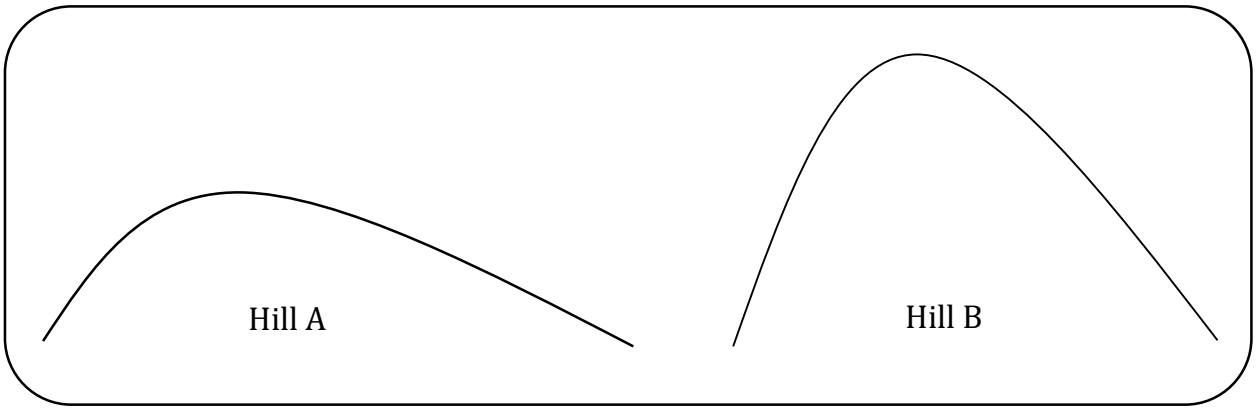
Why is it easier to climb up stairs than to use a ladder?

- Less effort is used to climb up stairs than on a ladder

How can inclined planes/slopes be improved?

- By making the slanting surface longer (increasing the effort distance)
- By reducing the angle of inclination

Study the diagrams below and answer the questions that follow.



On which hill will less effort be used in climbing?

- Hill A

Give a reason for your answer above

- Hill A has a longer slanting surface than hill B

Why does a person use much effort to climb hill B?

- Hill B has a steep slanting surface

Identify the inclined plane that can be used to reduce the effort needed in climbing hill B

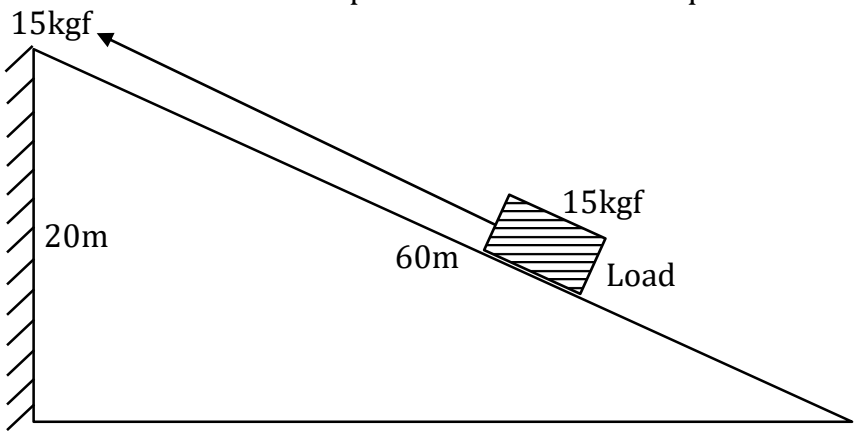
- Winding road

CALCULATING THE MECHANICAL ADVANTAGE OF SLOPES (INCLINED PLANE)

$$MA = \frac{L}{E} \quad \textbf{OR} \quad MA = \frac{ED}{LD}$$

EXAMPLE I

The diagram below shows an inclined plane. Use it to answer questions.



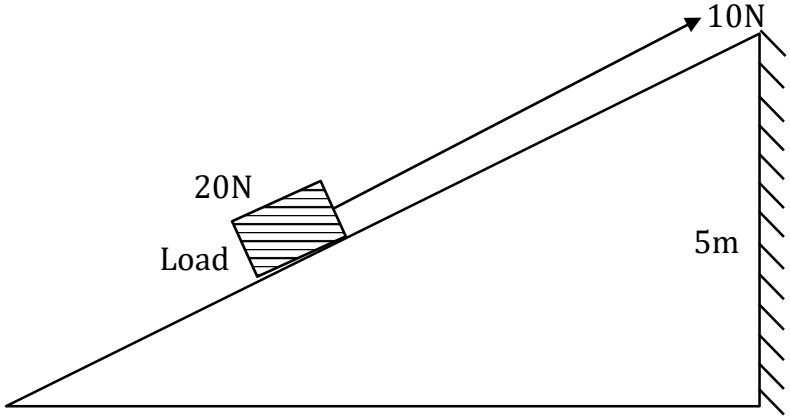
Calculate the work done on the load and Mechanical advantage

Work done = force x distance
= 15 x 2
= 30Joules

$$MA = \frac{ED}{LD}$$
$$= \frac{6m}{2m}$$
$$= 3$$

EXAMPLE II

Below is a slope. Use it to answer questions.



Calculate the mechanical advantage

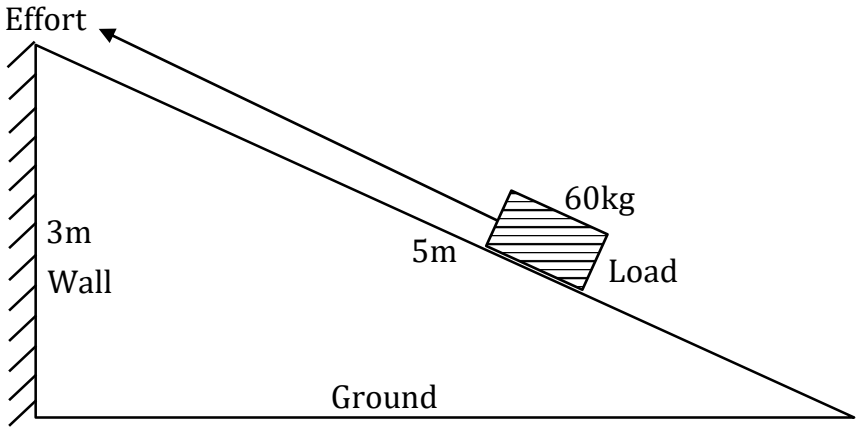
$$MA = \frac{L}{E}$$
$$= \frac{20N}{10N}$$
$$= 2$$

Find the distance moved by effort

$$MA = \frac{ED}{LD}$$
$$5m \times 2 = \frac{ED}{5m} \times 5m$$
$$10m = ED$$

Example III

The diagram below shows a slope. Use it to answer questions



If an effort of 30kg was used to raise the load from the ground to a higher level,

a) Calculate the mechanical advantage
b) Find the efficiency of the machine

WEDGES

- These are tools with a sharp edge that gets gradually wider

Why are wedges sometimes called double inclined planes?

- They have two slanting surfaces

EXAMPLES OF WEDGES

- Axe
- Panga
- Spear
- Sword
- Needle
- Razorblade
- Bullet
- Knife
- Nail
- Chisel
- Wooden wedge
- Safety pin
- Hoe

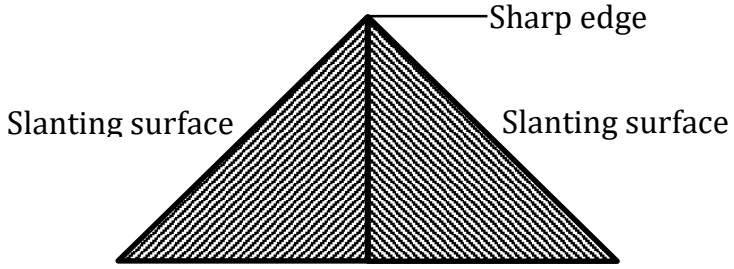
APPLICATIONS (USES) OF WEDGES

- Some wedges are used for splitting/chopping wood
- Some wedges are used for cutting
- Some wedges are used for sewing
- Some wedges are used for digging
- Some wedges are used for peeling
- Some wedges are used for piercing

Activities done using wedges

- Sewing
- Cutting
- Splitting firewood
- Peeling food
- Digging

AN ILLUSTRATION SHOWING A WEDGE



How do wedges simplify work?

- They have a sharp edge which makes the crack bigger.

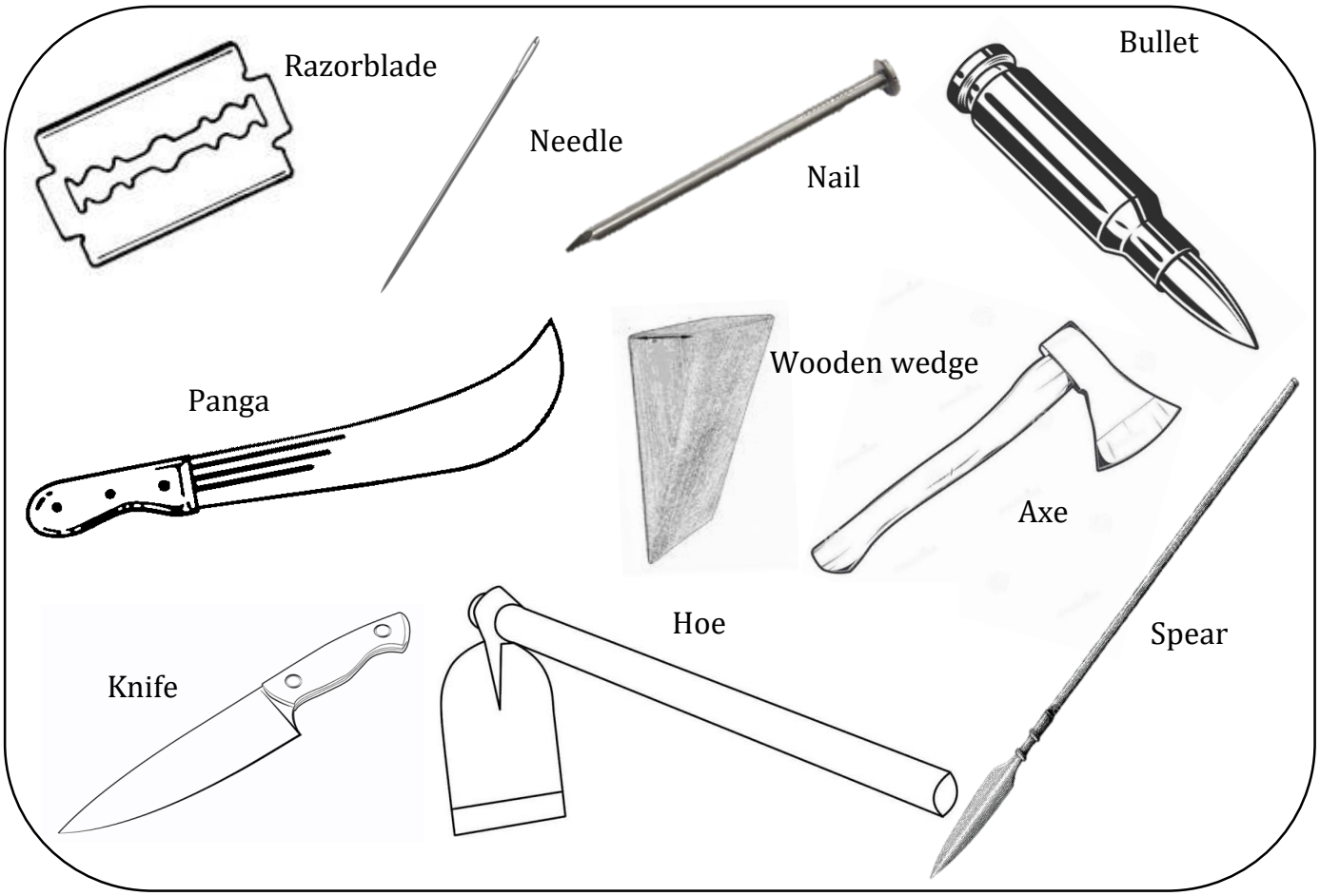
How can wedges be improved?

- By sharpening them

FACTORS THAT AFFECT THE EFFICIENCY OF WEDGES

- Rusting
- Friction
- Sharpness

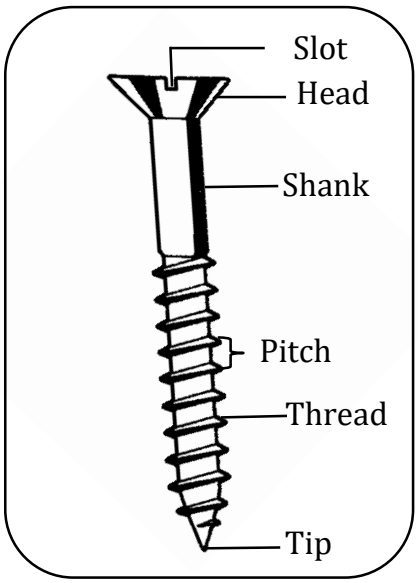
DRAWINGS SHOWING WEDGES



SCREWS

- A screw is an inclined plane wound round a bar/rod

PARTS OF THE SCREW



Threads (screw threads)

- They hold the screw nail into the material where it is driven

Pitch

- This is the distance between two consecutive threads

Head

- It has a groove/slot where the screw driver is fitted

Slot

- It is where the screw driver is fitted

Shank (rod)

- This is the smooth part above the threads but below the head

Tip

- This is the part of the screw nail that enters the material first

NOTE

A screw with many threads moves longer distance so;

- Less effort is needed to overcome the load

A screw with few threads moves a shorter distance so;

- Much effort is needed to overcome the load

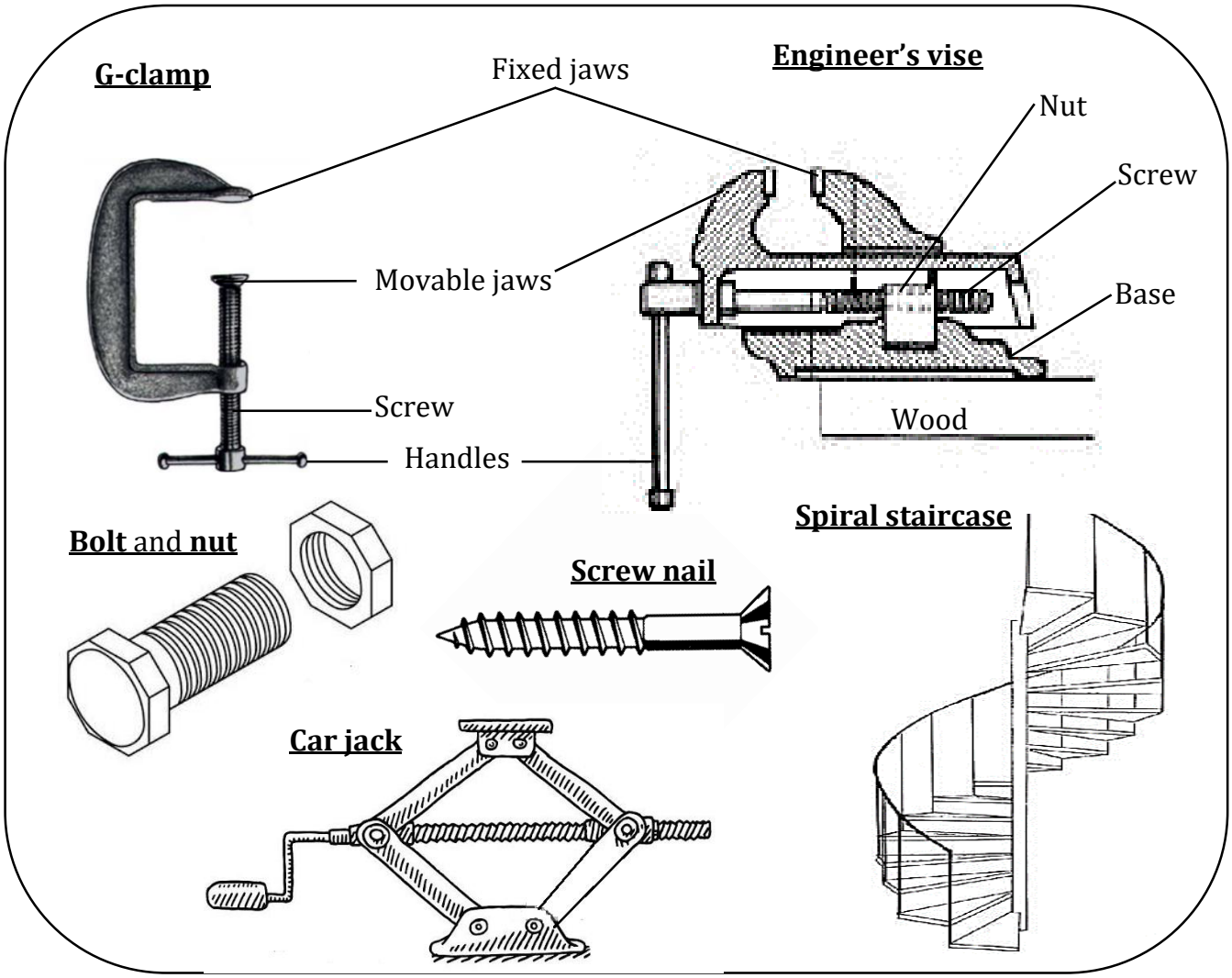
EXAMPLES OF MACHINES THAT USE SCREWS

- Bolt and nut
- Screw cap
- Car jack
- Screw nail
- Spiral staircase
- Engineer's vise
- G-clamp
- Drilling machine

FACTORS THAT AFFECT PROPER WORKING OF SCREWS

- Rusting
- Friction

DRAWINGS SHOWING SCREWS



USES OF SCREWS

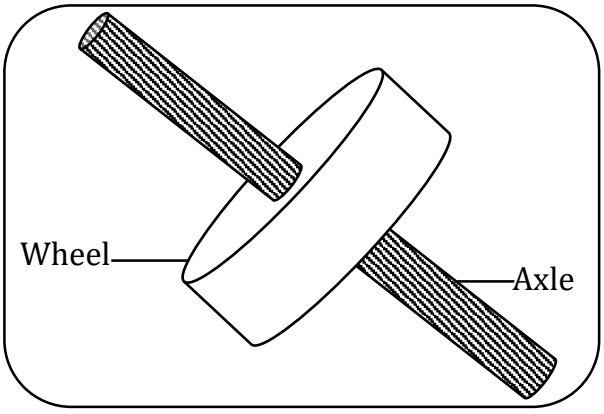
- Car jack is used to lift vehicles
- Screw nails are used to fasten(hold) wood or metals together
- Drilling machine is used to drill holes in wood or metals
- Screw caps are used to tighten bottle tops
- Spiral staircase make movement upstairs easier
- Engineer's vise is used to hold metals when filing or cutting
- Bolts and nuts are used to fasten metals together

WHEELS AND AXLE

- These are simple machines composed of two rotating wheels fixed together

✓ **A wheel** is a circular rim rotating on axle (shaft)
✓ **An axle** is a rod on which a wheel rotates
✓ A strong thread or chain is tightly around the axle
✓ A belt (chain) coming out of the wheel leads to the **Effort** and the one that comes out of the axle leads to the **Load**

AN ILLUSTRATION OF A WHEEL AND AXLE



- ✓ The radius of the wheel must be greater than the radius of the axle to use less effort

EXAMPLES OF WHEELS AND AXLE MACHINES

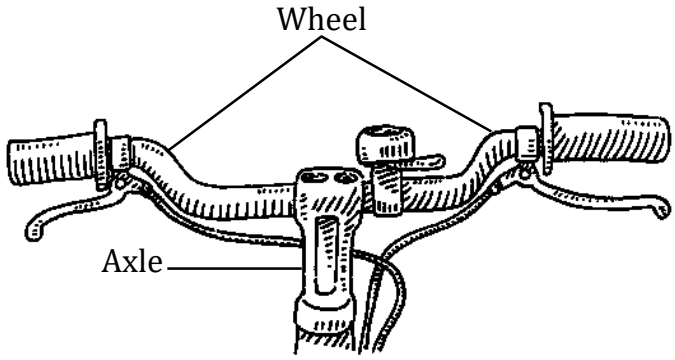
- Car steering wheel
- Doorknob
- Bicycle handles
- Bicycle pedal wheels
- Egg beater
- Windlass (winch)
- Brace
- Sewing machine
- Screw driver
- Windmill

APPLICATION (USES) OF WHEELS AND AXLE IN DAILY LIFE

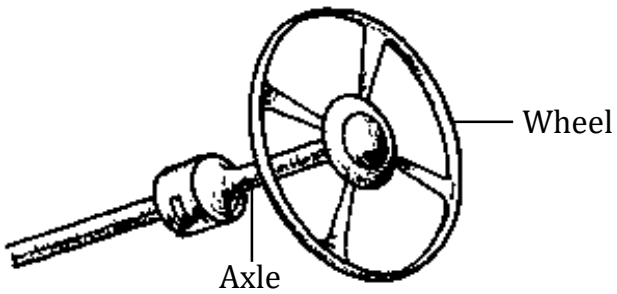
- Egg beater is used to prepare eggs for frying
- Windlass is used to draw water from deep wells
- Doorknob is used to open doors
- Steering wheel is used to turn cars
- Bicycle pedal wheels are used to ride bicycles
- Door knobs used to open doors
- Brace is used to drill holes in wooden materials
- Screw drivers are used to turn screw nails

DRAWINGS SHOWING WHEELS AND AXE MACHINES

HANDLES OF A BICYCLE

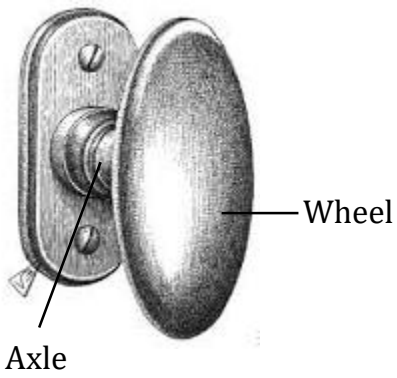


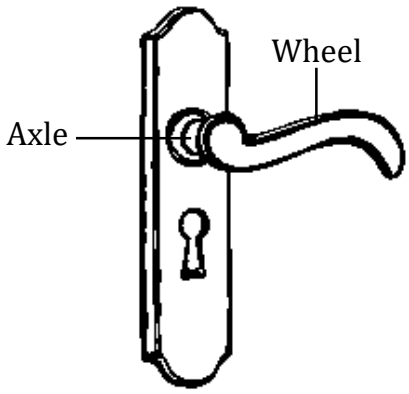
CAR STEERING WHEEL



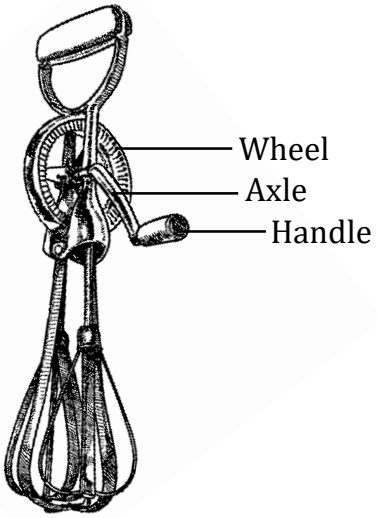
- ✓ The longer the steering wheel, the easier the turning of the wheel

DOORKNOB

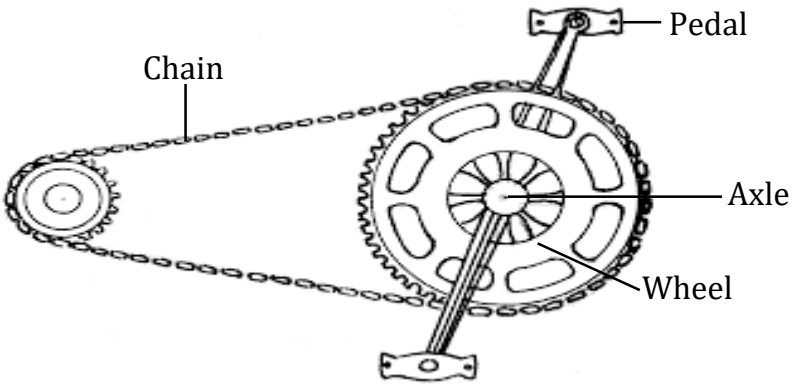




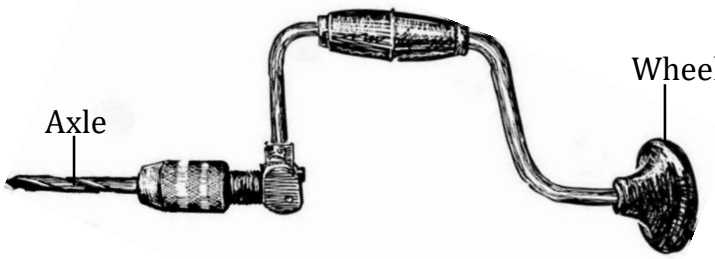
EGG BEATER



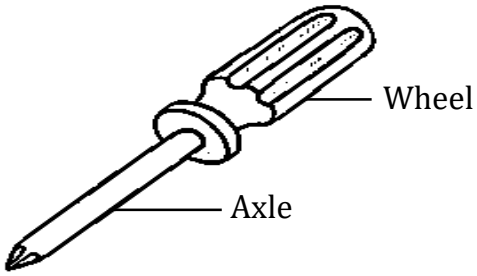
PEDAL WHEELS OF A BICYCLE



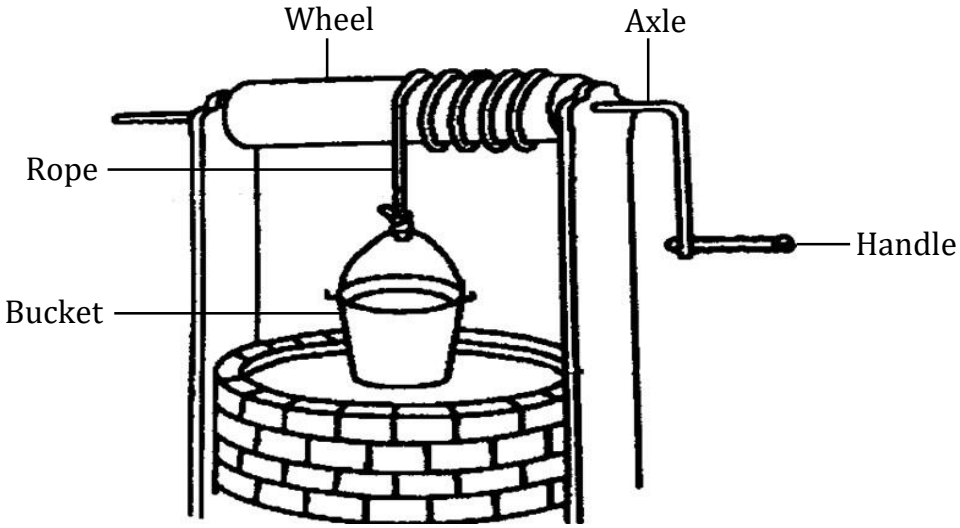
BRACE



SCREW DRIVER



WINDLASS



NOTE

- The handle of the windlass is turned in clockwise direction to move the bucket upwards

How can one turn the handle to make the bucket move downwards?

- In the anti-clockwise direction

On which principle does a windlass work?

- It works on the principle of wheels and axle

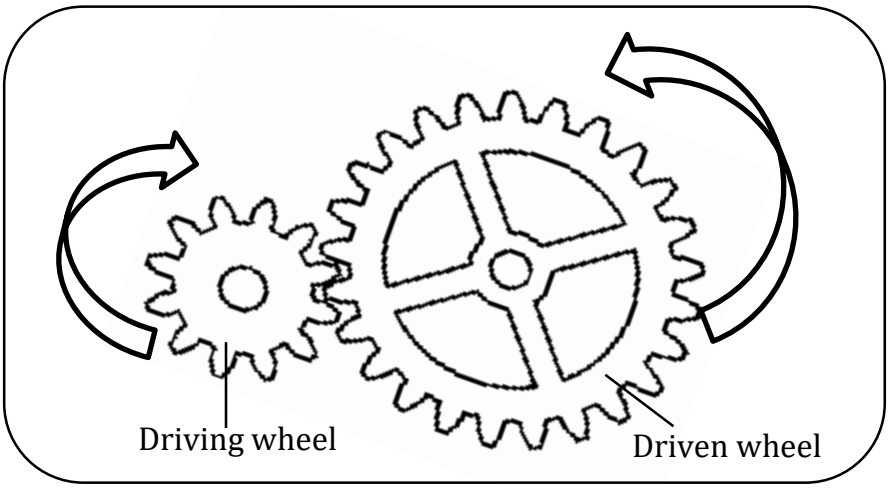
GEAR WHEELS AND BELT DRIVES

Gear wheel:

- This is a wheel with a toothed rim
- This is a wheel with teeth on edges around it
- ✓ It is sometimes called **cogwheel** or **toothed wheel**

ILLUSTRATIONS SHOWING COGWHEELS (GEARS)

i) **COG WHEELS A AND B MOVE IN OPPOSITE DIRECTIONS**



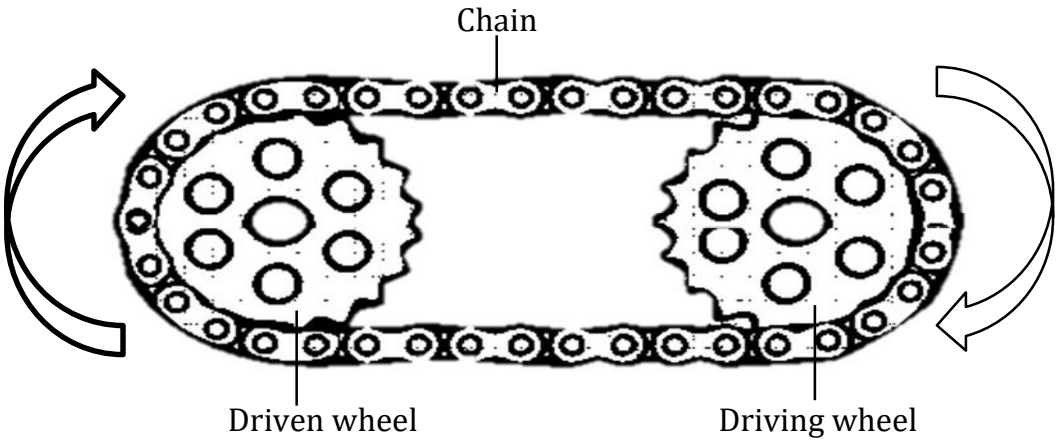
- If cogwheels are fixed, their teeth interlock and they move in opposite directions

CALCULATION ON GEARS

If the driving wheel has 12 teeth and a driven wheel has 48 teeth, how many revolutions will be made by a driving wheel in a complete turn (one revolution) of a driven wheel?

No. of revolutions = No. of teeth on driven wheel
No. of teeth on driving wheel
= 48
12
= 4 revolutions

ii) **COGWHEELS A AND B MOVE IN THE SAME DIRECTION**



- If cogwheels are connected with chains (belts), they move in the same direction

EXAMPLES OF MACHINES THAT USE GEAR WHEELS

- Motor cycles
- Bicycles
- Bulldozers
- Gear boxes
- Watches

ADVANTAGES OF USING GEAR WHEELS

- They multiply effort(reduce the effort applied)
- They increase the speed of rotation
- They change the direction of rotation/movement
- They can be used to slow the speed of rotation

BELT DRIVE:

- This is a mechanism where the movement of a flexible belt transmits power from one pulley shaft to another.
- Pulleys connected and driven by a belt move in the same direction

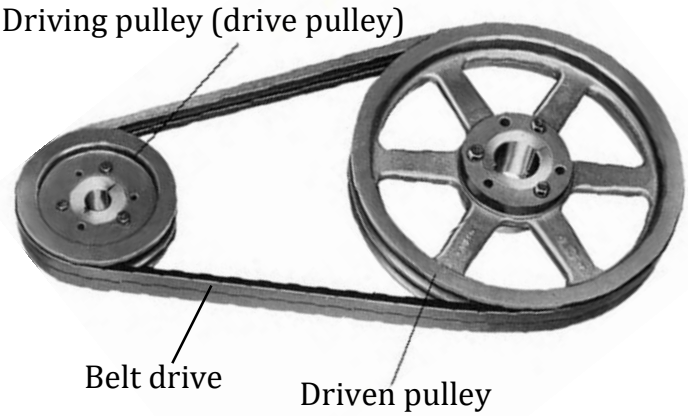
APPLICATIONS OF BELT DRIVE:

- It is used to transfer (transmit) power from one pulley to another.
- It is used in the mill industry.
- It is used in conveyor.
- It is used in washing machine.
- It is used in exhaust fan system.

MATERIALS USED TO MAKE BELT DRIVE:

- Leather
- Rubber
- Cotton
- Plastic
- Balata

AN ILLUSTRATION SHOWING PULLEYS DRIVEN BY BELT DRIVE



EXAMPLES OF MACHINES THAT USE BELT DRIVE

- Sewing machine
- Grain mill
- Sawmill
- Printing press
- Treadmill
- Belt conveyor / conveyor belt system
- Alternator
- Washing machine
- Generator
- Car radiator fans
- Water pump
- Air compressor

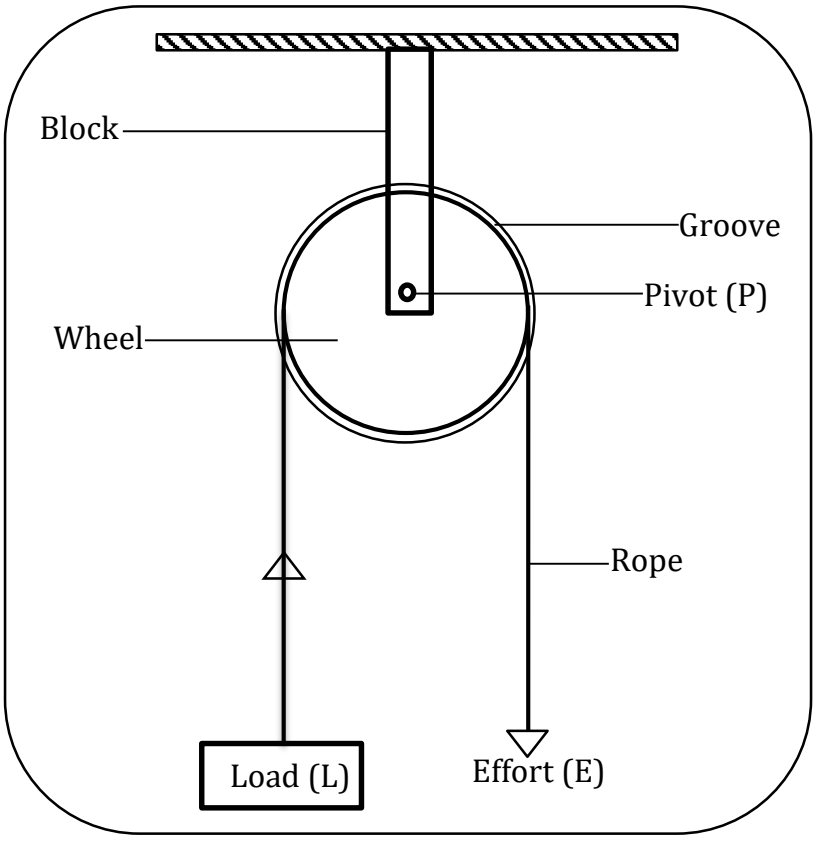
USES OF BELT CONVEYOR

- They are used in bottling industries to transport soda bottles in bottling lines
- They are used in escalators to transport people from one floor to another
- They are used to transport materials from one level to another

PULLEYS:

- A pulley is a wheel with a grooved rim

PARTS OF A PULLEY



Functions of the parts of a pulley

Block

- It holds (supports) the pulley

Grooved rim

- It prevents the rope from slipping (sliding) off

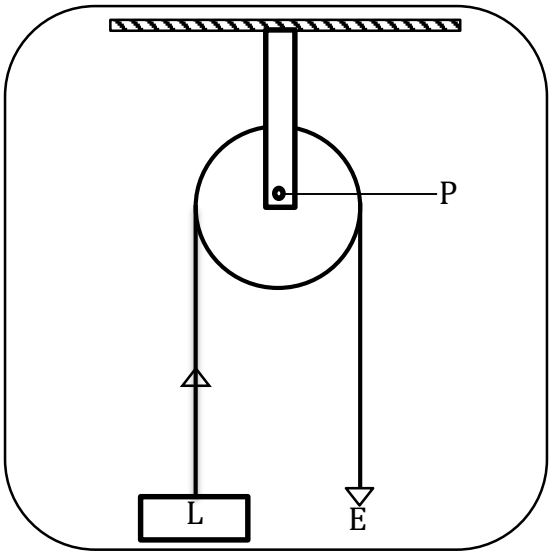
Rope/chain

- It holds the load
- It is where the effort is applied

TYPES OF PULLEYS

- Single fixed pulley
- Single movable pulley
- Block and tackle pulleys (fixed movable pulley)

SINGLE FIXED PULLEY



In a single fixed pulley;

- The block is fixed and only the wheel moves
- It changes the direction of forces
- The load and effort move in opposite direction
- The load and effort move the same distance
- It acts as a first class lever
- Work is done faster
- The effort applied is equal to the load
- The mechanical advantage is always one (1)

$$MA = \frac{L}{E} \quad \text{but; } L = E$$

$$= \frac{E}{E}$$

$$M.A = 1$$

How does a single fixed pulley simplify work?

- By changing the direction of force

How does changing the direction of forces simplify work?

- It is easier to raise the load by pulling downwards

Why is the M.A of a single fixed pulley always one?

- The load is equal to effort

Why is the load equal to effort applied in a single fixed pulley?

- The load and effort move the same distance

Advantage of using single fixed pulley

- It changes the direction of forces

Disadvantage of using single fixed pulley

- It does not reduce the effort needed to do work

Examples of single fixed pulley

- Flagpole
- Window blind
- Ski lift

CALCULATIONS ON SINGLE FIXED PULLEYS

Example I

Find the force applied to lift a load of 50kgf using a single fixed pulley

$$MA = \frac{Load}{Effort}$$

$$1 = \frac{50kgf}{E}$$

$$E = 50kgf$$

Example II

Find the effort applied to pull a load of 85N using a single fixed pulley.

$MA = \frac{L}{E}$ but; $MA = 1$, $L = 85N$

$1 = \frac{85N}{E}$ $E = ?$

$E \times 1 = \frac{85}{E} \times E$

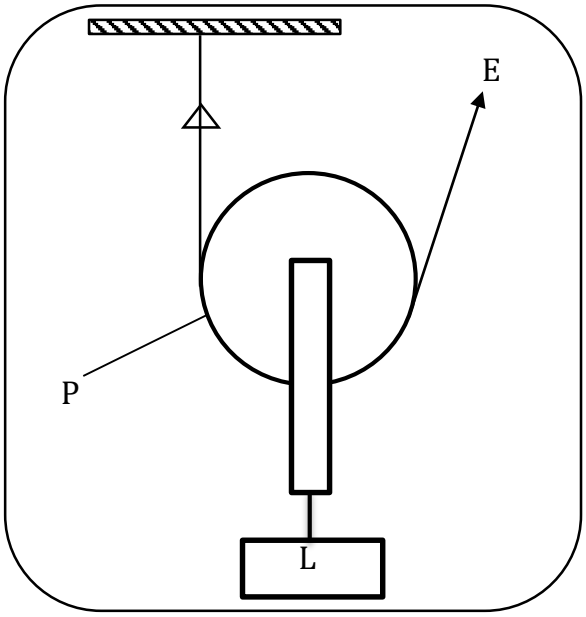
$E = 85N$

The force needed to lift the load is the same as the load.

Activity

1. An effort of 10kgf was applied on a single fixed pulley to raise a load to a height of 60m
i) Find the value of load to be raised
ii) Calculate the distance moved by effort
2. If a load of 30kg is to be lifted through a distance of 10m using a single fixed pulley
i) Find the value of effort needed for lifting the load
ii) Calculate the distance moved by effort

SINGLE MOVABLE PULLEY



In a single movable pulley;

- The whole pulley block moves along the rope
- It does not change the direction of force
- The load and effort move in the same direction
- The effort distance is twice the load distance
- It acts as a second class lever
- Work is done slower
- The effort applied is a half the load
- The mechanical advantage (M.A) is two (2)

$MA = \frac{L}{E}$ but; $L = 2E$

$= \frac{2E}{E}$

$M.A = 2$

How does a single movable pulley simplify work?

- It uses less effort
- It reduces the effort by a half the load

Why does a single movable pulley use less effort?

- The effort distance is longer than the load distance

Why is the M.A of a single movable pulley always two (2)?

- The load is twice the effort
- The effort is a half the load

Advantage of using single movable pulley

- It reduces the effort needed to raise the load (it uses less effort)

Disadvantage of using single fixed pulley

- It does not change the direction of forces

EXAMPLES OF SINGLE MOVABLE PULLEYS

- Construction crane
- Modern elevator
- Weight lifting machines at gyms

CALCULATIONS ON SINGLE MOVABLE PULLEYS

EXAMPLE I

What force will be needed to raise a load of 50kgf using a single movable pulley?

$$M.A = \frac{L}{E}$$

$$2 = \frac{50kgf}{E}$$

$$E \times 2 = \frac{50kgf}{E} \times E$$

$$2E = 50kgf$$

$$\frac{2E}{2} = \frac{50kgf}{2}$$

$$E = 25kgf$$

EXAMPLE II

If a single movable pulley is used to lift a load of 90N, find the value of effort.

$$M.A = \frac{L}{E}$$

$$2 = \frac{90N}{E}$$

$$E \times 2 = \frac{90N}{E} \times E$$

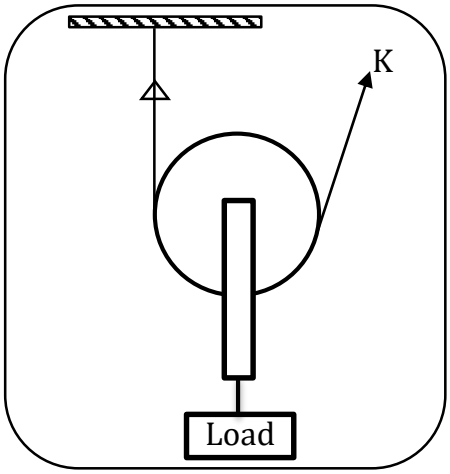
$$2E = 90N$$

$$\frac{2E}{2} = \frac{90N}{2}$$

$$E = 45N$$

EXAMPLE III

The diagram below shows a single movable pulley system on which an effort of 70kg was used to raise a load through a height of 40 m. Use it to answer questions.



a) Calculate distance moved by effort

$$M.A = \frac{ED}{LD}$$

$$40m \times 2 = \frac{ED}{40m} \times 40m$$

$$80m = ED$$

b) What does letter K represent?

- Effort

ACTIVITY

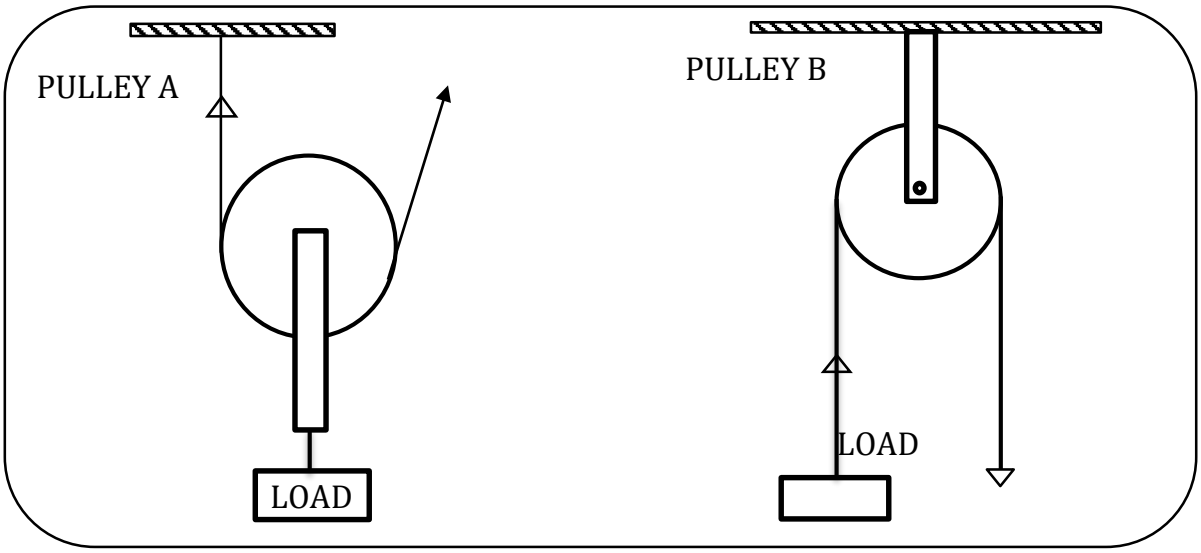
1. Calculate the effort needed to lift a load of 600N up the building using a single movable pulley
2. If the load is raised through a height of 50m using a single movable pulley, find the distance moved by the effort
3. A man used 40N to pull a load of 80N
   a) What type of pulley did he use?
   b) Give a reason for your answer
4. a) How much effort is needed to lift a load of 50kgf using a movable pulley system?
   c) Besides friction, name other force you overcome when using a single movable pulley

DIFFERENCES BETWEEN FIXED PULLEYS AND MOVABLE PULLEYS

FIXED PULLEY	MOVABLE PULLEY
It changes direction of forces	It does not change the direction of forces
The effort is equal to the load	The effort is half the load
Work is done faster	Work is done slower
It has mechanical advantage of one	It has mechanical advantage of two
It has velocity ratio of one	It has velocity ratio of two

ACTIVITY

The diagrams below show types of pulley systems used to raise similar load (W). Use them to answer questions that follow

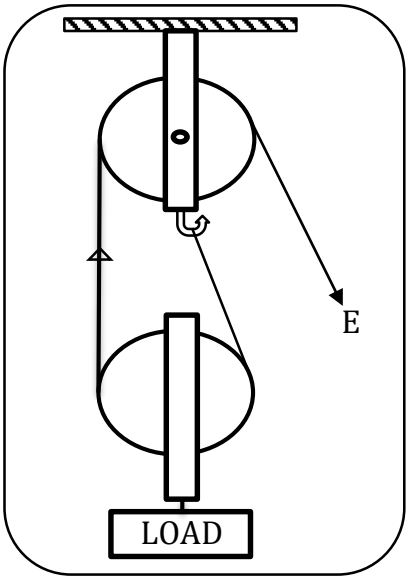


a) Identify the type of pulley system shown in each diagram
b) In which of the two pulley systems is less effort needed to raise the load
c) Give a reason to support your answer in (b) above
d) How can the pulley system in diagram B be useful at school?
e) If the load of 200N is raised from the ground to a roof of 5m high using arrangement B,
f) Calculate the work done
g) Find the effort needed to raise the load
h) f) Give one comparison between pulley system A and pulley system B
i) g) Why a pulley system is sometimes regarded as a lever machine?

BLOCK AND TACKLE PULLEY (FIXED MOVABLE PULLEY/DOUBLE PULLEY SYSTEM)

- This is a combination of a fixed pulley and a movable pulley both supported by one block

A DIAGRAM SHOWING A BLOCK AND TACKLE PULLEY



NOTE:

- The more movable pulleys used, the less effort needed to raise the load

ADVANTAGES OF USING BLOCK AND TACKLE PULLEY

- It changes the direction of force
- It reduces the effort needed to do work

WHAT DETERMINES THE MECHANICAL ADVANTAGE OF BLOCK AND TACKLE PULLEY?

- The number of wheels (pulleys) in the block
- The number of supporting ropes lifting the load

EXAMPLES OF DEVICES WHICH USE PULLEYS

- Cranes
- Flagpoles
- Elevators/house lifts
- Scaffolds
- Breakdown vehicles (tow trucks)

APPLICATIONS (USES) OF PULLEYS IN OUR DAILY LIFE

- They are used to raise (hoist) flags on flagpoles
- They are used in cranes to lift heavy loads
- They are used to draw curtains in curtain boxes
- They are used in elevators / house lifts
- They are used on tow trucks to pull stranded vehicles
- They are used in scaffolds by painters
- They are used to fetch water from deep wells

EXCRETORY SYSTEM

BODY SYSTEMS

- A system is a group of organs that perform a specific function
- An organ is a group of tissues that perform a specific function
- A tissue is a group of cells that perform a specific function
- A cell is the smallest unit of an organism (this is the basic unit of life)

Examples of body systems

- Digestive system
- Reproductive system
- Muscular system
- Skeletal system
- Nervous system
- Circulatory system
- Respiratory system
- Endocrine system
- Lymphatic system
- Excretory system

EXCRETORY SYSTEM

- This is a body system that removes metabolic waste products from the body

What is excretion?

- This is the process of removing metabolic waste products from the body

State two importance of excretion

- It prevents body poisoning
- It maintains the pH of body fluids

Mention three metabolic processes that form excretory products

- Respiration
- Deamination
- Synthesis of proteins

Organs of the excretory system (examples of excretory organs)

- The skin
- The kidney
- The lungs
- Liver

EXCRETORY ORGANS AND THEIR EXCRETORY PRODUCTS

EXCRETORY ORGAN	EXCRETORY (WASTE) PRODUCTS
Skin	Sweat ▪ Excess salts ▪ Excess water ▪ Urea ▪ Lactic acid
Kidney	Urine ▪ Excess salts ▪ Excess water ▪ Urea ▪ Uric acid
Liver	Bile pigments Cholesterol
Lungs	Carbon dioxide Water vapour

Why is faeces not regarded as an excretory product?

- It is not formed by a metabolic process

THE KIDNEYS

- These are two reddish brown bean shaped organs in the abdominal cavity
- They are found on either side of the spine **at the back of the abdomen**
- They are enclosed in a transparent membrane called **renal capsule**

Name the part of the skeleton that protects the kidneys.

- Pelvis (hip bone)

FUNCTIONS OF THE KIDNEYS

- They filter blood (remove urine from the body)
- They balance salt and water level in the body/balance body's fluids/for osmoregulation
- They produce a hormone to regulate blood pressure e.g. renin

Waste products by the kidney (components of urine)

- Urea
- Uric acid
- Excess salts
- Excess water

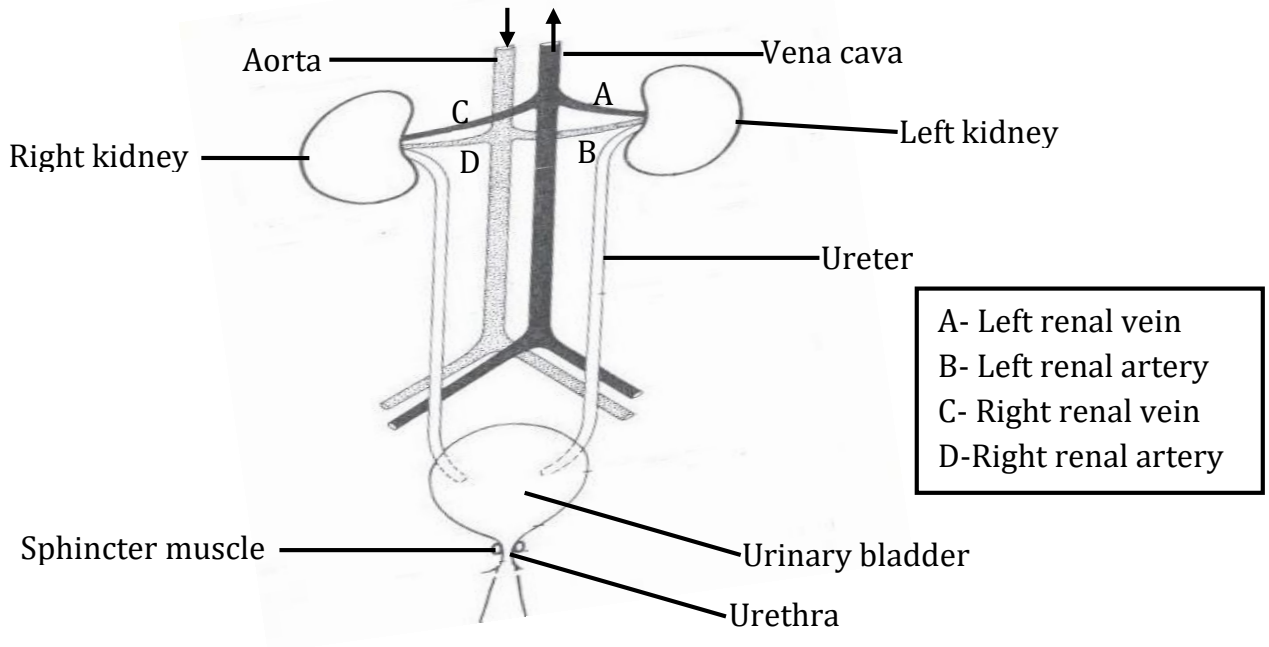
Name the nitrogenous compounds in urine/filtered by kidneys from blood

- Urea
- Uric acid

Name the two kidneys found in human beings

- Left kidney
- Right kidney

A diagram showing the position of the kidneys in the urinary system



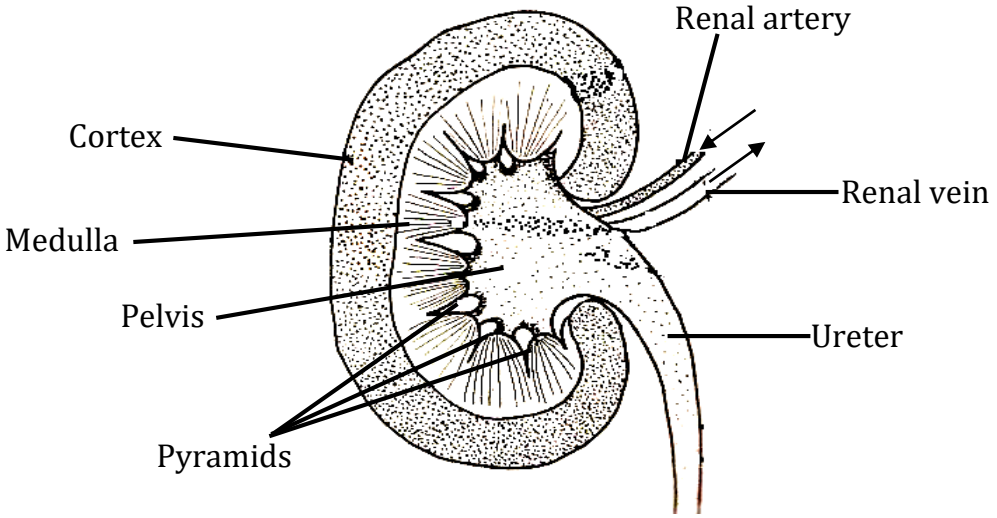
NOTE

- **Urinary system** is a body system that removes urine from the body
- It consists of the kidneys, ureters, urinary bladder and urethra
- **The kidneys** are the major organs of the urinary system

Why is the right kidney at a lower level than the left kidney?

- The right kidney is below the liver which is the largest body organ while the left kidney is below the spleen

THE STRUCTURE OF THE KIDNEY



Functions of each part of the kidney and urinary system

Renal artery

- It carries oxygenated blood from the aorta to the kidneys

Renal vein

- It carries deoxygenated blood from the kidney to the vena cava

Note

- ✓ Blood in renal vein is filtered while blood in renal artery is not filtered

Cortex (renal cortex)

- It is where blood is filtered

How is the cortex adapted to its function?

- It has nephrons to filter blood
- It has a dense network of capillaries (glomerulus)

Name the main process that occurs in the cortex of the kidney

- Filtration of blood (ultrafiltration)

Medulla

- It is where **selective reabsorption** of useful materials occurs

OR

- It reabsorbs water and mineral salts that are still needed by the body

Examples of useful materials reabsorbed by the medulla of the kidney

- Water
- Mineral salts
- Glucose
- Amino acids

- ✓ A lot of water is reabsorbed when blood volume is low
- ✓ Little water is reabsorbed when blood volume becomes normal

Ureter

- It passes urine from the kidney to the urinary bladder

Urinary bladder

- It stores urine before it is passed out of the body

Sphincter muscle

- It opens or closes the urinary bladder

Urethra

- It passes urine out of the body

Pyramids

- They pass urine from the medulla to the pelvis

Pelvis (renal pelvis)

- It collects urine before it goes to the urinary bladder

PROCESSES INVOLVED IN URINE FORMATION

- Ultrafiltration (Filtration)
- Selective reabsorption (Reabsorption)
- Tubular secretion (Secretion)

URINATION (MICTURITION)

- This is the removal of urine from the body

Factors that affect the amount of urine passed out of the body

- Fluid intake
- Temperature

Why do people urinate frequently on cold days?

- There is little or no sweating hence the kidneys pass out excess water as urine

Why do people pass out little urine on hot days?

- There is much sweating hence less work for the kidneys

Why do people pass out a lot of urine when they drink plenty of fluids?

- For the kidneys to balance the water level in the body

Name the blood vessel that carries purified blood from the kidney.

- Renal vein

Why is selective reabsorption important after filtration?

- It prevents loss of useful materials which are still needed by the body

Why do children below three years of age always urinate on the bed?

- Their urinary bladders are not developed enough to store urine for the whole night

What is meant by the term kidney dialysis?

- This is the process of removing urine from the blood of people with kidney failure

DISEASES OF THE KIDNEY

- Kidney stones
- Bilharziasis
- Nephritis
- Kidney cancer

KIDNEY STONES

- These are hard deposits of salts that form inside the kidneys

Causes of kidney stones

- Dehydration
- Eating too much raw salt
- Obesity

Signs of kidney stones

- Bloody urine
- Smelly urine
- Frequent urination

Symptoms of kidney stones

- Pain in the lower abdomen
- Painful urination

BILHARZIASIS

- It is caused by germs called **schistosomes (blood flukes)**
- It is spread by a vector called **fresh water snails**
- It spreads through drinking, swimming or bathing in contaminated water

Signs of bilharziasis

- Bloody urine
- Swollen abdomen

Nephritis

- It leads to inflammation of the kidney

DISORDER OF THE KIDNEYS

- Kidney failure

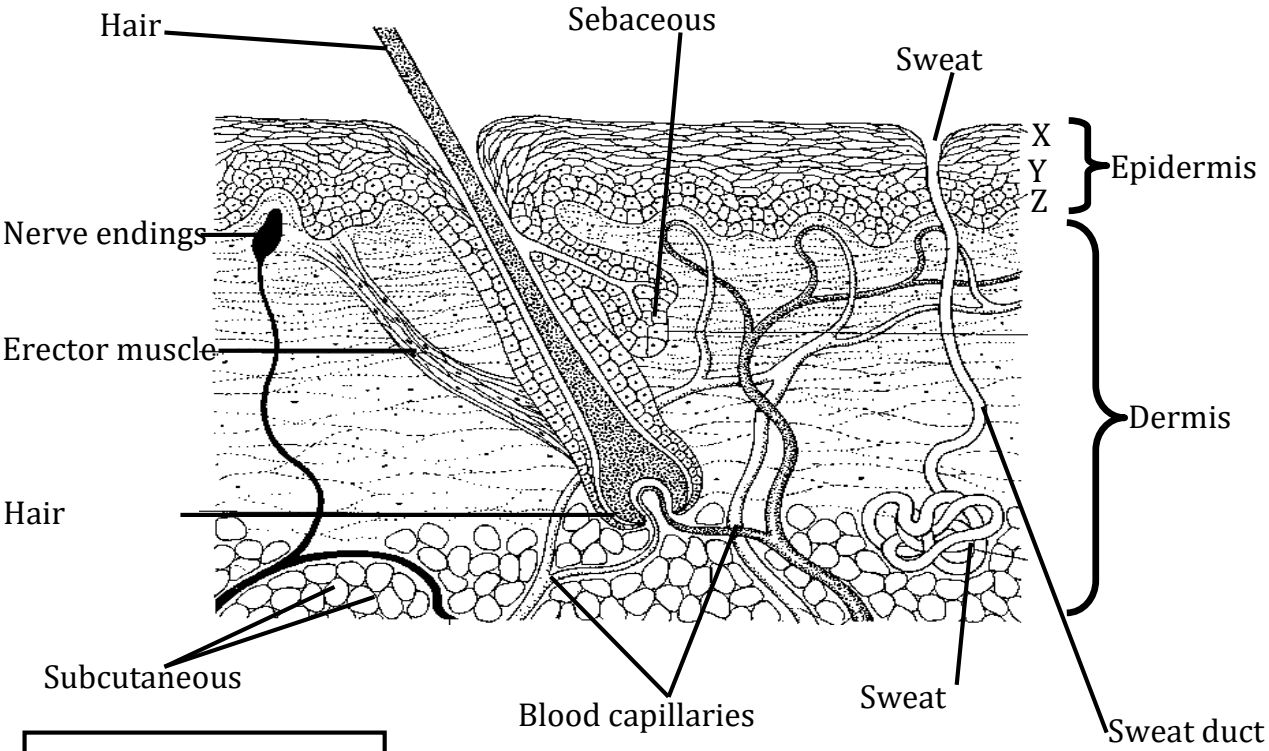
Ways of promoting proper working of the kidneys and the urinary system

- Feed on a balanced diet
- Do regular body exercises
- Drink plenty of safe water
- Do not hold back urine for a long time
- Avoid taking a lot of alcohol
- Avoid eating too much raw (uncooked)salt
- Avoid heavy blows at the lower back of the abdomen
- Have regular medical checkups

THE SKIN (INTEGUMENT)

- This is the outer protective organ of the human body
- It is the largest organ on human body
- The skin is an integumentary organ

STRUCTURE OF THE HUMAN SKIN



X- Cornified layer
Y- Granular layer
Z- Malpighian layer

Name the two main layers (regions) of the skin

- Epidermis
- Dermis (corium)

THE EPIDERMIS

- This is the outermost (upper) layer of the skin
- It has no nerves and blood vessels

Importance of epidermis region of the skin

- It protects the inner layer from damage
- It prevents germs and dirt from entering the body

Name the layers that make up the epidermis

- Cornified layer
- Granular layer
- Malpighian layer

1. **Cornified layer**
   - It is the outermost layer of the epidermis
   - It is made up of dead cells

Functions of the cornified layer

- It protects the inner parts from damage
- It prevents germs from entering the body
- It prevents water loss by evaporation

Why is the cornified layer very thick on palms of hand and soles of feet?

- To increase friction

2. **Granular layer**
   - It is made up of living cells that gradually die to form the cornified layer

Function of the granular layer

- It is responsible for gradual development of the cornified layer

3. **Malpighian layer**
   - It is made up of actively growing cells which divide by **mitosis** to form new epidermis
   - It contains a protein called **keratin**
   - It contains a dark pigment called **melanin**

Uses of melanin

- It determines the skin colour
- It acts as a screen to sunshine (it protects the skin from ultraviolet sun rays)

Explain the term albinism (albinoism)

- This is the congenital lack of melanin in the skin, eyes and hair

Who is an albino?

- This is a person with congenital lack of melanin

State the uses of keratin

- It makes the skin tough and flexible
- It produces fingernails and toenails

THE DERMIS (CORIUM)

- This is the innermost (lower) layer of the skin
- The dermis is thicker than the epidermis

PARTS OF THE DERMIS LAYER OF THE SKIN

- sweat glands
- sweat duct
- hair follicle
- erector muscle
- sebaceous glands (oil glands)
- blood capillaries
- nerve endings
- subcutaneous fats (fat cells

FUNCTIONS OF EACH PART OF THE HUMAN SKIN

Blood capillaries

- They supply food and oxygen to the cells
- They help in temperature regulation
- They remove excretory waste produced in the cells

Sweat glands (sudoriferous gland)

- They produce sweat

Components of sweat

- Excess salts
- Water
- Urea
- Lactic acid

Sweat duct

- They are passages of sweat from the sweat glands to the sweat pores
- They lead sweat to the skin surface

Sweat pores

- They let sweat out of the body

Hair follicle (hair root)

- It is where the hair grows from

Hair

- It regulates body temperature
- **Hair shaft** is the part of hair above the skin

How does hair on the skin regulate temperature on cold days?

- The hair stands on the skin to trap air which prevents heat loss

How does hair on the skin regulate temperature on hot days?

- The hairs lie flat on the skin surface to allow heat loss

List down three parts of the human body where hair does not develop

- Soles of the feet
- Palms of the hands
- The lips

Of what importance are the fingernails and toenails?

- They protect the tips of fingers and toes

Hair erector muscle

- It enables the hair to rise or lie flat on the skin

How does the erector muscle enable the hair to rise or fall on the skin surface?

- By contracting and relaxing

Sebaceous glands (oil glands)

- To produce sebum

Sebum

- This is the oily substance produced by sebaceous gland

Importance of sebum

- It prevents the skin from drying up (desiccation)/ It keeps the skin soft and moist
- It keeps the skin waterproof

Subcutaneous fat (fat cells)

- It stores fats which prevent heat loss
- It protects the muscles and bones from the effects of falls
- It acts as energy store for the body

Nerve endings

- They transmit impulses for heat, touch, pressure, pain and cold to the brain
- They enable the skin to feel

FUNCTIONS OF THE SKIN

- It excretes sweat (removes sweat from the body)
- It regulates body temperature
- It stores fats
- It makes vitamin D with help of sunlight
- It protects the inner parts of the body
- It acts as a waterproof to our bodies
- For feeling (It helps the body to be sensitive to touch, heat and cold)
- It reduces harmful effects of UV (ultra violet) radiation

Qn. How is the skin adapted to its function of feeling?

- It has sensory nerves

BODY TEMPERATURE REGULATION BY THE SKIN

a) HOW DOES THE SKIN REGULATE HUMAN BODY TEMPERATURE ON HOT DAYS?

- Through vasodilation
- Through sweating (perspiration)/sweat glands produce more sweat
- The hairs lie flat (fall) on the skin surface to allow heat loss

(Through relaxing of hair erector muscles to make the hair lie flat on the skin surface)

Vasodilation

- This is the widening of blood vessels at the skin surface
- It occurs when smooth muscles of blood vessels relax

How does vasodilation cool the human body?

- More blood flow at the skin surface to allow heat loss

State the importance of sweating to the human body

- It cools the human body

How does sweating cool the human body on a hot day?

- Evaporation of sweat causes heat loss

How is sweating similar to transpiration?

- Both cool the organisms/regulate body temperature

Why does a dog move while its tongue is out (how is panting important to a dog)?

- To cool its body/to regulate the body temperature

Mention the practices people use to regulate their body temperature on hot days

- Using umbrellas
- Taking cold drinks
- Wearing light clothes
- Moving under the shade
- Turning on an electric fan

Ways through which organisms cool themselves (regulate their body temperature)

ORGANISMS	HOW THEY COOL THEMSELVES
Dogs	▪ by panting
Plants	▪ though transpiration

Humans and horses	▪ by sweating
Elephants	▪ by flapping their big ears
Owls and doves	▪ by gular fluttering
Pigs and hippos	▪ by bathing in cool mud
Crocodiles	▪ by opening their mouth

b) <u>HOW DOES THE SKIN REGULATE HUMAN BODY TEMPERATURE ON COLD DAYS?</u>

- Through vasoconstriction
- Sweat glands produce little or no sweat
- Through shivering
- The hair stands on the skin to trap air which prevents heat loss

(Through contracting of hair erector muscles to make the hair stand on the skin surface)

<u>Vasoconstriction</u>

- This is the narrowing of blood vessels at the skin surface
- It occurs when the smooth muscles of blood vessels contract

<u>How does vasoconstriction keep the human body warm on cold days?</u>

- Little blood flows at the skin surface to prevent heat loss

<u>How does shivering keep the body warm on cold days?</u>

- Muscles contract rapidly to produce heat

<u>What causes goose pimples on cold days?</u>

- Contraction of erector muscles

<u>Mention the practices people use to regulate their body temperature on cold days</u>

- Taking hot drinks
- Putting on thick clothes
- Sitting near fire
- Doing body exercises

<u>Ways through which water is lost from the body (causes of dehydration)</u>

- Severe diarrhoea
- Severe vomiting
- Severe sweating
- Severe burns and scalds

<u>DISEASES WHICH AFFECT THE SKIN</u>

<u>Bacterial skin diseases</u>

- Leprosy
- Impetigo
- Boils
- Cellulitis

<u>Fungal skin diseases (mycosis/tinea infections)</u>

- Ringworm
- Athlete's foot
- Jock itch
- Barber's itch

<u>Viral skin diseases</u>

- Chicken pox (Varicella)
- Measles (Rubeola)
- German measles (Rubella)
- Smallpox (Variola)

<u>Deficiency skin diseases</u>

- Pellagra (caused by lack of vitamin B_3)
- Scurvy (caused by lack of vitamin C)

Other skin diseases

- **Scabies** (caused by itch mites)
- **Skin cancer:**(caused by over use of bleaching vaseline)
- Eczema

DISORDERS OF THE SKIN

- Burns
- Scalds
- Bruises
- Dandruff
- Pimples
- Vitiligo
- Acne
- Cuts and wounds
- Corns
- Blisters
- Skin allergy
- Herpes zoster

Note

- **A bruise** is a swelling on a skin caused by internal bleeding due to strong hit
- **Vitiligo** is a condition when the skin losses its pigment cells

Give two ways in which wounds heal?

- By regeneration
- By fibrosis

WAYS OF CARING FOR HUMAN SKIN

- Regular bathing with clean water and soap
- Dry your body with a clean towel after bathing
- Feed on a balanced diet
- Avoid skin bleaching vaseline and body cream
- Cover wounds and cuts with clean bandages
- Perform regular body exercises
- Protect the skin from direct sunshine
- Keep your fingernails short and clean
- Put on clean and dry underwear and stockings
- Do not share clothes with people having skin infections
- Avoid playing with sharp objects
- Put antiseptics on wounds to prevent infections

How is the skin similar to kidneys in terms of functions?

- Both remove metabolic wastes from the body

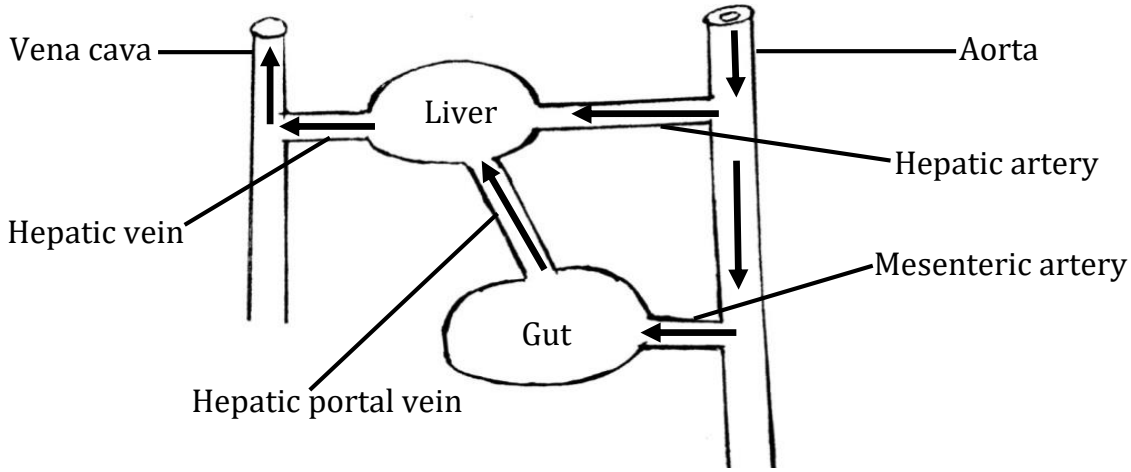
THE LIVER

- This is a large reddish brown organ below the diaphragm.
- It is found in the abdominal cavity
- The liver is the largest organ in the human body
- The liver is the most important organ in the body
- The liver has two lobes; **the right lobe and the left lobe**
- The two lobes are separated by the gall bladder
- The gall bladder **stores bile**

Why is the liver regarded as the most important body organ?

- It performs many functions compared to other body organs

POSITION OF THE LIVER



Mesenteric artery

- It carries oxygenated blood from the aorta to the digestive tract (gut)

Hepatic artery

- It carries oxygenated blood from the aorta to the liver

Hepatic vein

- It carries deoxygenated blood from the liver to the vena cava

Hepatic portal vein

- It carries blood with digested food from the gut (digestive tract) to the liver

Why does blood from the ileum go to the liver before circulation?

- To be detoxified (for the liver to remove toxic substances)
- For the liver to store excess nutrients

FUNCTIONS OF THE LIVER

- It produces bile juice (bile)
- It excretes bile pigments
- It helps in deamination

Deamination: is the process by which the liver converts excess amino acids into urea

- It regulates blood sugar level

How? By storing excess glucose

- It produces heat
- It detoxicates blood
- It stores some vitamins and mineral salts
- It makes plasma proteins; like fibrinogen
- It produces cholesterol

Why is a liver called an excretory organ?

- It removes bile pigments from the body

How are bile pigments formed?

- By the breakdown of dead red blood cells

Why does a dead body (corpse) feel cold?

- The liver which produces heat has stopped working

Why is a liver called a storage organ?

- It stores some vitamins, mineral salts and glucose

Note

- Vitamins stored by the liver include: **Vitamins A, D, E and K**
- Mineral salts stored by the liver include: **iron, copper and potassium**

BILE JUICE

- This is a digestive juice which has no enzymes
- It is produced by the liver and stored in the gall bladder

Importance of bile juice

- To breakdown (emulsify) fats in the duodenum
- To neutralize acidic chyme from the stomach
- To provide alkaline conditions for proper working of enzymes in duodenum

IMPORTANCE OF GALL BLADDER

- To store and concentrate bile
- To control the flow of bile into the duodenum

DETOXICATION (DETOXIFICATION)

- This is the process by which the liver removes toxic substances from blood

Name three toxic (harmful) substances removed from blood by the liver

- Alcohol
- Urea
- Expired drugs

FUNCTIONS OF PANCREAS

- It produces pancreatic enzymes
- It produces insulin hormone

FUNCTIONS OF INSULIN HORMONE

- It stimulates the liver to regulate blood sugar level
- It stimulates glucose uptake by the body cells to produce energy

Name the metabolic disease caused by lack of insulin in the body

- Diabetes

Give any two causes of diabetes

- Lack of insulin
- Insulin resistance
- Obesity

Insulin resistance is when the liver cells don't respond well to insulin

Mention two signs of diabetes

- Frequent urination
- Dark skin patches
- Slow healing of cuts and wounds

Symptoms of diabetes

- Severe thirst
- Severe hunger
- Tiredness
- Blurred vision

DISEASES OF THE LIVER

- Liver cirrhosis (caused by too much drinking of alcohol)
- Hepatitis A and B
- Liver cancer
- Liver abscess (these are boils which form pus in the liver)

HEPATITIS B

- It is caused by a virus called **hepatitis B virus (HBV)**
- It affects the liver

How does hepatitis B spread?

- Through playing unprotected sex with infected person
- Through sharing contaminated needles with an infected person
- Through body contact with infected body fluids

Signs of hepatitis B

- Dark urine
- Jaundice (the skin and sclera turn yellow)
- Vomiting

Prevention and control of hepatitis B

- Immunize using Hep B vaccine
- Avoid sharing needles with an infected person
- Use latex gloves during fisting or fingering
- Use condoms during sex

CARE FOR THE LIVER

- Avoid taking a lot alcohol
- Avoid drug abuse
- Feed on balanced diet
- Always drink safe water
- Make regular body exercises

THE LUNGS

- These are two spongy and elastic pink organs in the **chest cavity**
- The lungs are protected by the part of human skeleton called **rib cage**
- The lungs are both excretory and respiratory organs

Why are lungs regarded as excretory organs?

- They remove carbon dioxide and water vapour from the body

Why are lungs regarded as respiratory organs?

- They supply the body with oxygen for respiration

Name the two lungs in the human body

- Left lung
- Right lung

Why do lungs feel spongy?

- They have many alveoli (air sacs) inside them

Why are lungs elastic?

- For easy expansion and contraction during breathing

Name the membrane that encloses the lungs

- Pleural membrane

State the importance of the pleural membranes (pleura) on the lungs

- It produces pleural fluid

State the importance of the pleural fluid

- It reduces friction between the lungs and ribs

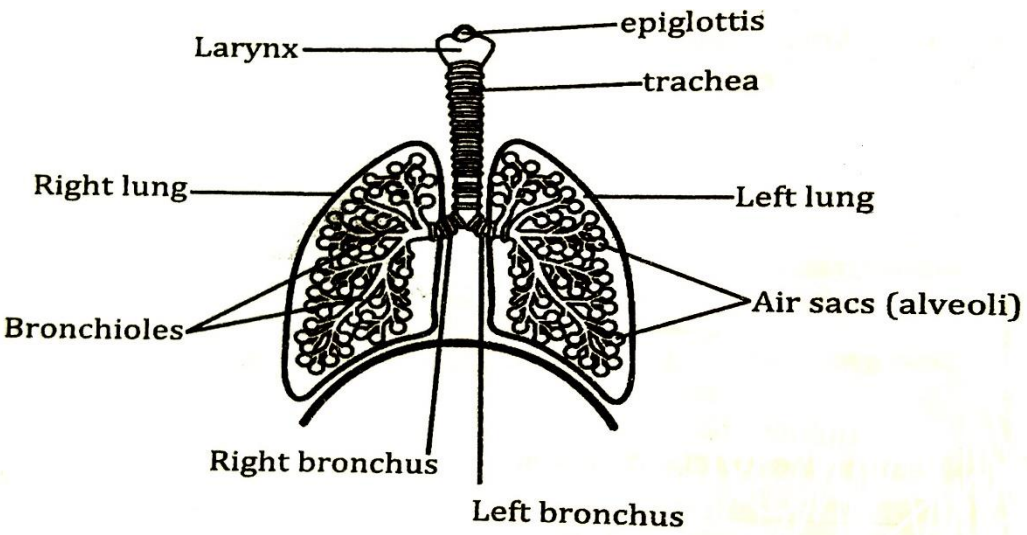
Of what importance is the pleural cavity?

- It holds the pleural fluid

What do we call the muscles that hold together the ribs in one position?

- Intercostal muscles

THE STRUCTURE OF THE LUNGS (RESPIRATORY SYSTEM)



FUNCTIONS OF LUNGS

- They remove carbon dioxide and water vapour from the body
- They supply the body with oxygen for respiration
- They are used for breathing

How are lungs adapted to their functions?

- They are spongy and elastic
- They have very many alveoli
- They contain very many blood vessels
- They have a moist surface
- They are covered in thin membranes

NOSE

- It is an olfactory organ (sense organ for smell)

Importance of the nose

- For smelling
- It cleans, warms and moistens inhaled air

Why is the temperature in the nose slightly higher than that of other body parts?

- To warm the inhaled air before it reaches the lungs

CONTENTS OF THE NOSE AND THEIR IMPORTANCE

1. **Mucus (snot)**
   - To trap germs and dust
   - To moisten air
   - To prevent the nose from drying up
2. **Cilia**
   - To filter air /to trap dust and germs

Of what function are cilia and mucus in the nose?

- To trap dust and germs (to clean the air)

Mention three things that happen to inhaled air in the nose

- Air is cleaned (filtered)
- Air is moistened
- Air is warmed

What warms the inhaled air in the nose?

- Blood in the vascular membrane

Why is it not advisable to breathe through the mouth?

- There is no cilia to filter air
- Air is not warmed and it can chill the lungs

Why do people sometimes breathe through the mouth?

- Due to nasal congestion
- Due to deviated nasal septum
- Due to nose bleeding

DISORDERS OF THE NOSE

- Nose bleeding
- Nasal congestion (accumulation of mucus in the nose)

Diseases of the nose

- Sinus infection (Sinusitis)
- Hay fever
- Nasal polyp

CARE FOR THE NOSE

- Wash the nose with clean water and soap.
- Do not share handkerchiefs
- Use a clean piece of cloth to clean the nose
- Avoid rough games that can harm the nose
- Do not allow mucus to flow and reach the lips

Why should we cover the nose while sneezing?

- To prevent spread of droplet infections

THROAT (PHARYNX)

This is a common passage for food and air

- It carries air to the wind pipe and food to the gullet.

EPIGLOTTIS

- It prevents food from entering the wind pipe during swallowing (it prevents choking)

How does the epiglottis prevent choking?

- By closing the wind pipe during swallowing

LARYNX (VOICE BOX)

- It has vocal cords which vibrate to produce sound

THE TRACHEA (WIND PIPE)

- It is the passage of air from the nose to the lungs.

Why is the trachea made up of rings of cartilage?

- To keep it open all the time.

State what would happen to the trachea in absence of the rings of cartilages if the air pressure inside is low.

- The trachea would collapse (close) and lead to suffocation

NOTE

- The trachea contains cilia **to trap dust and germs**
- The trachea divides into two **bronchi** (left bronchus and right bronchus)
- The bronchi subdivide into **bronchioles**
- The bronchioles end into tiny air sacs called **alveoli**

ALVEOLI (AIR SACS)

- It is where gaseous exchange occurs
- Gaseous exchange in the alveoli occurs by **diffusion**

In which human body organ does gaseous exchange take place?

- In the lungs

Where in the lungs does gaseous exchange take place?

- In the alveoli (air sacs)

By what process does oxygen in the alveoli enter red blood cells and carbon dioxide leave blood?

- Diffusion

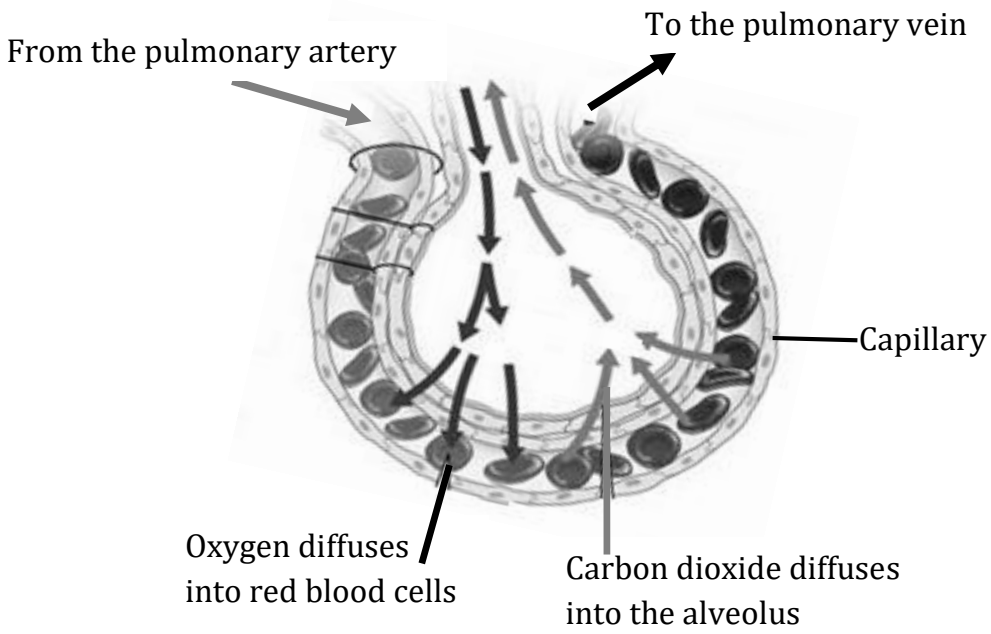
What is meant by the term diffusion?

- This is the movement of molecules from an area of high concentration to an area of low concentration

What is meant by the term gaseous exchange?

- This is the process by which blood releases carbon dioxide and gains oxygen

THE STRUCTURE OF THE ALVEOLUS



What do the arrows represent in the above diagram?

- They represent gaseous exchange.

ADAPTATIONS OF ALVEOLI (AIR SACS) TO THEIR FUNCTION

- They have thin walls

For easy diffusion of gases

- They have a lot of blood capillaries

To supply them with food nutrients

- They have a moist surface

For easy diffusion of gases

- They are numerous (very many in number)

To increase the surface area for gaseous exchange

DIAPHRAGM

This is a dome-shaped muscle that separates the chest cavity and abdominal cavity

- It helps in breathing

INTERCOSTAL MUSCLES

- They hold the ribs in position.

BREATHING (VENTILATION OF THE LUNGS)

- This is the movement of air in and out of the lungs

Give two importance of breathing

- It provides oxygen to the body for respiration
- It removes carbon dioxide and water vapour from the body

What is tidal air?

- This is the amount air that moves in and out of the lungs during a normal breath

TYPES (PHASES/MECHANISMS) OF BREATHING

- Breathing in (inhalation/inspiration)
- Breathing out (exhalation/expiration)

1. **BREATHING IN (INHALATION OR INSPIRATION)**
   - This is the movement of air into the lungs

Events/things that occur during inhalation

- Intercostal muscles contract
- Ribs go upwards and outwards
- Diaphragm contracts/flattens/moves downwards
- Volume of the chest cavity increases
- The lungs expand

Why do lungs expand during inhalation?

- To create space for the air entering
- They are filled with air

Which property of air enable lungs to expand during inhalation?

- Air occupies space

Why does the diaphragm go downwards during inhalation?

- To provide space for expansion of the lungs

Why do ribs go upwards and outwards during inhalation?

- To provide space for the expansion of the lungs

State the importance of inhalation/breathing in

- It provides oxygen to the body for respiration

Correct order showing the mechanism of inhalation

- Diaphragm and intercostal muscles contract
- Volume of chest cavity increases (size of the chest and lungs increases)
- Air pressure inside decreases
- Air rushes into the lungs

Why is inhalation said to be an active process?

- It involves muscle contraction that requires energy

2. **BREATHING OUT (EXHALATION OR EXPIRATION)**
   - This is the movement of air out of the lungs.

Events/things that occur during exhalation

- Intercostal muscles relax.
- Ribs go downwards and inwards
- Diaphragm relaxes and becomes dome-shaped (move upwards)
- Volume of the chest decreases
- The lungs contract (go to their original size)

Why do lungs contract during exhalation?

- To force out air

Which property of air enable lungs to contract during exhalation?

- Air can be compressed

State the importance of exhalation/breathing out

- It removes carbon dioxide and water vapour from the body

CORRECT ORDER SHOWING THE MECHANISM OF EXHALATION

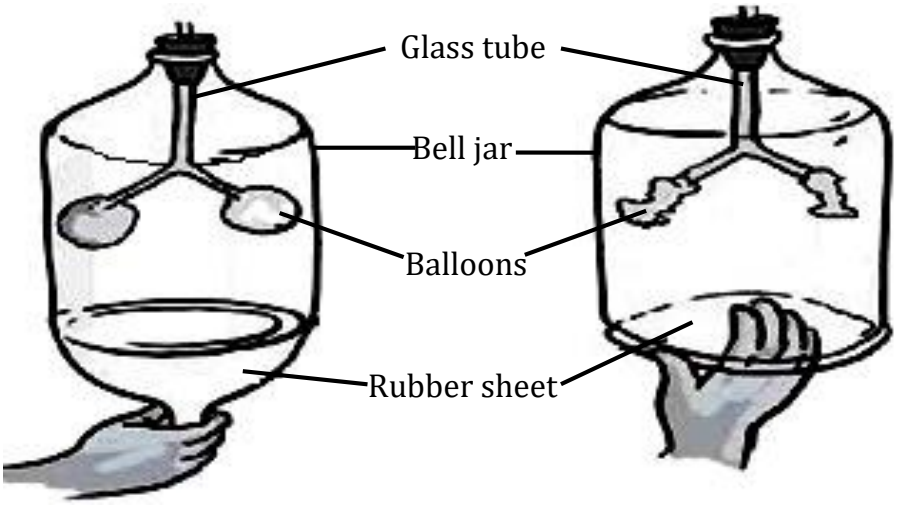
- Diaphragm and intercostal muscles relax
- Volume of chest cavity decreases (size of the chest and lungs decreases)
- Air pressure inside increases
- Air moves out of the lungs

Why is exhalation regarded as a passive process?

- It does not involve muscle contraction

A MODEL SHOWING THE MECHANISMS OF BREATHING

- Cut off the bottom of a plastic bottle
- Cover and tie the open end with a rubber sheet
- Tie two empty balloons to a Y – shaped (straw) glass tube
- Insert the straw into the bottle through its cork



Which body system is illustrated above?

- Respiratory system

What do the following parts represent?

- Glass tube (straw) ---------- trachea
- Balloons---------- lungs
- Bell jar (plastic bottle) ---------- chest cavity
- Polythene bag (rubber sheet)------- diaphragm

What happens to the balloons when the rubber sheet is pulled outwards/downwards?

- The balloons expand

What happens to the balloons when the rubber sheet is pushed inwards?

- The balloons contract

COMPOSITION OF AIR BREATHED IN AND OUT

Type of air	Inspired air	Expired air
Oxygen 0_2	21%	16%
Carbon dioxide Co_2	0.03%	4%
Nitrogen N_2	78%	78%
Water vapour	Less	More
Rare gases	0.97%	0.97%

QUESTIONS:

Why do we breathe out less oxygen?

- It is used in the body during respiration

Why is there more carbon dioxide and water vapour in exhaled air?

- They are produced in the body during respiration.

Why is the percentage of nitrogen and rare gases the same in both inhaled air and exhaled air?

- They are neither produced nor used in the body

Why does a person breathe heavily after a vigorous exercise?

- To pay the oxygen debt.

Why does a person breathe heavily during a vigorous exercise?

- To supply the body with more oxygen for respiration

RESPIRATION

- This is the oxidation of food (glucose) in the living body cells to produce energy
- It is a **chemical change**
- It takes place in the **living cells** (living body cells)

How is respiration an important process among living things?

- It enables them to get energy

AN EQUATION SHOWING RESPIRATION

Glucose (Food) + Oxygen ⟶ Energy + Carbon dioxide + Water vapour

Raw materials for respiration

- Glucose (food)
- Oxygen

Products of respiration

- Energy ⟶ main/useful product
- Carbon dioxide
- Water vapour

} byproducts/waste products

Explain the meaning of the term oxidation.

- This is the process by which oxygen combines with a substance

TYPES OF RESPIRATION

AEROBIC RESPIRATION

- This is the type of respiration that uses oxygen

ANAEROBIC RESPIRATION

- This is the type of respiration that does not use oxygen

Mention three human respiratory organs

- Nose
- Lungs (they are the main respiratory organs)
- Trachea (wind pipe)

DISORDERS OF THE RESPIRATORY SYSTEM

- Hiccups
- Sneezing
- Choking: it is caused by blockage of the wind pipe by a foreign object
- Yawning
- Coughing: it is caused by irritation of wind pipe by the dust

Hiccups

- These are involuntary contractions of the diaphragm

Causes of hiccups

- Taking carbonated drinks
- Taking too much alcohol
- Sudden excitement
- Swallowing air along with food
- Overeating

DISEASES OF THE RESPIRATOTY SYSTEM (RESPIRATORY DISEASES)

1. **COMMUNICABLE (INFECTIOUS) RESPIRATORY DISEASES**
   - Tuberculosis (TB)
   - Diphtheria
   - Whooping cough (Pertussis)
   - Pneumonia
   - Influenza (Flu)
   - Common cold
   - Acute bronchitis
   - COVID-19
2. **NON-COMMUNICABLE (NON-INFECTIOUS) RESPIRATORY DISEASES**
   - Lung cancer
   - Asthma
   - Emphysema
   - Chronic bronchitis
   - Asbestosis: it is caused by too much exposure to asbestos

List down three respiratory diseases caused by tobacco smoking

- Lung cancer
- Emphysema
- Chronic bronchitis

Name two respiratory diseases worsened by tobacco smoking

- Asthma
- Tuberculosis

ASTHMA

- It is a hereditary disease of the respiratory system

Sign of asthma

- Difficulty in breathing on cold days
- Wheezing

How does asthma make breathing difficult?

- It blocks the bronchioles

Why is asthma called a hereditary disease?

- It is genetically transmitted from parents to offspring

LUNG CANCER

- It is a respiratory disease
- It is caused by exposure to tobacco smoke and radon gas

Signs of lung cancer

- Coughing up -blood
- Difficulty in breathing
- Wheezing
- Weight loss

Symptom of lung cancer

- Chest pain

Name the poisonous gas in tobacco smoke

- Carbon monoxide

Name the carcinogen (substance that causes lung cancer) in tobacco smoke

- Tar

Name the addictive drug in tobacco

- Nicotine

Give two effects of nicotine to human health

- It narrows/constricts blood vessels
- It increases blood pressure

Why is lung cancer called a death sentence?

- It has no cure

How does regular tobacco smoking cause lung cancer?

- It causes abnormal growth of lung cells

TUBERCULOSIS

- It is a bacterial airborne disease (droplet infection)
- It attacks the respiratory and skeletal system
- It mainly affects the lungs and the backbone (spine)

Name the germ (bacterium) which causes tuberculosis

- Mycobacterium tuberculosis

How does tuberculosis spread?

- Through inhaling contaminated air
- Through drinking unboiled milk from tubercular cows

Signs and symptoms of tuberculosis

- Chronic cough
- A lot of sweating at night
- Loss of body weight

Prevention and control of tuberculosis

- Immunize babies using BCG vaccine
- Isolate and treat the sick people
- Drink boiled or pasteurized milk

PNEUMONIA

- It is a respiratory disease
- It mainly affects the lungs
- It can be caused by bacteria or viruses

Signs of pneumonia

- Difficulty in breathing
- Wheezing
- Stuffy nose

How does pneumonia make breathing difficult?

- It causes inflammation of the alveoli

Name the vaccine that protects infants against pneumonia

- PCV (Pneumococcal conjugate vaccine)

CARE FOR THE RESPIRATORY SYSTEM

- Perform regular body exercise
- Eat meals containing low animals fats
- Avoid cigarette smoking
- Feed on a balanced diet
- Take infants for immunization
- Always keep the nose away from dust

TOPIC: LIGHT ENERGY

ENERGY

- This is the ability to do work

Examples of forms of energy

- Light energy
- Sound energy
- Electricity
- Heat energy
- Chemical energy
- Mechanical energy
- Solar energy
- Magnetism

Optics

- This is the study of light

LIGHT ENERGY

- This is the form of energy that enables our eyes to see objects.
- This is the form of energy that stimulates sense of sight
- This is the form of energy produced by luminous objects

Why is light called a form of energy?

- It does work

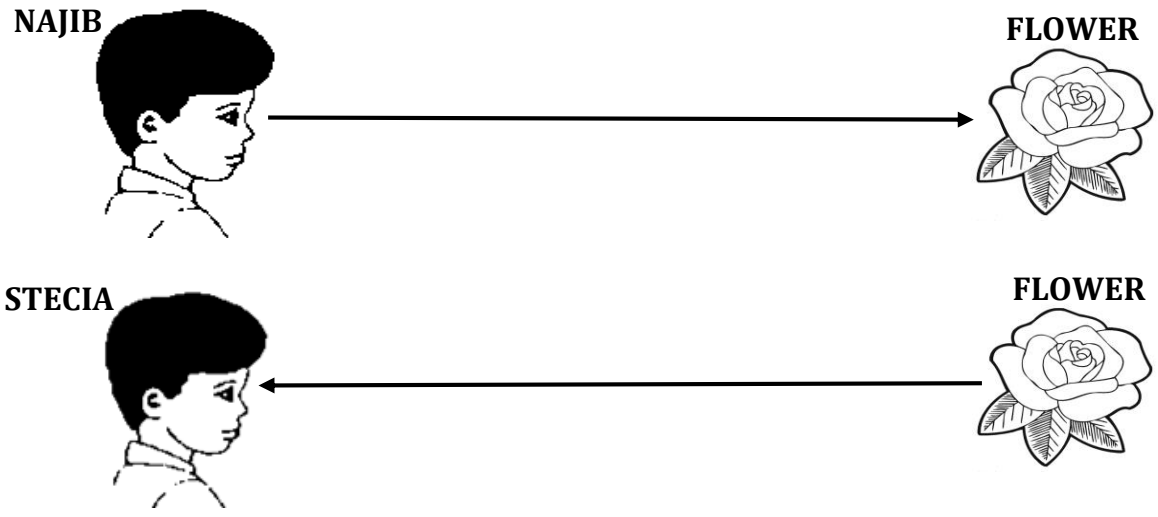
Importance (uses) of light/work done by light

- Light enables us to see objects
- Light enables us to use optical instruments
- Sunlight enables plants to make their own food
- Sunlight enables eggs of reptiles, amphibians and fish to hatch.
- Sunlight helps human skin to make vitamin D
- Sunlight is used to generate solar electricity
- Ultraviolet (UV) light is used in water treatment to kill germs
- Light is used in photography

How are we able to see objects?

- We are able to see objects when they reflect light into our eyes.

Study the diagrams below



Who is able to see the flower?

- Stecia

Give a reason for your answer

- The flower reflects light into her eyes

Why is Najib unable to see the flower?

- The flower does not reflect light into his eyes

Ways through which objects give out light

- Some objects emit light on their own
- Some objects reflect light from other sources

SOURCES OF LIGHT

- A source of light is an object which produces light.

Groups (types) of sources of light

- Natural sources of light
- Artificial sources of light

Natural sources of light

- These are sources of light that exist by nature

Examples of natural sources of light

- Sun: it is the main natural light source
- Stars
- Lightning
- Erupting volcanoes
- Glow-worms
- Fireflies
- Jellyfish
- Dragonfish
- Sea star

Artificial sources of light

- These are manmade objects that produce light

Examples of artificial sources of light

- Light-bulbs
- Torches
- Lamps
- Burning candles
- Fire
- Red hot charcoal
- Lanterns
- Televisions

LUMINOUS OBJECTS

- These are objects which produce their own light

They are also called **direct sources of light**

Examples of luminous objects

- Sun
- Stars
- Light bulb
- Burning candle
- Lantern
- Red hot charcoal
- Fire
- Fireflies
- Glow-worms
- Burning charcoal
- Erupting volcano
- Jellyfish
- Dragonfish
- Sea star

Groups of luminous objects

- Incandescent objects
- Luminescent objects

i) Incandescent objects

- These are objects that produce both light and heat

Examples of incandescent sources of light

- Sun
- Stars
- Electric bulbs
- Red hot charcoal
- Erupting volcanoes
- Burning candles

ii) Luminescent objects

- These are objects that emit light without heat

Examples of luminescent objects

- Glow-worms
- Fireflies
- Jellyfish
- Fluorescent lamps
- Television
- Dragonfish
- Sea star

Name any three living things that produce light/ bioluminescent organisms

- Glow-worms
- Fireflies
- Jellyfish
- Dragonfish
- Sea star

Why do some organisms glow (produce light)?

- To attract mates
- To scare away predators
- To trap their prey

NON LUMINOUS OBJECTS (ILLUMINATED OBJECTS)

- These are objects which do not produce their own light

They are also called **indirect sources of light** or **reflectors of light**

Examples of non-luminous objects

- Moon
- Mirrors
- Planets

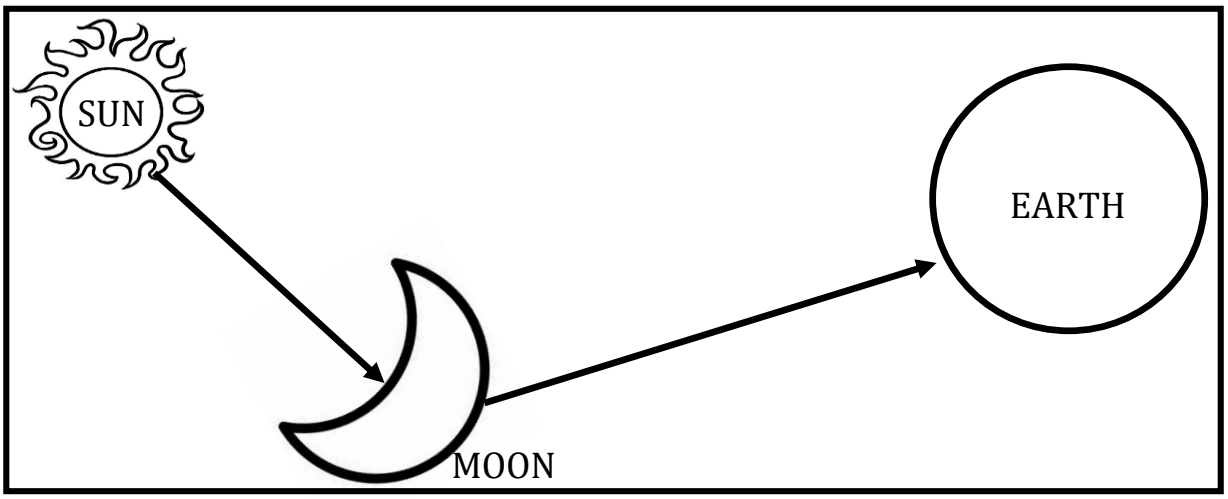
Why is the moon not called a luminous source of light?

- It does not produce its own light but reflects it from the sun

How does light from the sun reach the earth at night?

- It is reflected onto the earth by the moon

An illustration showing how the moon reflects light from the sun to the earth



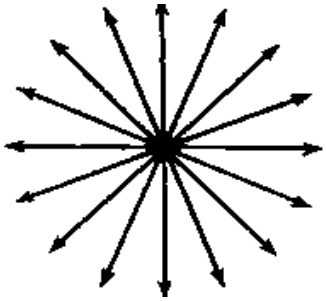
PROPERTIES OF LIGHT

- Light travels in a straight line
- Light travels in all directions from the source
- Light can be reflected
- Light can be refracted
- Light does not need a medium to travel (can travel through vacuum)

Transmission of light (how does light travel?)

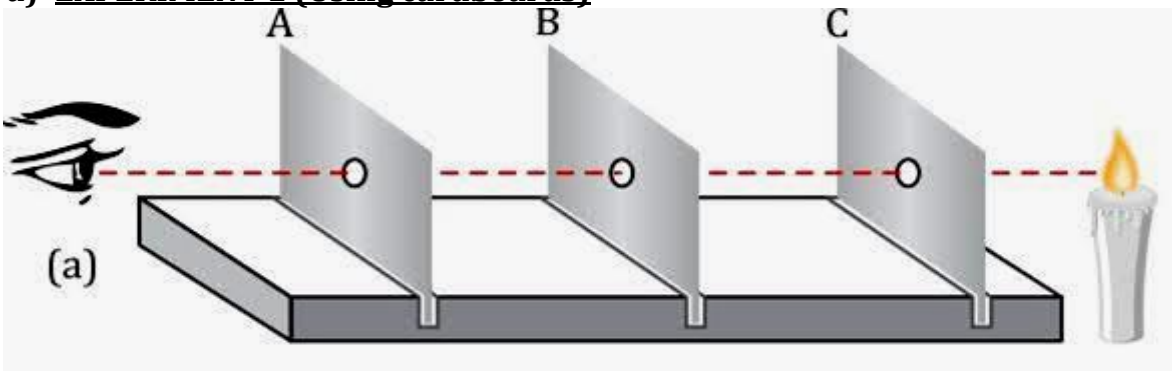
- Light travels in a straight line
- Light travels in all directions from the source

An illustration to show that light travels in all directions from the source



EXPERIMENT TO SHOW THAT LIGHT TRAVELS IN A STRAIGHT LINE

a) **EXPERIMENT 1 (Using cardboards)**



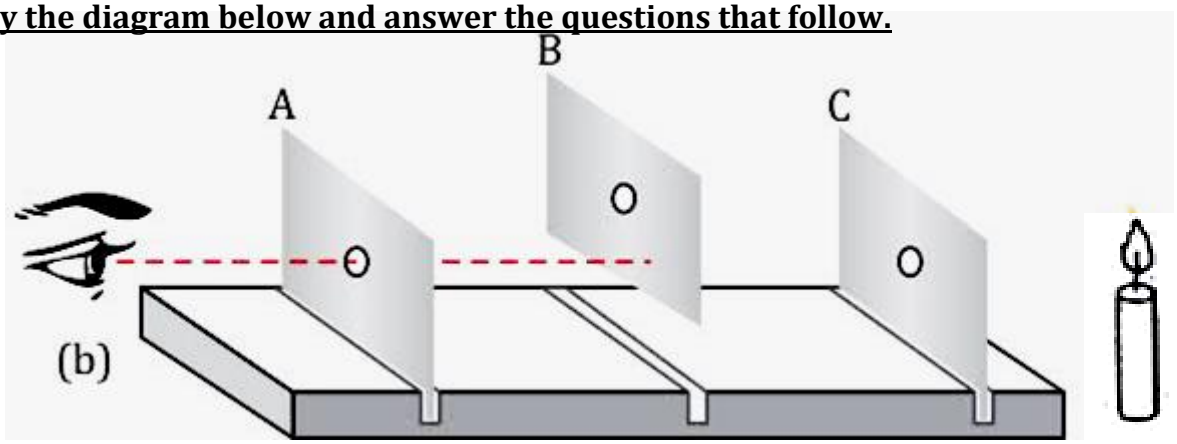
Why is the observer able to see candle light in figure (a) above?

- The holes in the cardboards are in a straight line

What does the experiment above represent?

- It shows that light travels in a straight light

Study the diagram below and answer the questions that follow.



Why is the observer unable to see candle light in figure (b) above?

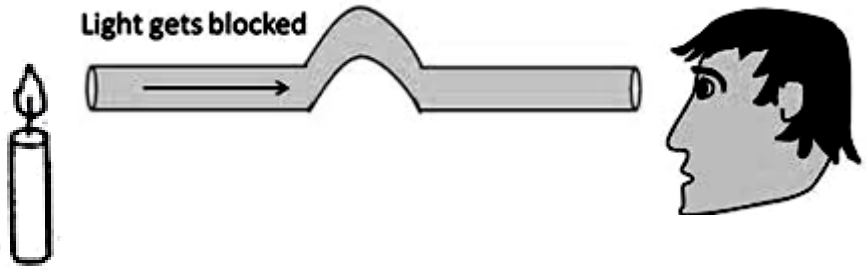
- The holes in the cardboards are not in straight line

EXPERIMENT 2: (Using a straight tube/straw/pipe)

Why is the observer able to see light in the diagram above?

- The tube/pipe is straight

Use the diagram below to answer the question about it.



Why is the observer unable to see light in the diagram above?

- The tube is bent/not straight

FACTS TO PROVE THAT LIGHT TRAVELS IN A STRAIGHT LINE.

- We cannot see objects around corners **because** light travels in a straight line
- Shadows occur because **due** to obstruction of light by an opaque object
- Light from a projector travels in a straight line
- Sunlight passing through a hole in a roof travels in a straight line
- Light from rising and setting sun travels in a straight line
- Light from a torch travels in a straight line

Why can't we see around corners and barriers?

- Light travels in straight lines

How is light similar to sound and heat?

- They travel in all directions from the source
- They are forms of energy

How does light differ from sound in terms of movement?

- Light travels by rays while sound travels by waves
- Light can travel through vacuum while sound cannot travel through vacuum
- Light travels faster than sound

Why is light and heat able to travel through vacuum?

- They do not need a medium to move

Why is light able to travel through vacuum yet sound cannot?

- Light does not need a medium to move while sound needs a medium to move

RAY OF LIGHT

- This is the path of light
- This is a straight line along which light travels

An illustration of a ray of light

Why is a ray of light represented by an arrow on a straight line?

- To show direction of light

BEAM OF LIGHT

- This is a group/collection/stream of light rays.

A pencil of light

- This is a group of light rays coming or spreading out from a point
- This is a group of converging or diverging rays

Types of beams of light

- Parallel beam
- Diverging beam (divergent beam)
- Converging beam (convergent beam)

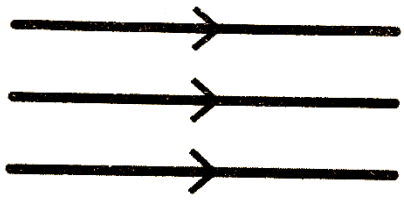
PARALLEL BEAM

- This is the type of beam where light rays do not meet

Use of parallel beam

- It enables us to see things which are directly in front of us.

An illustration of parallel beams of light



DIVERGING BEAM

- This is a type of beam where light rays from spread in different directions

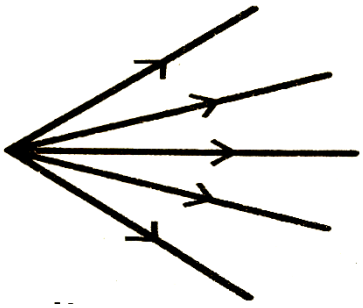
Use of diverging beam

- It enables us to see over a wider area

Devices that produce diverging beam

- Car headlamp
- Bicycle headlamp
- Torch
- Projector
- Electric bulb
- Sun
- Burning candle

An illustration of diverging beams of light



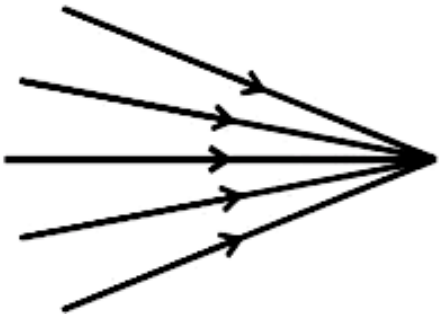
CONVERGING BEAM

- This is a type of beam where light rays meeting at a point

Use of converging beam

- It enables doctors to examine body organs which are dark e.g nose

An illustration of converging beams of light



THE SPEED OF LIGHT

- Light does not need a medium to move
- The speed of light reduces as it moves from a rarer (less dense) to denser medium
- The speed of light increases as it moves from a denser to a rarer (less dense) medium
- Light travels faster than sound in air
- The speed of light in air is 299,000,000 m/s while that of sound is 343 m/s

FACTS TO PROVE THAT LIGHT TRAVELS FASTER THAN SOUND

- Lightning is seen before thunder is heard
- Light is seen before sound is heard during fireworks
- The starter's gun flash is seen before the bang is heard at the race track
- An axe is seen striking a tree before sound is heard when cutting a tree

Why is lightning seen before thunder is heard on a rainy day?

- Light travels faster than sound

Qn. The sun is 150,000,000 Km away from the earth and light travels at a speed of 300,000 Km/s. How long does sunlight take to reach the earth?

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

$$T = \frac{150{,}000{,}000 \text{ km}}{300{,}000 \text{km/s}}$$

$$T = 500 \text{ seconds}$$

∴ Sunlight takes 500 seconds to reach the earth

EFFECTS OF DIFFERENT OBJECTS ON LIGHT

State the things that may happen to light as it meets an object

- Light may be reflected
- Light may be refracted
- Light may be absorbed
- Light may be transmitted (allowed to pass through)

GROUPS OF OBJECTS (MATERIALS) THAT AFFECT LIGHT

- Transparent objects
- Translucent objects
- Opaque objects

1. Transparent objects

- These are objects which allow all the light to pass through them.

Why are we able to see clearly through transparent objects (why can't transparent objects form shadows)?

- They allow all the light to pass through them

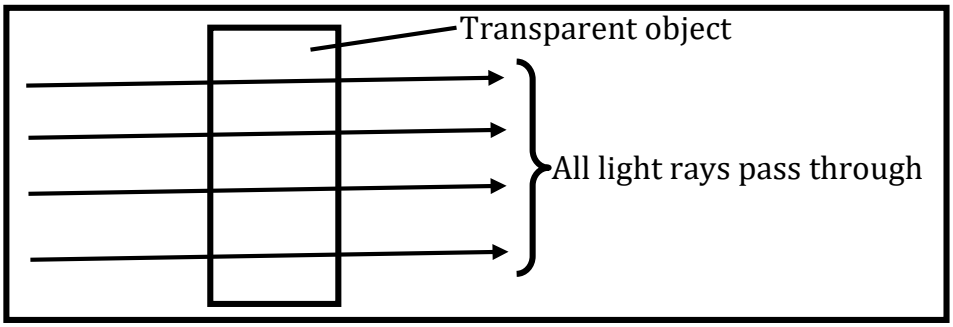
Examples of transparent objects

- Clear glass
- Clear water
- Clear air
- Vacuum

What happens to light when it strikes a transparent object?

- All light pass through it

A diagram showing the effect of a transparent object on light



Uses of transparent objects

- Clear glass is used to make car windscreens
- Clear glass is used in windows on houses
- Clear glass is used in lenses
- Clear glass is used in lamps

2. Translucent objects

- These are objects which allow little (some) light to pass through them

Why are we unable to see clearly through translucent objects?

- They scatter light rays
- They allow little light to pass through them

Why does little light pass through translucent objects?

- It is due to diffusion

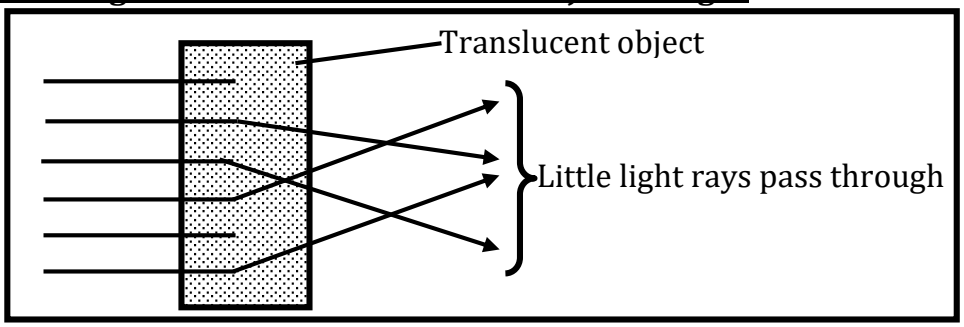
Why can a person behind a translucent material get a sunburn on a sunny day?

- Some sun rays can pass through it

Examples of translucent objects.

- Frosted glass
- Tinted glass
- Tracing paper
- Wax paper
- Oiled paper
- Sunglasses
- Stained glass
- Lampshade
- Smoky air
- Cloudy water
- Plastic skylight
- Thin cloth

A diagram showing the effect of a translucent object on light



Uses of translucent materials

- Frosted glass is used in church windows
- Frosted glass is used in doors and windows of bathrooms
- Tracing paper is used in class
- Tracing paper is used as a screen in pinhole cameras
- Tinted glass is used in cars
- Tinted glass is used to make some light bulbs
- Sunglasses protect our eyes from direct sunlight
- Plastic skylights allow daylight into the house
- Wax paper is used to wrap food for cold storage

Why are doors and windows of bathrooms made with frosted glasses?

- For privacy of the user

3. Opaque objects

- These are objects which do not allow any light to pass through them

Why are we unable to see through opaque objects?

- They do not allow light to pass through them

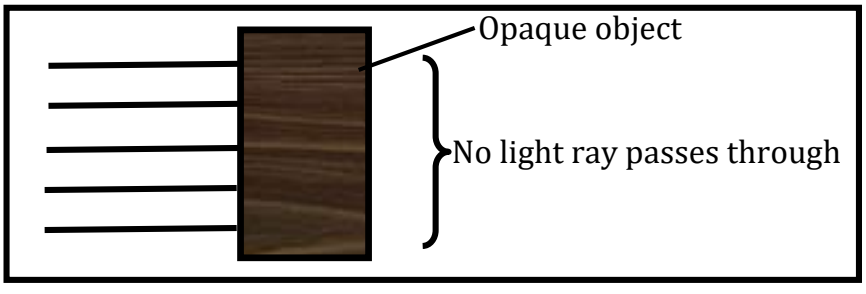
What happens when light strikes an opaque object?

- Light is blocked and a shadow is formed

Examples of opaque objects

- Wood
- Blackboard
- Human body
- Stone
- Metal
- Brick wall
- Blackout fabric

A diagram showing the effect of an opaque object on light



Uses of opaque objects

- They form shadows which provide shades
- Brick walls promote privacy in buildings
- Blackout fabrics keep out sunlight and heat in party tents

Name two groups of objects used to make windowpanes

- Transparent objects
- Translucent objects

SHADOWS

- This is a dark region formed when light is blocked by an opaque object

How is a shadow formed?

- When light is blocked/obstructed by an opaque object

On which principle is a shadow formed?

- Light travels in a straight line

CHARACTERISTICS OF A SHADOW

- A shadow resembles the shape of the opaque object
- A shadow is formed in opposite direction of the light source
- A shadow is dark in colour

FACTORS THAT AFFECT (DETERMINE) THE SIZE OF A SHADOW

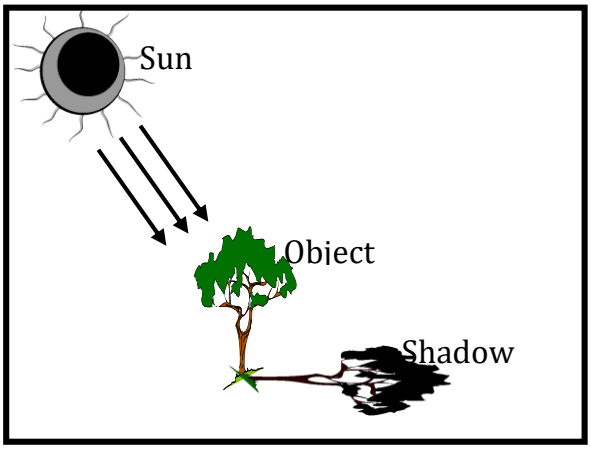
- Distance of the light source from the opaque object
- Size of the opaque object
- Size of the light source
- Position of the light source (angle at which light strikes an opaque object)

Note

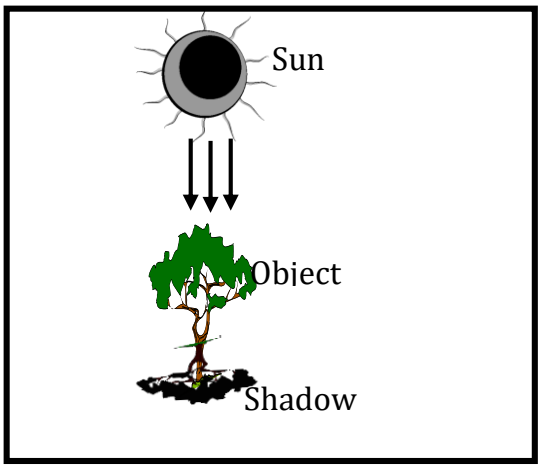
- The shadow is smaller when the light source is far and it is bigger when the light source is nearer to the opaque object

DIAGRAMS SHOWING THE SIZE OF SHADOWS FORMED BY THE SUN AT DIFFERENT POSITIONS IN THE SKY

IN THE EARLY EVENING



AT MIDDAY (NOON)



Why is the shadow shortest at noon (midday)?

- The sun is directly overhead

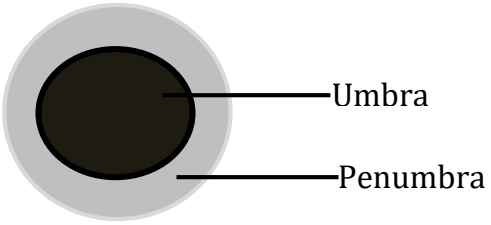
Why is the shadow longest at sunrise and sunset (in the early morning and early evening/late afternoon)?

- The sun is low on the horizon/the sun is low in the sky

TYPES/REGIONS/PARTS OF THE SHADOW

- Umbra (total shadow)
- Penumbra (partial shadow)

A DIAGRAM SHOWING PARTS/REGIONS OF A SHADOW



UMBRA

- This is the darkest part of the shadow
- This is the region of complete shadow

It is dark **because** it does not receive any light

How is an umbra formed?

- By total obstruction of light from a small source

When is an umbra shadow formed?

- When the light source is far away from an opaque object
- When light from a small source is completely blocked by an opaque object
- When light passing through a narrow opening is blocked by an opaque object

PENUMBRA

- This is the lighter part of the shadow
- This is the region of partial shadow

It is light **because** it receives some light

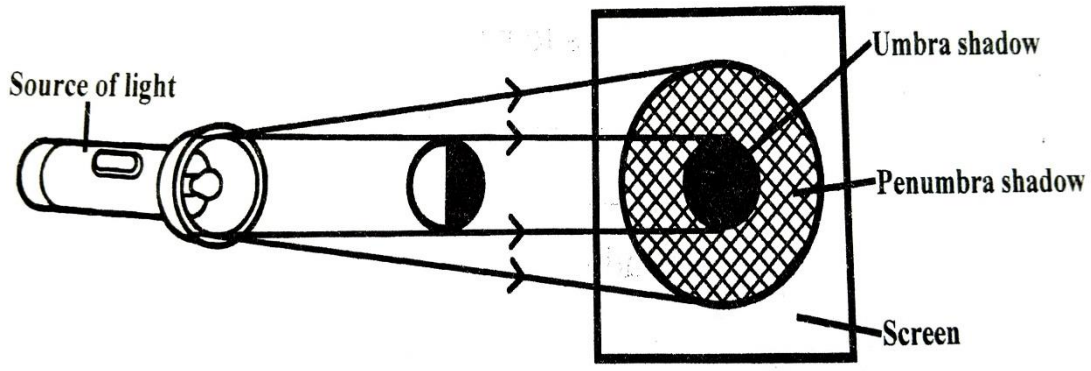
How is penumbra formed?

- By partial obstruction of light from a big source

When is penumbra formed?

- When the light source is nearer to the opaque object
- When light from a big source is blocked by an opaque object
- When light passing through a wider opening is blocked by an opaque object

A simple illustration of formation of a shadow



USES OF SHADOWS

- They provide shades
- They are used to estimate time
- They are used to tell directions
- They help people to hide

DANGERS OF SHADOWS

- They are a source of fear at night
- They are hiding places for dangerous people and animals

ECLIPSE

- This is a shadow formed when sunlight is obstructed by the moon or earth

Note:

- The sun is stationary/fixed/does not move
- The earth moves around sun
- The moon moves around the sun and earth at the same time
- **An orbit** is a curved path of an object (heavenly body)
- The moon moves around the earth but the moon's orbit is not fixed
- The moon and earth sometimes come in straight line with the sun as they move
- When this occurs, either the moon or the earth is blocked from receiving sunlight
- In this case, we say that it is an eclipse

TYPES OF ECLIPSES

i) Solar eclipse (eclipse of the sun)
ii) Lunar eclipse (eclipse of the moon)

SOLAR ECLIPSE (ECLIPSE OF THE SUN)

- This is the type of eclipse that occurs when the moon comes between the sun and the earth.
- The moon blocks sunlight and its shadow is cast on the earth

How is solar eclipse formed?

- When the moon comes between the sun and earth.

Characteristics of solar eclipse

- The moon comes between the sun and earth
- The moon casts its shadow on the earth
- It happens at new moon during day time
- It can happen once every 1-2 years (it is a rare type of eclipse)

Where is the shadow cast during solar eclipse?

- On the earth

Why can't the moon's shadow fully cover the earth?

- The moon is smaller than the earth

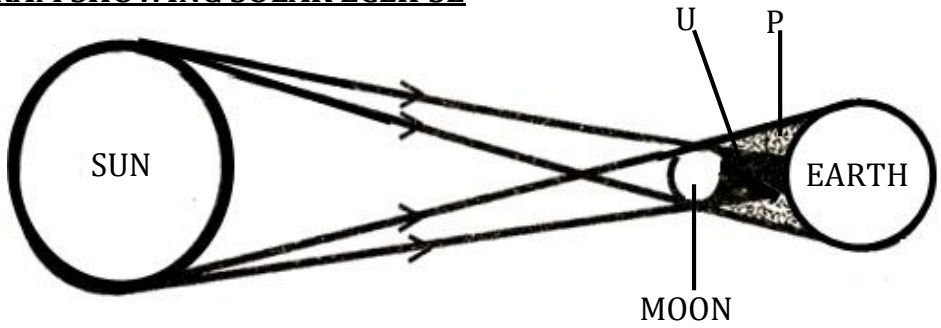
Why is it dangerous to expose the eyes directly to solar eclipse?

- It can damage the eyes/retina
- It can cause blindness

Mnemonic for solar eclipse

- Some Men Eat Snakes (SME----Solar eclipse)

A DIAGRAM SHOWING SOLAR ECLIPSE



P – Penumbra (partial eclipse)
U – Umbra (total eclipse)

TYPES OF SOLAR ECLIPSES

- Total solar eclipse
- Partial solar eclipse
- Annular solar eclipse

Total solar eclipse

- This is when the moon completely covers the sun and casts its umbra on the earth
- It is the only safe time to look directly at the sun **because** the sky is very dark

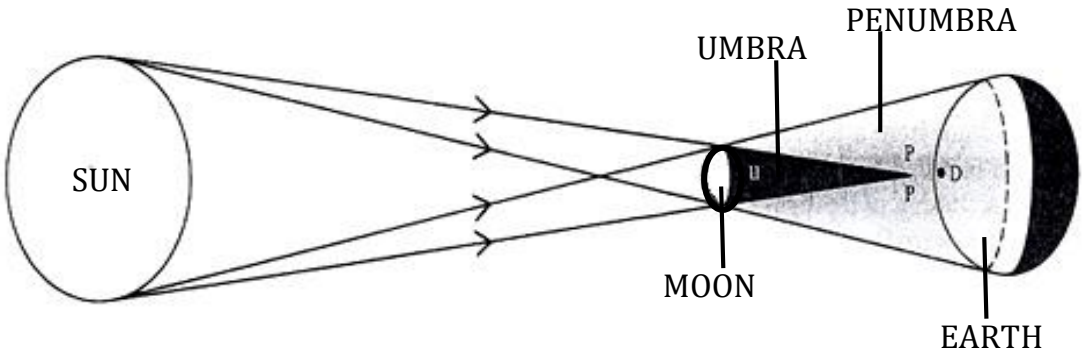
Partial solar eclipse

- This is when the moon partially covers the sun and casts its penumbra on the earth

Annular solar eclipse

- This is when the moon covers sun's centre to form a ring of fire around a dark moon
- The moon's umbra fails to reach the earth and it receives penumbra and antumbra

A diagram showing annular solar eclipse



What will a person at position D see?

- A ring of fire around the dark moon

Why does the moon's umbra fail to reach the earth during annular solar eclipse?

- The moon is farther away from the earth

Name the shadow that extends from the umbra to reach a person at position D?

- Antumbra

LUNAR ECLIPSE (ECLIPSE OF THE MOON)

- This is the type of eclipse that occurs when the earth comes between the sun and the moon.
- The earth blocks sunlight and its shadow is cast on the moon

How is lunar eclipse formed?

- It is formed when the earth comes between the sun and the moon

CHARACTERISTICS OF LUNAR ECLIPSE

- The earth is in between the sun and moon
- It happens at full moon during the night
- The shadow is cast on the moon
- The moon is in total eclipse so it doesn't reflect any light

Why is the whole moon under total eclipse/total shadow/umbra during lunar eclipse?

- The earth is bigger than the moon

Why can't the moon reflect any light during lunar eclipse?

- The moon is in total eclipse

Why is the earth's shadow able to cover the moon fully during lunar eclipse?

- The earth is bigger than the moon

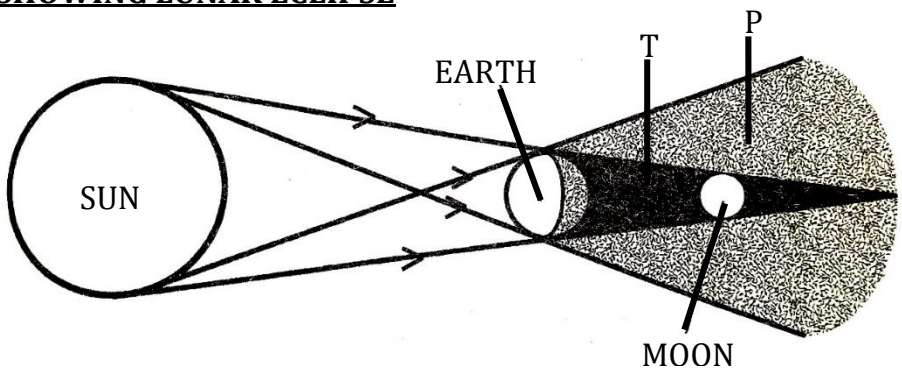
Where is the shadow cast during lunar eclipse?

- On the moon

MNEMONIC FOR LUNAR ECLIPSE

- Simon Entered My Latrine (SEM-----Lunar eclipse)

A DIAGRAM SHOWING LUNAR ECLIPSE



- **P** – Penumbra (partial eclipse)
- **T** – Umbra (total eclipse)

DIFFERENCES BETWEEN SOLAR AND LUNAR ECLIPSE

Solar eclipse	**Lunar eclipse**
The moon is between the sun and the earth	The earth is between the sun and the moon
The shadow is cast on the earth	The shadow is cast on the moon
It occurs during day time	It occurs on the night of full moon

THE SOLAR SYSTEM

This refers to the sun and all the objects that move around it

- The sun is at the centre of the solar system
- The sun is orbited by; planets, moons, asteroids, comets and meteoroids

CELESTIAL (ASTRONOMICAL) BODIES

- These are natural objects in the sky

Celestial (astronomical) bodies in the solar system

- Sun
- Moons
- Asteroids
- Planets
- Comets
- Meteoroids

✓ **Asteroids** and **meteoroids** are space rocks

✓ **Comet** is a big snowball with a rock in the middle

Why the sun is called a star?

- The sun produces heat and light

What is the colour of stars?

- Stars are either yellow, red or blue

PLANETS

- These are celestial bodies moving round the sun

THE EIGHTPLANETS IN SOLAR SYSTEM

ORDER FROM THE SUN (NEAREST TO FARTHEST)	**ORDER OF SIZE (LARGEST TO SMALLEST)**
1. Mercury	1. Jupiter
2. Venus	2. Saturn
3. Earth	3. Uranus
4. Mars	4. Neptune
5. Jupiter	5. Earth
6. Saturn	6. Venus
7. Uranus	7. Mars
8. Neptune	8. Mercury

Mnemonic for order of planets from the sun

- My Very Excellent Mother Just Served Us NIDO

- Venus is **brightest planet** known as the **morning star (evening star)**
- **Mercury** is the **closest planet to the sun** but it is not the hottest planet
- **Venus** is **hottest planet**

Why is Venus the hottest planet yet it is not the closest to sun?

- Venus has a lot of greenhouse gases than other planets

FACTS ABOUT THE UNIVERSE

- Earth takes 24 hours to rotate on its axis and 365 days to move around the sun
- Earth's only natural satellite is **the moon**
- Earth is the only planet that can support life

Why are living things able to survive on earth?

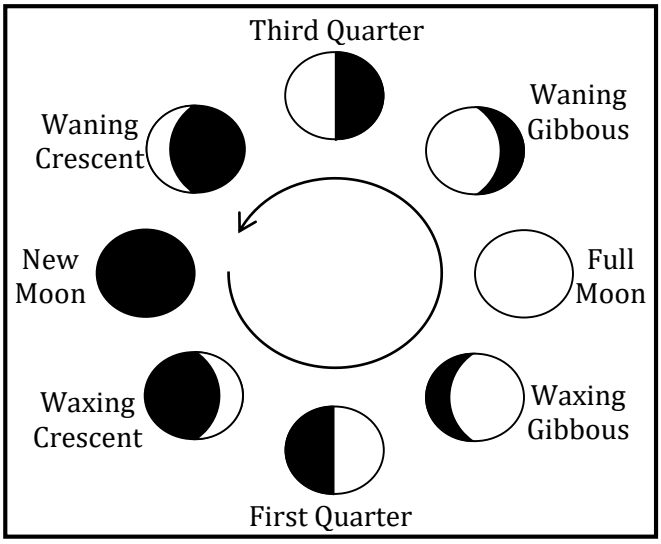
- Earth has enough oxygen in its atmosphere
- Earth has water on its surface
- Earth's temperature is not too hot or too cold

Why is there no life on other planets except Earth?

- There is no oxygen to support life

MAIN PHASES OF THE MOON

- New moon
- Crescent moon
- Quarter moon/half moon
- Gibbous moon
- Full moon



When does a blue moon occur?

- It occurs once every three years

WHEN IS THE MOON SAID TO BE;

i) Waxing?

- When it is increasing in size day by day

ii) Waning?

- When it is decreasing in size day by day

What general name is given to the first and last quarter moons?

- Half moon

GALAXY

- This is a group of stars in the night sky
- Our galaxy is called **Milky Way galaxy**
- A galaxy is held together by the **force of gravity**
- **Astrology** is the study of movements and relative positions of celestial bodies to judge their influence on human actions
- **Astronomy** is the study of all celestial bodies outside the earth's atmosphere
- **Astronomer** is a scientist who studies about celestial bodies
- **Astronaut** is a person who is trained to travel in a spacecraft

Why do objects weigh less on moon than on earth?

- The moon's gravity is less than the earth's gravity

REFLECTION OF LIGHT

- This is the bouncing (sending back) of light rays as they strike a shiny surface
- It occurs due to presence of a shiny object in the path of light

Types of light reflection

- Regular (specular) reflection
- Irregular (diffuse) reflection

REGULAR (SPECULAR) REFLECTION

This is the type of reflection where light rays are bounced (sent back) in a definite direction

- It occurs on **smooth shiny surfaces** (such as plane mirror and silvered metal)

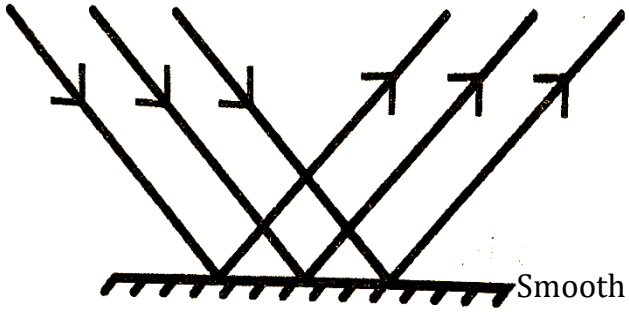
Why do we see clear images in plane mirrors and silvered metals?

- They produce regular reflection

Why do plane mirrors and silvered metals produce regular reflection?

- They are smooth shiny surfaces

An illustration showing regular (specular) reflection



Smooth shiny surface

IRREGULAR (DIFFUSE) REFLECTION

- This is the type of reflection where the light rays are bounced (sent back) in different directions.
- ✓ It occurs on **rough shiny surfaces** (such as iron sheets and painted walls)

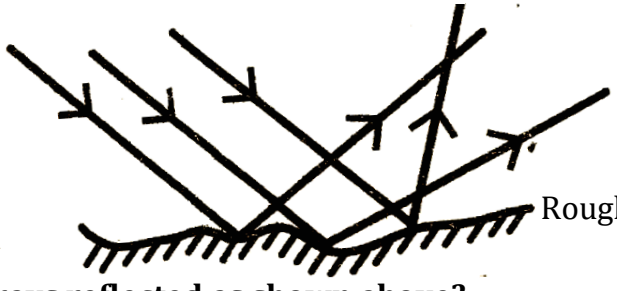
Why are we unable to see clear images on painted walls and iron sheets?

- They produce irregular reflection.

Why do iron sheets and painted walls produce irregular reflection?

- They are rough shiny surfaces

AN ILLUSTRATION SHOWING IRREGULAR (DIFFUSE) REFLECTION



Rough shiny surface

Why are the rays reflected as shown above?

- The surface is rough and shiny

DIFFERENCES BETWEEN REGULAR AND IRREGULAR REFLECTION

Regular reflection	Irregular reflection
▪ It occurs on smooth shiny surfaces	▪ It occurs on rough shiny surfaces
▪ Light rays are sent back in a definite direction	▪ Light rays are sent back in different directions

- Smooth shiny surfaces are also called **highly polished surfaces**
- Rough shiny surfaces are also called **unpolished surfaces**

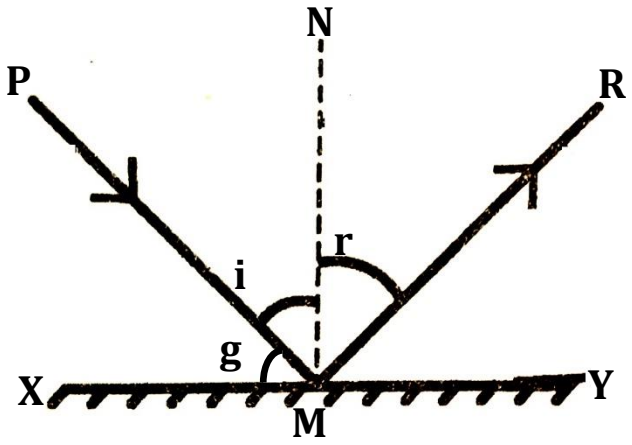
Why do we polish our shoes?

- To reflect heat

LAWS OF REFLECTION:

- The incident ray, the reflected ray and the normal at the point of incidence all lie in the same plane.
- The angle of incidence is equal to the angle of reflection.

A diagram showing regular reflection



XMY -Plane mirror
M -Point of incidence
PM-Incident ray
RM-Reflected ray
NM-Normal
i-Angle of incidence
r-Angle of reflection
g -Glancing angle

Point of incidence

- This is the point at which the incident ray strikes the shiny surface.

Incident ray

- This is the ray of light that hits the shiny surface.

Reflected ray

- This is the ray of light sent back by the shiny surface

Normal

- This is an imaginary line drawn perpendicular to shiny surface at the point of incidence.

Why is the normal always dotted?

- It is imaginary

Angle of incidence

- This is an angle between the incident ray and the normal

Angle of reflection

- This is an angle between the reflected ray and the normal

Glancing angle

- This is the angle between the shiny surface and the incident ray

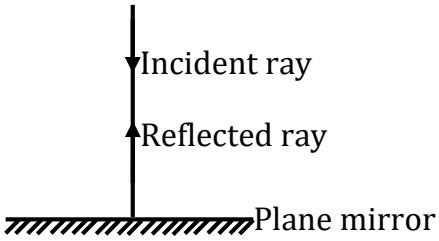
NOTE

- The ray of light that strikes the mirror at a right angle is reflected in the same direction (path)
- If the incident ray and the reflected ray are perpendicular to the surface, the angle of incidence and the angle of reflection are equal to 0^0 while the glancing angle is 90^0

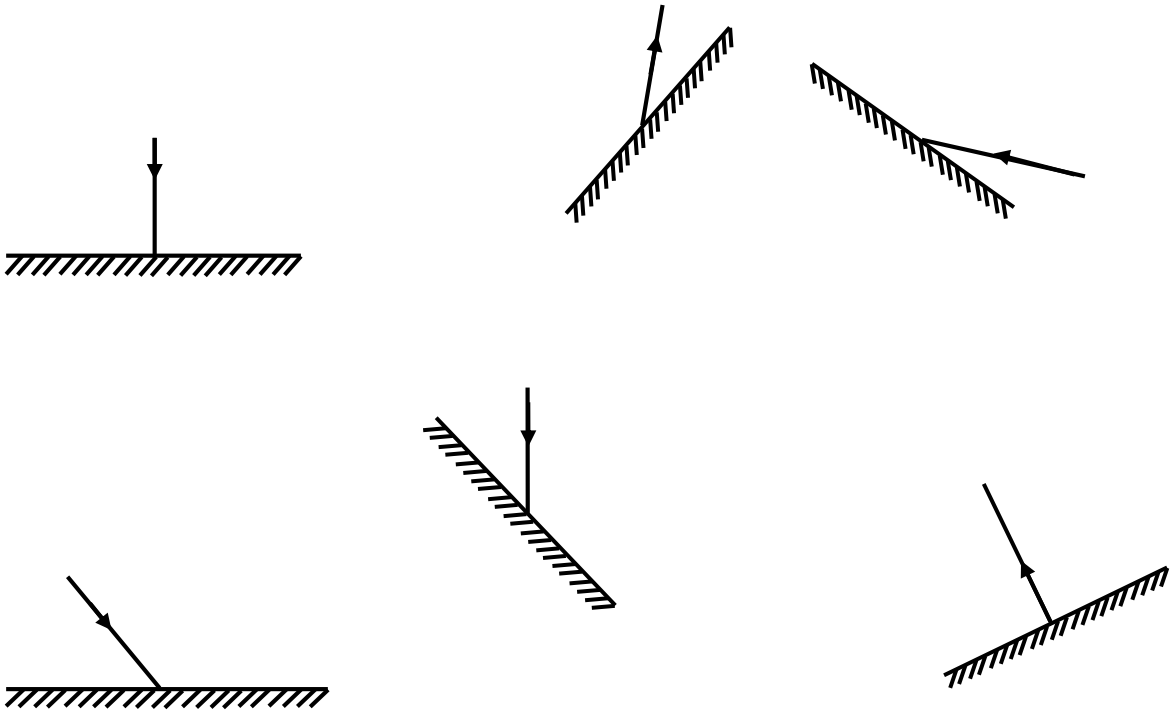
TOTAL INTERNAL REFLECTION

- This is when the incident ray strikes the mirror perpendicularly and the reflected ray takes the same route (path)

AN ILLUSTRATION SHOWING TOTAL INTERNAL REFLECTION



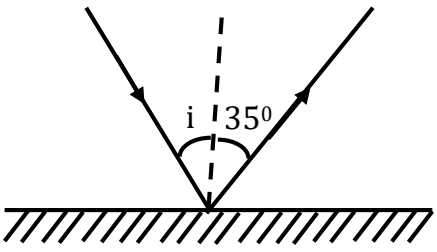
COMPLETE THE FOLLOWING DIAGRAMS



CALCULATIONS RELATED TO LIGHT REFLECTION

Example 1

Find the value of the angle of incidence in the figure below.



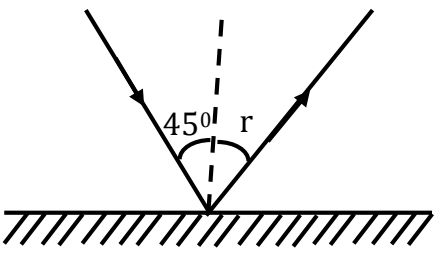
$i + 35^0 = 90^0$

$i + 35^0 - 35^0 = 90^0 - 35^0$

$i = 55^0$

Example 2

Find the value of the angle of reflection



Since; i = r

$r = 45^0$.

Example 3

The incident ray makes an angle of 60^0 to the mirror. What is the angle of reflection?

The normal makes 90^0 to the mirror

$60^0 + i = 90^0$

$60 - 60 + i = 90^0 - 60^0$

$i = 30^0$

Since; i = r

$r = 30^0$

Example 4

If the angle between the incident ray and the mirror is 32^0, what is the size of the reflected ray?

Let the angle of incidence be i

$i + 32^0 = 90^0$

$i + 32^0 - 32^0 = 90^0 - 32^0$

$i = 58^0$

Since; i = r

$r = 58^0$.

IMPORTANCE OF LIGHT REFLECTION

- It enables us to see objects
- It enables formation of images in mirrors
- It enables us to identify colours of objects
- It enables us to see around corners using periscopes

How does reflection help drivers to control accidents?

- It enables them to see images of vehicles and people behind through driving mirrors

REFLECTORS OF LIGHT

- These are materials which reflect light

Examples of good reflectors of light

- Shiny (polished) objects
- White objects/brightly coloured objects

ABSORBERS OF LIGHT

- These are materials which absorb light

Examples of absorbers of light

- Unpolished objects
- Black/dull coloured objects

Why do people in hot places (desert areas) wear white clothes?

- White reflects heat (sun's heat)

Why do people in cold weather wear dark clothes?

- Dark clothes absorb heat and keep the body warm

Why is a white cloth seen easily at a distance than a black cloth?

- White reflects light while black absorbs light

Why do objects appear their colour?

- They absorb all other colours and reflects their own colour

Why does a black object appear black?

- It absorbs all colours and reflects none

Why does a white object appear white?

- It reflects all other colours and absorbs none

Why does a green dress appear green?

- It absorbs all other colours and reflects green

Why does a red shirt appear red?

- It absorbs all other colours and reflects red

Why do most people in hot weather prefer wearing white clothes to black or dark clothes?

- White clothes reflect sun's heat while black clothes absorb sun's heat

Why are most car boards painted white?

- To reflect sun's heat

IMAGES

- An image is the reflection of a real object
- An image is a copy of an object formed by reflection or refraction of light

How is an image formed?

- When light rays meet or appear to meet after reflection

Types of images

- Real images
- Virtual images

Real images

- These are images which are formed on the screen
- They are formed by light rays that meet at a point after reflection

Instruments that form real images

- Camera
- Projector
- Human eye
- Convex lens
- Telescope

Virtual images

- These are images which cannot be formed on the screen
- They are formed by light rays that appear to meet behind the mirror after reflection

Instruments that form virtual images

- Periscope
- Mirrors
- Microscope
- Concave lens

EXAMPLES OF IMAGES

- Diminished images
- Erect images
- Magnified images
- Inverted images

Diminished images

- These are images which are smaller than the object

Instruments that form diminished images

- Convex mirror
- Pinhole camera
- Concave lens
- Human eye

Magnified images

- These are images which are bigger than the object

Instruments that form magnified images

- Concave mirrors
- Magnifying glasses
- Projector
- Convex lens
- Microscope

Erect images

- These are images which are upright

Instruments that form erect images

- Plane mirror
- Convex mirror
- Concave mirror
- Concave lens

Inverted images

- These are images which are upside down

Instruments that form inverted images

- Pinhole camera
- Lens camera
- Projector
- Human eye

MIRRORS

- A mirror is a smooth glass material with a silvered surface that reflects light

Groups (types) of mirrors

- Plane mirrors
- Curved (spherical) mirrors

PLANE MIRRORS

- These are mirrors with flat reflecting surfaces e.g. dressing mirrors

On which principle do plane mirrors form images?

- On the principle of light reflection

Characteristics of an image formed by plane mirrors

- The image distance is equal to the object distance from the mirror
- They are laterally inverted (image is turned sideways)
- They are equal to the object in size
- They are upright (erect)
- They are virtual

Mnemonic is VEELD

V --- Virtual
E --- Erect
E --- Equal to the object in size
L --- Laterally inverted
D --- Distance of image and object from the plane mirror is equal

LATERAL INVERSION

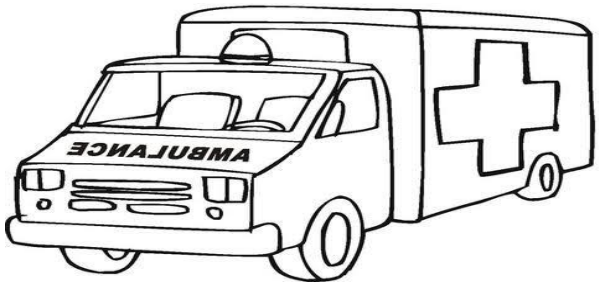
- This is the sideways reversal of images

An illustration showing lateral inversion

Why are images formed by plane mirrors laterally inverted?

- Due to reflection of light by the plane mirror

The word AMBULANCE is indicated in mirror writing on the vehicle as shown below



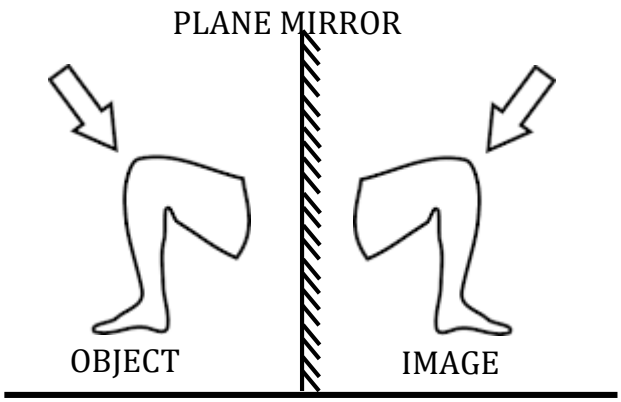
Why is the word AMBULANCE put in mirror writing?

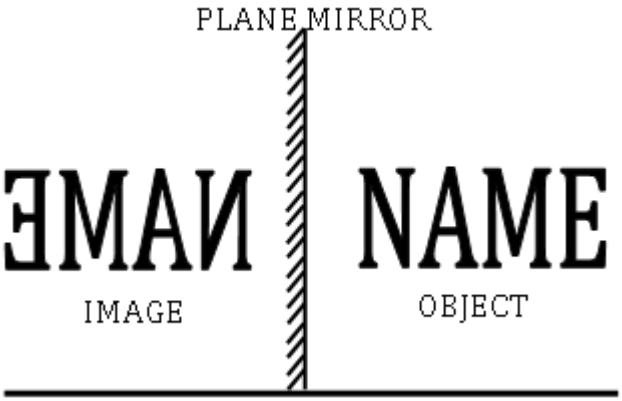
- For correct reading by other drivers in their side mirrors (rear-view mirrors)

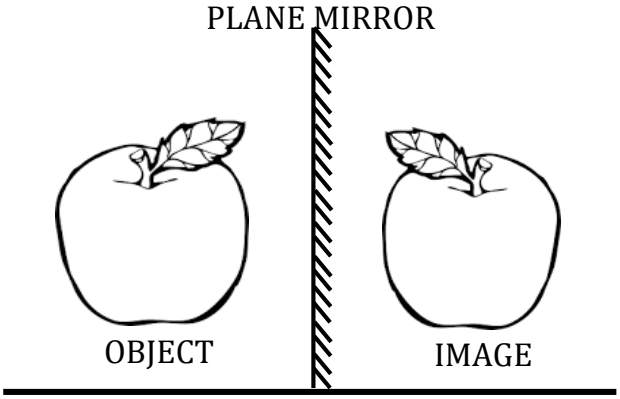
Why is it easier for drivers in front to read the word AMBULANCE in mirror writing on the vehicle?

- It is corrected by the driving mirror during reflection
- It is corrected by lateral inversion during reflection by the driving mirror

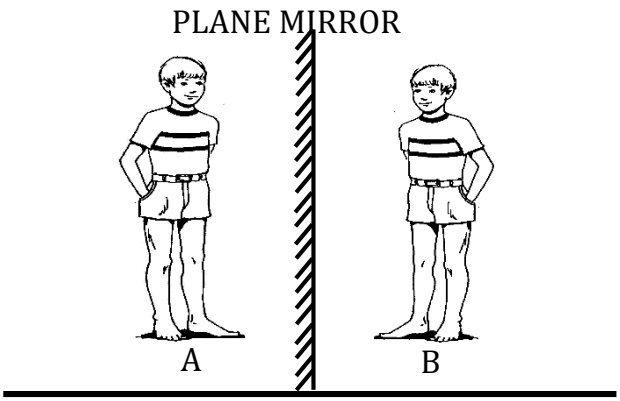
DRAWING IMAGES FORMED BY PLANE MIRRORS







The diagram below shows a boy using a plane mirror. Use it to answer the questions below



Which letter which shows the object?

- Letter B

Give a reason to support your answer in (a) above.

- It is in front of the mirror

What enables a very big tree to fit in the view of a human eye?

- The human eye forms diminished images

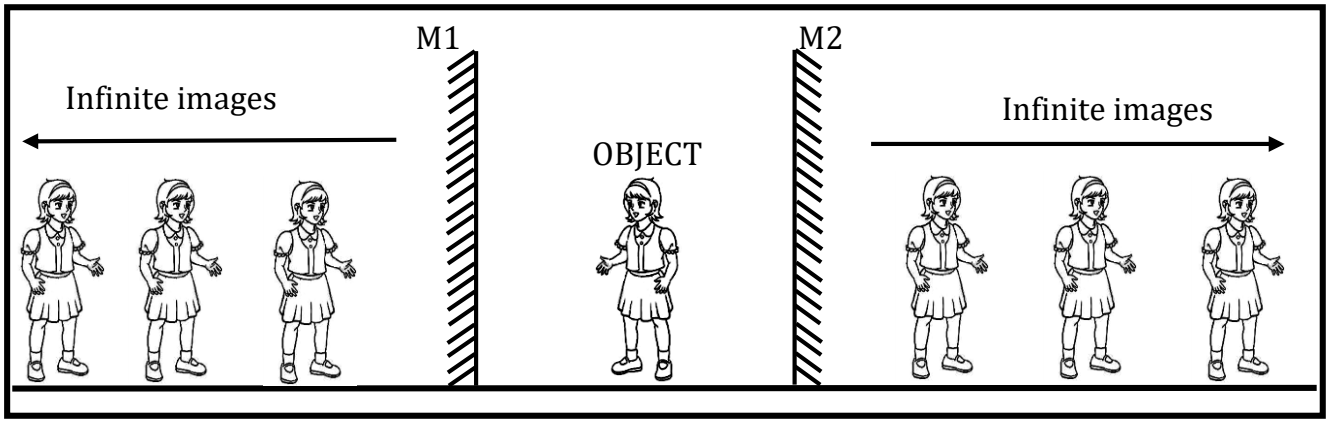
INFINITE IMAGES

- These are images which are endless

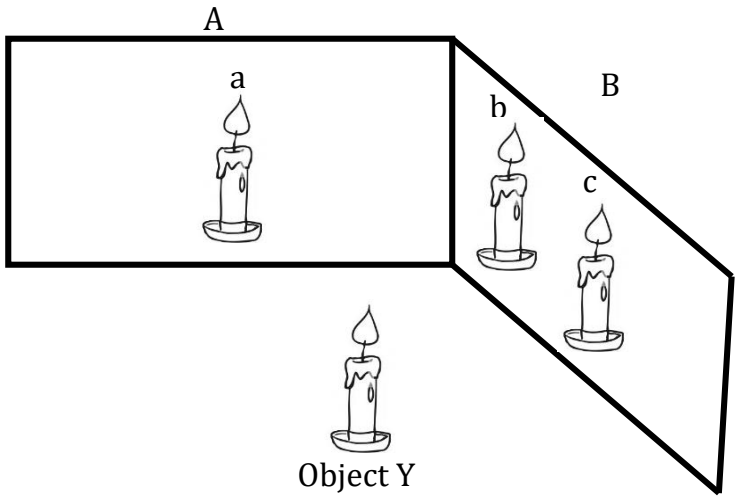
How are infinite images formed?

- When an object is placed between two plane mirrors which are parallel to each other

A diagram showing infinite images



An illustration showing two plane mirrors placed perpendicularly (at a right angle)



Note

- They form three images of an object in front of them.

Why?

- This is because the image of object Y in mirror A is **a**, in mirror B is **c** and the image of **a** in mirror B is **b**

How is an image similar to an echo?

- Both are formed by reflection

CALCULATING DISTANCES OF IMAGES AND OBJECTS FROM PLANE MIRRORS

1. An object was placed 5m away from the plane mirror.

a) How far was the image from the plane mirror?

Solution

Since the distances of the image (v) and object (u) from the plane mirror is equal,

U = V

5m = V

The image was 5m away from the plane mirror

b) How far was the image from the object?

5m + 5m

= 10m

2. After reflection by a plane mirror, the image was formed 15m away from the plane mirror.

a) How far was the object from the plane mirror?

- The object was 15m away from the plane mirror

b) How far was the object from the image?

- The image distance is equal to the object distance from the mirror.

c) How far was the object from the image?

15m + 15m

= 30m

Applications (uses) of plane mirrors

- They are used as dressing mirrors
- They are used in periscopes in submarines
- They are used in kaleidoscopes
- They are used in a sextant
- They are used in an overhead projector

Devices that use plane mirrors

- Periscope
- Kaleidoscope
- Overhead projector

KALEIDOSCOPE

- This is an optical device that produces colourful designs and patterns

What enables a kaleidoscope to produce colourful designs and patterns?

- Multiple reflections in the plane mirrors

PERISCOPE

- This is an instrument used to see over an obstacle and around corners
- ✓ It consists of a tube with two plane mirrors set parallel to each other in its corner and inclined at an angle of 45^0 to the path of light rays

Why are plane mirrors fixed parallel to each other in a periscope?

- To reflect light

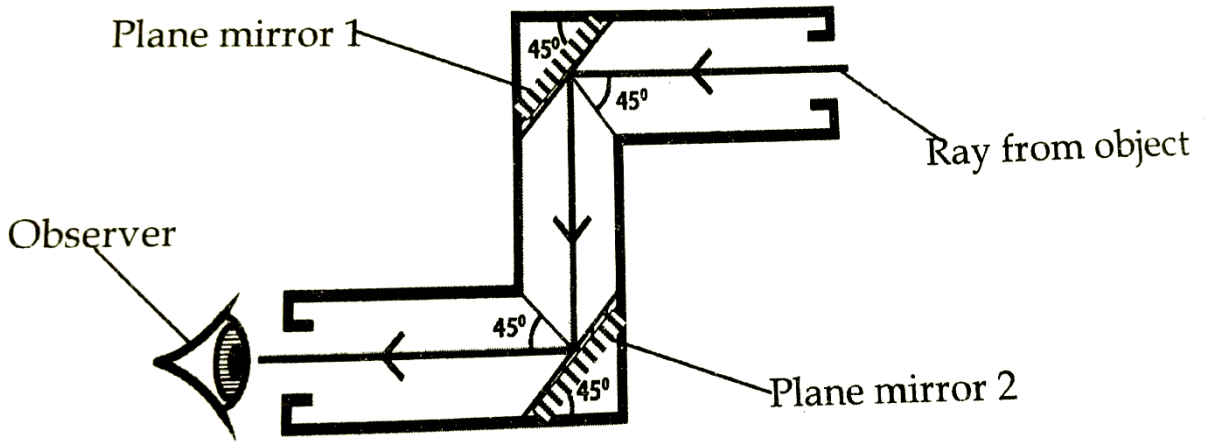
On which principle does a periscope work?

- It works on the principle of reflection of light

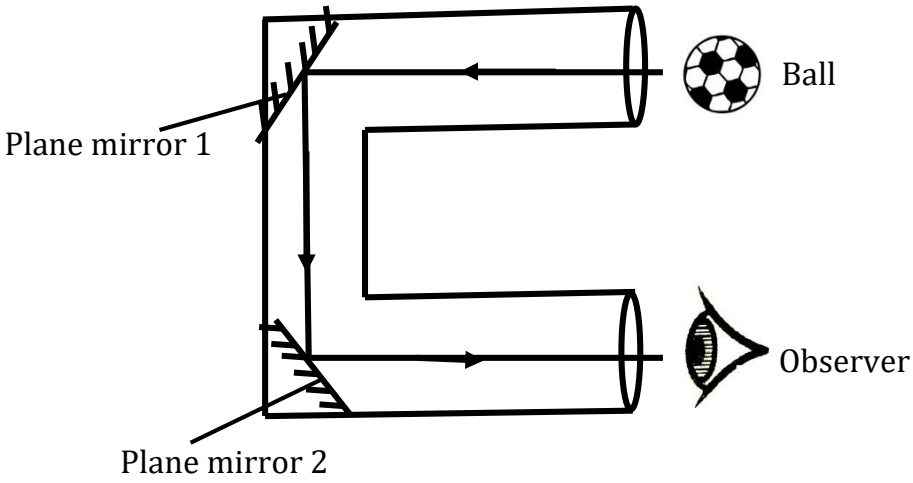
Why are we able to see around corners using a periscope?

- It is due to reflection of light

A DIAGRAM SHOWING A PERISCOPE



Below is an optical instrument. Use it to answer the following questions below.



a) **Name the above optical instrument.**

- Periscope

b) **What role is played by the plane mirrors in the above device**?

- They reflect light

c) **How is the observer able to see the ball?**

- By reflection of light

d) **At what angle are the plane mirrors inclined?**

- At 45^0

USES OF A PERISCOPE

- It is used to see around corners
- It is used by soldiers in trenches to see the enemies on ground
- It is used to see objects ahead
- It is used by marines to see over the water surface
- It is used by spectators to watch overhead the crowd
- They are used by security guards to watch over tall fences at night

Groups of people who use periscopes

- Soldiers
- Marines
- Security guards
- Spectators

CURVED (SPHERICAL) MIRRORS

- These are mirrors with a curved reflecting surface

How are curved mirrors made?

- By silvering either the inside or outside surface of the sphere

TYPES OF CURVED MIRRORS

- Concave (converging) mirrors
- Convex (diverging) mirrors

CONVEX (DIVERGING) MIRRORS

- These are mirrors made by silvering the inside surface of the sphere.

Why is a convex mirror also called diverging mirror?

- Light rays spread/scatter after reflection by a convex mirror

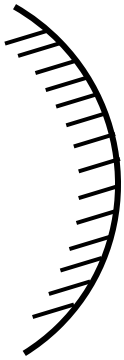
What happens to light rays when they strike a convex mirror?

- They are diverged

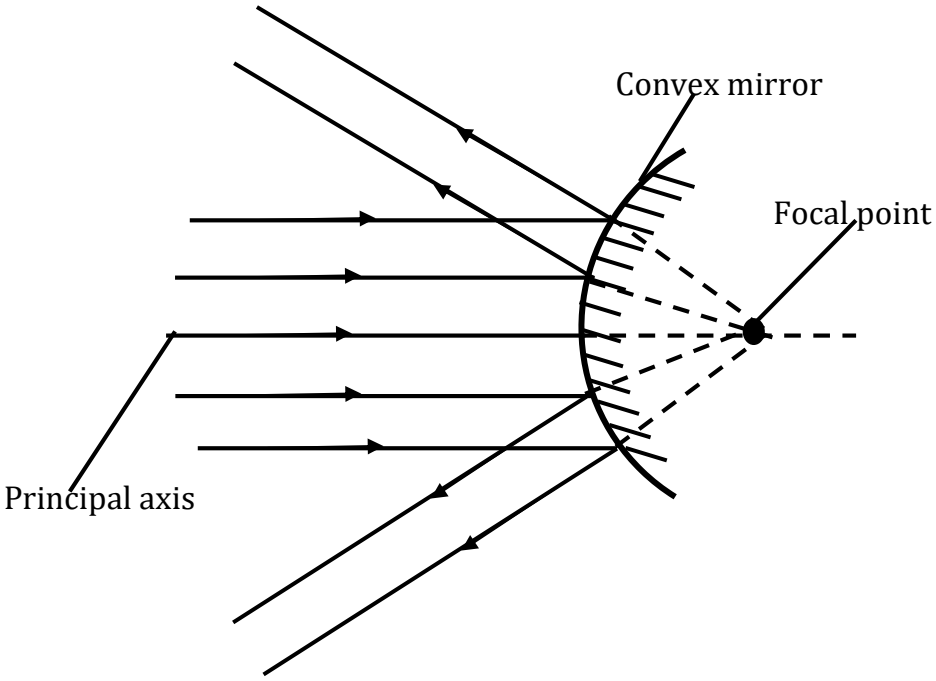
How does a convex mirror affect the beam of light?

- It diverges light rays after reflection

A diagram to show convex mirrors



Reflection of light by a convex mirror



Characteristic of images formed by convex mirrors

- The image is diminished (smaller than the object)
- The image is upright (erect)
- The image is laterally inverted
- The image is virtual (formed behind the mirror)

USES OF CONVEX MIRRORS

- They are used as rear view mirrors (driving mirror/side mirrors) on vehicles.

✓ They give a wider field of view

- They are used as security mirrors in shops and buses
- They are used in making lenses of sunglasses
- They are used in magnifying glasses

Difference between images formed by convex mirrors and plane mirrors

- Images formed by convex mirrors are diminished while images formed by plane mirrors are equal to the object in size

CONCAVE (CONVERGING) MIRRORS

- These are mirrors made by silvering the outside surface of the sphere.

Why is a concave mirror also called converging mirror?

- Light rays meet at a point after reflection by a concave mirror

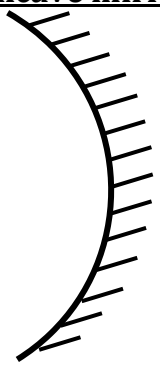
What happens to light rays when they strike a concave mirror?

- They are converge after reflection

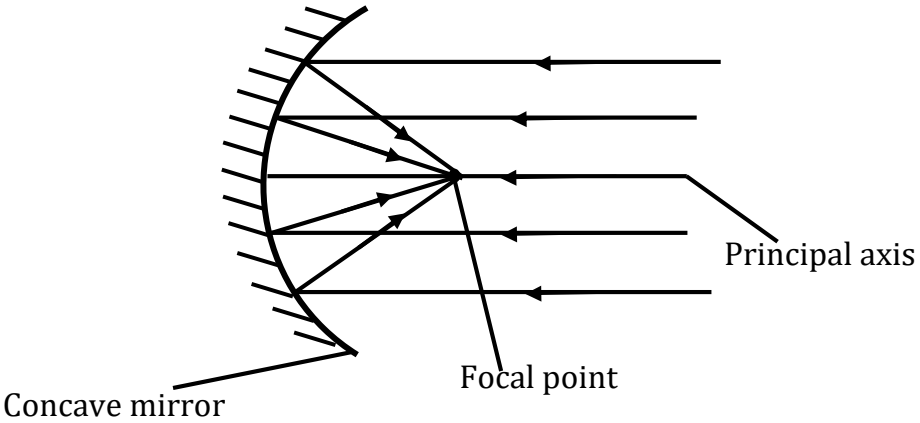
How does a concave mirror affect the beam of light?

- It converges light rays after reflection

A diagram to show concave mirrors



Reflection of light by a concave mirror



Characteristics of images formed by concave mirrors

- The image is magnified (larger than the object)
- They are erect (upright)
- They are laterally inverted
- They are virtual (cannot be cast on the screen)

Differences between images formed by concave mirrors and plane mirrors

- Images formed by concave mirrors are magnified while images formed by plane mirrors are equal to the object in size

USES OF CONCAVE MIRRORS

- They are used as shaving mirrors e.g. by barbers

✓ They form enlarged erect image of the face

- They are used by dentists to examine teeth

✓ They form enlarged images of teeth

- They are used in solar ovens

✓ They converge sun rays to produce heat (high temperature)

- They are used in search-lights and torches
- They are used in car headlights to reflect light

✓ They produce a powerful parallel beam of light

- They are used at airports to guide landing aeroplanes
- They are used in electron microscope
- They are used in satellite dishes
- They are used in visual bomb detectors

REFRACTION OF LIGHT

- This is the bending of light as it moves from one transparent medium to another

What causes refraction of light?

- Change in speed of light as it moves from one transparent medium to another

Why does light bend as it moves from one transparent medium to another?

- Due to change in speed of light

THE SPEED OF LIGHT IN DIFFERENT MEDIA

Medium	**Speed of light**
Vacuum	**300,000 Km/s**
Air	**299,700 Km/s**
Water	**225,000 Km/s**
Glass	**200,000 Km/s**
Diamond	**12,400 Km/s**

✓ Light travels faster in a rarer (less dense) medium

✓ Light travels slower in a denser medium

Why does light travel fastest in vacuum?

- There is no matter

Why does light travel faster in air than in glass?

- Air is less dense than glass

Explain the meaning of the following terms as used in refraction of light?

i) Rarer (less dense) medium

- This is the medium in which the speed of light is more

ii) Denser medium

- This is the medium in which the speed of light is less

NOTE

1. When a ray of light is moving from a rarer (less dense) medium to a denser medium (e.g from air to glass), the refracted ray bends towards the normal

Why?

- The speed of light reduces

2. When a ray of light is moving from a denser medium to a rarer (less dense) medium (e.g from glass to air), the refracted ray bends away from the normal

Why?

- The speed of light increases

3. When a ray of light falls normally (perpendicularly) on a medium, it is not refracted (it goes straight)

PRINCIPLES OR LAWS OF REFRACTION (SNELL'S LAW)

- The incident ray, the refracted ray and the normal at the point of incidence all lie in the same plane.
- The ratio of sine angle of incidence to sine angle of refraction is constant
- A ray of light travelling along the normal is not refracted

When does refraction occur?

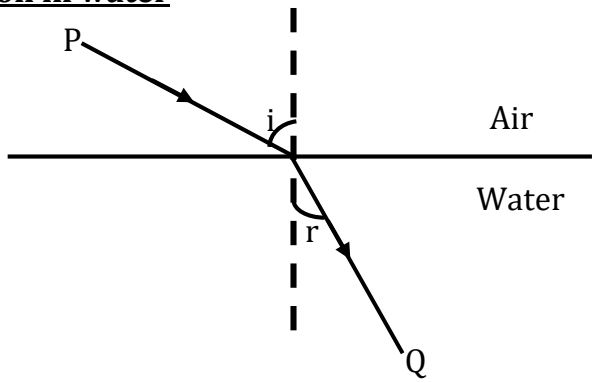
- When the incident ray strikes the boundary of another medium at an angle

When does no refraction of light occur?

- When the incident ray strikes the boundary of other medium normally
- When the refractive indices of two media in contact is equal

DIAGRAMS SHOWING REFRACTION OF LIGHT

a) Refraction in water



Naming the rays of light

P ---- Incident ray

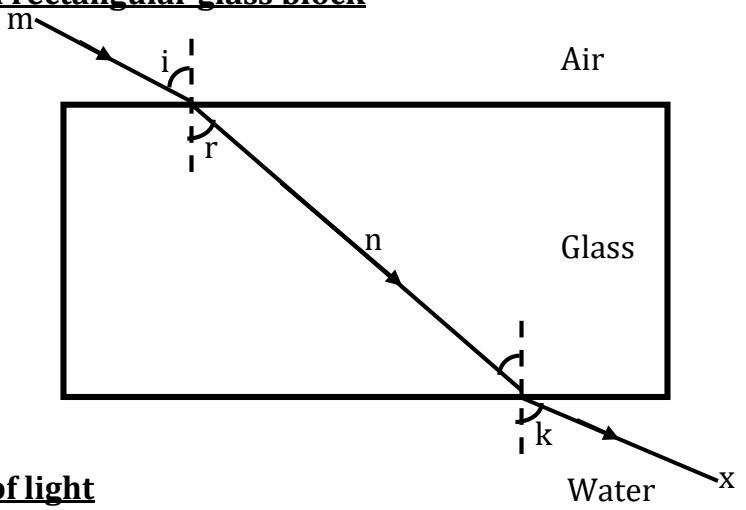
Q---- Refracted ray

Naming the angles

i ---- Angle of incidence

r ---- Angle of refraction

b) Refraction in a rectangular glass block



Naming the rays of light

- m ---- Incident ray
- n ---- Refracted ray
- x ---- Emergent refracted ray

Naming the angles

- i ---- Angle of incidence
- r ---- Angle of refraction
- k ---- Angle of emergence

Why does a ray of light bend as it moves from air to glass?

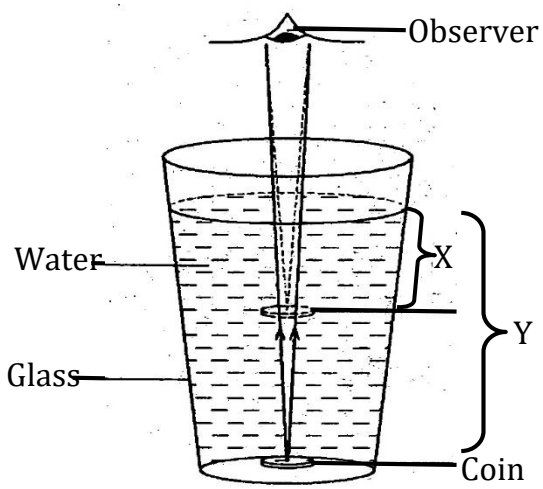
- Due to change in speed of light

EFFECTS OF REFRACTION

- It makes a swimming pool to appear shallower than its real depth
- It makes a coin or stone at the bottom of water in the container to appear raised
- It makes a ruler or stick partly dipped in water at an angle to appear bent or broken
- It makes a fish appear to be nearer the water surface than its real depth
- It makes a line or words on a paper to appear raised when seen through a glass block
- It causes dispersion of light
- It makes a lemon put in a glass of water to appear bigger when seen from the sides of a glass
- It forms optical illusions e.g. mirage and looming
- It makes stars to appear twinkling at night

DIAGRAMS SHOWING EFFECTS OF REFRACTIONS

Illustration 1



X- Apparent depth
Y- Real depth

Qn. Why does the observer see the coin as if it's in the middle of the bucket?

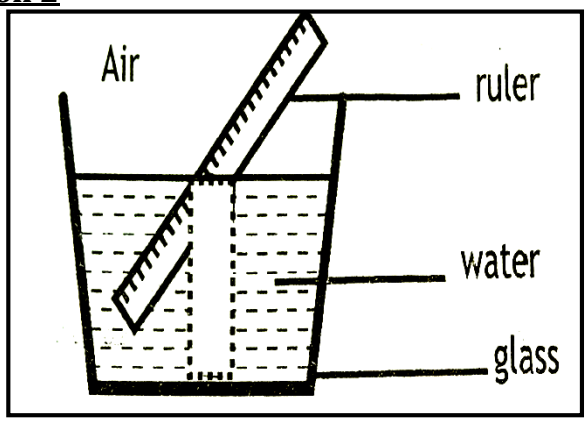
- Due to refraction

Qn. What causes real and apparent depth?

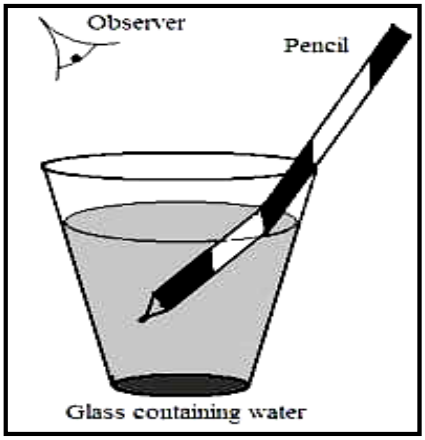
- Refraction

Illustration 2

A



B



Qn. Why does a pencil appear bent in diagram B?

- Due to refraction

MIRAGE

- This is an optical illusion of water in a desert and on a hot road caused by refraction of light from the sky by hot air near the ground.

EFFECTS OF MIRAGE

- It leads to accidents on highways (on tarmac roads)
- It causes false images along high ways in deserts.

Name any two places where mirages are common during sunny weather?

- Highways (tarmac roads)
- Deserts

DANGERS OF REFRACTION OF LIGHT

- It can lead to near drowning and drowning in swimming pools
- It makes harvesting of fish difficult
- It forms mirages which can lead to road accidents

DISPERSION OF LIGHT

- This is the splitting of white light into the seven colours.

What causes dispersion of light?

- Refraction of light

LIGHT SPECTRUM

- This is a band of seven distinct colours that make up white light
- This is the arrangement of the seven colours that make up white light

How is a light spectrum formed?

- It is formed when white light is split by a prism.

What is a prism?

- This is a transparent glass that splits white light into seven colours.

Who discovered that white light is made up of seven colours?

- Sir Isaac Newton

THE ORDER OF LIGHT SPECTRUM FROM TOP TO BOTTOM

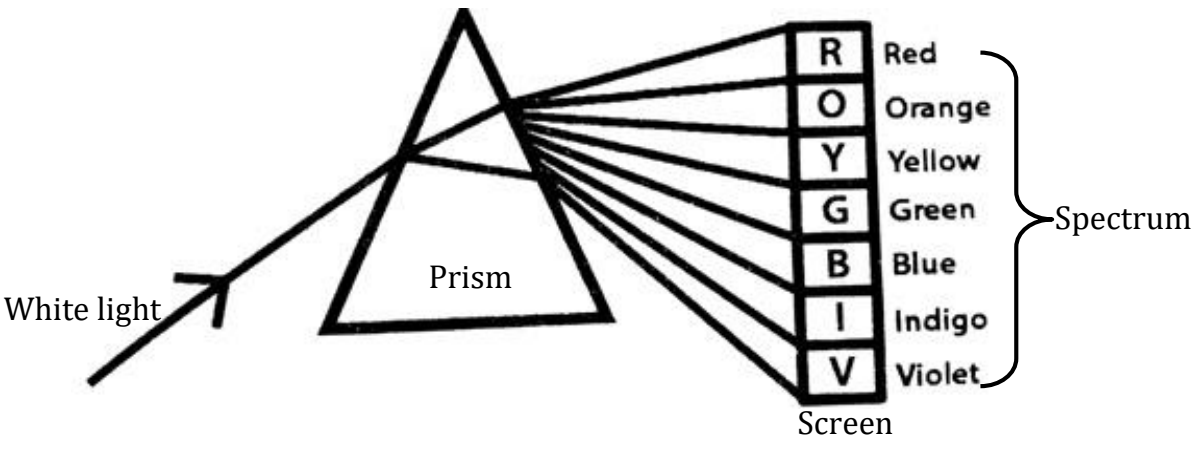
- Red
- Orange
- Yellow
- Green
- Blue
- Indigo
- Violet

MNEMONICS FOR THE ORDER OF SPECTRUM

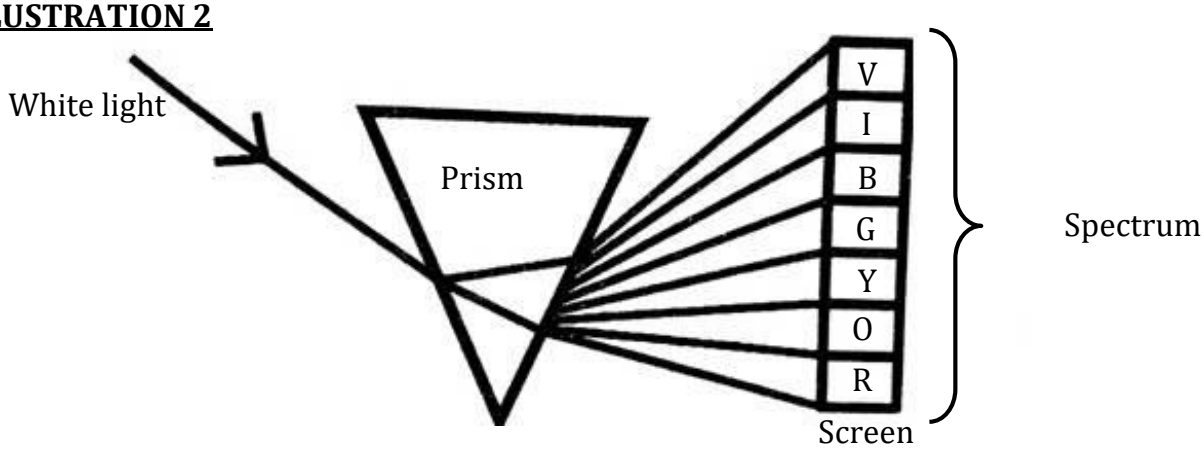
1. Richard Okello Your Girl Betty Is Vomiting
2. Richard Of York Gave Birth In Vain
3. Read Only Your Golden Book In Venus

DIAGRAMS TO SHOW DISPERSION OF WHITE LIGHT

1. ILLUSTRATION 1



2. <u>ILLUSTRATION 2</u>

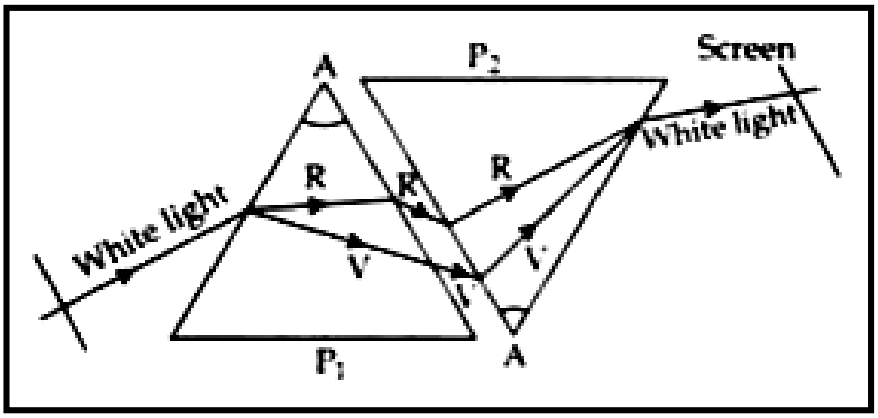


- Light rays in the prism bend at different angles because they move at different speed
- The fastest ray of light bends most and it has the shortest wavelength
- The slowest ray of light bends least and it has the highest wavelength
- **Red** colour bends the least and **violet** bends most.

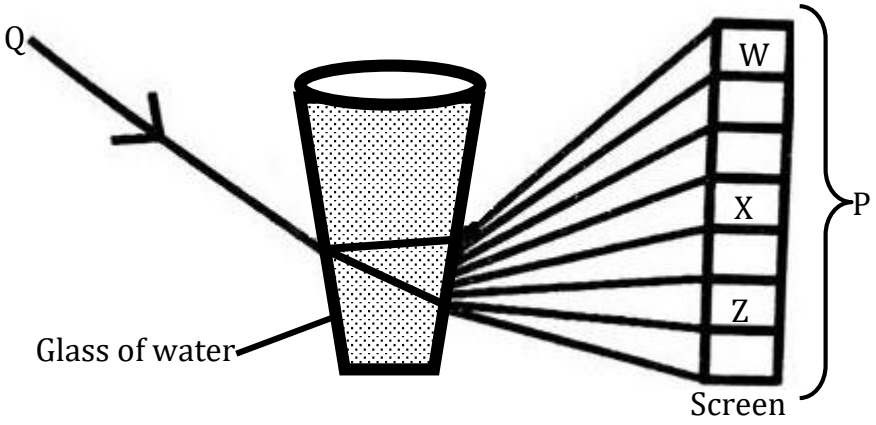
<u>NOTE</u>

- The seven colours of light spectrum can be recombined to form white light by arranging the second prism to deviate light in the opposite direction

<u>ILLUSTRATION</u>



<u>Study the diagram below and answer the questions about it.</u>



<u>What does the diagram above illustrate?</u>

- Dispersion of light

<u>Name the parts marked Q and P</u>

- Q is white light
- P is spectrum/light spectrum

<u>Name the colours marked W, X and Z</u>

- W is Violet
- X is Green
- Z is Orange

What role does a glass of water play in the experiment above?

- It splits white light into seven colours (it causes dispersion of light)

Give any one source of white light

- Sun
- Torch
- Fluorescent light bulb
- White LED

Why is a laser light not dispersed/spread when passed through a prism?

- It has perfectly parallel rays with only one colour

RAINBOW

- This is a natural light spectrum

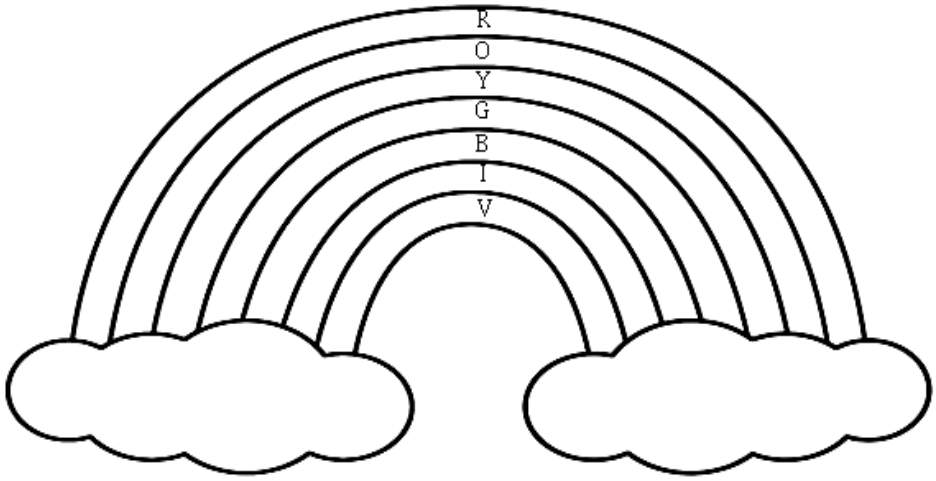
How is a rainbow formed?

- When sunlight is split by raindrops

Why does a rainbow appear in the morning and evening (late afternoon) only?

- The sun is at an angle to the earth's surface

A DIAGRAM SHOWING A RAINBOW



- The outer (top most) colour of rainbow is red and Violet is at the bottom

Why is the rainbow seen with red on top and violet at bottom?

- Red bends the least and violet bends the most

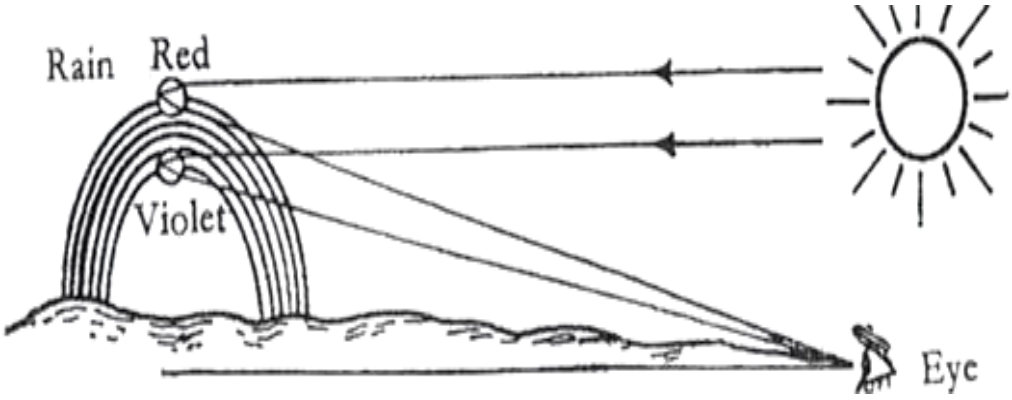
Why is red bent the least in a rainbow?

- Red travels slowest

Why is violet bent the most?

- Violet travels fastest

An illustration showing the formation of a rainbow



PRIMARY, SECONDARY AND COMPLEMENTARY COLOURS OF LIGHT

1. **PRIMARY COLOURS**

- These are colours that cannot be got by mixing other colours.

✓ Primary colours exist on their own

Examples of primary colours

- Red
- Blue
- Green

NOTE

- **Primary colours** absorb other colours and reflect themselves.
- When all primary colours are mixed, we get **white.**
- **White** is a universal colour
- **Red + Blue + Green = White**

Who is a colour blind person?

- This is a person who cannot see any of the primary colours.

2. SECONDARY COLOURS

- These are colours got by mixing two primary colours

Examples of primary colours

- Yellow
- Cyan (peacock blue)
- Magenta

Mixture of primary colours	**Secondary colour**
Red + Green	Yellow
Blue + Green	Cyan (peacock blue)
Red + Blue	Magenta

3. COMPLEMENTARY COLOURS

- These are any two colours that mix to form white
- This is a pair of colours that mix to form white

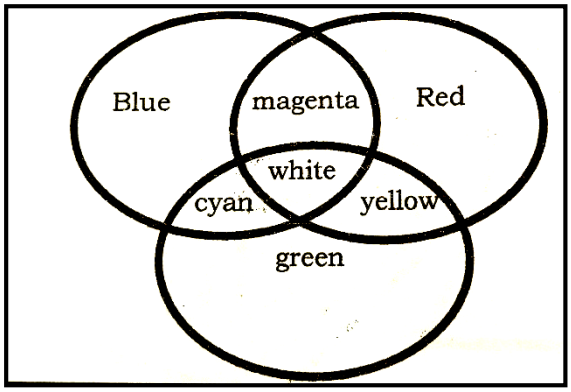
One colour must be a primary colour and another is a secondary colour mixing that primary colour.

Examples of complementary colours

- Blue and yellow
- Green and magenta
- Red and cyan

COMPLEMENTARY COLOURS	**PRODUCT**
Blue and yellow	White
Red and cyan	
Green and magenta	

AN ILLUSTRATION SHOWING COLOUR CHART



What is observed when the colour wheel (Sir Isaac Newton's colour Disc) is rotated at high speed?

- White light is observed

LENSES

- This is a transparent glass or plastic material with curved sides that refract light.

What is the use of the curved sides of a lens?

- They refract light passing through the lens.

Name any two materials from which lenses are made.

- Glass
- Plastic

Types of lenses

- Convex (converging) lens
- Concave (diverging) lens

CONVEX LENS (CONVERGING LENS)

- This is a lens which is thicker in the middle but thinner at the edges.

An illustration of convex lens

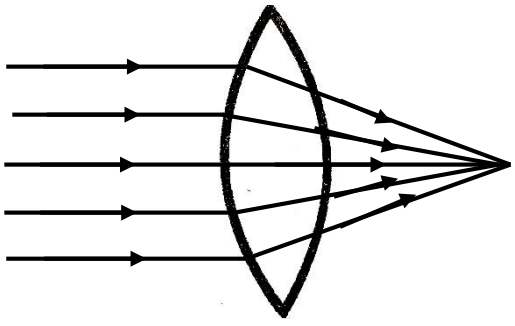
Why is a convex lens also called a converging lens?

- It refracts parallel light rays to meet at a focal point

What happens to parallel light rays when they strike a convex lens?

- They converge at a focal point (they bend and meet at a focal point)

A diagram to show the effect of light rays on a convex lens.



Characteristics of an image formed by a convex lens

- It is real
- It is magnified
- It is inverted

Uses of convex lenses

- They are used in some optical instruments e.g. magnifying glasses, light microscopes, eyeglasses, lens cameras and human eye
- They are used to correct long sightedness

CONCAVE LENS (DIVERGING LENS)

- This is a lens which is thinner in the middle but thicker at the edges.

AN ILLUSTRATION OF A CONCAVE LENS

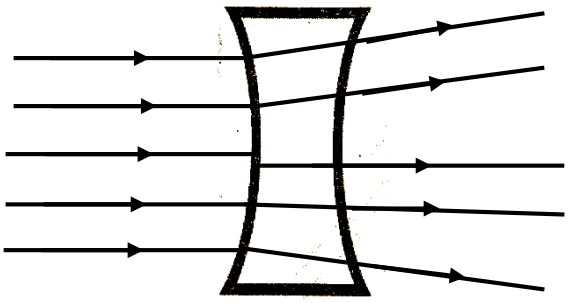
Why is a concave lens also called a diverging lens?

- It refracts parallel light rays to spread out in different directions

What happens to parallel light rays when they strike a concave lens?

- They diverge (they bend and spread out in different directions)

A diagram to show the effect of light rays on a concave lens.



Characteristics of an image formed by a concave lens

- It is virtual
- It is erect (upright)
- It is diminished

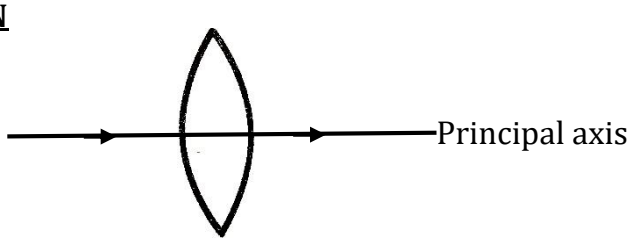
Uses of concave lenses

- They are used in some optical instruments like telescopes, binoculars, eyeglasses and TV projectors
- They are used to correct short sightedness

NOTE:

- A ray of light travelling along the normal is not refracted

ILLUSTRATION



EXPLAIN THE MEANING OF THE FOLLOWING TERMS

Principal axis of the lens

- This is the line passing through the centre of the lens

Focal point (principal focus)

- This is the point at which light rays converge

Focal length

- This is the distance between the centre of the lens and the focal point

GENERAL USES OF LENSES

- They are used in optical instruments
- They are used to correct eye defects

OPTICAL INSTRUMENTS

- These are instruments which use light to work
- These are instruments whose proper working depends on presence of light

How do optical instruments form images?

- They use mirrors and lenses to reflect and refract light and form images

Examples of optical instruments that use lenses.

- **Telescopes (refracting telescopes)**

They are used to see magnified image of very distant small objects e.g. stars

- **Binoculars**

They are used to see magnified images of distant objects

- **Projectors**

They are used to focus magnified images onto a screen

- **Magnifying glasses**

They are used to produce a magnified image for clear vision

An illustration showing a magnifying glass

- **Light microscopes**

They are used to magnify germs or tiny objects

- **Lens camera**

They are used to take photographs or videos

- **Eyeglasses (spectacles)**

They act as vision aids

- **Human eyes**

They enable us to see

Examples of optical instruments that use plane mirrors.

- Periscopes
- Kaleidoscopes

Examples of optical instruments that use concave mirrors

- Telescopes (reflecting telescopes)
- Electron microscope

An example of optical instrument that uses convex mirrors

- Magnifying glasses

Optical instruments that form real images

- Camera
- Convex lens
- Projector
- Telescope
- Human eye

Optical instruments that form virtual images

- Periscope
- Microscope
- Mirrors
- Concave lens

Characteristics of images formed by projectors

- They are real
- They are magnified
- They are inverted

CAMERAS

- These are optical devices used to capture still images (pictures)

Types of cameras

- Pinhole camera
- Lens camera (photographic camera)

A PINHOLE CAMERA

- This is a device that forms images by allowing light through a very small hole.

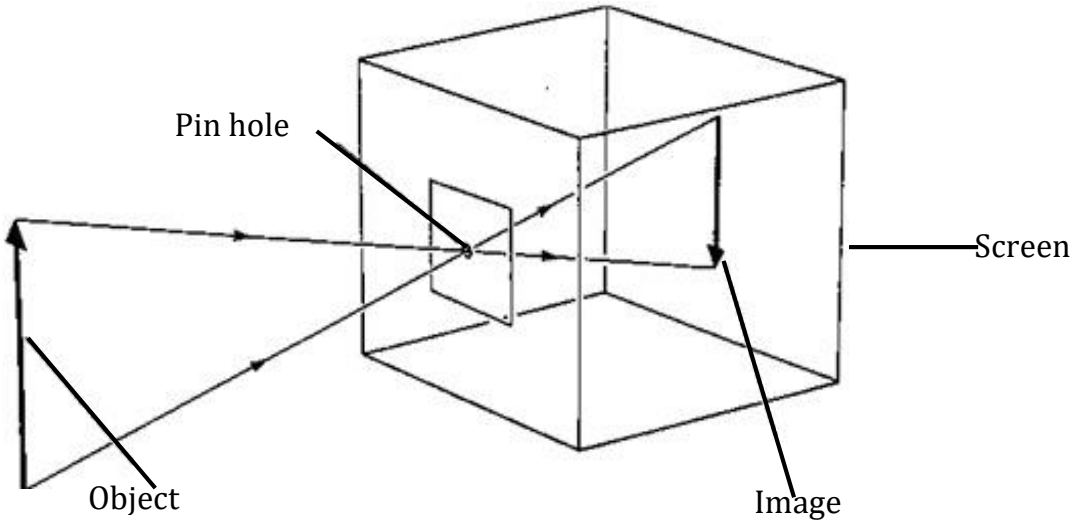
On which principle does a pinhole camera work?

- It works on the principle that light travels in a straight line (rectilinear propagation of light)

Why does a pinhole camera form an inverted image?

- Light travels in straight line (due to rectilinear propagation of light)

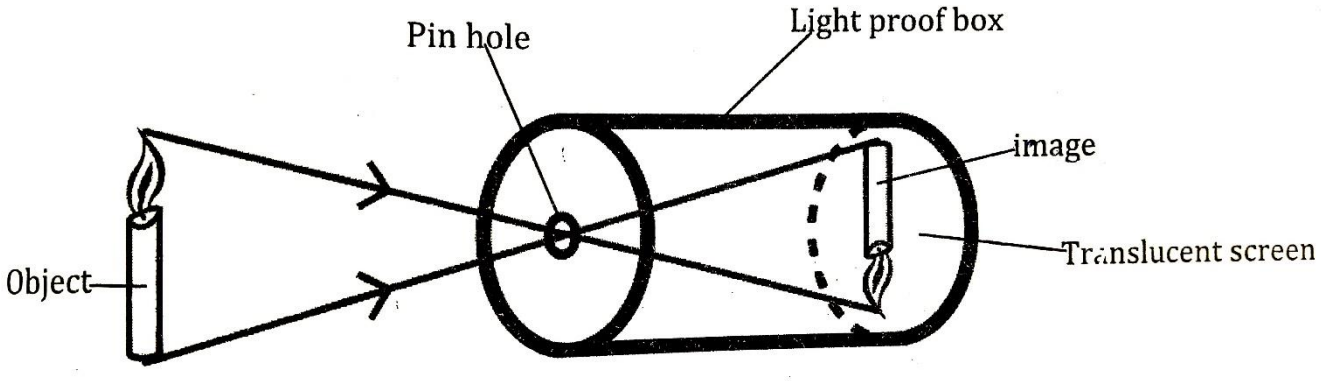
A diagram showing a pinhole camera



NOTE

- You can make your own pinhole camera using a cylindrical tin

ILLUSTRATION



Characteristics of the image formed by a pinhole camera

- It is real
- It is inverted
- It is diminished

RID

Why is an image formed by a pinhole camera real?

- The image is formed (cast) on the screen

Why is (the light proof box) the inside of a pinhole camera painted black?

- To prevent internal reflection/to prevent unwanted reflections inside

Why is the image formed by a pinhole camera sharp but not bright?

- The pinhole allows in little light

State the importance of a screen in a pinhole camera?

- It is where the image is formed

State the importance of the translucent paper (e.g. oiled paper) on a pinhole camera?

- It acts as a screen on which an image is formed

Note

- The **screen** in a pinhole camera acts as the **retina** in the eye or the **film** in the lens camera

FACTORS THAT AFFECT THE SIZE OF AN IMAGE FORMED BY PINHOLE CAMERA

- Length of the pinhole camera (distance from the pinhole to the screen)
- Distance of an object from the pinhole

Length of the pinhole camera

- Longer pinhole camera forms bigger images while a shorter one forms smaller images

Distance of an object from the pinhole

- An object nearer to the pinhole camera has a big and clear image while an object far from the camera has a small and blurred image

When does a pinhole camera form a blurred image?

- When the pinhole is made larger(When the size of pinhole is increased)
- When the object is far from the camera

Note

- A smaller pinhole makes the image sharper (clear)

THE LENS CAMERA (PHOTOGRAPHIC CAMERA)

- This is an optical instrument used to take photographs and videos

Why is a photographic camera called an optical instrument?

- It uses light to work

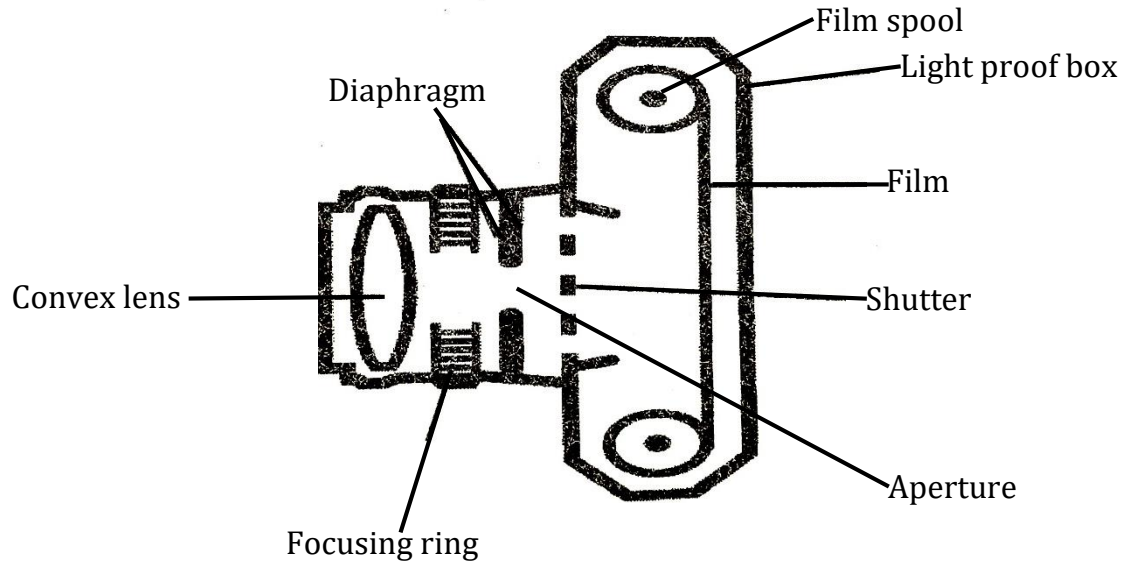
Name the type of lens used in a lens camera?

- Convex lens

Note

- A photographic camera consists of a light proof box with a glass lens, diaphragm, shutter, film and focusing ring.

THE STRUCTURE OF A PHOTOGRAPHIC CAMERA (LENS CAMERA)



FUNCTIONS OF EACH PART

Glass lens (convex lens)

- It focuses light onto the film
- It refracts light and focuses a real image on the film

Film

- It is where the image is formed.

Why are images formed on the film?

✓ It has light sensitive silver halide crystals

Diaphragm

- It regulates (controls) the amount of light entering the aperture

How?

✓ By regulating the size of the aperture

Aperture

- It allows light into the camera

Shutter

- It exposes the film to light
- It keeps out light when it is not needed
- It opens or closes the aperture

Focusing ring (screw mounting)

- It adjusts the distance of the lens from the film to produce a sharp image

Why?

✓ To produce a sharp image (for accommodation)

How does a focusing ring adjust the distance of the lens from the film?

- By moving the lens forward and backward

How is focusing (accommodation) made in a lens camera?

- By adjusting the distance of the lens from the camera using a focusing ring

Which part of a photographic camera determines accommodation?

- Focusing ring

Why is the inside of a light proof box of a photographic camera painted black?

- To prevent internal reflection/to prevent unwanted reflections inside

Characteristics of images formed by a lens camera (photographic camera)

- They are real.
- They are inverted.
- They are diminished.

RID

How does a photographic camera work?

- The film is exposed to light
- It is removed from camera and treated with chemicals in a darkroom to produce a negative image. This is called **developing.**
- A negative image has the bright parts of the photographed object appear dark and the dark parts appear bright.
- The negative is printed to give a positive image which has the same colour as the object.

THE HUMAN EYE

- The eye is an organ of sight
- It is a receptor organ for light
- It is an optical organ
- It is spherical in shape and enclosed in **the orbit (eye socket)**

In which part of the skull are the eyes fixed?

- In the orbit (eye socket)

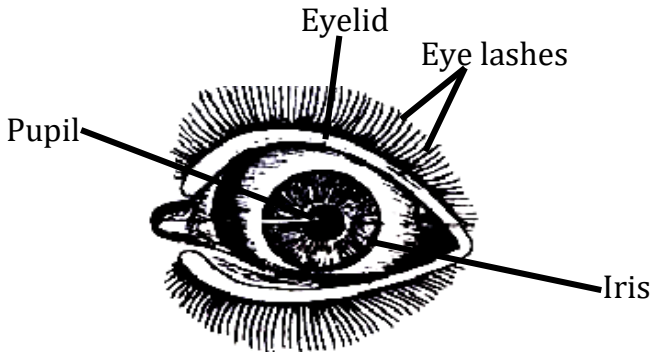
How are eyes protected from mechanical injury?

- They are enclosed in the orbits of the skull

Why is the human eye called an optical organ?

- ✓ It requires light to work

FRONT VIEW OF THE EYE



Eyelids

- They protect the eye from foreign bodies e.g. dust, small stones and small insects
- They close and keep out light when it is not needed

Blinking

- This is the closing and reopening of the eye quickly

It can be voluntary or involuntary (reflex) action.

Importance of regular blinking to the eye

- It provides the eye with protection from foreign bodies
- It spreads tears over the surface of the eye

Tear glands (lacrimal gland).

They are located on the outer corner of each eye

- They produce tears

USES OF TEARS

- They kill some germs (bacteria) on the eye
- They clean the eye (wash away dust from the eye)
- They keep the eye moist (prevent the eye from drying up)
- They lubricate the surface of the eye
- They heal damage on the surface of the eye

Sclera

It is the white part of the eye

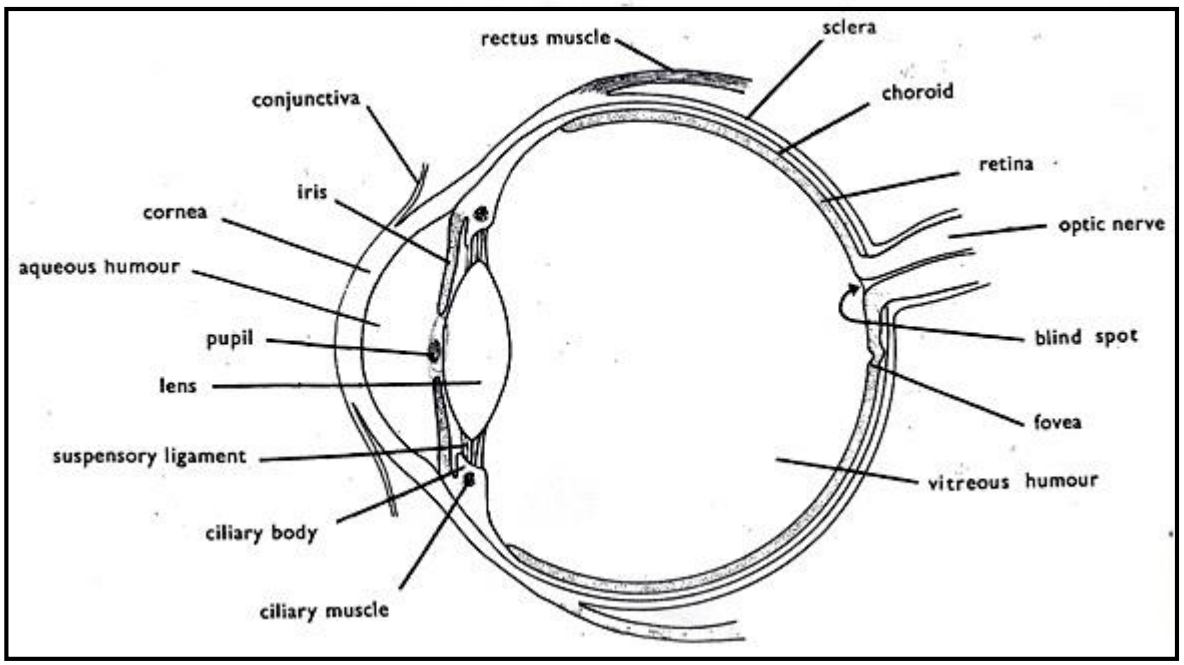
It acts as a protective outer coat for the eyeball.

- It protects the inner parts of the eye
- It maintains the shape of the eyeball

Name the diseases that can make the sclera turn;

i) **Yellow** --- yellow fever, liver cirrhosis, malaria, sickle cell anaemia, pancreatitis, hepatitis A, B and C
ii) **Pink** --- conjunctivitis
iii) **Red** --- trachoma

THE STRUCTURE OF THE HUMAN EYE



FUNCTIONS OF EACH PART OF THE EYE

Cornea

It is a transparent part of the eye

- It refracts light
- It protects the iris and pupil

Pupil

It is the small hole in the middle of the iris of the eye

It is the darkest part in the centre of the eye

- It allows light into the eye.

Iris

It is the coloured part of the eye

The iris has the pigment which determines the colour of the eyes

- It regulates the amount of light entering the eye

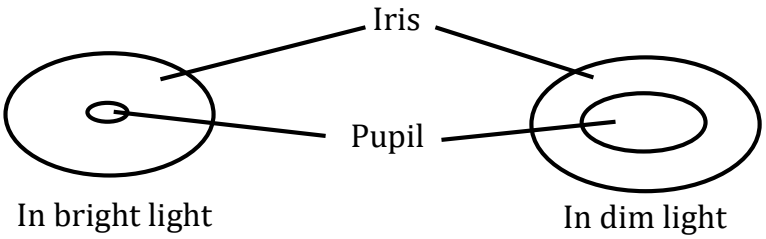
How does the iris regulate the amount of light entering the eye?

- By regulating the size of the pupil

How does the iris regulate the size of the pupil in different light intensities?

- It widens the pupil in dim light to allow more light enter the eye
- It constricts the pupil in bright light to allow little light enter the eye

DIAGRAMS SHOWING THE HUMAN EYE IN BRIGHT LIGHT AND DIM LIGHT



Eye lens (crystalline lens)

It is convex in nature

- It focuses light onto the retina.

Retina

- It is where the images are formed.

Why are images formed on the retina?

- It has light sensitive cells (**rod cells** and **cone cells**)

Cone cells and rod cells

- **Cone cells** are nerve cells in retina that are sensitive to bright light.

Cone cells help in day light and colour vision.

- **Rod cells** are nerve cells in retina that are more sensitive to dim light.

Rod cells help in dim light and night vision.

Why do human beings see more clearly during day than at night?

- They have more cone cells than rod cells

Why do cats see more clearly at night than during day time?

- They have more rod cells than cone cells

Fovea

This is a small depression on the retina

- It is where the sharpest image is formed.
- It helps to give a very clear vision.

Why is the fovea called the most sensitive part of the retina?

- It has the highest concentration of cone cells

Blind spot (optic disc)

- It is where the optic nerve connects to the retina
- It is the entry of blood vessels that supply the retina
- It is where the optic nerve leaves the eye.

Why is the optic disc also called the blind spot?

- It has no light sensitive cells

Optic nerve

- It transmits nerve signals from the eye to the brain for interpretation

Conjunctiva

This is a thin mucous membrane which lies inside the eyelid

- It has mucus which keeps the eye moist

Choroid

It is located between the retina and sclera

It is pigmented black and has a dense network of blood capillaries

- It supplies food and oxygen to the eye.
- It prevents internal reflection of light in the eye

Suspensory ligament

- It holds the lens in one position by connecting it with the ciliary muscle

Ciliary muscle

- It controls the shape of the eye lens
- It controls the accommodation of the eye

Explain the meaning of the term "Accommodation of the eye."

- This is the ability of the eye lens to focus near and distant objects

How do ciliary muscles control accommodation of the eye?

- By contracting and relaxing to change the shape of the lens

Aqueous humour and vitreous humour

Aqueous humour is a watery liquid between the eye lens and the cornea

Vitreous humour is a clear gel (jelly-like liquid) between the eye lens and the retina

- They maintain the shape of the eye
- They refract light

Besides refracting light and giving the eye its shape, give other two functions of aqueous humour.

- It maintains eye pressure
- It provides nutrients to the cornea and eye lens

Eyelashes

- They prevent foreign bodies from entering the eye

Eyebrows

- They prevent sweat from falling down into the eye socket

Rectus muscle

- It holds the eyeball in the orbit

Characteristics of images formed by the eye

- The images are real
- The images are inverted
- The images are diminished

RID

PARTS OF THE HUMAN EYE AND LENS CAMERA WITH SIMILAR FUNCTIONS

HUMAN EYE	LENS CAMERA	FUNCTION
Convex lens	Convex lens	Focus light
Iris	Diaphragm	Regulate the amount of light that enters
Pupil	Aperture	Allow in light
Eyelids	Shutter	Keep out light (prevent light from entering)
Ciliary muscle	Focusing ring	Determine accommodation
Retina	Film	They are where images are formed

SIMILARITIES BETWEEN THE EYE AND LENS CAMERA

- Both have light sensitive parts where images are formed
- Both have convex lenses
- Both form real, inverted and diminished images
- Both are black inside to prevent internal reflection of light

DIFFERENCES BETWEEN A HUMAN EYE AND LENS CAMERA

The human eye	The photographic camera
▪ The distance between the lens and retina is fixed.	▪ The distance between the lens and film changes.
▪ The iris adjusts itself.	▪ The diaphragm is adjusted physically.
▪ The eye lens is soft and elastic.	▪ The lens is a hard glass.
▪ Image is focused by making lens thicker.	▪ The image is focused by moving lens.
▪ The lens, aqueous and vitreous humour refracts light.	▪ Only the lens refracts light
▪ The thickness of the lens changes.	▪ Thickness of the lens is constant
▪ The eye has a wider view	▪ The camera has a narrow view

DIFFERENCES BETWEEN THE HUMAN EYE AND A PINHOLE CAMERA.

Eye	Pin hole camera
Focusing is done by changing the shape of the lens.	Focusing is done by moving the camera forward or backward
Image is formed on the retina.	Image is formed on the screen
Iris controls light entering the eye	No control of light.
The eye can be covered by eyelids.	The pinhole is always exposed to light

SIMILARITIES BETWEEN THE EYE AND PINHOLE CAMERA

- Both have light sensitive parts where images are formed
- Both form real, inverted and diminished images
- Both are black inside to prevent internal reflection of light

NORMAL EYESIGHT

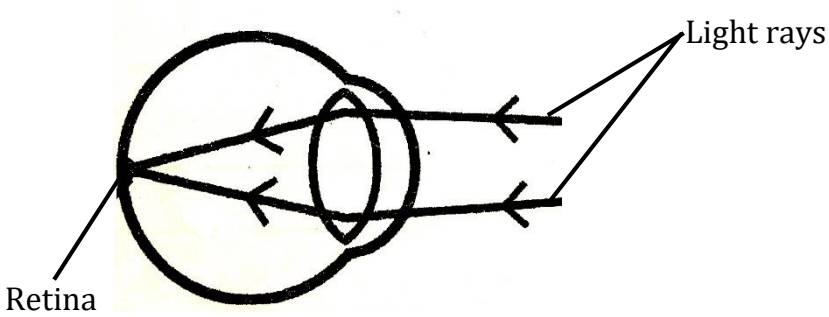
- During normal vision, both near and distant objects can be focused on the retina.

The normal eyesight acuity is 20/20 vision or 6/6 vision mean?

What does 20/20 vision or 6/6 vision mean?

- A person is able to see clearly at 20 feet or 6 metres what should normally be seen at that distance

An illustration showing normal vision (normal eyesight)



EYE DEFECTS (REFRACTIVE ERRORS/EYE DISORDERS)

- An eye defect is the inability of an eye to focus certain distances normally.

Causes of eye defects (refractive errors)

- Eye strain
- Abnormal shape of the eyeball
- Abnormal shape of the eye lens
- Aging (old age)

EXAMPLES/TYPES OF EYE DEFECTS (REFRACTIVE ERRORS/EYE DISORDERS)

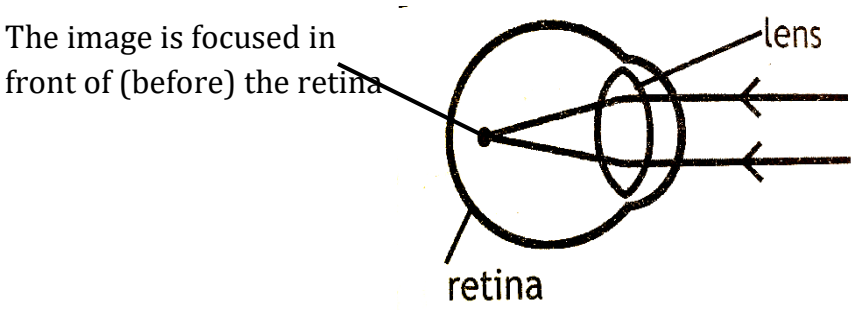
- Short sightedness (myopia)
- Long sightedness (hyperopia)
- Old age sight (presbyopia)
- Astigmatism

1. **Short sightedness (myopia)**
   - This is the condition when a person can only see near objects clearly but cannot see distant objects
   - ✓ Images from distant objects are focused in front of the retina.

Causes of short sightedness

- Very thick eye lens
- Very long eyeball (elongated eyeball)

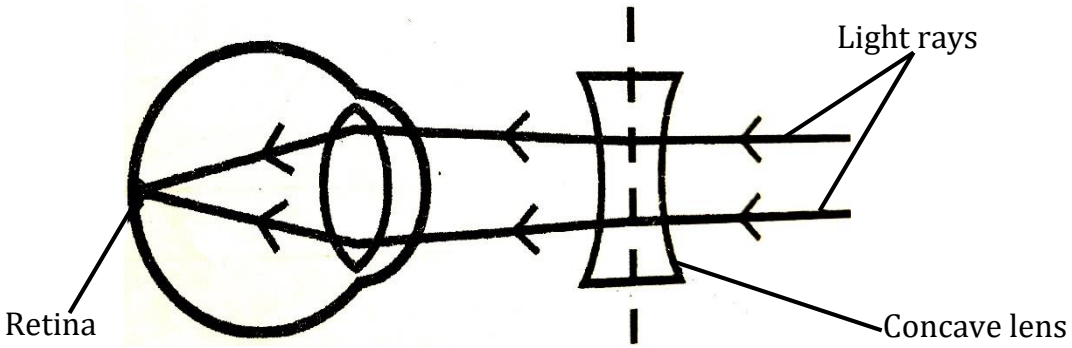
AN ILLUSTRATION SHOWING MYOPIA



How is short sightedness corrected?

- By wearing spectacles with concave lenses (diverging lenses)

A diagram showing correction of short sightedness



How does a concave lens help to correct short sightedness?

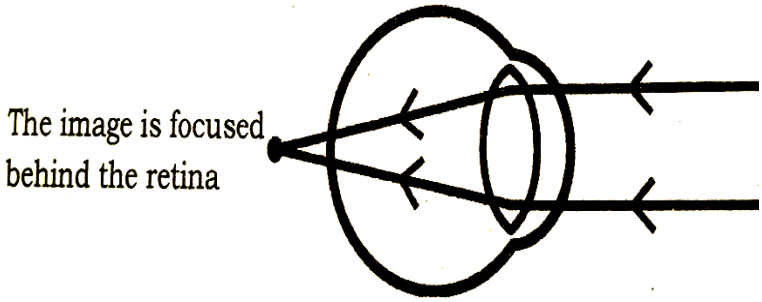
- It slightly diverges light rays

2. **Long sightedness (hyperopia)**:
   - This is a condition when a person can see distant objects clearly but cannot see nearby objects.
   - ✓ Images from nearby objects are focused behind the retina.

Causes of long sightedness

- Very thin eye lens
- Very short eyeball

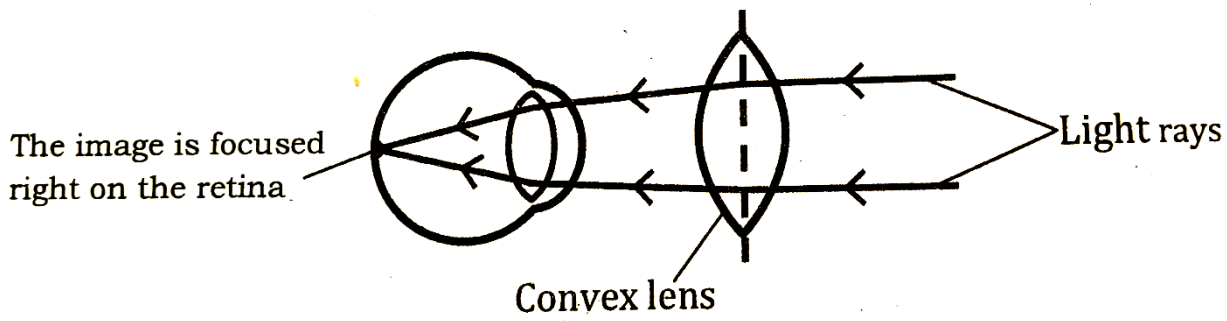
AN ILLUSTRATION SHOWING HYPEROPIA



How is long sightedness corrected?

- By wearing spectacles with convex lenses (converging lens)

A diagram showing correction of long sightedness



How does a convex lens help to correct long sightedness?

- It slightly converges light rays

3. **Old age sight (presbyopia)**
   - This is the loss of focusing power for near objects that occurs naturally with age as eye lens loses its elasticity
   - ✓ It occurs in old age above 60 years
   - ✓ A person with presbyopia can clearly see only distant objects and has poor vision for objects that are up close, such as; reading from books and computers

How is presbyopia corrected?

- By wearing reading eyeglasses with convex lenses

4. Astigmatism

- This is the condition in which light fails to come to a single focus on the retina hence blurred vision (distorted vision)
- ✓ Here light rays are not focused on the fovea resulting into blurred vision
- ✓ Astigmatism is the most common of all eye defects

Causes of astigmatism

- Unevenly curved cornea
- Rough cornea

How is astigmatism corrected?

- By wearing spectacles with cylindrical lenses
- By refractive surgery

DISEASES OF THE HUMAN EYE

Major eye diseases

- Trachoma
- River blindness (onchocerciasis)
- Night blindness (xerophthalmia)
- Conjunctivitis

Other eye diseases

- Blepharitis
- Cataracts
- Glaucoma
- Keratitis
- Stye (sty)
- Leucoma

TRACHOMA

- It is a bacterial eye disease
- It is caused by a bacterium (germ) called **chlamydia trachomatis**
- It is spread by **houseflies**
- It is common in places with poor sanitation
- It is a water cleaned disease which affects the eyes

How does trachoma spread?

- When infected houseflies land on our eyes
- Through sharing face towels with an infected person.
- Through sharing the same basin with an infected person.
- Through shaking hands with an infected person and then touch your eyes
- Through sharing handkerchiefs with an infected person

Signs of trachoma

- Eyes turn red
- Watery discharge from the eyelids
- Swollen eyelids

Symptoms of trachoma

- Pain while looking at light
- Itching of the eyes

Control of trachoma

- Always wash eyes with enough clean water
- Avoid sharing face towels with an infected person
- Always wash and iron handkerchiefs
- Avoid touching your eyes with dirty hands
- Avoid places with a lot of houseflies

NIGHT BLINDNESS

- It is a **deficiency eye disease** common in children between 2 – 5 years
- It is caused by **lack of vitamin A** in the diet

Signs of night blindness

- Poor sight at night (poor night vision)
- Dry eyes

Prevention of night blindness

- Feeding children on food rich in vitamin A

RIVER BLINDNESS

- It is caused by a filarial worm (nematode) called **onchocerca volvulus**
- It is spread by a small humped fly called **blackfly** (**Simulium fly/Jinja fly)**
- A black fly breeds in rapidly flowing rivers
- Female blackflies usually bite during **day time** as they suck blood to develop their eggs

Why a blackfly lays its eggs in fast flowing rivers?

- Water in fast flowing rivers has a lot of oxygen

Signs of river blindness

- Bumps under the skin (nodules in the skin)
- Swelling of the lymph nodes
- Tough rough skin
- Red watery eyes

Symptoms of river blindness

- Itching skin rashes
- Itching of the eyes
- Severe skin itching

Prevention and control of river blindness

- Spraying adult blackflies with insecticides
- Avoid sleeping near rivers or streams during day time
- Early treatment of an infected person

CONJUNCTIVITIS

- This is the swelling (inflammation) of conjunctiva
- It is caused by **virus, bacteria** or **chemicals**
- It is also known as **pink eyes**

Mention three types of conjunctivitis

- **Bacterial conjunctivitis**

It is caused by eye contact with bacteria for gonorrhoea or chlamydia

- **Viral conjunctivitis**

It is caused by eye contact with viruses for common colds

- **Allergic conjunctivitis**

It is caused by eye contact with chemicals (e.g. air irritants **or** Chlorine in swimming pools)

How do newly born babies get infected with bacterial conjunctivitis?

- When gonorrhoea or chlamydia germs come into contact with the baby's eyes at birth

Signs of conjunctivitis

- The white of the eye (sclera) becomes pink
- Watery discharge from the eyes with pus
- Swollen eyelids

Symptoms of conjunctivitis

- Itchy eyes
- Pain when looking at light

BLEPHARITIS

- It is an inflammation of the eyelids
- The eyes itch, burn and swell

CATARACT

- This is when the eye lens becomes grey and opaque.
- It is caused by diabetes or continued exposure of the eyes to high temperature.

GLAUCOMA

- It is caused by increased internal pressure of fluids.
- It damages the optic nerve

KERATITIS

- This is the inflammation of the cornea
- It is caused by virus or bacteria or fungus

STYE

- This is a small inflammation of the eyelid
- It is caused by bacteria
- It is usually a sign of poor health, anaemia or diabetes.

LEUCOMA

- This is where an opaque white spot on the cornea.

CARE FOR OUR EYES

- Always wash your eyes with clean water and soap
- Never look directly at the sun
- Do not touch your eyes with dirty fingers
- Do not share face towels with a person who has sick eyes
- Feed on rood rich in vitamin A
- Avoid staying in smoky and dusty places
- Read books in enough light
- Never use eyeglasses without health worker's advice

CAUSES OF BLINDNESS

- Uncorrected eye defects (uncorrected refractive errors)
- Eye diseases
- Vitamin A deficiency
- Injuries to the eye
- Birth defects
- Premature birth
- Measles during childhood
- Use of traditional eye medicines
- Looking directly at an eclipse
- Conjunctivitis in new born babies