Waves

Waves are classified as either progressive or stationary(not studying stationary).

In a progressive wave, as it moves it transfers energy from one point to another

Progressive waves are further classified into transverse and longitudinal waves

In a **transverse** wave, the direction of vibration is perpendicular to the direction in which the wave travels. Examples include ropes, water waves, electromagnetic.

In a **longitudinal** wave the direction of vibration is parallel to the direction in which the wave travels examples include springs or sound waves.
Transverse waves in a graph:

Amplitude is the maximum displacement from the mean position

Crest crests are points which exhibit maximum positive displacement

Trough are points which exhibit the maximum negative displacement

In phase points are those whose behaviour is exactly identical to each other, for example a crest when compared with crest

Out of phase points are those whose behaviour is exactly opposite to each other for example a crest when compared with a trough

Formulas of speed, wavelength, time and frequency

$$v = \frac{\lambda}{T} \qquad \text{speed} = \frac{\text{wavelength}}{\text{time}}$$

OR

$$v = f\lambda \qquad \text{speed} = \text{Frequency} \times \text{wavelength}.$$

$$\text{Frequency} = \frac{1}{\text{time}}$$

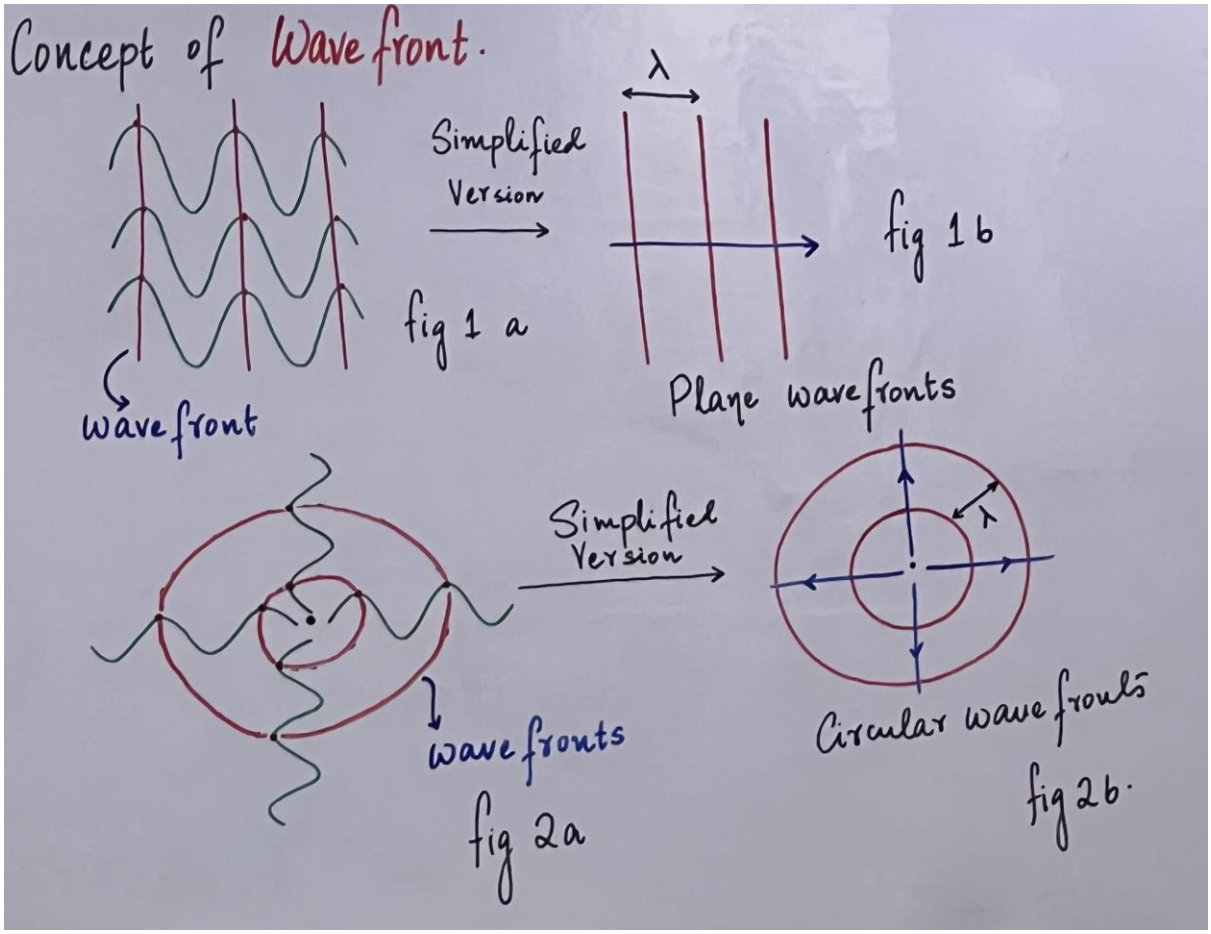
Wavefront

Wavefronts are lines which are made by joining all the crests belonging to different waves

Water waves can be classified into two types plane waves and circular waves

If waves are travelling in one direction then the wave fronts will appear to be straight lines, these are known as plane wavefronts. This is shown in figure 1A and he simplified version is fig 1B(only learn 1B for exams)

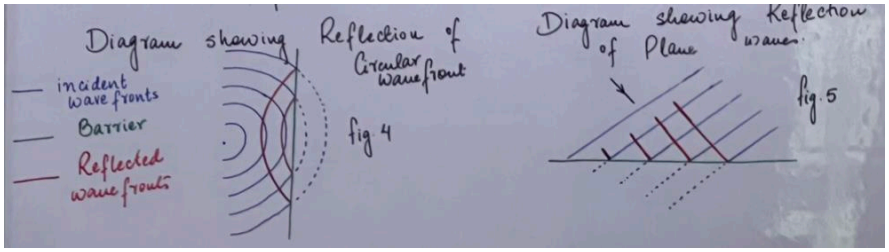
If the waves are travelling in all directions then the wavefronts will appear to be round in shape these are known as circular wavefront. This is shown in figure 2A and the simplified version is 2B(only learn 2B for exams)



Properties of waves

Water waves can undergo the phenomena of reflection refraction and diffraction

Reflection of circular wavefronts is shown in figure 4 and reflection of plane wavefronts is shown on figure 5



During reflection the speed frequency and lambda all remains unchanged, However the direction of the wave changes and some energy is lost due to impact with the barrier hence the intensity of the wave, the strength of the wave or the amplitude of the wave decreases

Refraction of water waves occcurs when waves are made to travel either from a deep medium into a shallow medium or vice versa. This change in depth can be seen in figure 6.

When water waves travel from a deep medium to a shallow one, they exhibit the following properties:

- The wavefronts bend away from the normal
- The wavelength decreases
- The speed of the wave is decreased
- Since frequency is dependent on the source therefore the frequency remains unchanged.

Similarly when waters waves travel from a shallow medium to a deep medium the properties are reversed:

- wavefronts bend towards the normals
- Wavelength increases
- Speed of the wave increases

Sound waves

Sound waves are examples of longitudinal waves

In a longitudinal wave the direction of vibration is parallel to the direction in which the wave travels

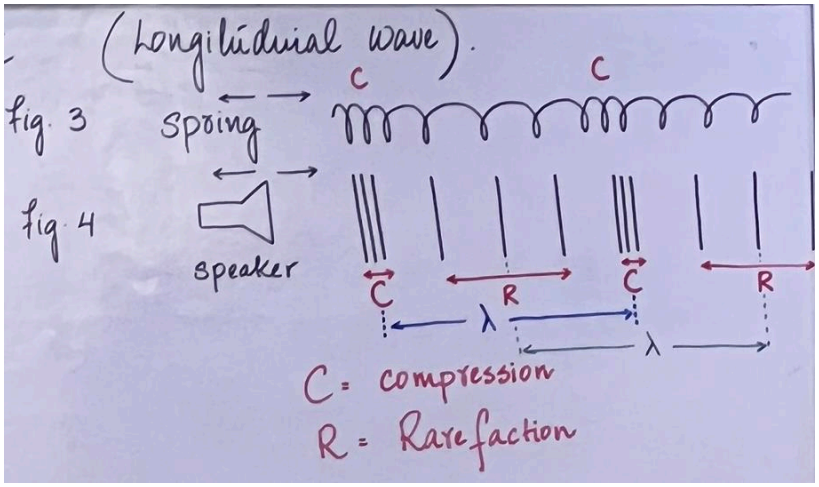
Longitudinal waves can be provided using a spring as shown in fig 3 or using a loudspeaker as shown in fig.4

A longitudinal wave is produced by creating alternate regions of compression and rarefaction

Compression is a region of maximum pressure where the molecules are the closest

Rare faction is the region of minimum pressure where the molecules are far apart

The wavelength lamba shown on the diagram can either be defined as distance between two successive compressions or two successive rare faction

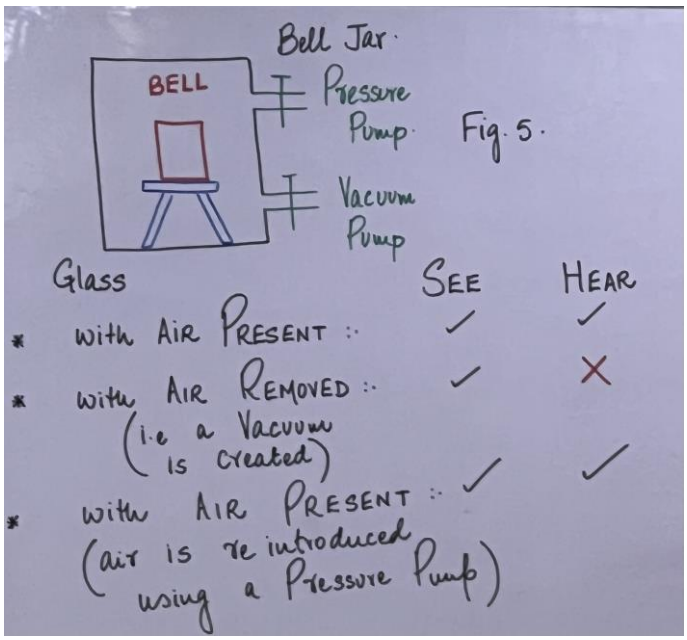


Speed of sound in different mediums:
Solids 5000-6000m/s
Liquids 1500-1600m/s
Gas 330-350m/s
Vacuum 0m/s

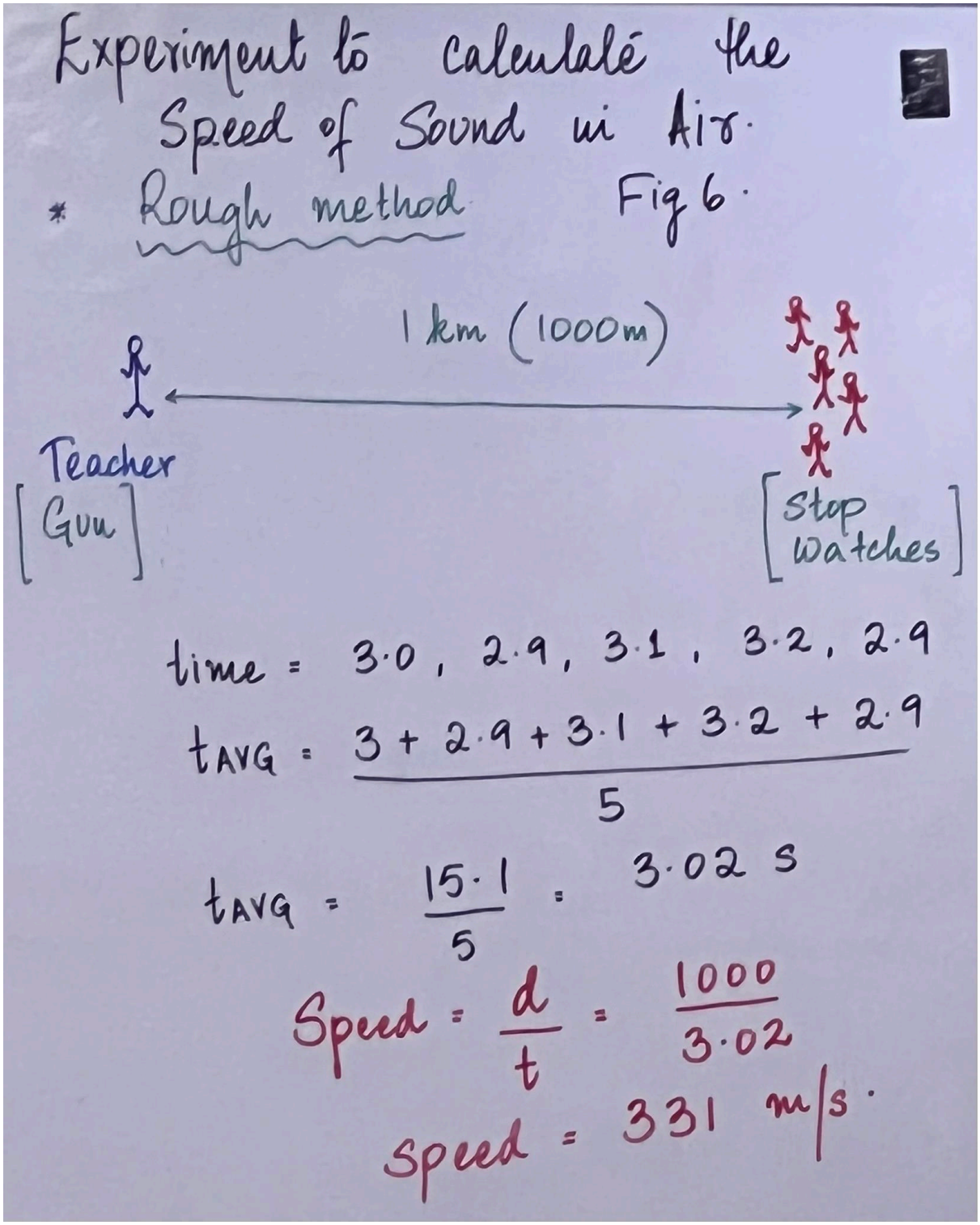
Sound travels the fastest in solids and the slowest in gases.

sound requires a medium to travel therefore it does not travel through a vacuum

Experiment to show that sound requires a medium to travel whereas light can travel in vacuum. This is shown in fig5

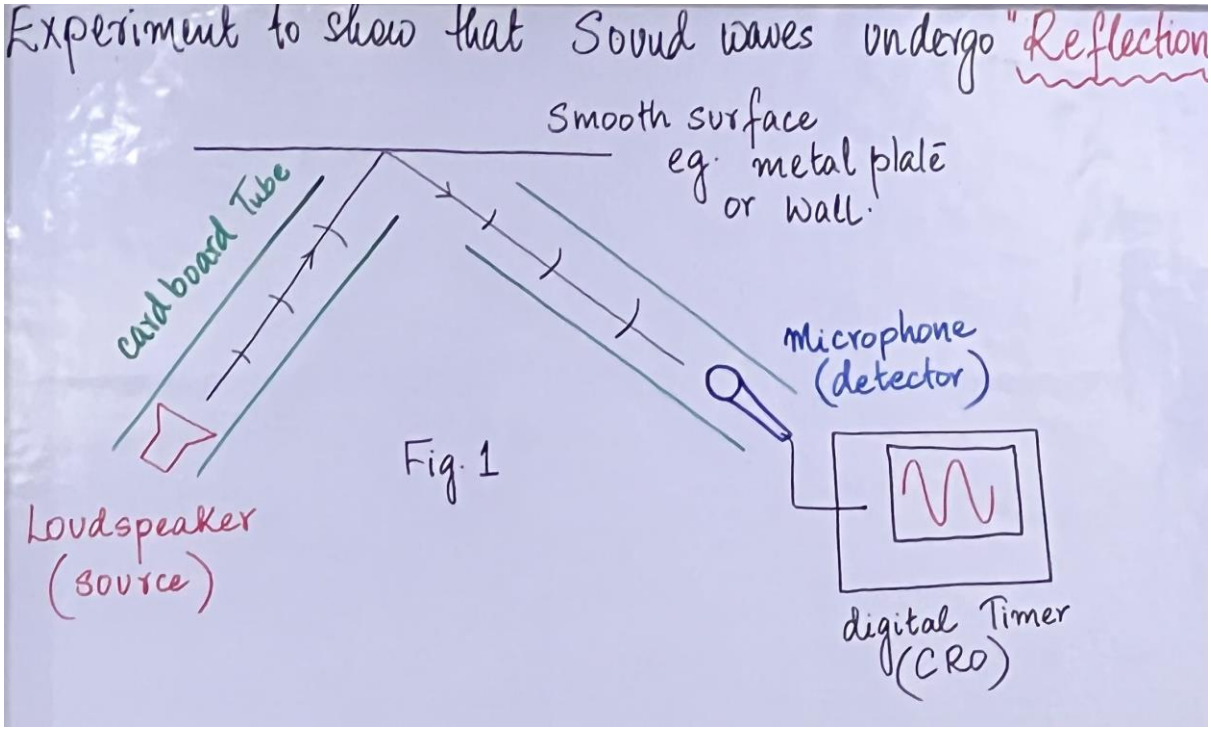


Experiment to calculate the speed of sound in air



Experiment that sound waves undergo reflection

- Setup the arrangement
- Switch on the microphone and the loudspeaker
- As microphone receives sound waves a wave pattern is displayed on the CRO screen which confirms that sound waves have undergoes reflection



Note:

- The cardboard tubes are placed to prevent sound from travelling directly to the microphone
- During reflection of sound the speed, wavelength and frequency all remain unchanged however the direction of sound changes and the intensity of sound reduces because some sound energy is absorbed by the reflective surface

Properties of sound waves:

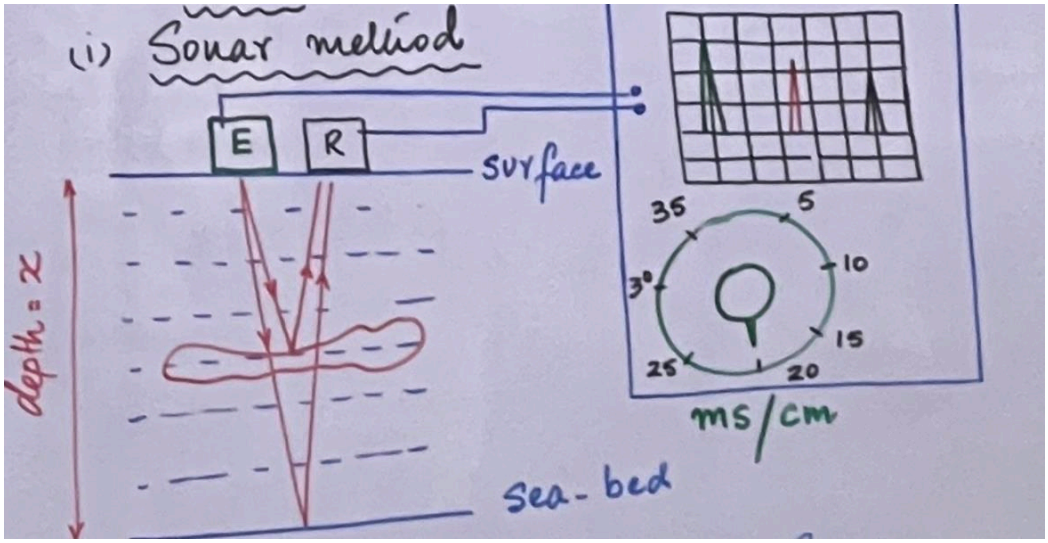
The term loudness in sound refers to its **amplitude**. The larger the amplitude the louder the sound and vice versa.

The term pitch refers to the **frequency** of sound, the higher the frequency the higher the pitch and the lower the frequency the lower the pitch

The **quality of sound** in music industry is also called timbre of sound. Quality of sound can be classified into two types, pure and impure sound. A pure sound is one which appears to consist of a single wave. An impure sound consists of many waves within a single wave.

Sonar method

The term sonar method refers to a technique which makes use of ultrasounds to measure the depth of the sea bed. The application is shown in figure 5, an ultrasound emitter and receiver are positioned on the surface, they are connected to a CRO as the emitter generated a pulse a wave Pattern appears on the CRO screen and sometime later when the receiver receives a reflected pulse, a similar wave pattern appears on the CRO screen.



Note: if the ultrasound pulses are interrupted by any marine life the following changes would appear in the CRO screen

- The new pulse will now be received earlier than before
- The amplitude of the new pulse will be greater than before

Uses:

ultrasound is used for cleaning purposes.

Since ultrasounds are sound waves therefore they can cause vibrations hence if some jewellery dipped in a solvent is exposed to ultrasonic waste the vibrations will cause the loosening of the dust particles, they will get get dissolved in the solvent and can finally be removed.

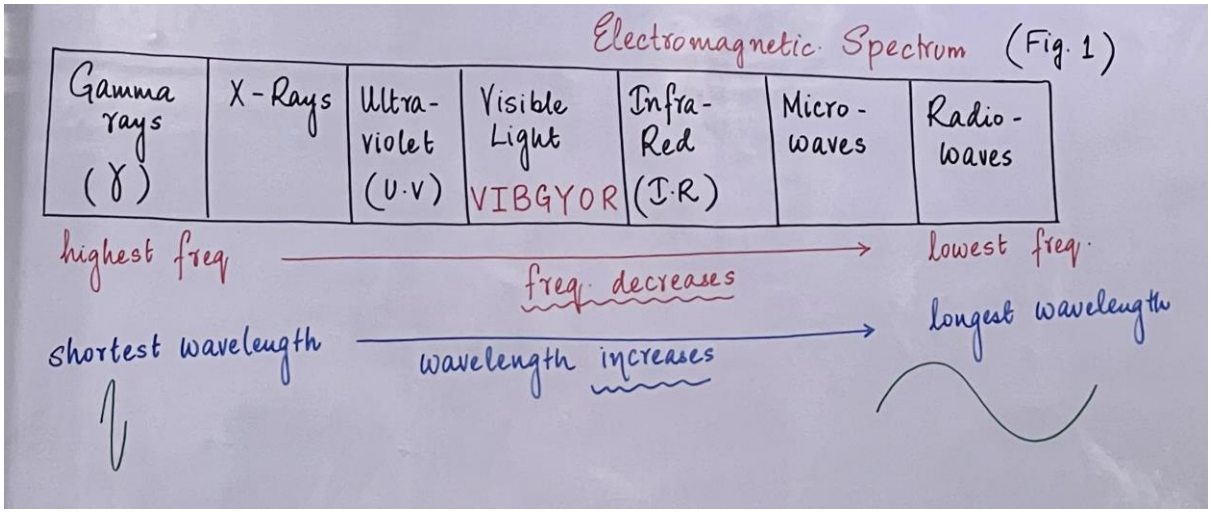
Ultra sounds are used in medical diagnosis to obtain internal body images, an ultrasonic device is positioned on the body and is made to emit Pulses of ultra sound. These pulses will enter the body and will get reflected from the tissues or the organs within the body. These reflected pulses are sent to a processing unit which converts these pulses into images that can be displayed on a monitor screen. Ultrasounds do not involve ionising radiations unlike X-rays therefore they do not pose any side effect.

Properties of electromagnetic waves(EMW)

- All electromagentic waves are transverse
- They can all travel through vacuum
- Speed of electromagnetic waves in air or vacuum is the same as the speed of light (3x10^8)
- When electromagnetic waves travel, they transfer energy
- Electromagnetic waves can undergo reflection, refraction and diffraction

Note: based on their wavelengths and frequencies electromagnetic waves are arranged in a particular order. This is displayed in a chart which is known as thr electromagnetic spectrum. This diagram is shown down below

Read **M**y **I**nstructions **V**isible **U**nder **X**ray **G**lasses



Uses of electromagnetic waves

Radio waves: radio communication, television communication, astronomy

Microwaves: microwave oven, cell phone communication, Bluetooth, satellite communication

Satellite communication:

The transmitter T sends microwave signals towards the satellite. The satellite receives the signals and amplified them. The satellite then sends the signal towards the receiver and this is how signals can be transferred from one point to another on the earths surface.

Infrared: house hold electrical appliances, used in intruder alarms, used in remote controls, used in night vision goggles, used in optical fibres for internet communication

Side effects of infrared: if the intensity of infra red is too high it can cause burning of soft tissues and muscles

How a security alarm works: the infra red sensor detects heat signature from the human body during night time and sends this information to the alarm which gets triggered and produces a warning sound

How a remote control works: the infra red emitter inside the remote control sends out signals to the television sensor. The sensor receives these signals and carries out the desired function

Visible light: used in cameras for photography,

Ultraviolet: skin tan, water sterilisation, fake currency notes and finger print scanners
Side effects: excessive exposure leads to skin cancer

Xrays: used to locate fractures in bones, used to kill cancerous cells, used to locate cracks in metals
Side effects: high exposure can cause genetic mutation and cancer

How are X-rays used to locate fractures in bones: the X-ray machine is positioned on one side and the photographic film which works as a detector is positioned on the other side. When X-rays pass through soft tissues they will cause the film to turn black. When X-rays strike bones they get absorbed by the bones and so the film stays white. X-rays will pass through the fractured bone and the radiologist can locate the position of the fracture. This technique can also be used to locate cracks in metals

Gamma rays: used to kill cancer cells, used to locate cracks in metals
Side effects: same side effects as xrays

Diffraction

- The term diffraction refers to spreading of waves when they pass through a narrow gap or a narrow opening as shown in fig.1
- During diffraction the speed the wavelength the wavelength and the frequency all remains unchanged
- As the size of the gap increases the amount of spreading or the amount of diffraction decreases as shown in fig.2

Light

A ray of light is the path taken by a light wave

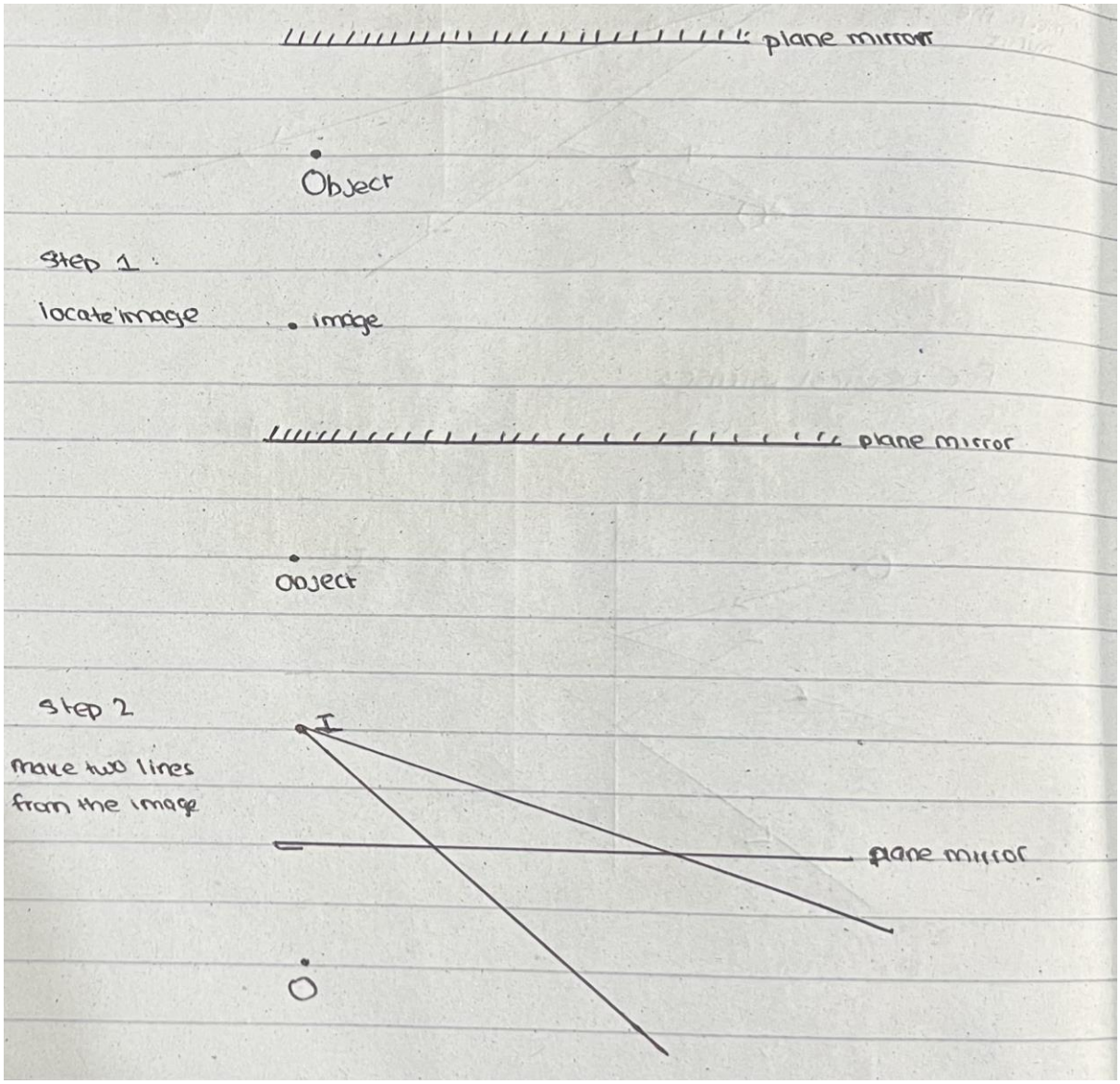
Beam is a collection of rays

Reflection

Laws of reflection

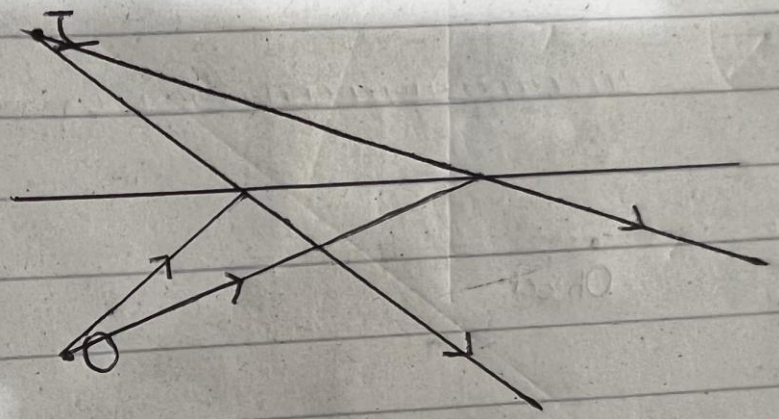
- Angle of incidence is equal to angle of reflection
- The incident ray, normal, and reflected ray are all located in the same plane, thus can be constructed on a piece of paper

How to construct a ray diagram to show reflection of light using a plane mirror

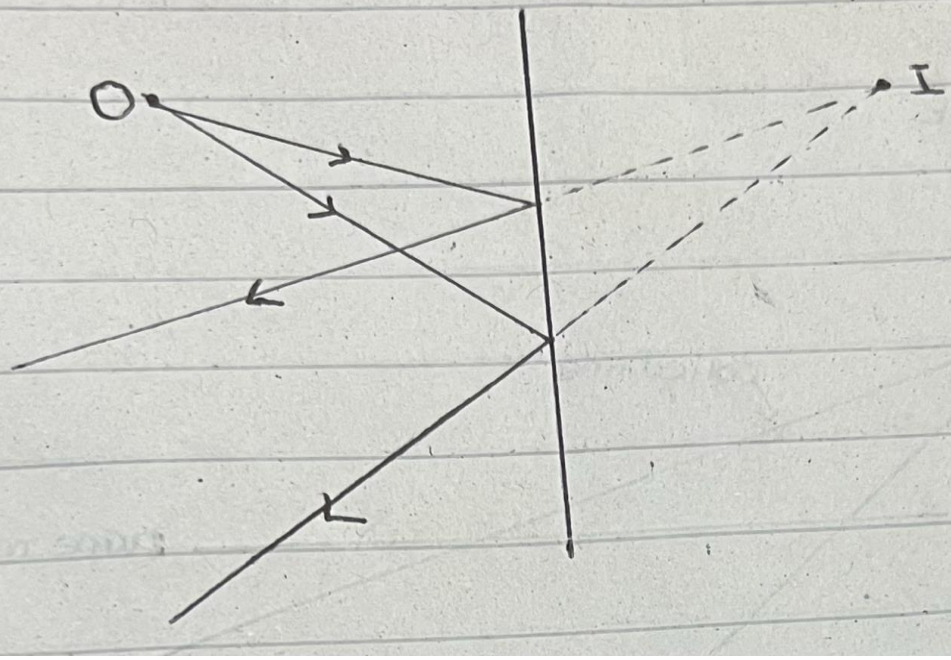


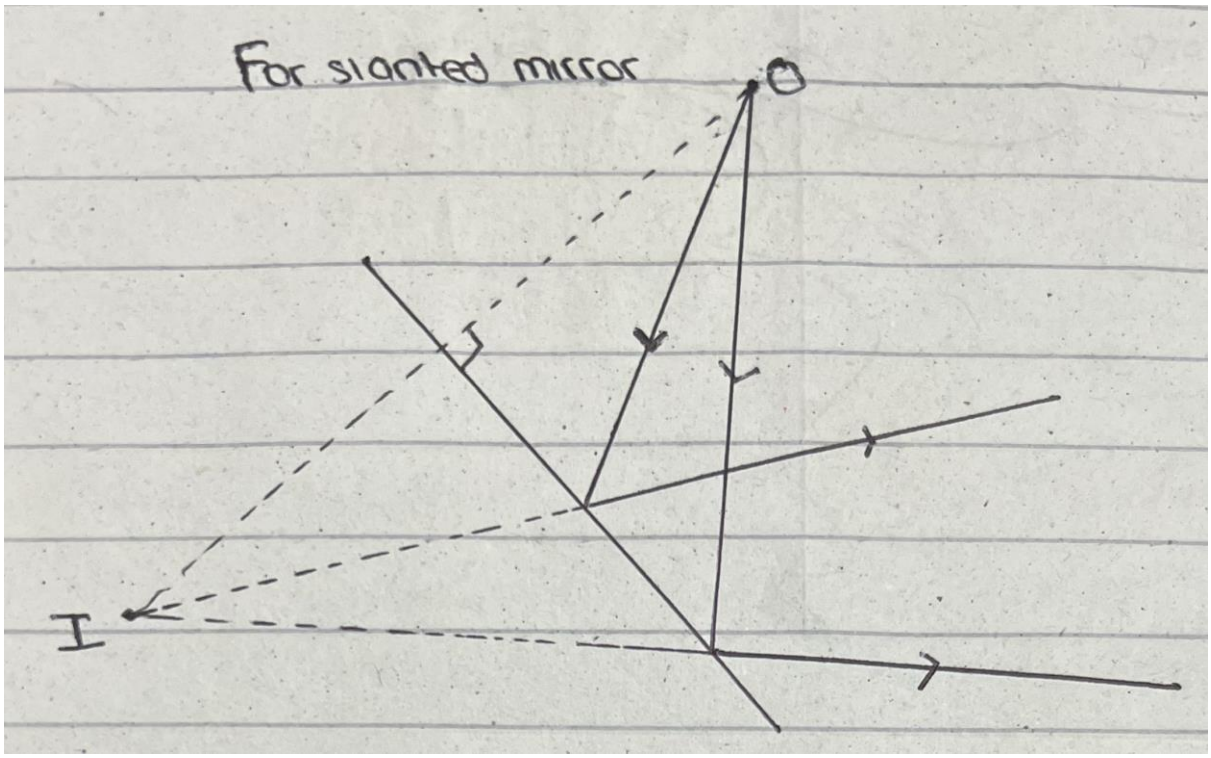
Step 3

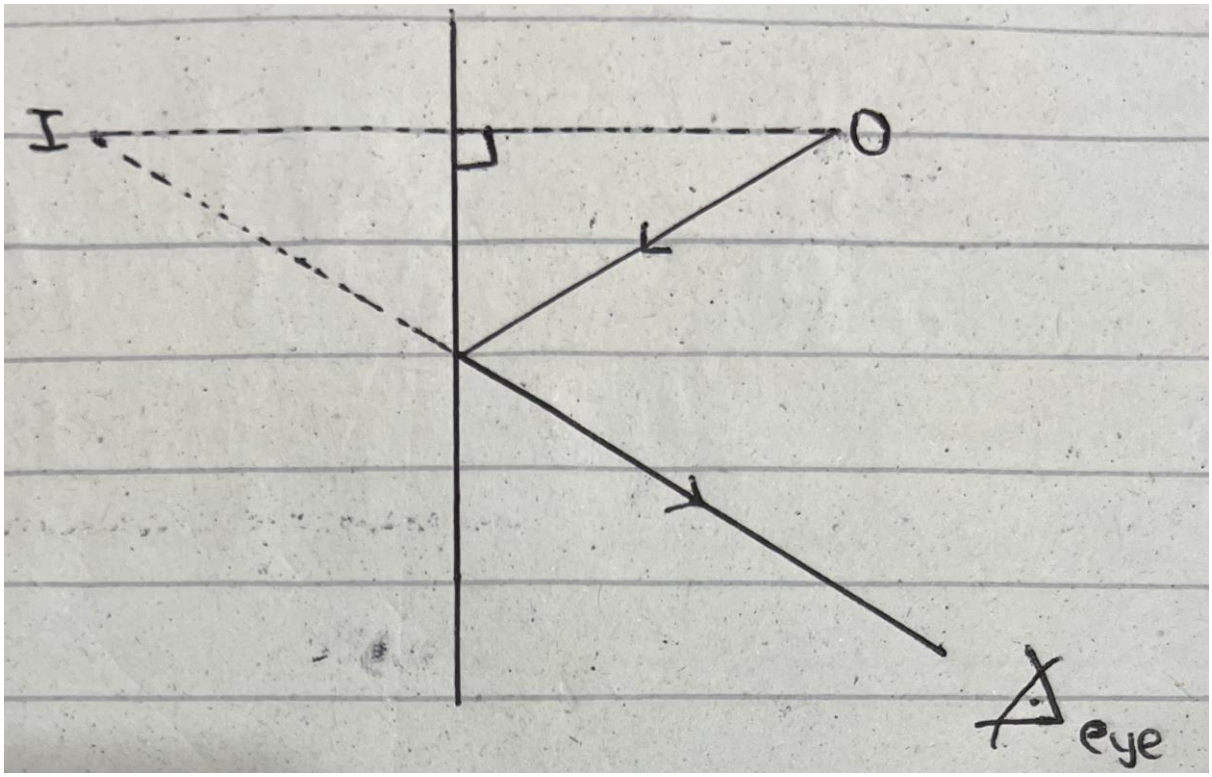
Connect two line from the object, joining the point where the image ray meets the mirror

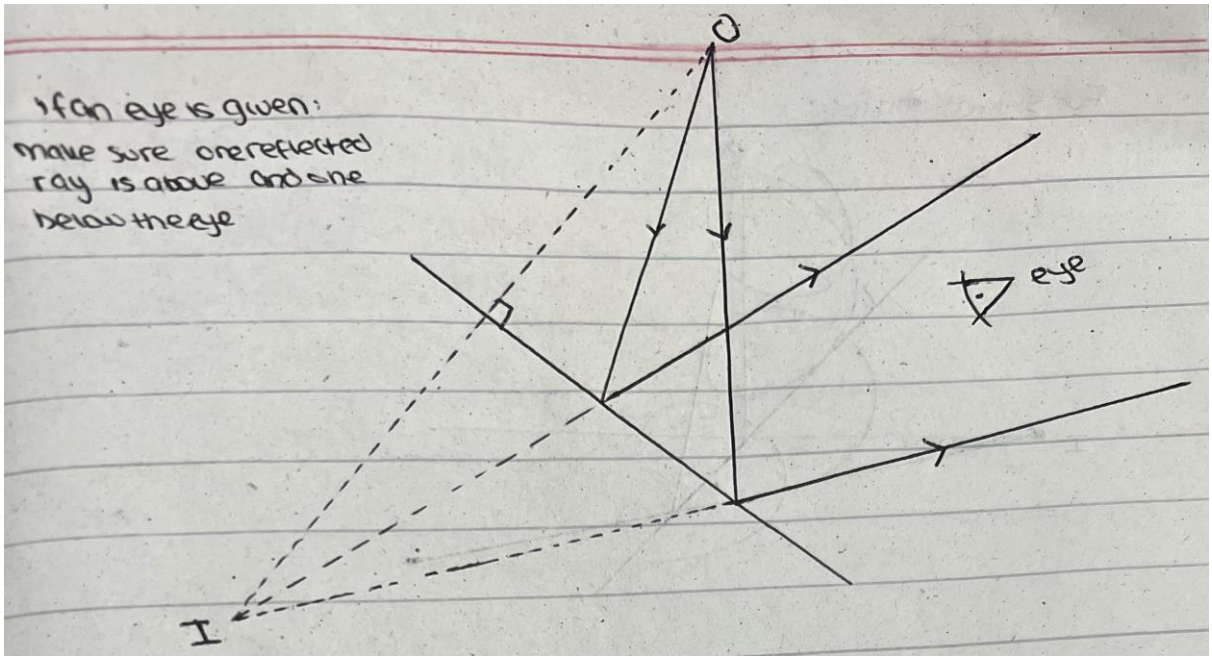


For vertical mirror:




For slanted mirror
O
I

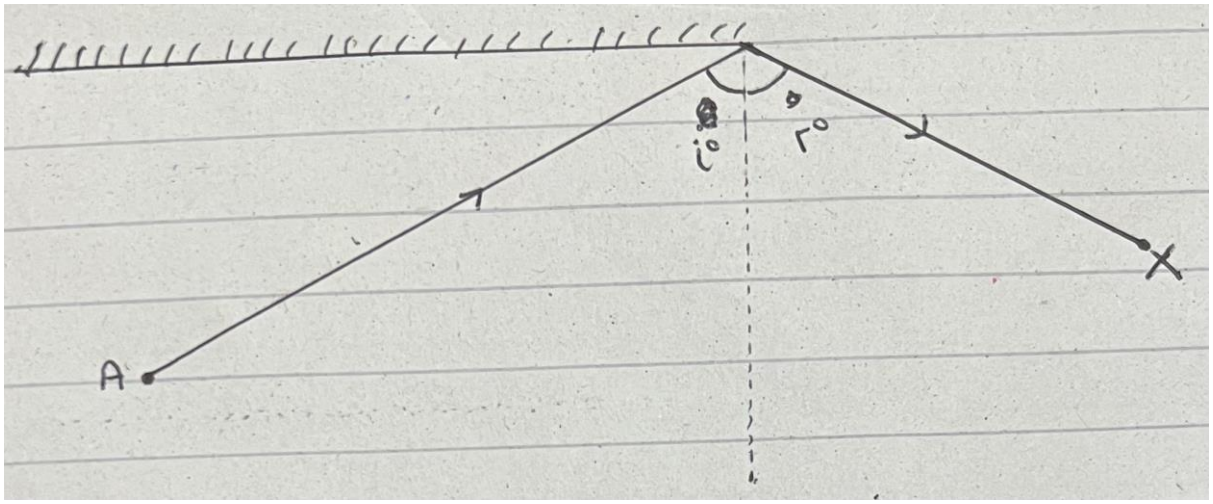

I
O
eye



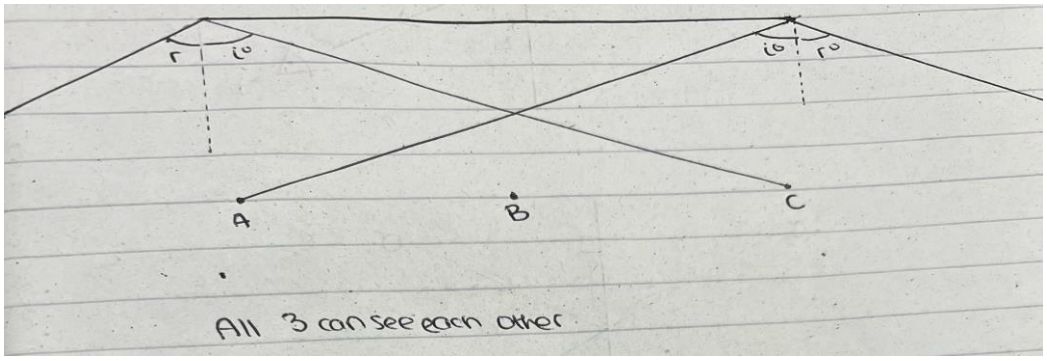
Properties of the image formed during reflection on a plane mirror

- Same distance
- Same size
- Laterally inverted
- Upright
- Image is virtual
- Imaginary image
- Does not exist in reality
- Non real image
- It cannot be located behind a mirror
- It cannot be projected on a screen
- Virtual images are represented by constructing dotted lines

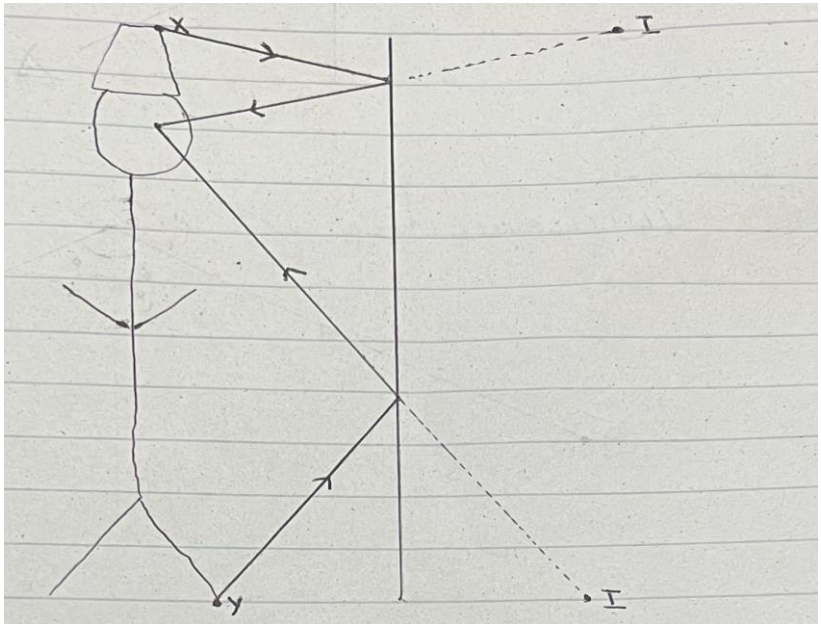
two individuals A and B standing next to each other infront of a plane mirror. B starts to move away from A, locate the point on the diagram beyond which A is not able to see the image of B, mark this position as X



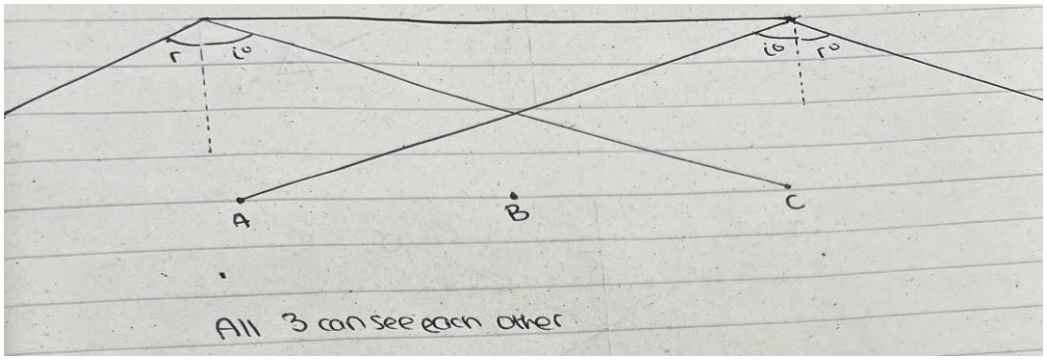
In the given diagram, three students labelled as A, B and C are standing together infront of a mirror, how many of these students can see the image of the other two students



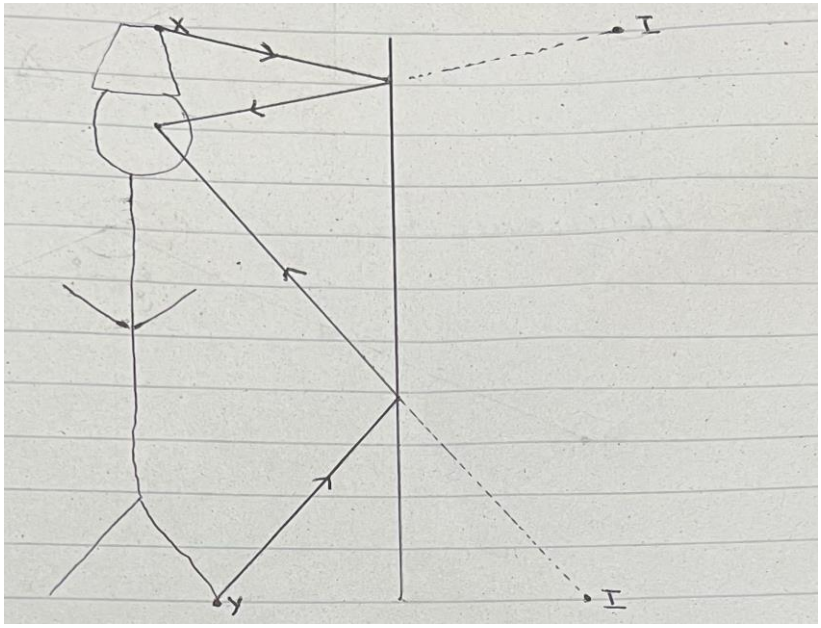
The diagram below shows a man standing infront a plane mirror, construct a single ray diagram to show how the image of the point x can be located in the plane mirror, construct a single ray diagram to show how the image of the point y, can be located in the plane mirror



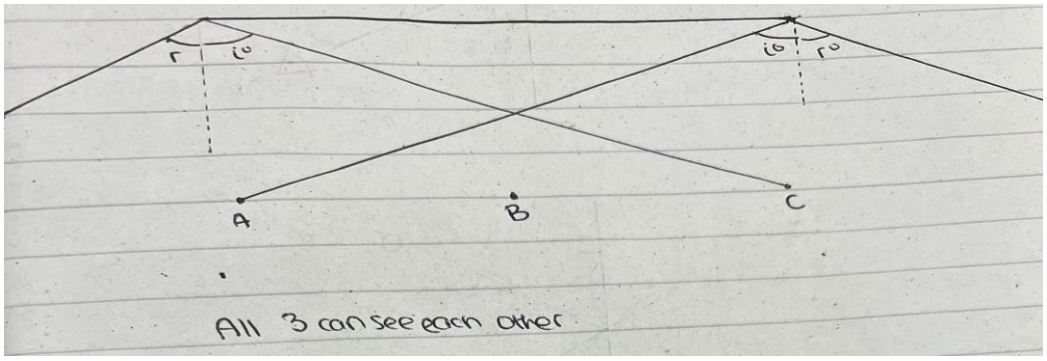
In the given diagram, three students labelled as A, B and C are standing together infront of a mirror, how many of these students can see the image of the other two students



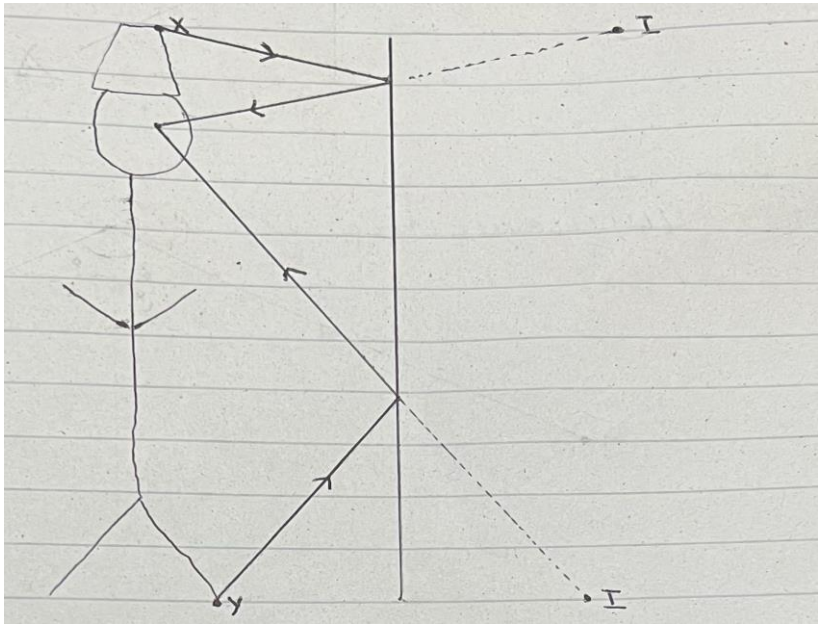
The diagram below shows a man standing infront a plane mirror, construct a single ray diagram to show how the image of the point x can be located in the plane mirror, construct a single ray diagram to show how the image of the point y, can be located in the plane mirror



In the given diagram, three students labelled as A, B and C are standing together infront of a mirror, how many of these students can see the image of the other two students



The diagram below shows a man standing infront a plane mirror, construct a single ray diagram to show how the image of the point x can be located in the plane mirror, construct a single ray diagram to show how the image of the point y, can be located in the plane mirror



$$R = \frac{V}{I}$$

$$120 = \frac{240}{I}$$

$$120I = 240$$

$$I = 2A$$

$\div 5$ $\div 2^2$

$600 : 240$

$5 : 2$

$5 : 2$

5Amps

$P = I^2R$

$P = 4 \times 120$

$P = 480$

$K.E = \frac{1}{2}mv^2$

$K.E = \frac{1}{2} \times 1000 \times 10$ (500)

$= 5000$

5000 J

2 seconds $\times$ 10

= 20 seconds