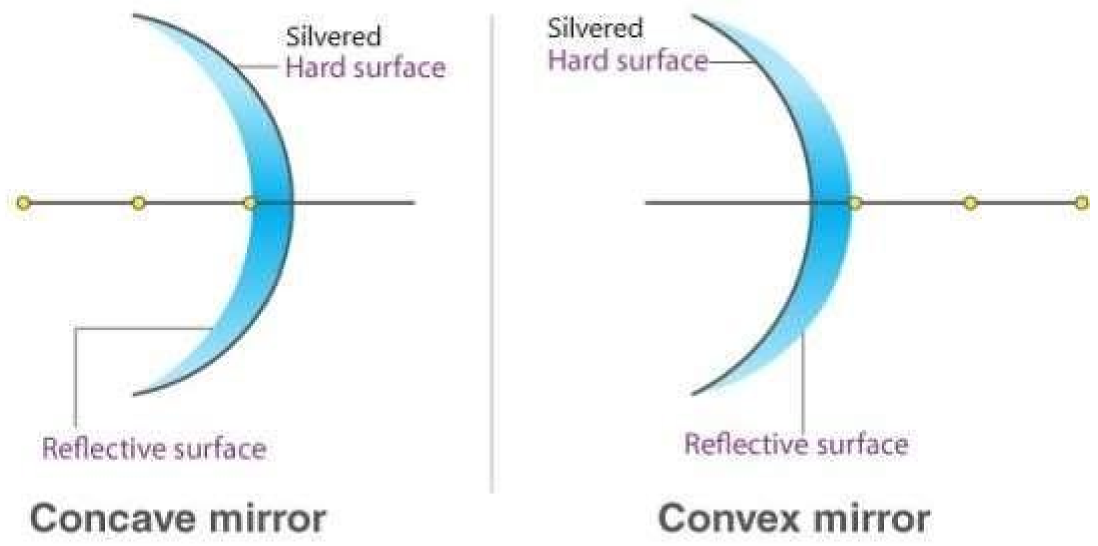
STRAND 3: FORCE AND ENERGY

Concave and Convex Mirrors

-They are also known as spherical mirrors and are formed when a spherical glass is silvered.

-If the inside is silvered a **convex** or **diverging** is formed while a **concave** or **converging** mirror is formed when the outside is silvered.



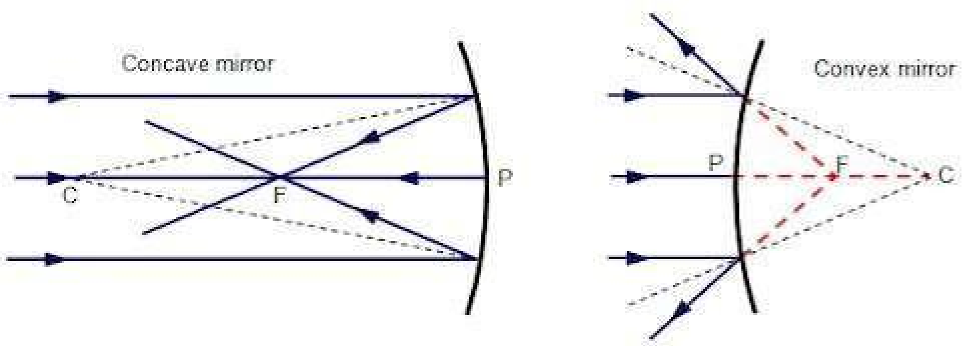
Parts of a Spherical Mirror

1. ***Centre of curvature* (C)** – this is the centre of the sphere of which the mirror is part of. The centre itself is called the pole **(P).**
2. ***Principal axis*** – this is the line joining the centre of curvature **(C)** to the pole **(P).**

3. ***Principal focus*** **(F)** – is a point on the principal axis through which a ray is reflected when it hits a concave mirror. In a convex mirror the ray is

reflected and appears to originate from the point. **F** is virtual for a convex mirror while it is real for a concave mirror.

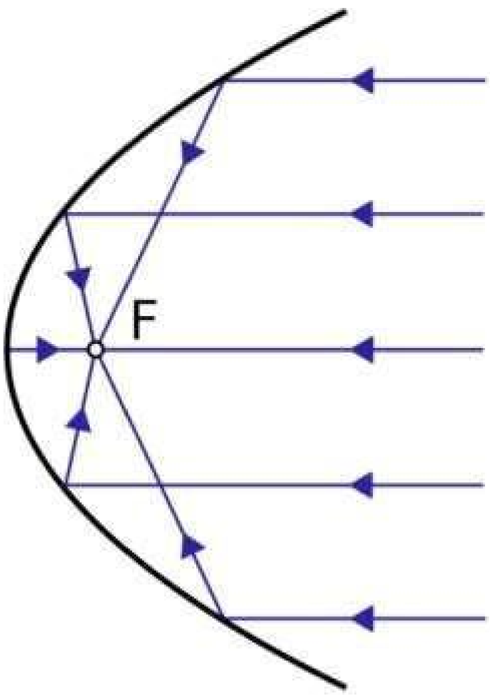
4. ***Radius of curvature* (r)** - this is the distance from the pole to the centre of curvature. The distance from the pole to the principal focus is called the focal length **(f).**



Parabolic Mirrors

- They produce a wide parallel beam or converge a large beam of light to a point.

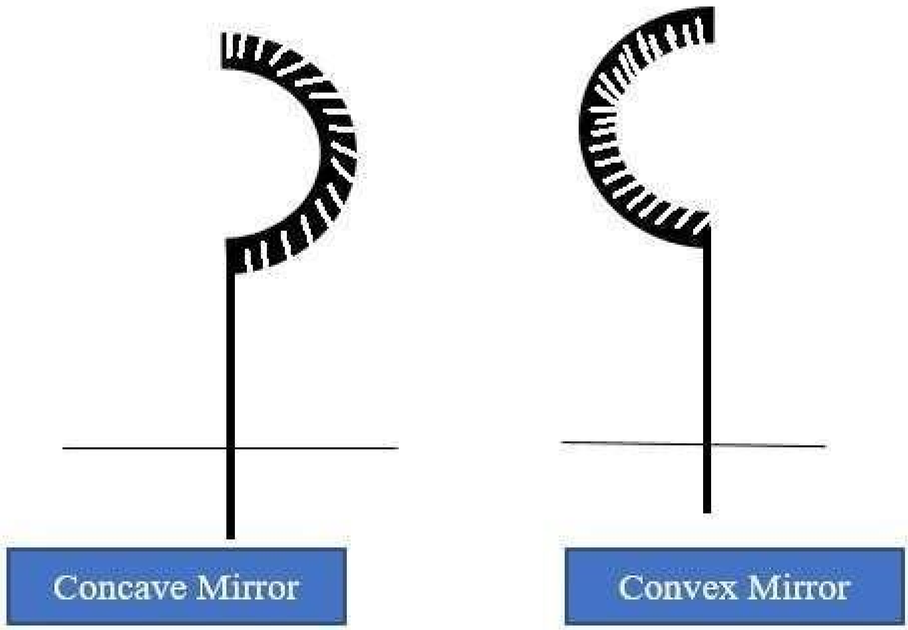
- They are widely used in making **car headlights** or in **spotlights.**



Images Formed by Spherical Mirrors

Location of images using ray diagrams

represent the mirrors.



The image is located by drawing any two of the following rays:

A ray parallel to the principal axis which is reflected through the principal focus.

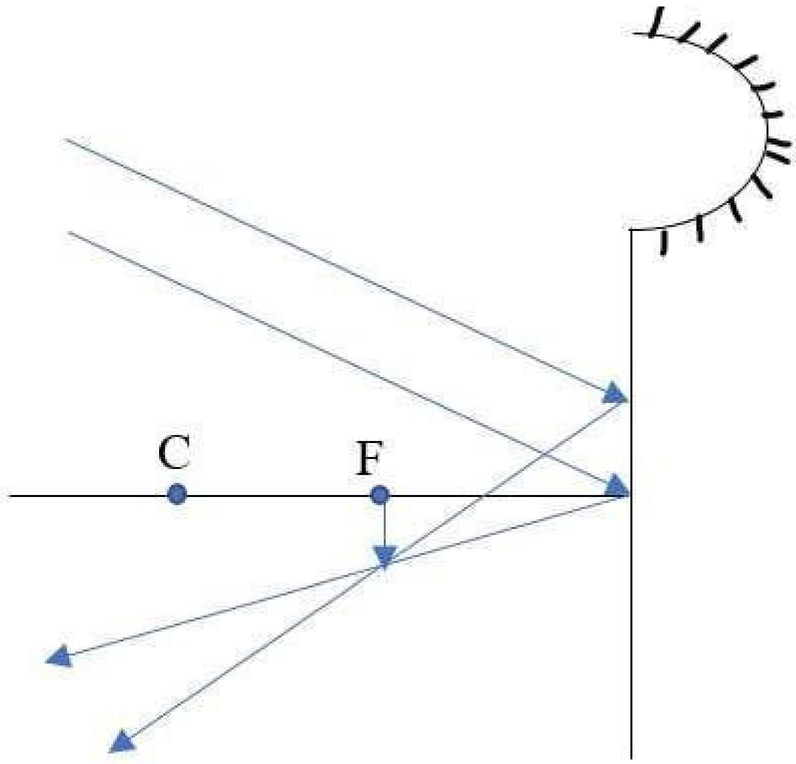
1. A ray through the centre of curvature which is reflected along its own path since it hits the mirror normally.
2. A ray through the principal focus which is reflected parallel to the principal axis.

- Virtual images are formed when rays diverge and as such the rays are extended backwards using dotted line till they meet.

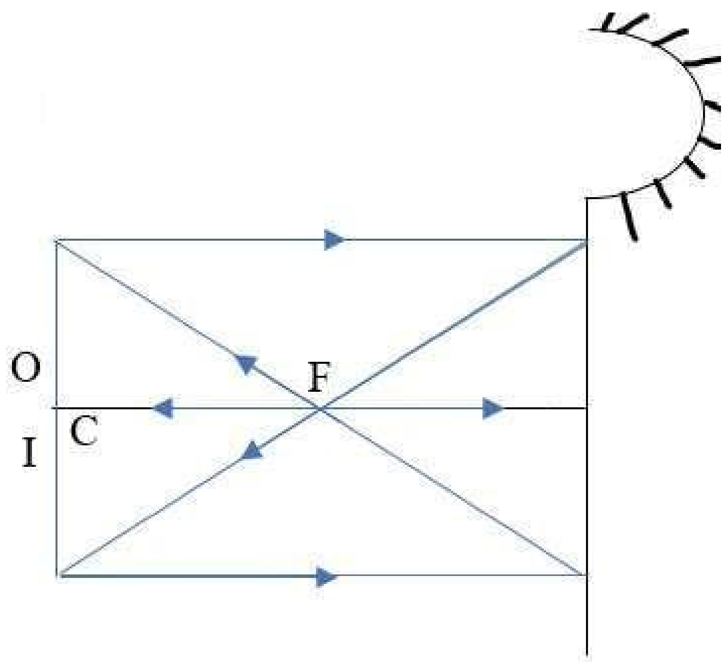
- A real image is formed by intersection of real rays.

a) Concave mirror

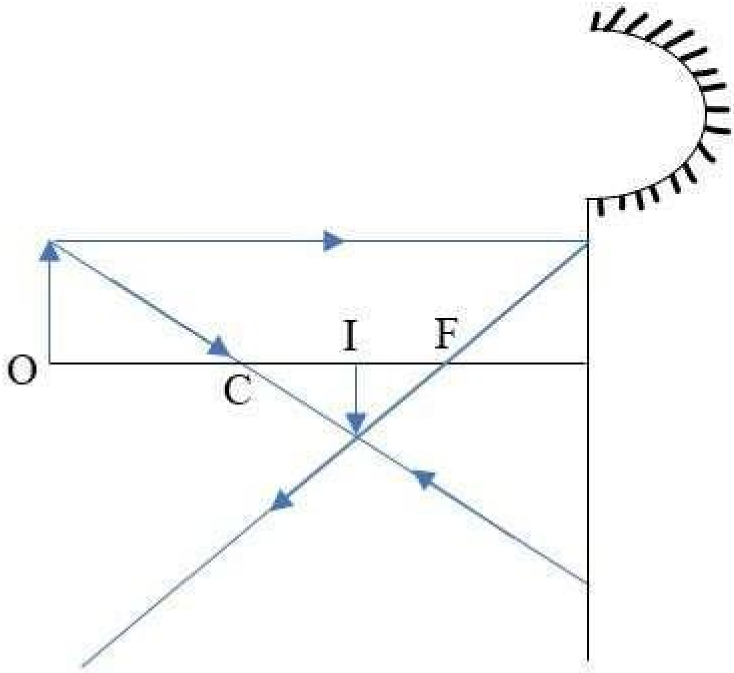
a) Object at infinity: image is formed at F. It is real, inverted and diminished.



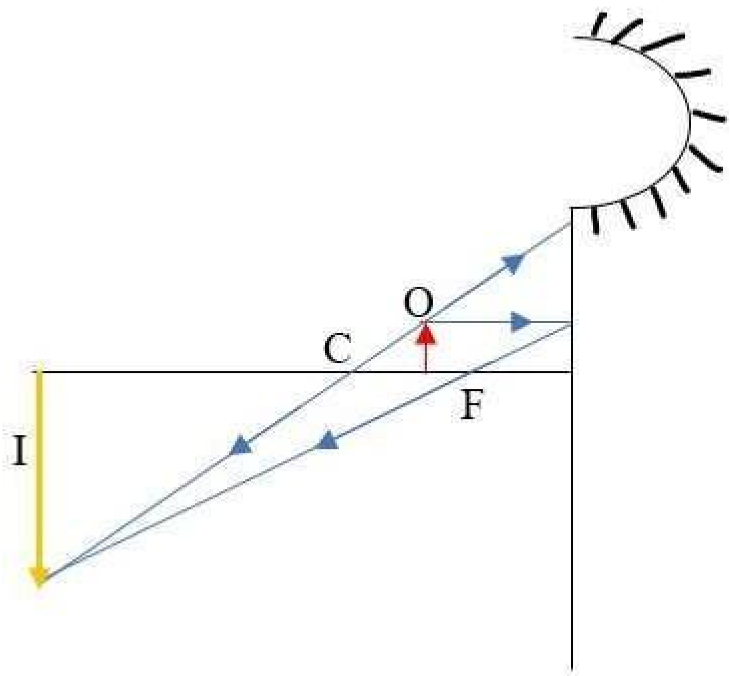
b) Object at C: image formed at C. It is real, inverted and the same size as the object.



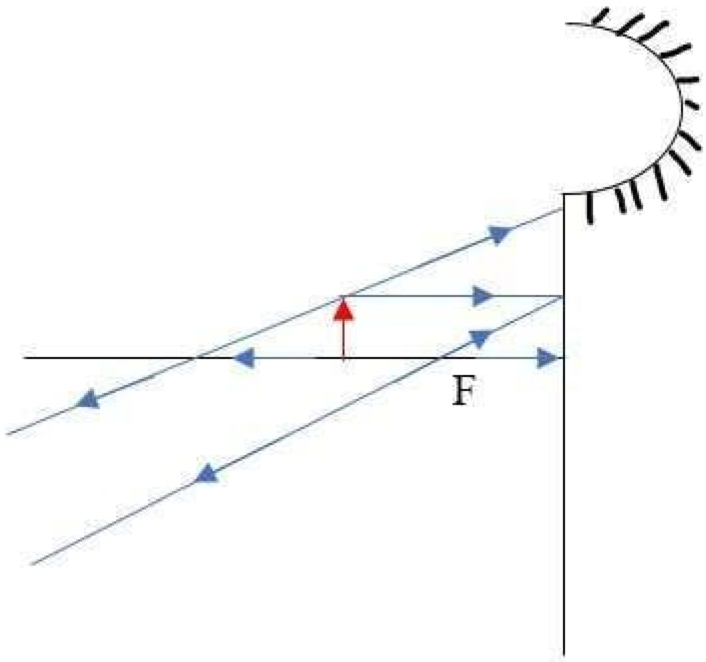
c) Object behind C: image is formed between C and F. It is real, inverted and diminished.



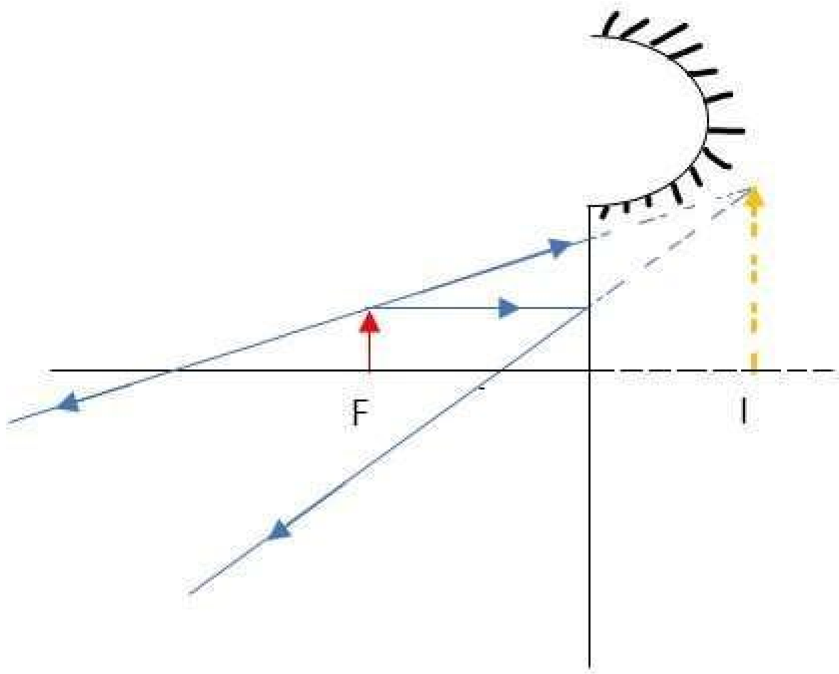
d) Object between F and C: Image is formed behind C. It is real, inverted and magnified.



e) Object at F: Image formed is at infinity.

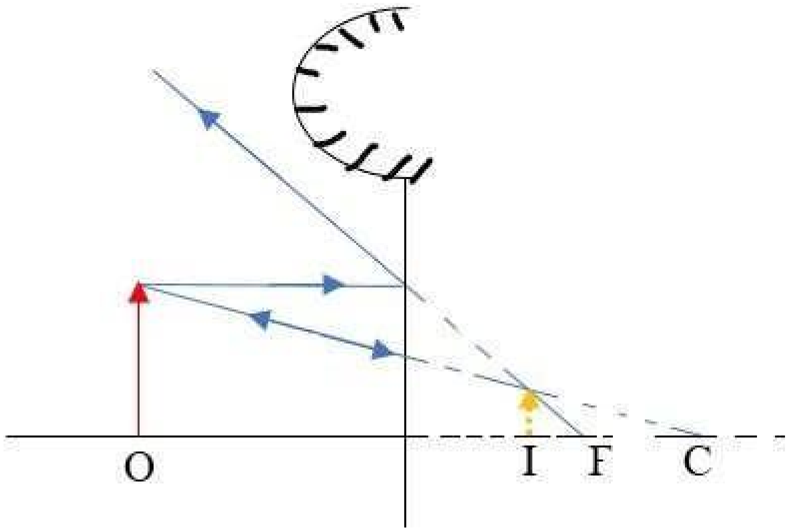


f) Object between F and P: Image is formed behind the mirror. It is virtual, erect and magnified.



b) Convex mirror

erect and **always** diminished.



Applications of curved reflectors

a) They are used in satellite dishes.

b) They are used in making shaving mirrors.

c) They are used in telescopes.

d) They are used in driving mirrors.

Magnification

- Magnification is the ratio of the image size to the object size.

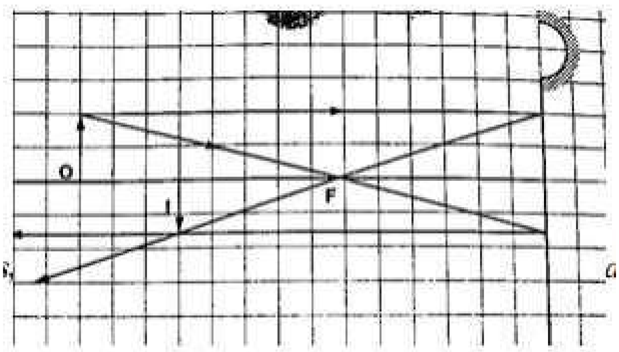
- ***Magnification (M) = height of the image / height of the object.***

- When the ratio is greater than one we say the image is magnified and when less than one we say it is diminished.

- ***Also magnification = image distance from the mirror / object distance from the mirror.***

Practice Example 1

1. Determine the size, position and nature of the image of an object 5.0 cm tall, placed on the principal axis of a concave mirror of focal length 15 cm, at a distance 35 cm from the mirror.



Solution

Let 1 cm represent 5 cm. Then the focal length is 3 cm.

Object distance = 7 cm, object height = 1 cm.

From the scale drawing,

Image position = 5.4 cm × 5 = 27 cm in front of the mirror.

Image size = 0.75 cm × 5 = 3.75 cm.

Image is real and inverted.

Practice Example 2

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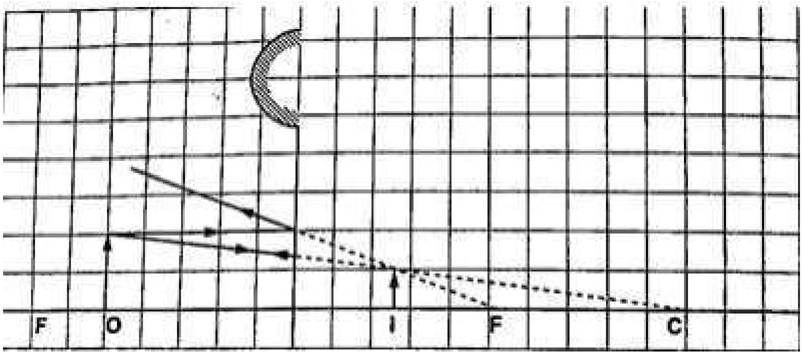
2. A vertical object 5 cm high is placed 10 cm in front of a convex mirror of focal length 15 cm. find the position, size and nature of image formed.

Determine the

magnification of the image.



Solution

Let 1 cm represent 5 cm, then the focal length = 3 cm, object size = 1 cm

Object distance = 2 cm.

From the scale drawing,

Image position = 1.2 cm × 5 = 6.0 cm behind the mirror.

Image size = 0.6 cm × 5 = 3.0 cm.

The image is virtual and erect.

Magnification = image distance / object distance. Hence 6 /10 = 0.6 (diminished).

Waves

Introduction

-        A wave is simply a disturbance that moves through a medium. Other waves do not require a medium to travel i.e. they can travel in a vacuum, are known

as **electromagnetic waves** e.g. radio, X-rays, gamma rays UV rays etc.

-        Other waves require a material medium to be transferred and are called **mechanical waves** i.e. water, sound waves etc.

Transverse and Longitudinal Pulses and Waves

1. Transverse waves

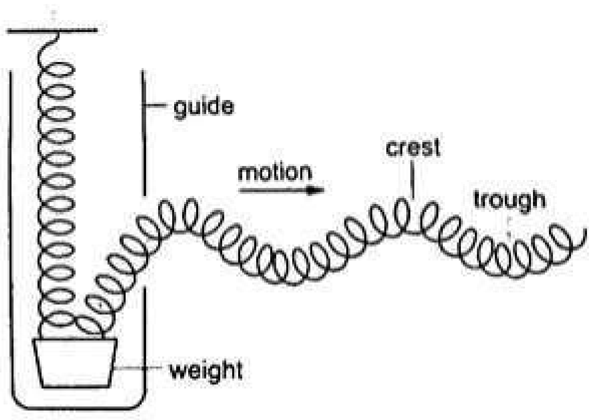
– They consist of a crest and a trough.

-        In this case the displacement of the medium caused by these pulses are perpendicular to the direction in which the wave (disturbance) travels.

- A pulse is a single non-repeated disturbance.

-        If the pulses are repeated periodically (regularly) they produce a series of waves called periodic transverse wave train.

- They can be produced as shown below.



2. Longitudinal waves

- These are waves whereby the particles of the medium vibrate parallel to the direction of movement of the disturbance.

- When several turns of a spring are pulled together (**compression**) and then released they tend to spread out to their original position.

- When pulled apart (**rarefaction**) they also turn to their original position.

- In this case the displacement of the spring is parallel to the motion of the wave and this is known as longitudinal.

Characteristics of waves

1. All waves have **speed** which depends on the nature of disturbance.
2. All waves have **wavelength** (distance between two successive points in a wave). Represented by the symbol **λ** and is measured in ***metres.***
3. All waves have **frequency - ' f '** which is the number of waves passing a point in one second. It is measured in cycles per second or **hertz (Hz).**

   The period of a wave is the time required for a complete wave to pass a given point.

   Therefore **T = 1 / f or f = 1 / T** (period is measured in ***seconds***).

   The speed **'v'** is given as: **v = λ / T, since f = 1 / T** then **v = (1 / T) x λ = f λ or v = f λ.** This is the wave equation.
4. All waves have **amplitude** which is the maximum displacement of the particles of the medium as the wave passes.

Practice Example 1

1. A rope is displaced at a frequency of 3 Hz. If the distance between two successive crests of the wave train is 0.8 m, calculate the speed of the waves

along the rope.

Solution

v = f λ = 3 x 0.8 = 2.4 m

Hz = 2.4 m/s.

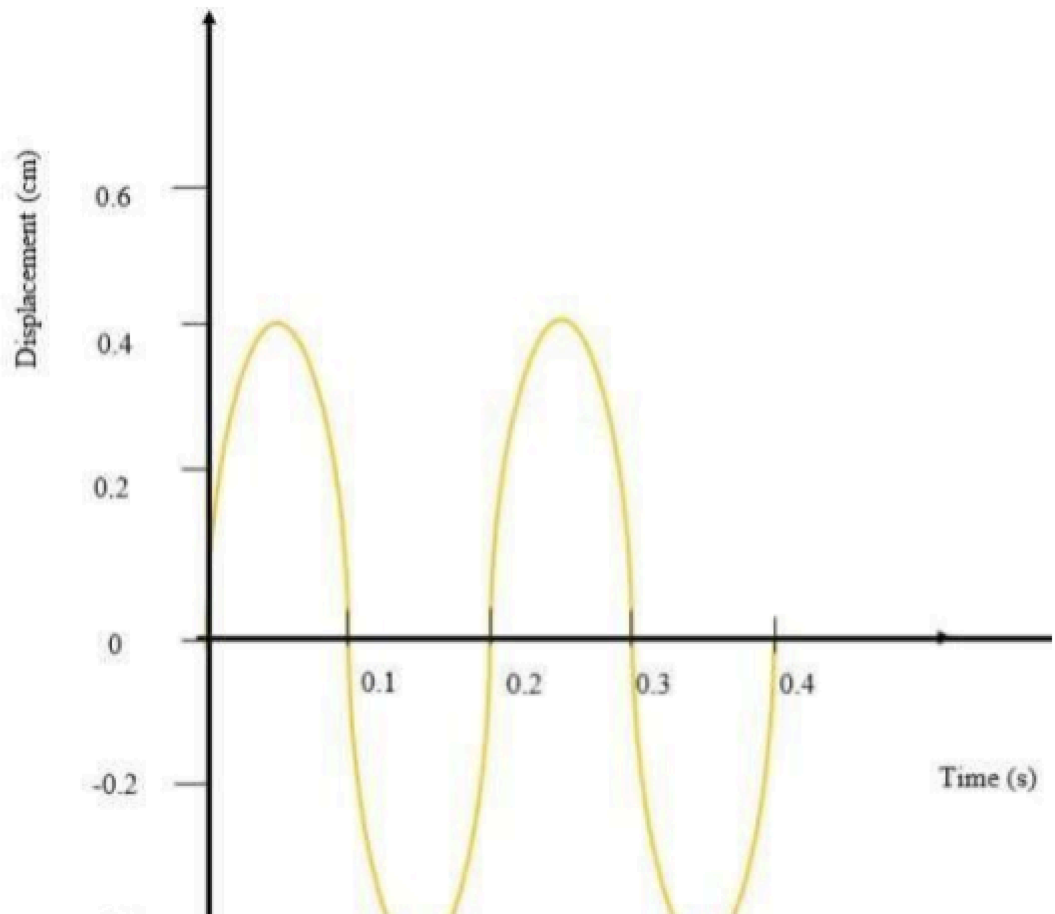
Practice Example 2

2. The figure below illustrates part of the displacement-time graph of a wave travelling across water at a particular place with a velocity of 2 ms^{-1} Calculate the wave's:

a) Amplitude

b) Frequency (f)

c) Wavelength (λ)



Solution

a) From the graph, maximum displacement

(a) = 0.4
cm.

b) From the graph, period T = time for one cycle = 0.20 seconds.

So $f = 1 / T = 1 / 0.20 = 5$ Hz.

c) Velocity = $f \lambda$ hence $\lambda = 2 / 5 = 0.4$ m.