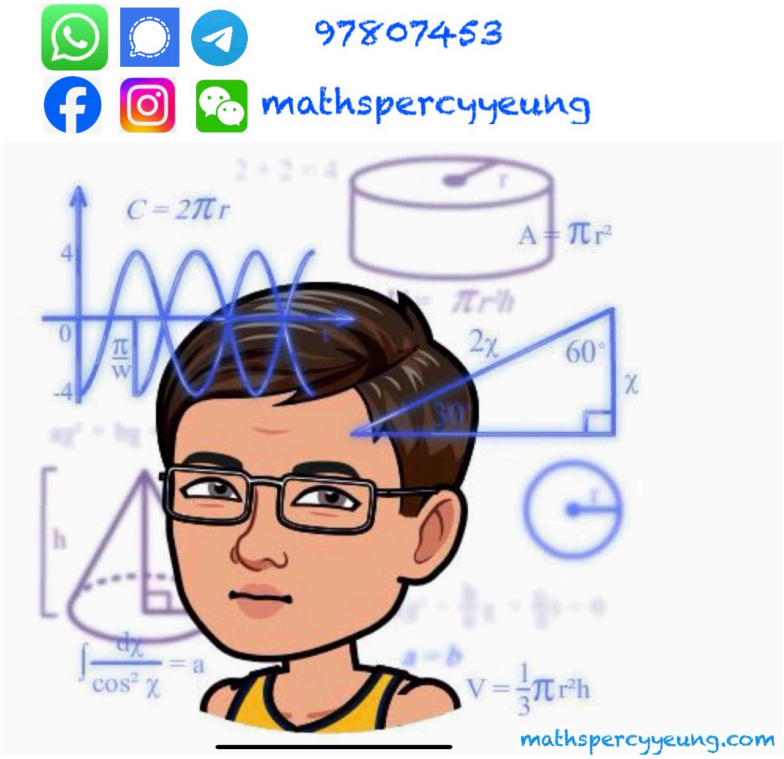
FKS F3 Phy Book 2

Fundamentals of F.3 Physics (2025-2026)



Book 2

Content

Lens

Introduction to Lenses

Due to refraction, light can be bent.

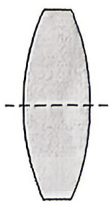
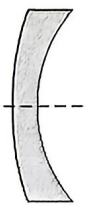
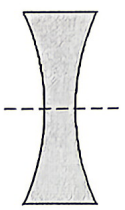
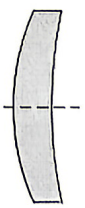
↓

Lens is designed to *converge* or *diverge* the light

Convex and concave lenses:

Convex Lens	Concave Lens
converging lens	diverging lens
(thinner thicker) in the middle.	(thinner thicker) in the middle.
examples	examples

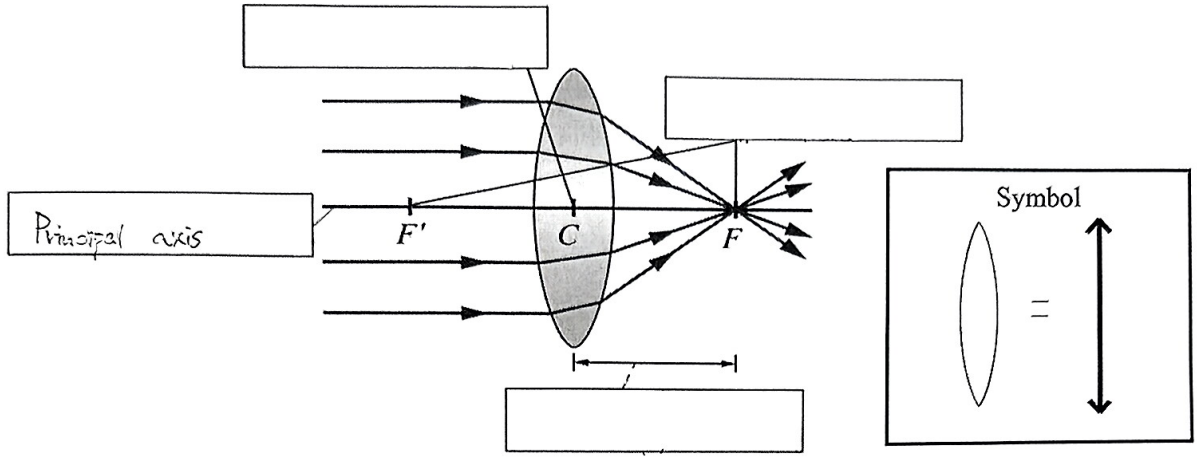
Exercise

a	b	c	d	e	f
					

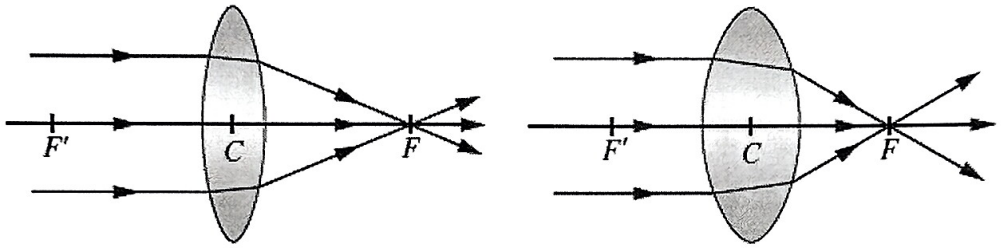
Convex lens: _____ Concave lens: _____

Description of convex and concave lens

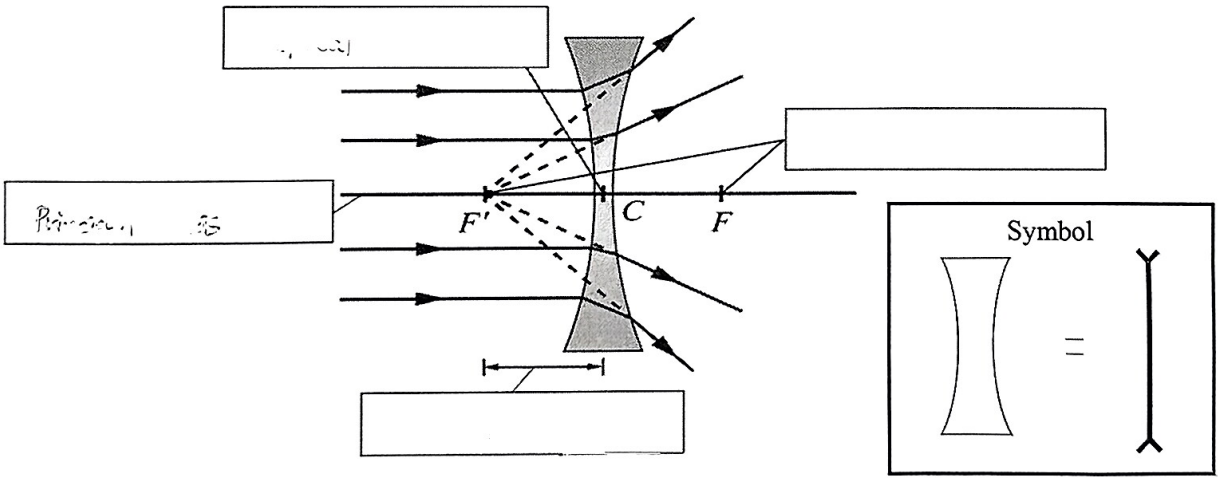
Convex lens (converging lens)



- When the thickness (or the curvature) of a lens increases, the focal length _____.



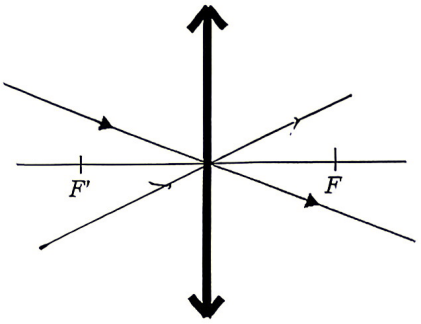
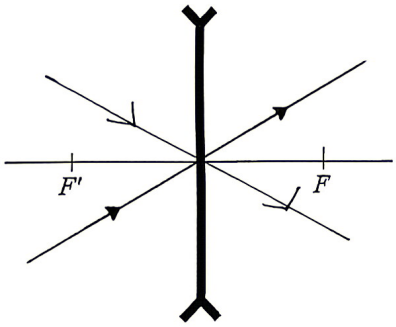
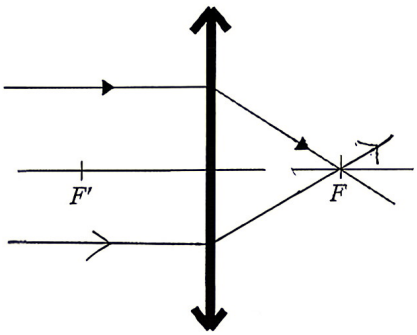
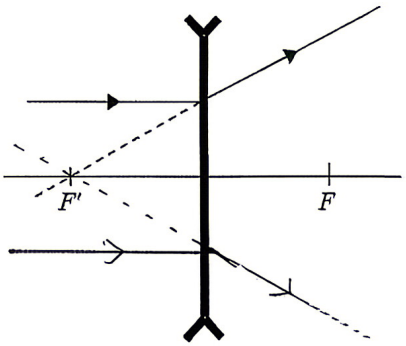
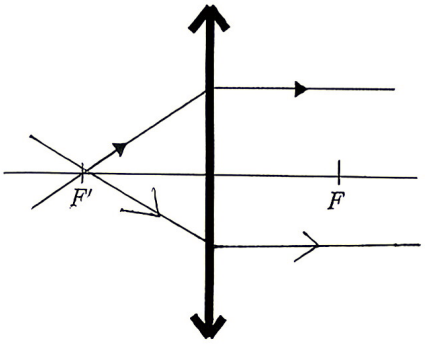
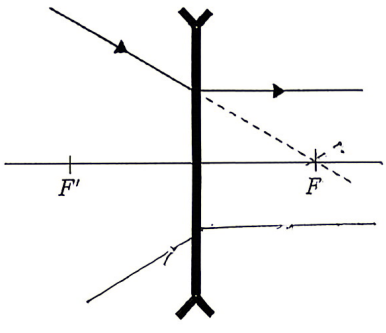
Concave lens (diverging lens)



- Other things being equal, a convex or a concave lens with a greater refractive index has a _____ focal length.
- As light can pass through a lens from both sides, each lens has _____ principal foci, one on each side of the lens.

Optical centre	The centre of the lens
Principal axis	The line which passes through the optical centre and is perpendicular to the lens
Principal focus / foci	Refer to the light rays on page 2
Focal length	The distance between a principal focus and the optical centre

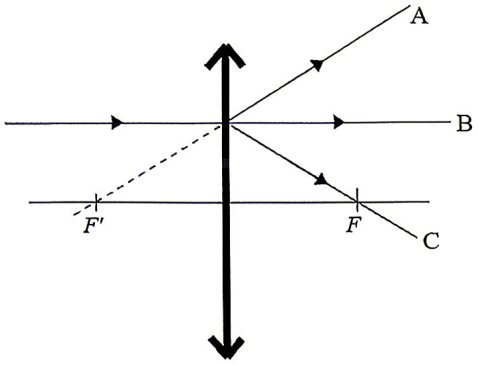
Construction Rules

Convex Lens	Concave Lens
 穿心不變	 穿心不變
 平行『穿焦』	 平行『飛焦』
 『穿焦』平行	 『向焦』平行

Exercise

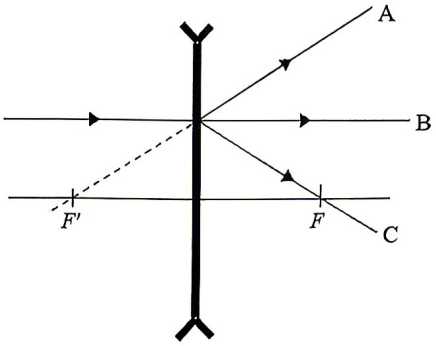
Which light ray is correct?

1)



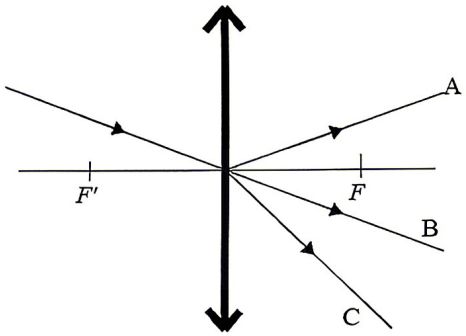
Answer: C

2)



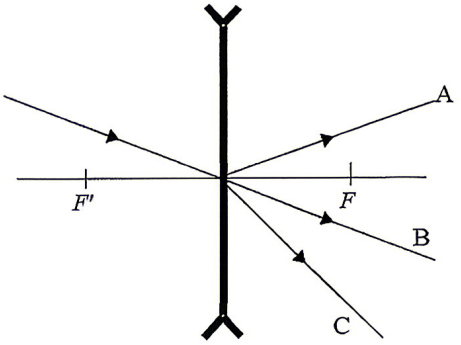
Answer: _____

3)



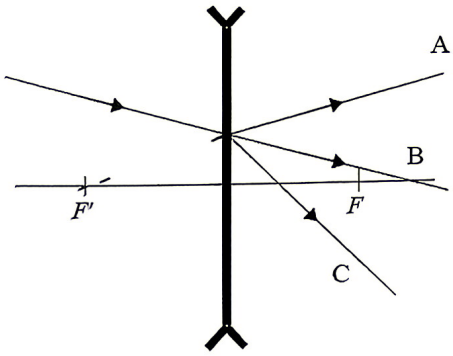
Answer: _____

4)



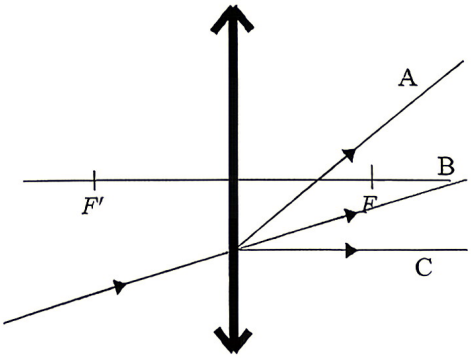
Answer: _____

5)



Answer: _____

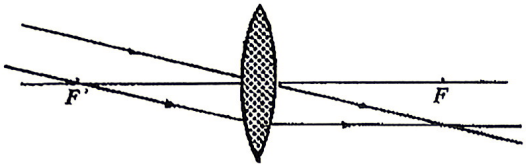
6)



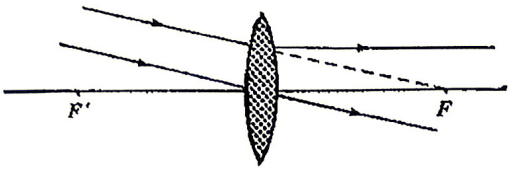
Answer: _____

7) Which of the following ray diagrams is/are correct?

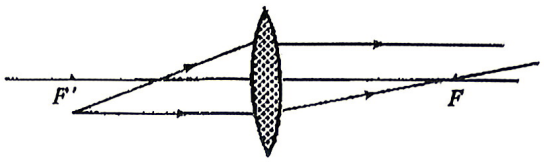
(1)



(2)



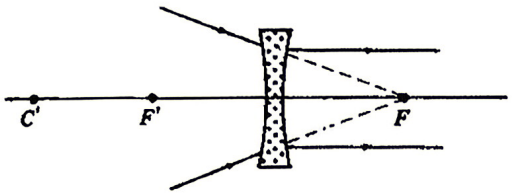
(3)



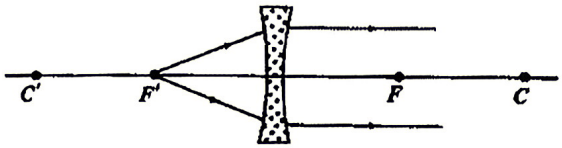
A. (1) only
B. (3) only
C. (1) and (3) only
D. (2) and (3) only

8) If *F*, *F'* are foci and *C*, *C'* are both at a distance of two times the focal length from the lens, which of the following ray diagrams is/are incorrect?

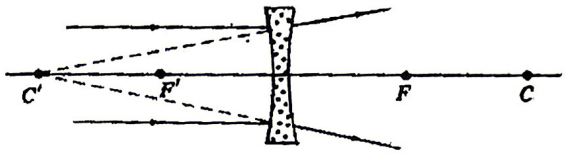
(1)



(2)



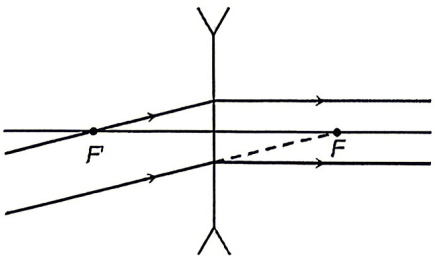
(3)



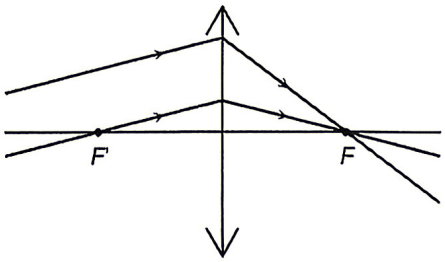
A. (1) only
B. (3) only
C (1) and (2) only
D (2) and (3) only

9) If *F* and *F'* are the foci of the concave lens, which of the following ray diagrams is correct?

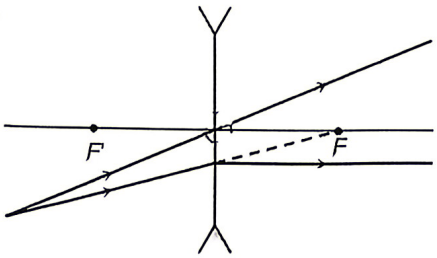
A.



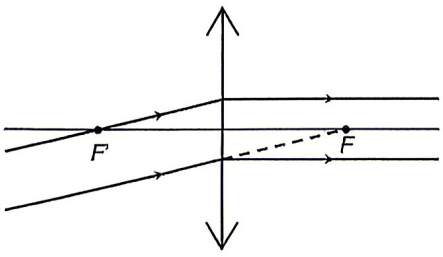
B.



C.



D.

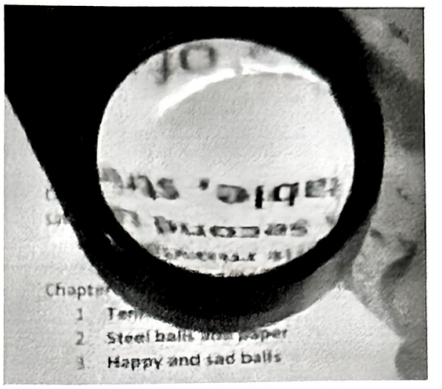


Examples: Images Formed by a Convex or a Concave Lens

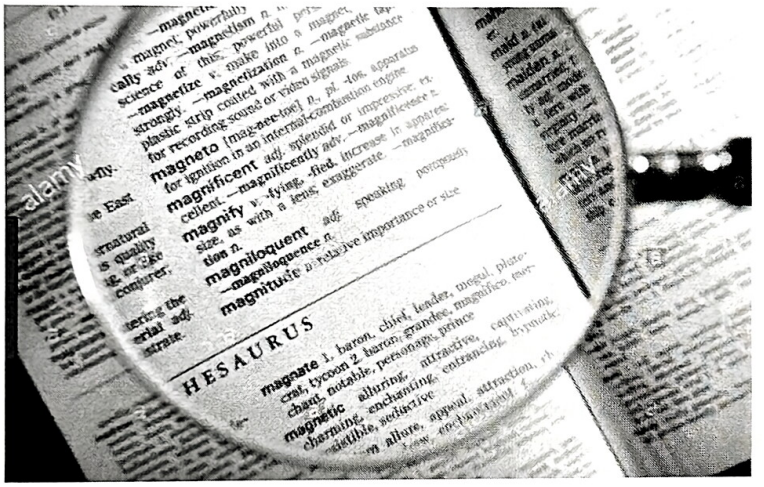
Example 1: Convex lens – The image is inverted and (i) diminished (ii) magnified.

(i)

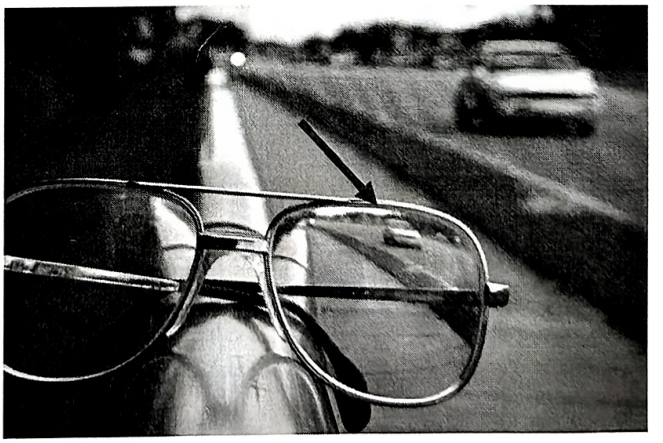
(ii)



Example 2 (Magnifying glass): Convex lens – The image is magnified and erect.



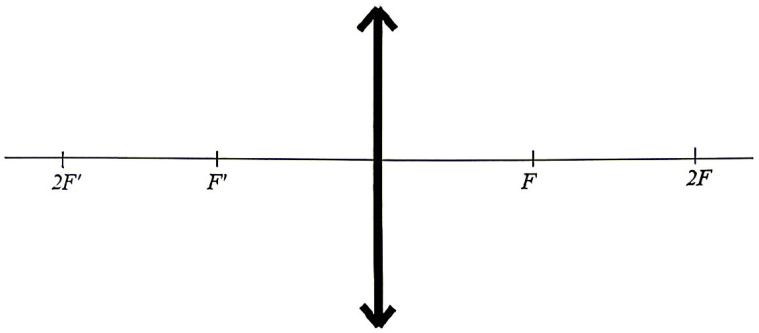
Example 3: Concave lens – The image is _____ and _____.



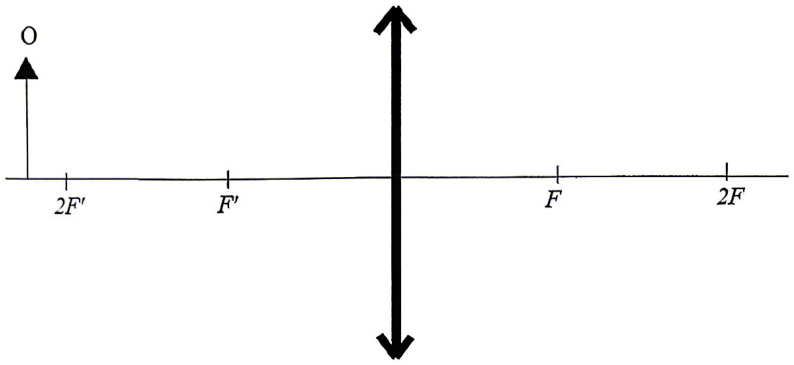
Constructing Ray Diagrams to Find Out the Images

Step 1

- Draw a horizontal line (principal axis) and the symbol of the lens (e.g. convex lens).
- Mark the position of foci (*F* and *F'*) on both sides of the lens. Mark *2F* and *2F'*.



Step 2 – Use an arrow to represent an object. Draw the object IN SCALE.



Step 3

- Using construction rules to draw two light rays from the head of the arrow.
- Elongate the refracted light rays until they intersect each other.

> Forward elongation: use solid lines (represent light rays)
> Backward elongation: use dotted lines (no light rays)

- The head of the image forms at the point where two light rays intersect.
- The tail of the image is on the principal axis.

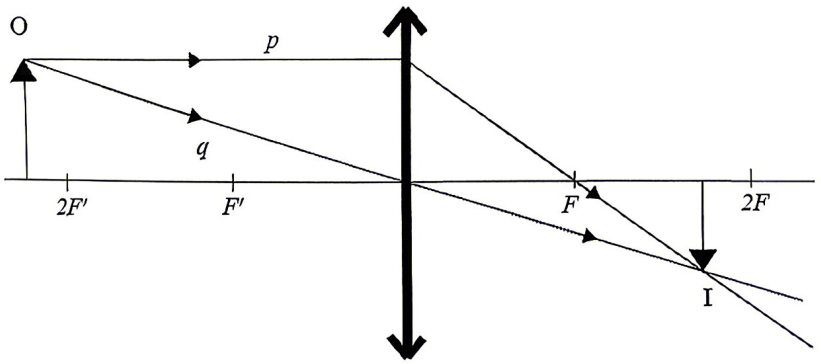
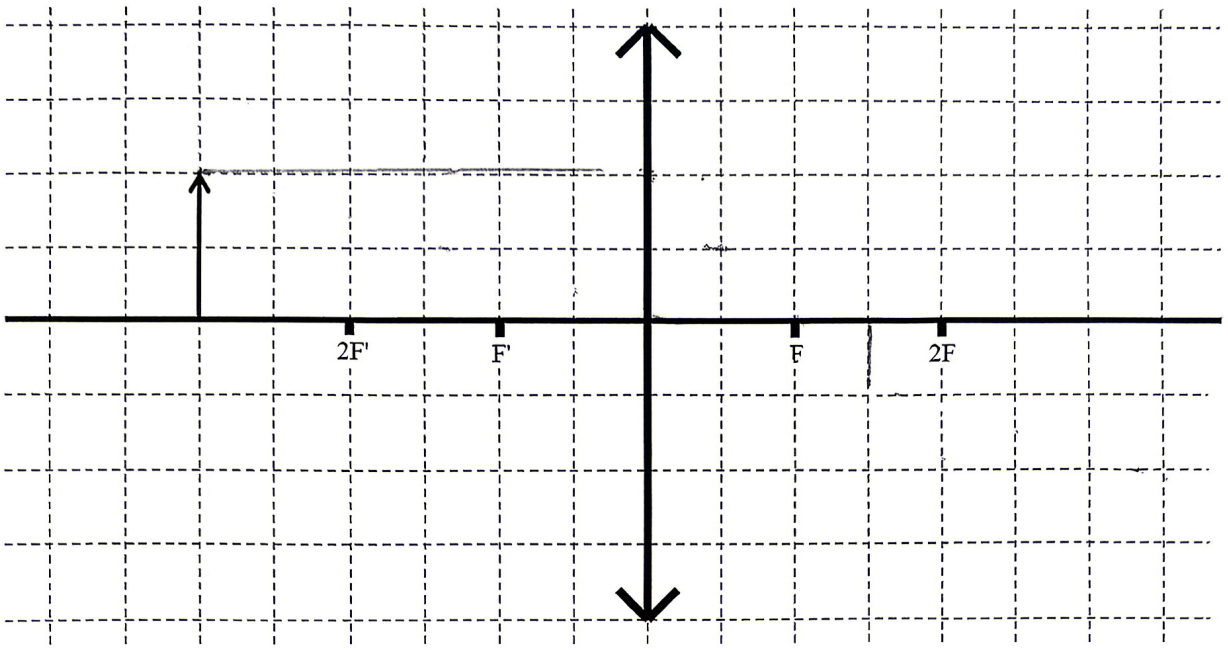


Image formation by convex and concave lenses:

Exercise

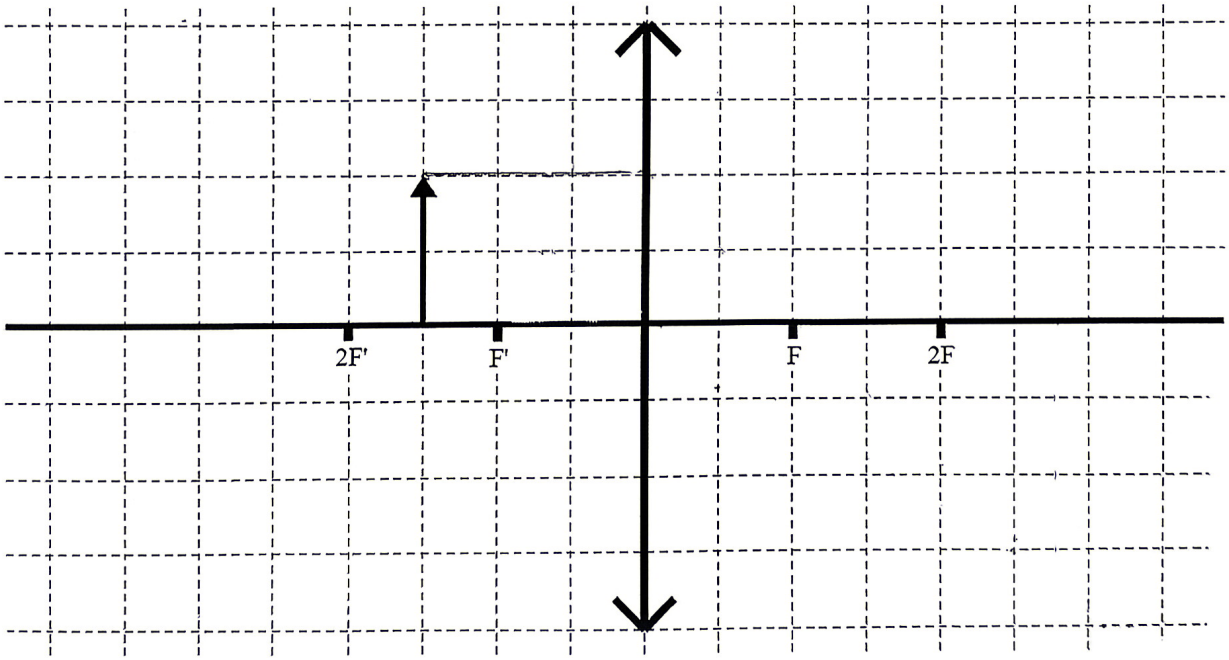
Find the image by drawing two light rays from the head of the object.

1.



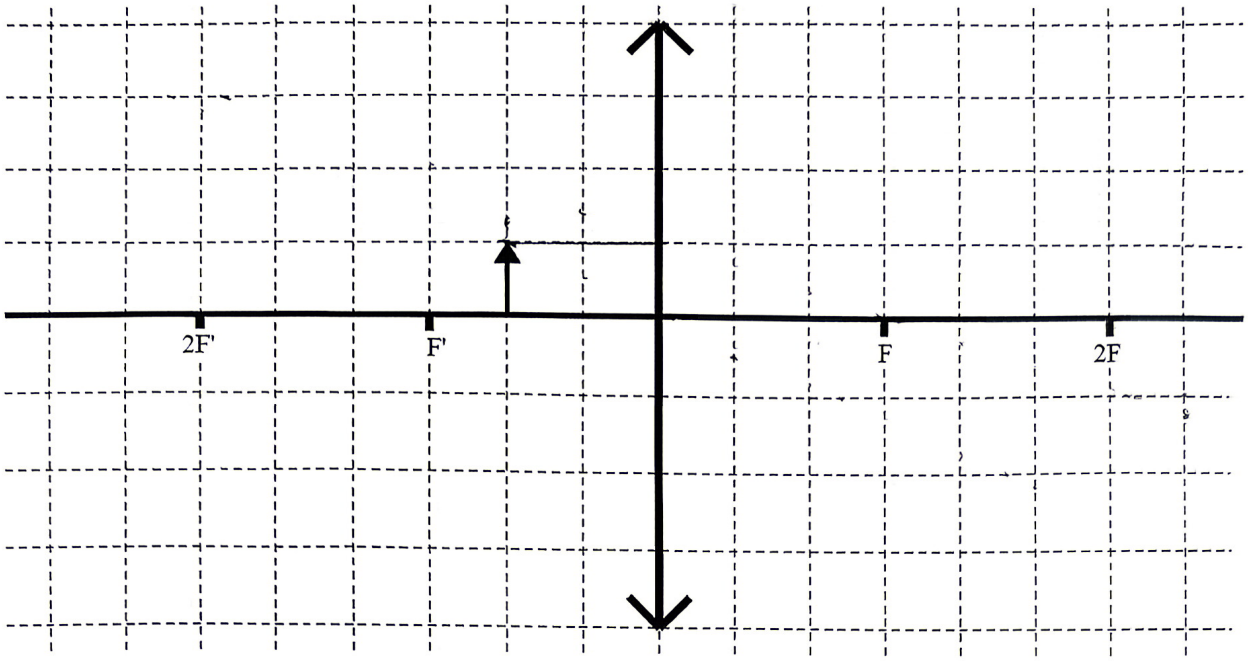
Nature of the image: _____

2.



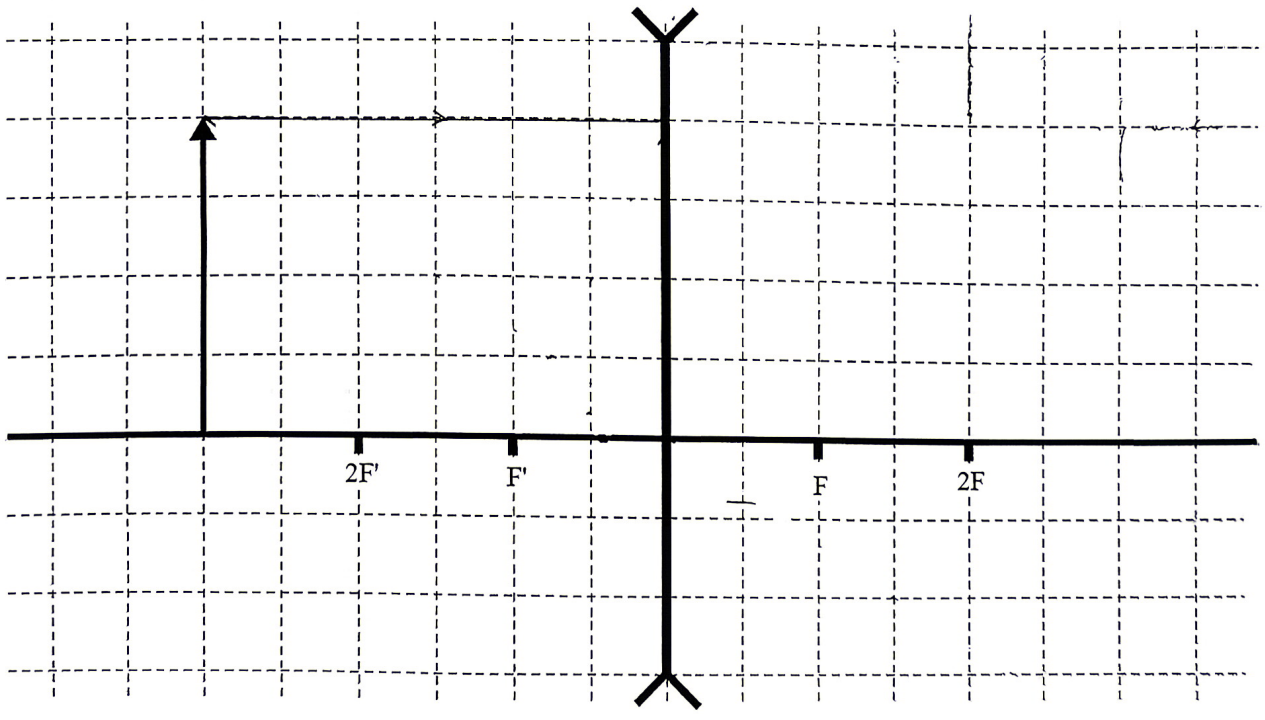
Nature of the image: _____

3.



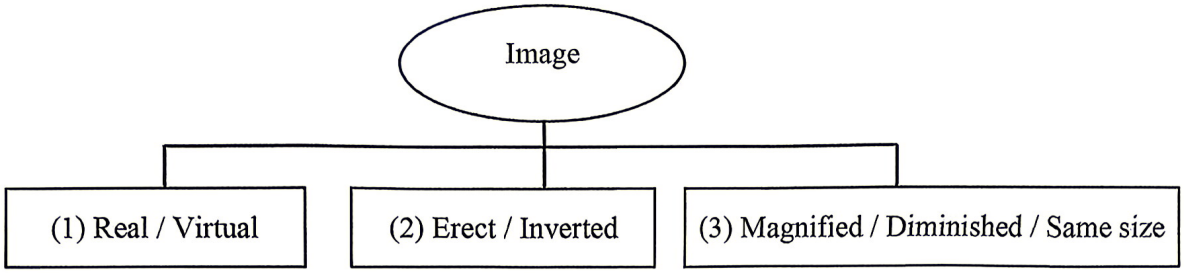
Nature of the image: _____

4.



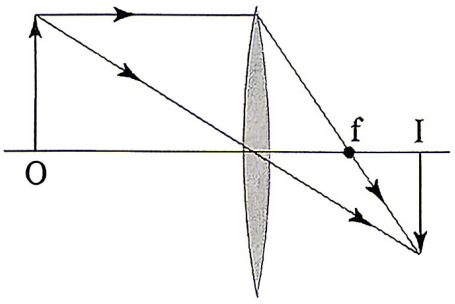
Nature of the image: _____

The Nature of the Image Formed by Lenses

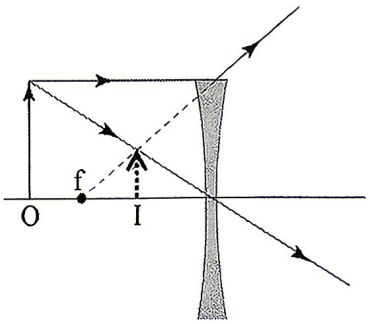


Real Image and Virtual Image

	Real	Virtual
Light rays	Light rays converge to form an image	- Light rays diverge - Elongate the rays backward to find the intersection (image) - Light rays reach our eyes as if they come from the image.
Project on screen	√	×
How to draw?	Solid lines	Dotted lines



Real Image

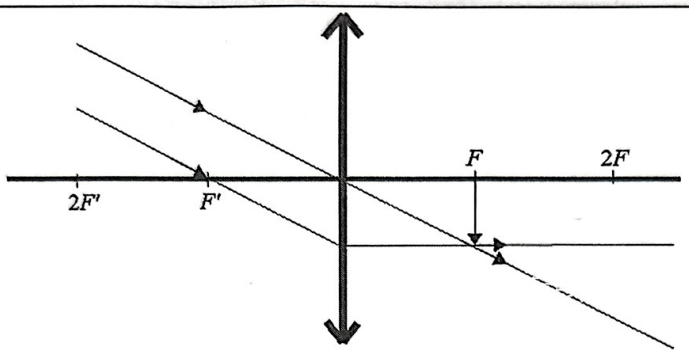
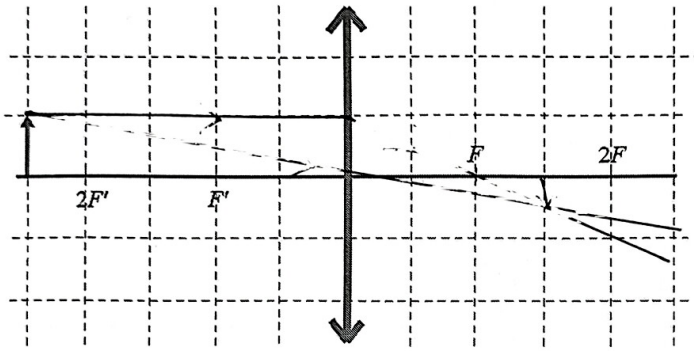
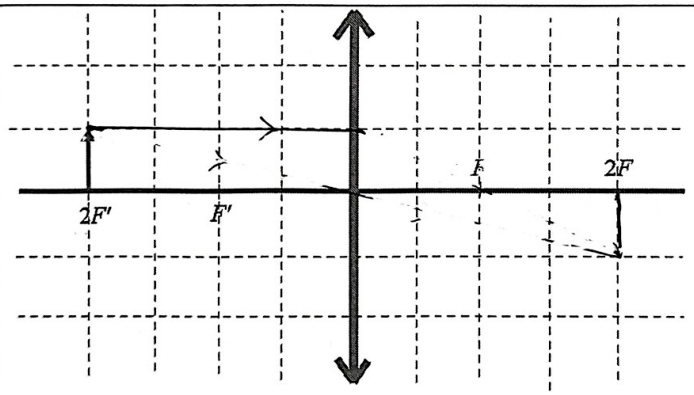
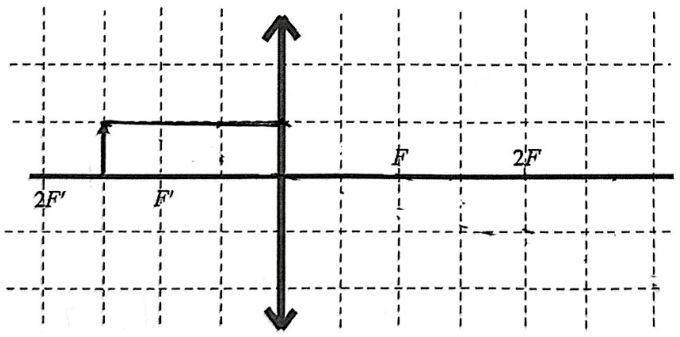


Virtual Image

Erect and Inverted

	Object	Image
Erect	F	
Inverted	P	

Image formed by convex lens

Position of object	Ray Diagram	Nature of image formed
At infinity (無限遠)		1. Diminished 2. Inverted 3. Real **Image is formed on the focal plane**
Beyond $2F'$		1. _____ 2. _____ 3. _____
At $2F'$		1. _____ 2. _____ 3. _____
Between $2F'$ and F'		1. _____ 2. _____

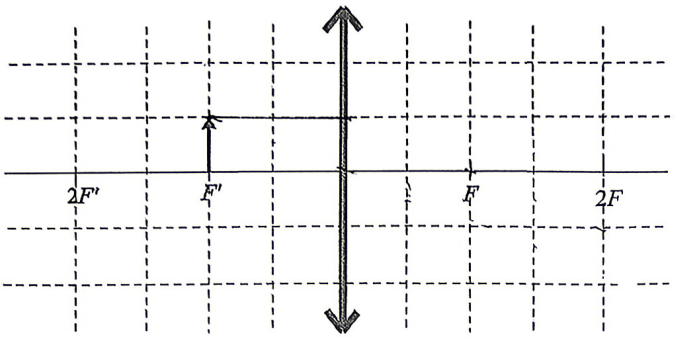
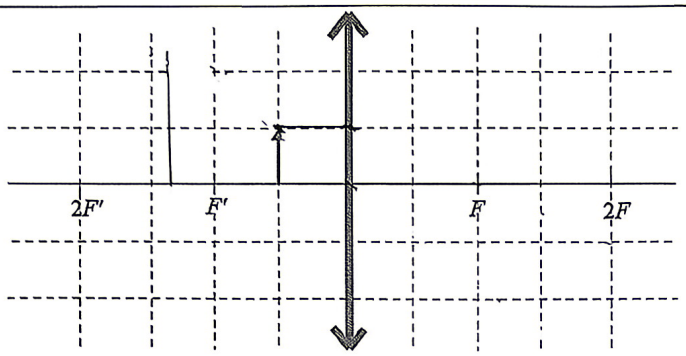
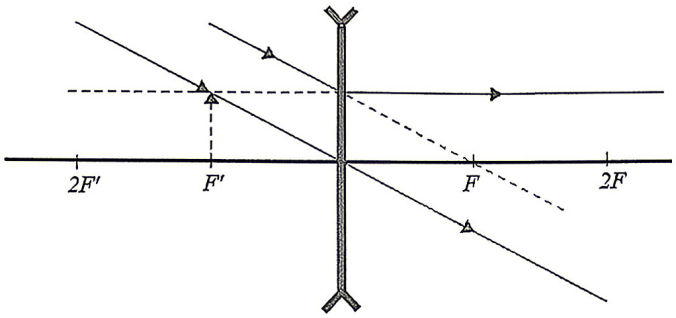
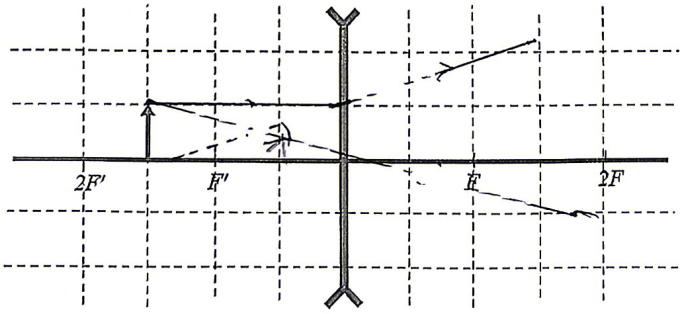
At F'		1. _____
Within F'		1. _____ 2. _____ 3. _____

Image formed by concave lens

Position of object	Ray Diagram	Nature of image formed
At infinity (無限遠)		1. Diminished 2. Erect 3. Virtual **Image is formed on the focal plane**
Other positions		For all cases: 1. _____ 2. _____ 3. _____

Tips

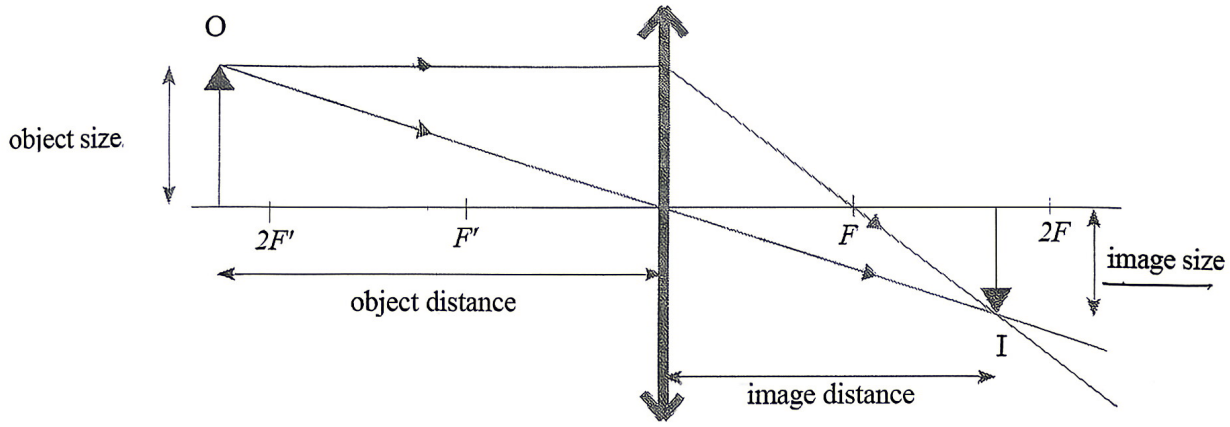
1. Real image must be inverted
2. Virtual image must be erect

Magnification

As the image can be magnified or diminished, it is meaningful to find out the ratio of image size to object size.

The magnification, m is calculated as:

$$m = \frac{Image\ size}{Object\ size} = \frac{Image\ distance}{Object\ distance}$$

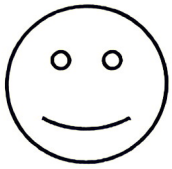


Meaning of different values of m

$m > 1$	
$m = 1$	
$m < 1$	

Further Study on Lenses

1. A smiley face is viewed through a lens. The face and its image are shown below.



Object

Image

(a) What is the nature of the image? _____

(b) Is the lens convex or concave? _____

Reason: _____

_____

2. For each of the following cases, finish parts (i), (ii) and (iii).

(a)

(i) Nature of image: _____

_____

(ii) Can we capture the image on a screen?

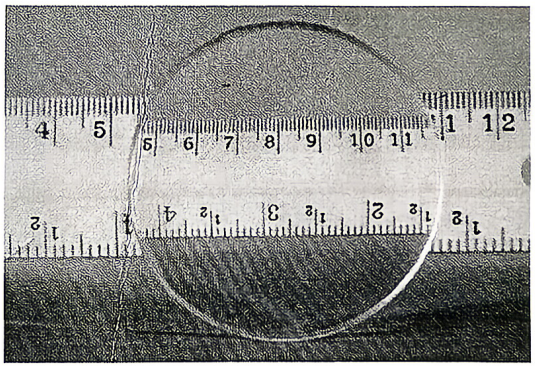
_____

(iii) Convex / Concave

Reason: _____

_____

(b)



(i) Nature of image: _____

_____

(ii) Can we capture the image on a screen?

_____

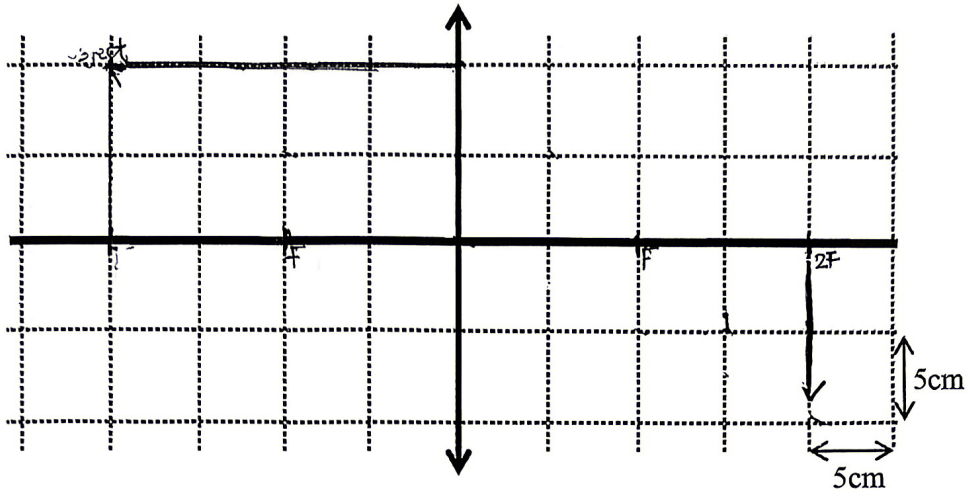
(iii) Convex / Concave

Reason: _____

_____

3. An object (10 cm tall) is placed 20 cm in front of a convex lens of focal length 10 cm.

a) Use a ray diagram to find out the position of the image.



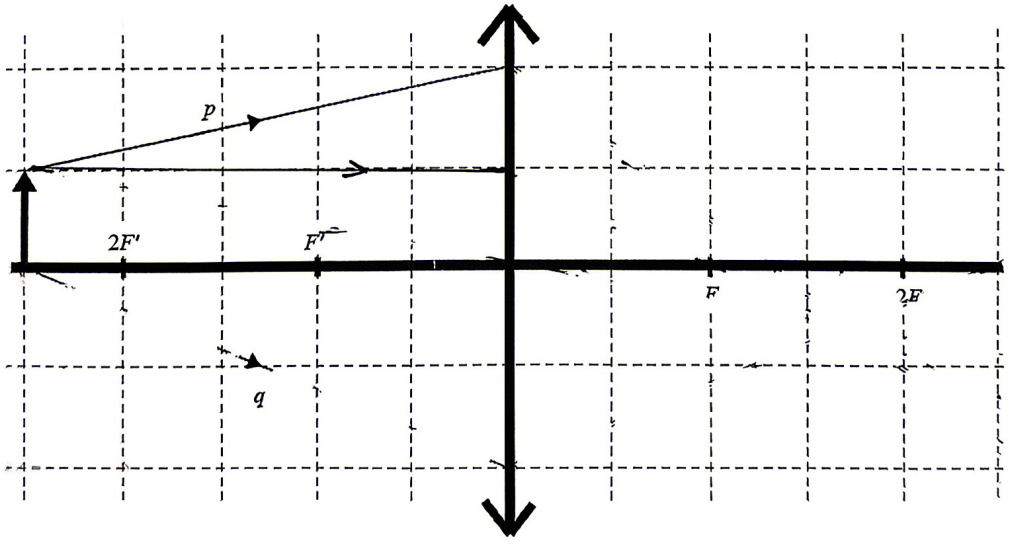
b) What is the magnification of the image? _____

c) What is the nature of the image? _____

d) If the object moves further away from the lens, what is the change of its image?

_____

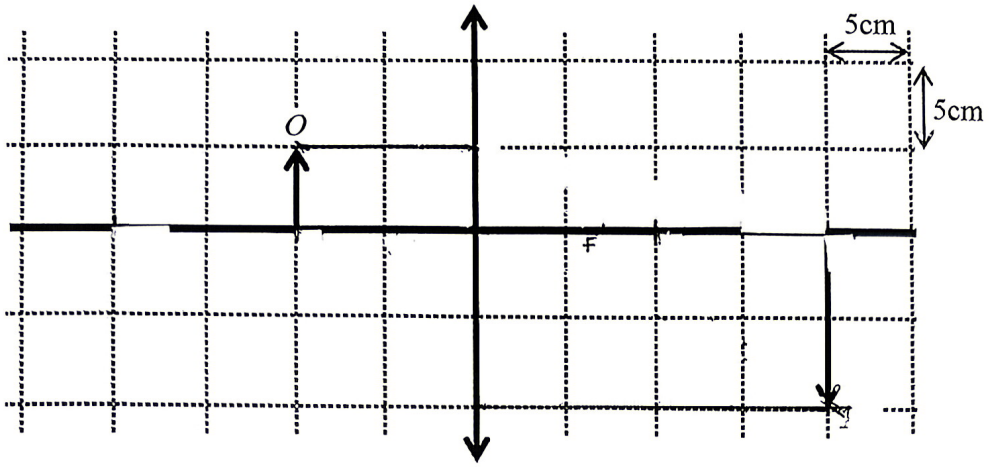
4. Find out the image and complete light rays p and q.



a) What is the nature of the image? _____

b) What is the magnification of the image? _____

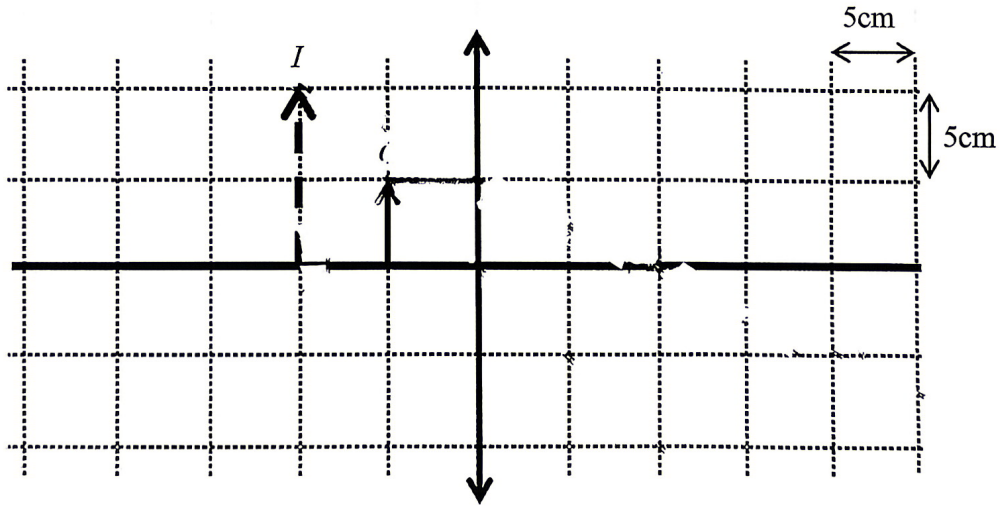
5. Label the foci and find out the focal length of the convex lens below.



Focal length: _____

What is the magnification of the image? _____

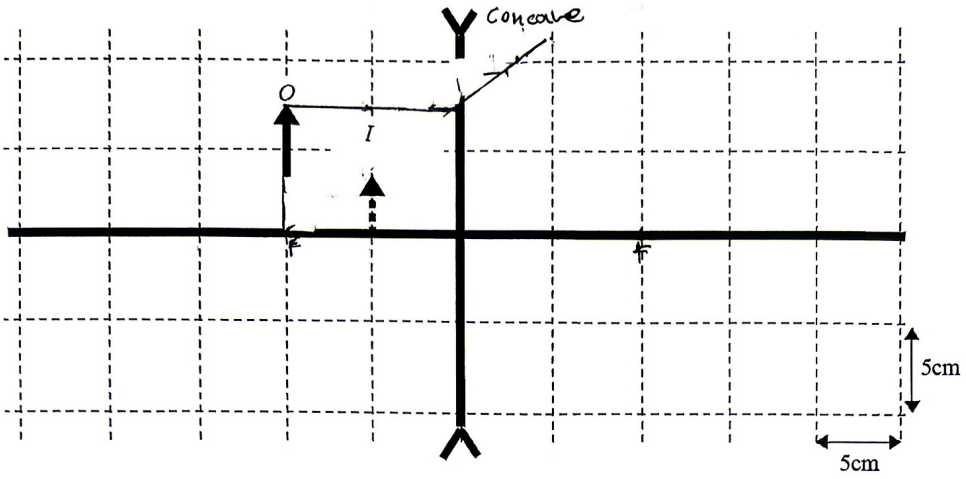
6. Label the foci and find out the focal length of the convex lens below.



Focal length: _____

What is the magnification of the image? _____

7. Label the foci and find out the focal length of the concave lens below.



Focal length: _____

8. An object of height 10 cm is placed 30 cm from a lens. The image is inverted and its magnification is 3.

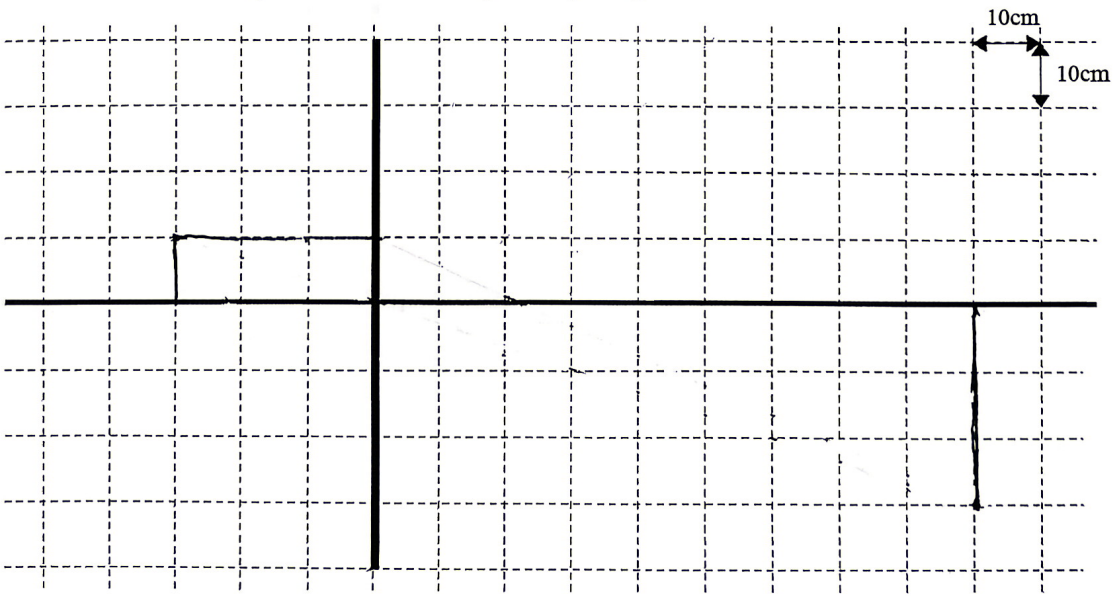
a) Is the image real or virtual? _____

b) Is the lens convex or concave? _____

c) What is the height of the image? _____

d) What is the image distance? _____

e) Find out the focal length of the lens using the ray diagram below.



Focal length: _____

9. When an object of height 15 cm is placed 30 cm from a lens, the image can be projected on the screen and its height is 10 cm.

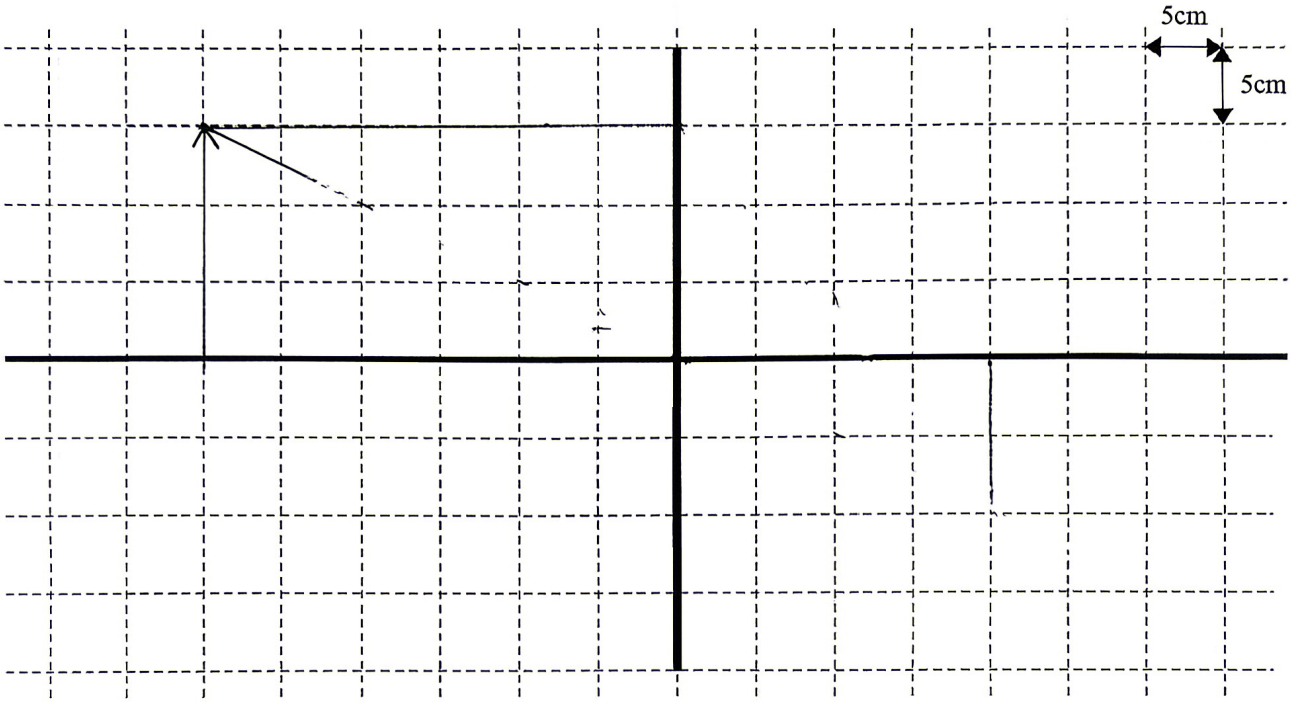
a) Is the image real or virtual? _____

b) Is the lens convex or concave? _____

c) What is the magnification? _____

d) What is the image distance? _____

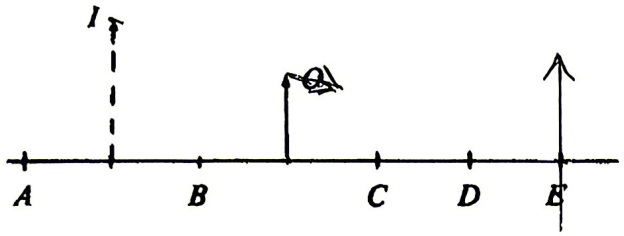
e) Find out the focal length of the lens using the ray diagram below.



Focal length: _____

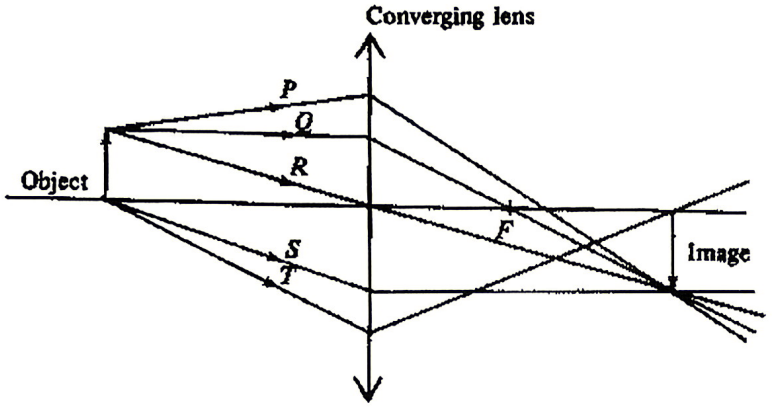
Multiple Choice Exercise

1. In the diagram below, the image I of an object O is produced by a lens. Which is the nature and position of this lens?



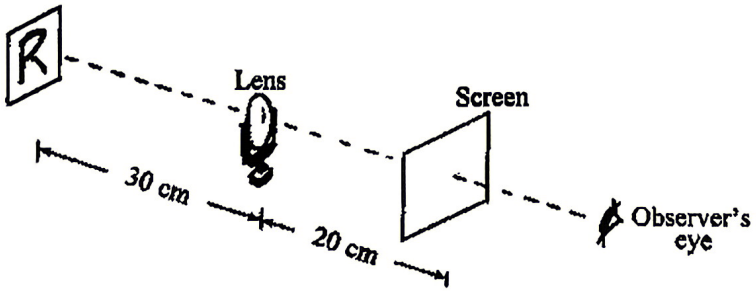
A. convex and placed at A
B. concave and placed at B
C. concave and placed at C
D. concave and placed at D
E. convex and placed at E

2. In the figure below, F is the focus of the converging lens. Which of the five rays is INCORRECTLY drawn?



A. P
B. Q
C. R
D. S
E. T

3. An illuminated letter 'R' is placed in front of a lens as shows below and an image is formed on a translucent screen. The object distance is 30 cm and the image distance is 20 cm. Which of the following statements is/are correct?



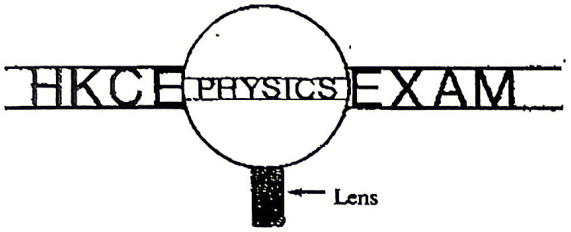
(1) The lens is a converging lens.
(2) The image is diminished.
(3) The shape of the image seen by the observer is 'Ь'.

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only
E. (1), (2) and (3)

4. If a piece of paper is used to cover one-half of the lens in **Question 3**, which of the following describes the change in the image as seen by the observer?

A. The whole image can still be seen but the image becomes dimmer.
B. The whole image can still be seen and its brightness remains unchanged.
C. Only half of the image can be seen and the image becomes dimmer.
D. Only half of the image can be seen but its brightness remains unchanged.
E. The whole image disappears.

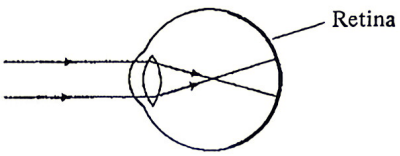
5. A lens is used to look at some print on a paper. The image of the word "PHYSICS" is shown below. Which of the following statements is/are true?



(1) The lens is a converging lens
(2) The image lies between the paper and the lens
(3) The image is real

A. (2) only
B. (3) only
C. (1) and (2) only
D. (1) and (3) only
E. (1), (2) and (3)

6. The diagram below shows the image formation of a distant object by an eye. Which of the following statements is true?



A. The eye is short-sighted and can be corrected by a diverging lens.
B. The eye is short-sighted and can be corrected by a converging lens.
C. The eye is long-sighted and can be corrected by a diverging lens.
D. The eye is long-sighted and can be corrected by a converging lens.
E. The eye is normal.

7. A man uses his spectacles to focus sunlight on a paper and set it on fire. What kind of spectacles does he wear and what defect of vision does he have?

	Spectacles	*Defect of vision*
A.	Converging lens	short-sighted
B.	Converging lens	long-sighted
C.	Diverging lens	short-sighted
D.	Diverging lens	long-sighted
E.	Sun-glass	no defect

8. A convex lens is used as a magnifying glass to read some small print in a book. Which of the following statements is/are correct?
(1) The image distance is greater than the object distance.
(2) The image of the print is real.
(3) The image of the print is erect.
A. (1) only
B. (2) only
C. (3) only
D. (1) and (3) only
E. (2) and (3) only

9. A magnifying glass is used to read some small print in a book. The glass is placed 3 cm from the book and the magnification is 3. What is the distance between the book and the erect image of the print?
A. 1 cm
B. 3 cm
C. 6 cm
D. 9 cm
E. 12 cm

10. Which of the following statements concerning the properties of virtual images is/are correct?
(1) Virtual images can be seen by the eye.
(2) Virtual images can be formed on a screen.
(3) Virtual images can be photographed with a camera.
A. (1) only
B. (2) only
C. (3) only
D. (1) and (3) only
E. (2) and (3) only

Lens Formula

The object distance u, the image distance v and the focal length f of a lens are related by the lens formula:

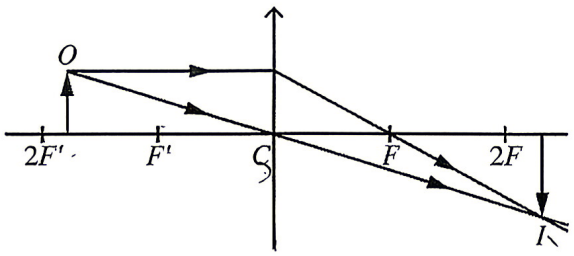
$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

The table below summarizes the signs for different quantities:

Quantity	Sign
object distance u	+
image distance v	+ (for real image)
	− (for virtual image)
focal length f	+ (for convex lens)
	− (for concave lens)

In each of the following figures, determine the signs of u, v and f.

1.

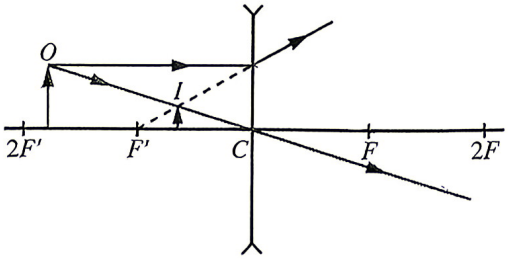


u: (positive / negative)

v: (positive / negative)

f: (positive negative)

2.



u: (positive negative)

v: (positive / negative)

f: (positive / negative)

Example 1

A student examines a stamp using a convex lens of focal length 6 cm. He places the lens 2 cm from the stamp.

(a) Find the image distance.

(b) Is the image real or virtual? Explain your answer.

Example 2

When an object is 10 cm from a lens, a virtual image or magnification 0.2 is formed.

(a) What kind of lens is used? Explain your answer.

(b) Find the focal length of the lens.

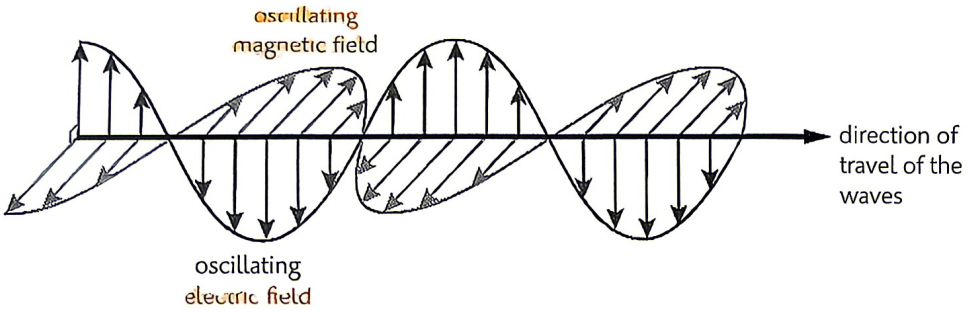
Example 3

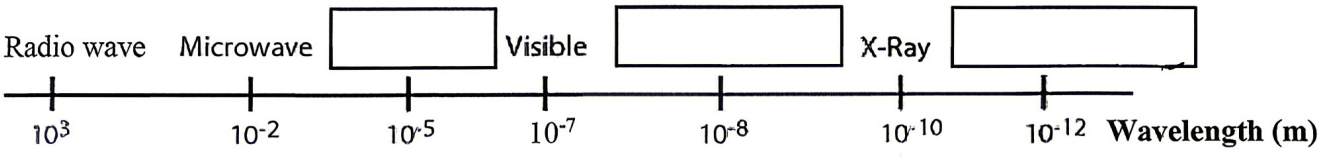
Try to use the lens formula to find the focal lengths on p. 16-17.

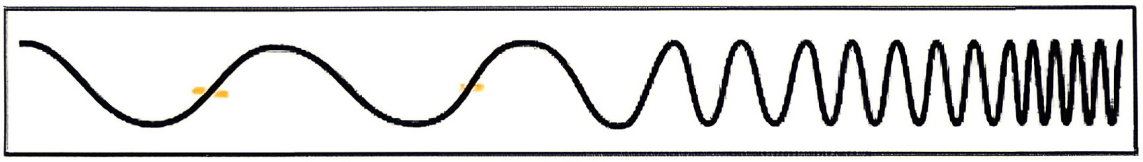
Electromagnetic Waves

Electromagnetic Spectrum

The electromagnetic spectrum is a collection of _____ with all possible frequencies. Electromagnetic waves consist of oscillating electric fields and magnetic fields which are perpendicular to each other.





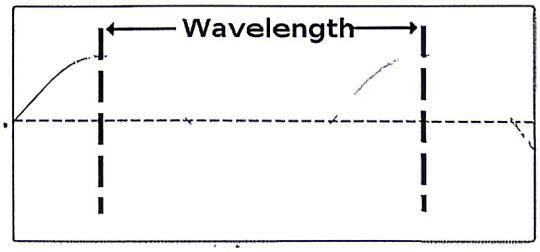


Longer wavelengths Lower frequencies	Shorter wavelengths Higher frequencies

Description of EM waves

Wavelength

- Wavelength is the distance between repeating units of a propagating wave.



Frequency

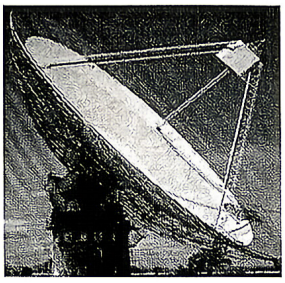
- The unit of frequency is _____.
- 1 Hz means one wave / one oscillation per second, 2 Hz means two waves / two oscillations per second, and so on.

Common properties of EM waves

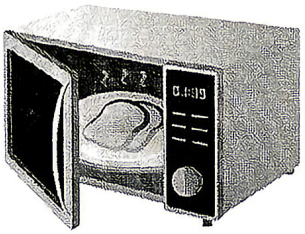
- They are transverse waves.
- They do not need any medium for transmission. They can travel in _____.
- All of them have the same speed in vacuum/air (_____ m/s).
- Wave speed $v = f\lambda$, where the speed v is the same for all EM waves.
  - → Higher the frequency f, _____ the wavelength λ.
  - → Relationship between f and λ
    - f is __directly proportional__ / __inversely proportional__ to λ.

Applications of electromagnetic radiation

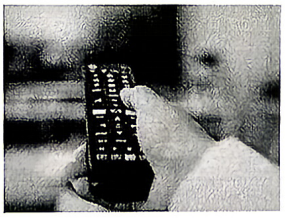
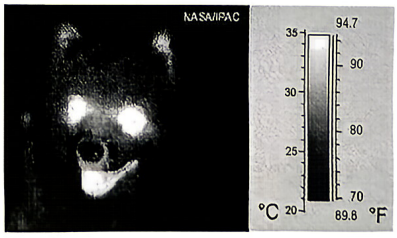
1. Radio wave
   - TV broadcast
   - Radar
   - Telecommunication
   - Remote controls (long range)




2. Microwaves
   - GPS navigation
   - Mobile communication
   - Wireless devices
   - Cooking (microwave oven)




3. Infra-red
   - Remote controls (short range)
   - Sensing nearby objects
   - Measuring temperature
   - Heating
   - Optical fibre communication

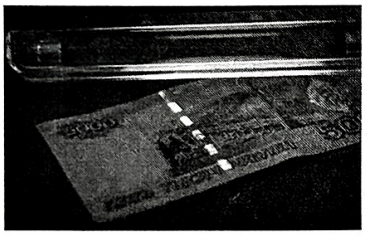



4. Visible light

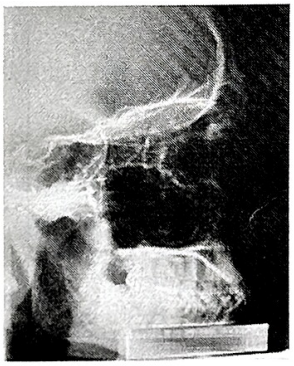
Color	Wavelength
violet	380–450 nm
blue	450–495 nm
green	495–570 nm
yellow	570–590 nm
orange	590–620 nm
red	620–750 nm

- Human sight (only visible light can be seen by human eyes)
- The wavelength: _____ nm (violet) to _____ nm (red).

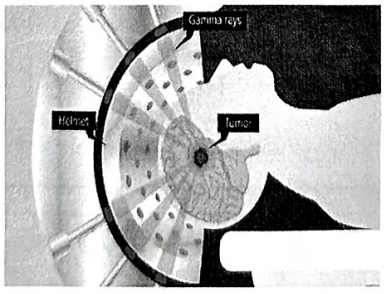
5. Ultraviolet
   - Checking fake banknotes / UV watermark
   - Sterilizing water
   - Causing fluorescent materials to emit light



6. X-ray
   - Medical imaging
   - Luggage scanners
   - Studying crystal structure



7. Gamma ray
   - Medical imaging
   - Radiotherapy



Summary

	Wavelength (m)	Applications
Radio wave	$> 10^{-1}$	
Microwave	10^{-3} - 10^{-1}	
Infra-red	7×10^{-7} - 10^{-3}	
Visible light		
Ultraviolet	10^{-8} - 4×10^{-7}	
X-ray	10^{-11} - 10^{-8}	
Gamma ray	$< 10^{-11}$	

Check your concept

1. Which of the following statements is / are correct?
   I. In visible spectrum, the frequency of purple light is lower than that of red light.
   II. Microwave is used in luggage scanners in airport.
   III. Infra-red is not red in colour.

   A) I only
   B) III only
   C) I and II only
   D) All of the above

   Answer: _____ _____

2. Which of the following statements is / are correct?
   I. The wavelength of microwave is longer than that of X-ray.
   II. Any electromagnetic rays can be transmitted through the vacuum.
   III. Radio wave is mainly used for communication.

   A) I only
   B) I and III only
   C) II and III only
   D) All of the above

   Answer: _____

3. Which of the following statements is / are correct?
   I. All electromagnetic waves need a medium for transmission.
   II. The frequency of ultraviolet light is higher than that of infra-red light.

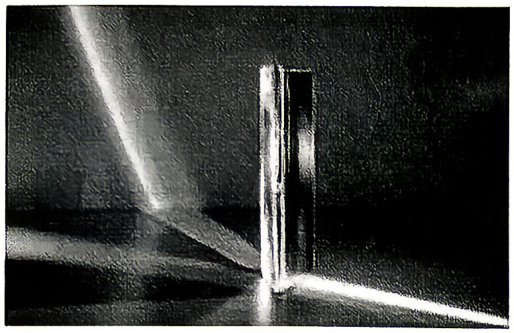
   A) I only
   B) II only
   C) I and II
   D) None of the above

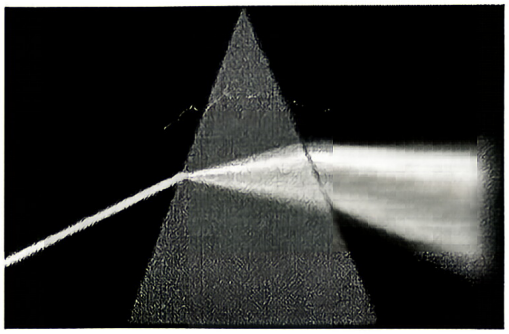
   Answer: _____

4. Given that the wavelength of microwaves is 3 cm. Find the frequency of the microwaves.

Colour of Objects

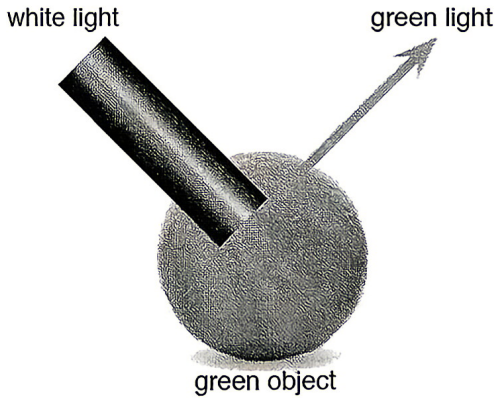
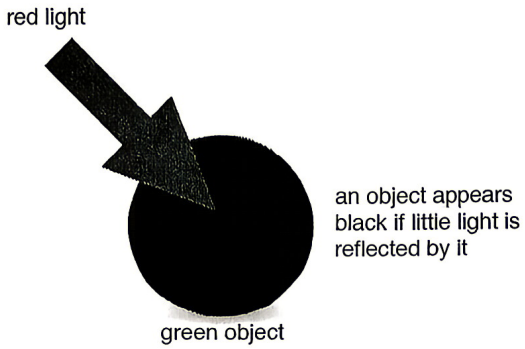
White light is a mix of light of _____. We can use _____ to observe the dispersion phenomenon





We perceive the colour white when our eyes receive light from the entire visible spectrum or an equal mix of light in red, green and blue, the _____of light. Light in the three primary colours can be combined in different intensities to produce the perception of different colours. This allows us to generate colour images on an electronic display like a TV screen.

The colour of an object is determined by the light it reflects.

When white light strikes a green object, most red light and blue light are absorbed while most green light is reflected by the object. Therefore, the object appears green.	
When the green object is observed under only red light, almost all red light is absorbed, no (or little) light is reflected and so the object appears black.	

Check your concept

1. Green objects mainly reflect green light. Blue objects mainly reflect _____
White objects reflect_____.

2. If a white object is placed under white light, most of the visible light in the spectrum is reflected, and the object appears_____.

3. If white objects are placed under red light, most_____ _____are reflected, the object appears _____.

4. A red object appears red in light of all colours. __(T (F) __

5. Light of different wavelengths travel at the same speed in vacuum. __T__ ___

6. Which of the following statements about light is/are correct?
(1) Light is a wave.
(2) Light of wavelength 400 nm is red to humans.
(3) Light transfers energy.
A. (1) only B. (1) and (2) only
C. (1) and (3) only D. (2) and (3) only

7. Which of the following objects appear(s) black to an observer?
(1) A white object in total darkness
(2) A green leaf in red light
(3) A red ball in white light
A. (1) only B. (2) only
C. (1) and (2) only D. (1), (2) and (3)

8. Name the three primary colours of light. _____

Wave

Introduction to Wave

What is wave?

Examples:

1._____

2._____

Definition of wave

A wave is produced from _____ that propagates through space. It means that the vibrations can travel from one place to another.

From another point of view,

wave is a propagation of energy through matter or space.

It transmits _____ but not _____.

!!! Important !!!

Take water wave as an example:

Water Molecules

☐ vibrate / oscillate

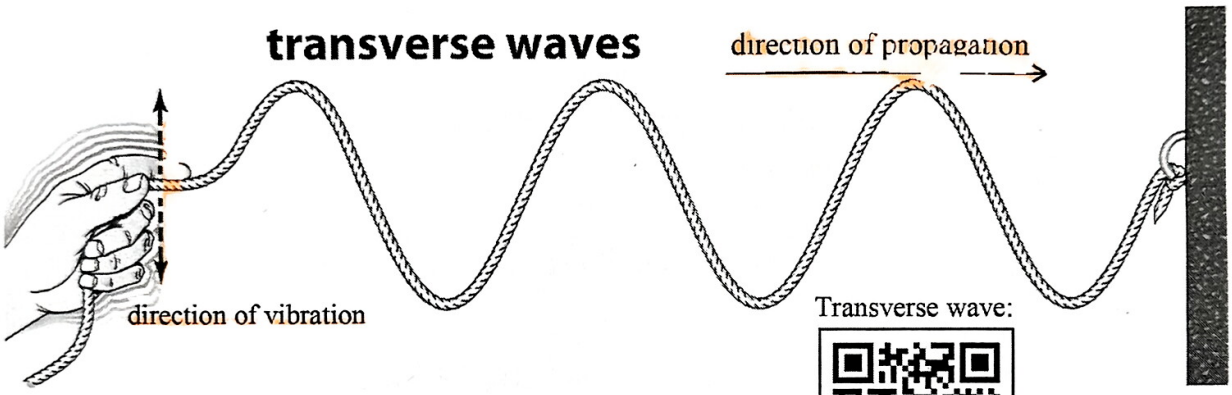
☐ have net movement

Types of waves

Type	Examples
⟍	
X	

Transverse Wave

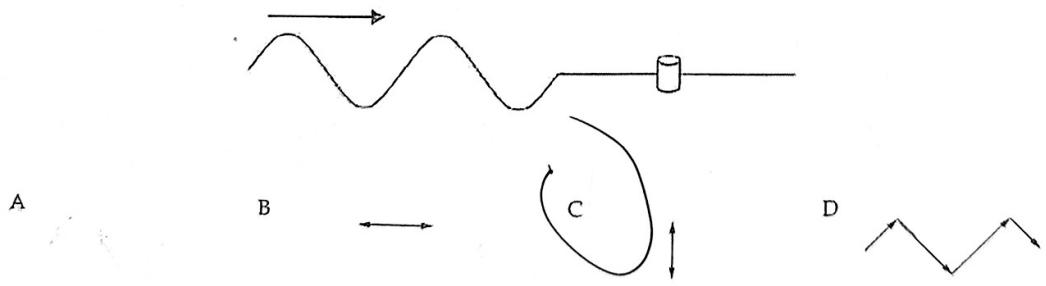
The direction of vibration is _perpendicular / parallel_ to the direction of propagation or the direction of energy transfer.



Transverse wave:

Exercise

1. A can is put on the water surface. Which of the following figures correctly shows the motion of the can when the water wave (transverse wave) passes by?

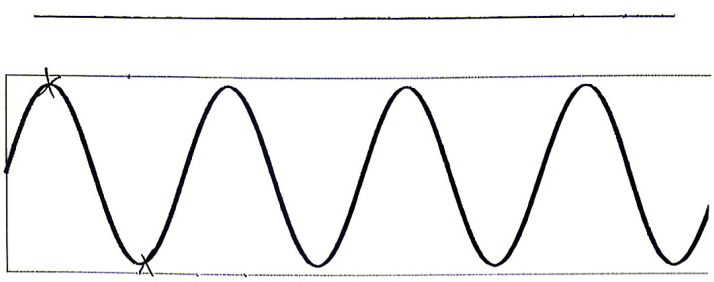


Answer: _____

Description of Waves

Crests & Troughs

- _____ are the high points of a wave at certain instant.
- _____ are the low points of a wave at certain instant.



Amplitude

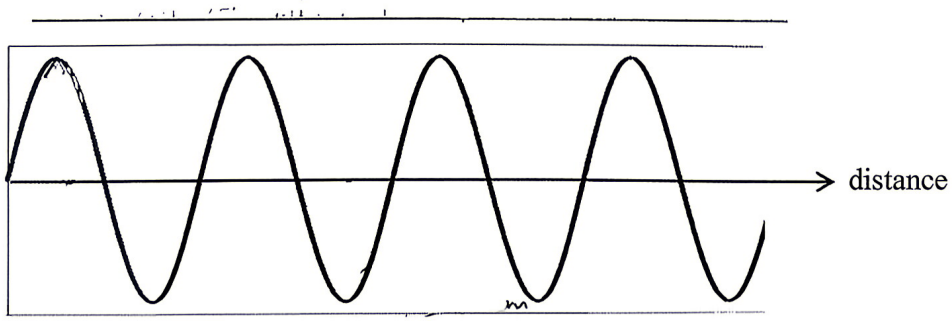
Definition

The amplitude of a wave is the magnitude of the vibrations from the equilibrium position

- Physical meaning: describe how strong does the wave vibrate.
- Symbol: _____ Unit: _____

Larger amplitude => __More / Less__ energy of the wave carries.

Hints: *Think about the case of water wave!!*



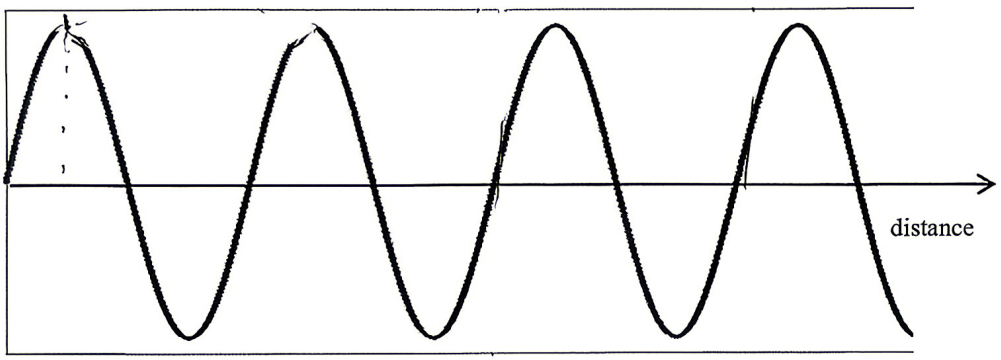
Wavelength

Definition

The wavelength of a wave is the shortest distance in which a wave repeats itself.

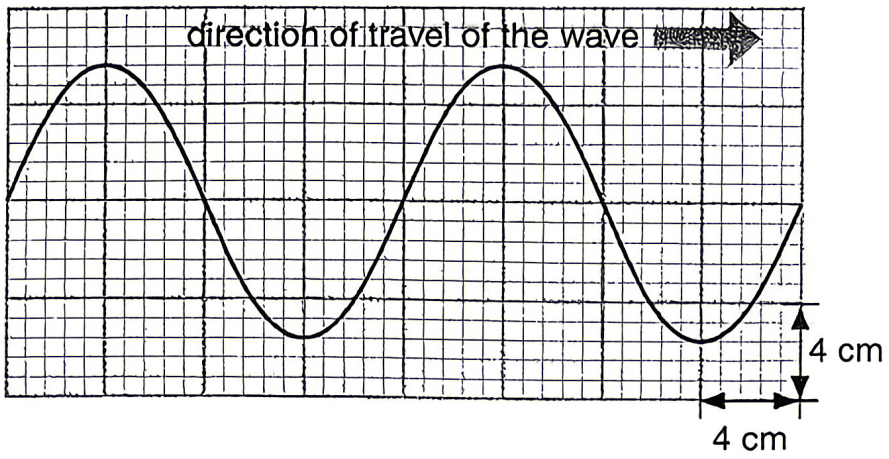
- Common way to measure the wavelength:
  The distance between two successive crests or troughs.

- Symbol: _____ Unit: _____



Exercise

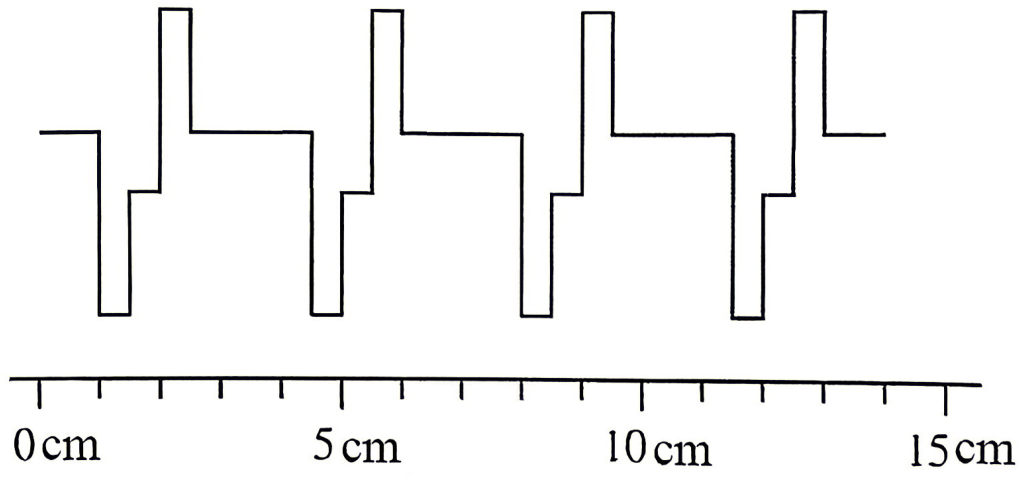
1.



(a) What is the amplitude of the wave? _____

(b) What is the wavelength of the wave? _____

2.



Find out the wavelength of the wave shown in the diagram.

_____

Period

Definition

- The time required to form 1 complete wave
- The time for a particle on the wave to complete 1 oscillation.
- The time required for the wave to propagate 1 wavelength.

$$\text{Period} = \frac{Time}{Number\ of\ oscillations}$$

- Symbol: _____ Unit: _____
- Example:

  In 1 second, there are 2 complete oscillations, $T = \frac{1}{2} = 0.5$ s.

  In 2 seconds, there are 8 complete oscillations, $T =$ _____ s.

Frequency

Definition

Frequency of a wave is the number of oscillations in 1 second.

$$\text{Frequency} = \frac{Number\ of\ oscillations}{Time}$$

- Physical meaning: how frequent a vibration occurs.
- Symbol: _____ Unit: _____ ( )

Check your concept

1 oscillation in 1 second, $f =$ _____ Hz

3 oscillations in 1 second, $f =$ _____ Hz

4 oscillations in 2 seconds, $f =$ _____ Hz

1 oscillation in 5 seconds, $f =$ _____ Hz

Relationship between frequency and period

$$f = \frac{1}{T}$$

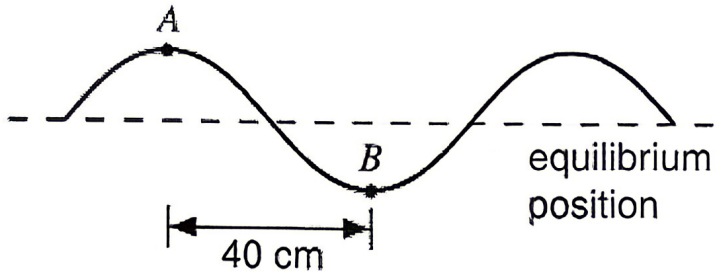
f= 10 Hz → T = _____

T= 0.05 s → f = _____

f= 1 kHz → T = _____ (k = 1000)

Exercise

1. At the instant shown, particles *A* and *B* are at a crest and trough of a transverse wave respectively. The particles are 40 cm apart when they are at their equilibrium positions. Particle *A* takes 8 s to complete 2 oscillations.



(a) What is the wavelength? _____

(b) What is the period? _____

(c) What is the frequency? _____

Wave speed

Definition

The wave speed is the distance that the wave travels in 1 second.

$$\textbf{Wave speed} = \frac{\textbf{Distance}}{\textbf{Time}}$$

- Amplitude and frequency do not affect the wave speed.
- **The wave speed ONLY depends on the properties of the medium.**

  (such as water depth, tension, density, etc.)

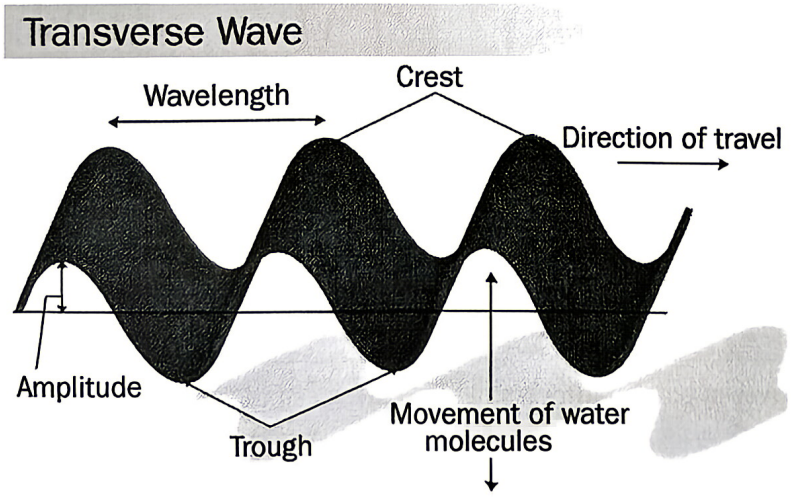
- Symbol: _____ Unit: _____

$$v = \frac{Distance}{Time} = \frac{\lambda}{T}$$
$$= \lambda \times f \ \ (as \ \frac{1}{T} = f)$$
$$= f\lambda$$

$$\boldsymbol{v = f\lambda}$$

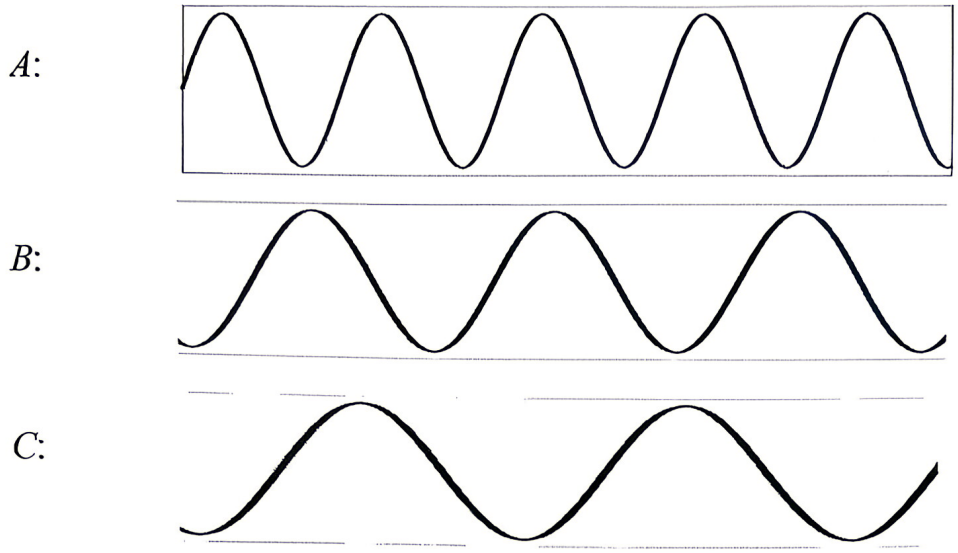
*** This is the most important equation. TRUE for ALL kinds of waves. ***

The whole picture:



Exercise

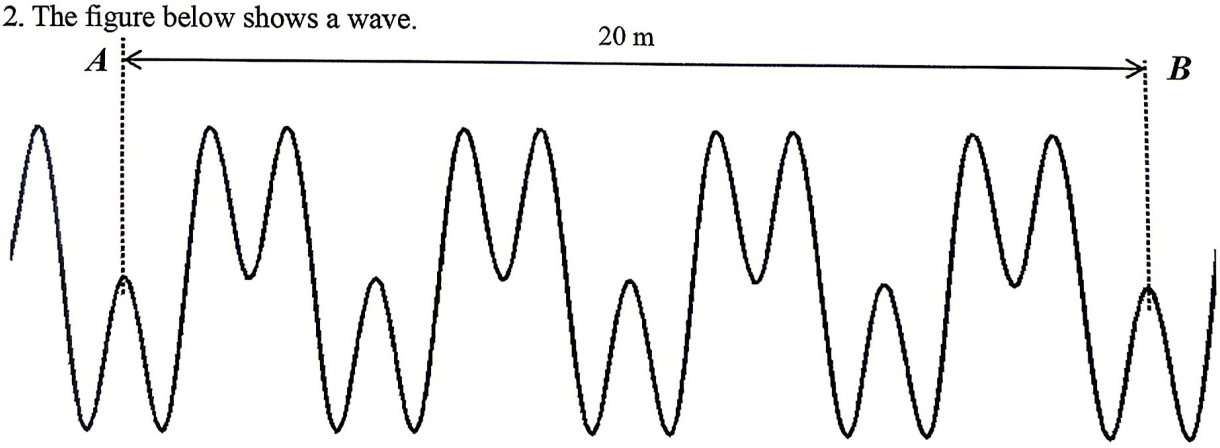
1. The figure below shows three waves with the same wave speed.



(a) Which wave (*A*-*C*) has the shortest wavelength? _____ A _____

(b) Which wave (*A*-*C*) has the highest frequency? _____ A _____

2. The figure below shows a wave.



(a) What is the wavelength of this wave?

_____ _____

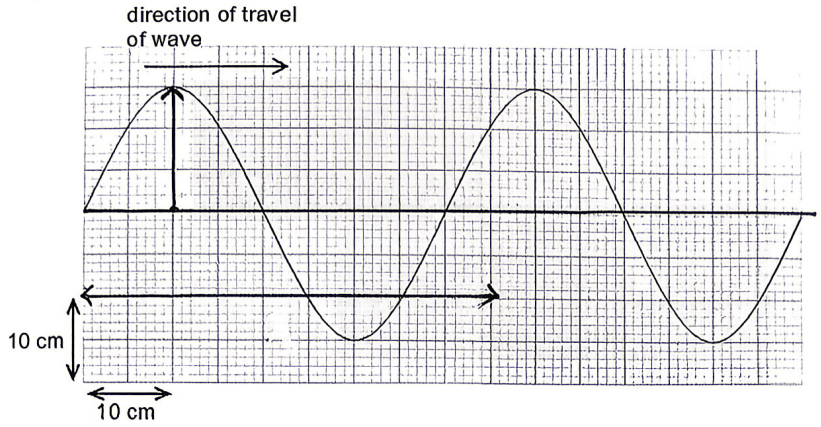
(b) If point *A* arrives at point *B* after 4 s, what is the speed of the wave?

_____

(c) What is the frequency of this wave?

_____ _____

3. A string is shaken at one end at 4 Hz and a wave travels from left to right. The figure below shows the shape of the string at a certain instant.



(a) (i) Is the travelling wave transverse or longitudinal? _____

(ii) What is the relationship between the direction of vibration of the particles and the travelling direction of the wave? _____

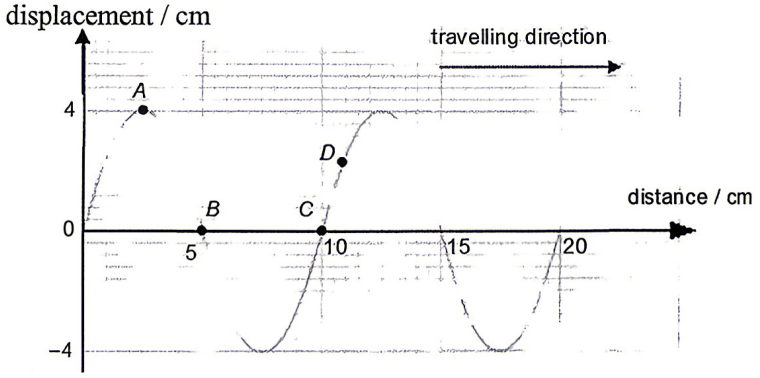
(b) Find

(i) its amplitude. _____ (ii) its wavelength. _____

(iii) its period. _____

(iv) its speed. _____

4. A transverse wave is travelling along a string. The figure below shows the shape of the wave at $t = 0$.



(a) Give an example of transverse waves other than string waves. _____

(b) (i) State the amplitude of the wave. _____

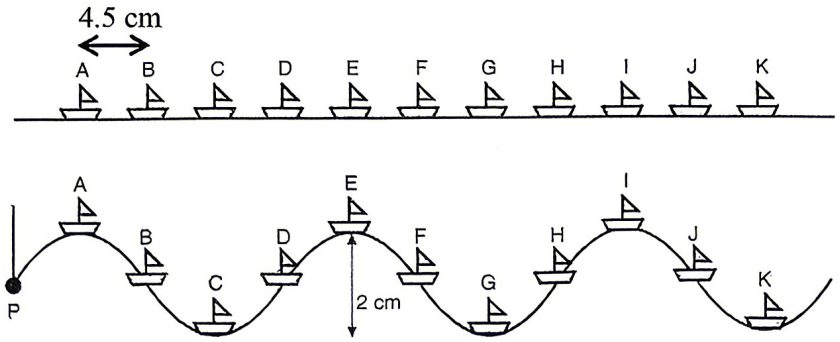
(ii) State the wavelength of the wave. _____

(c) If particle *B* performs 5 complete oscillations in 2 s,

(i) find the frequency of the wave. _____

(ii) find the speed of the wave. _____

5. The first diagram below shows a vibrator P in a ripple tank with 11 small toy boats A to K. The separation between successive boats is 4.5 cm. The frequency of the vibrator is 15 Hz.



The position of the boats at an instant is as shown in the second diagram above.

(a) What is the wavelength? _____

(b) What is the amplitude of the wave? _____

(c) What is the wave speed of the water? _____

Now, the frequency of the vibrator P increases to 30 Hz.

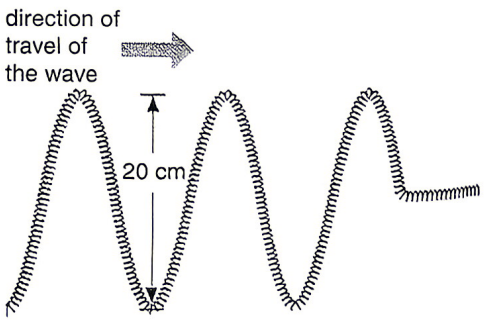
☆ (d) Will the wave speed change? _____

(e) What is the wavelength? _____

6. A long spring is stretched to 3 m and placed on the floor. A student shakes one of its ends and a pulse is produced. It takes 1.5 s for the pulse to travel from one end to the other. He uses this method to estimate the travelling speed on this spring.

(a) What is the speed of the pulse? _____

Now, he shakes the spring at a frequency of 4 Hz and a train of waves is produced. Find the



☆ (b) travelling speed _____

(c) wavelength

_____

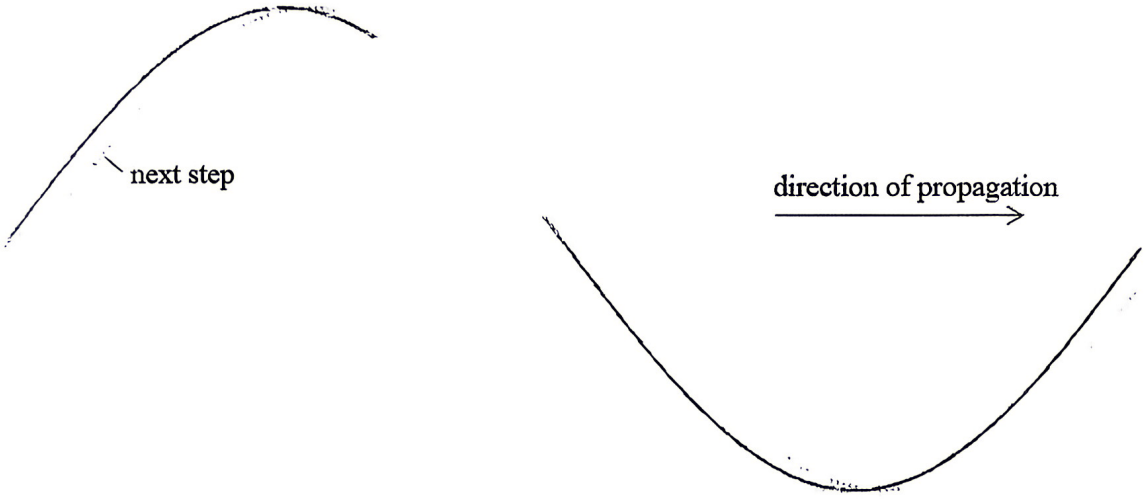
(d) amplitude _____

Particle Motion

For transverse waves, the particle motion has three possibilities:

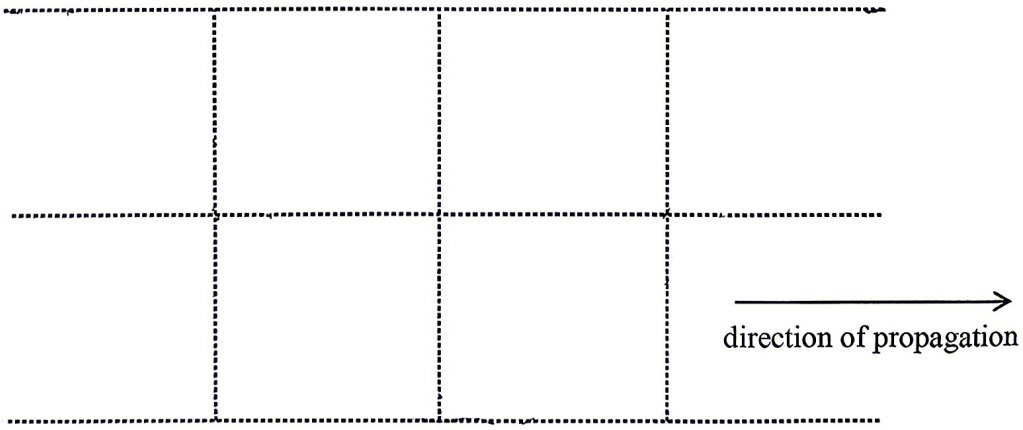
moving upwards
moving downwards
momentarily at rest

To understand the motion of particles, we need to know the waveform at the next step first. The waveform will shift along the direction of propagation.

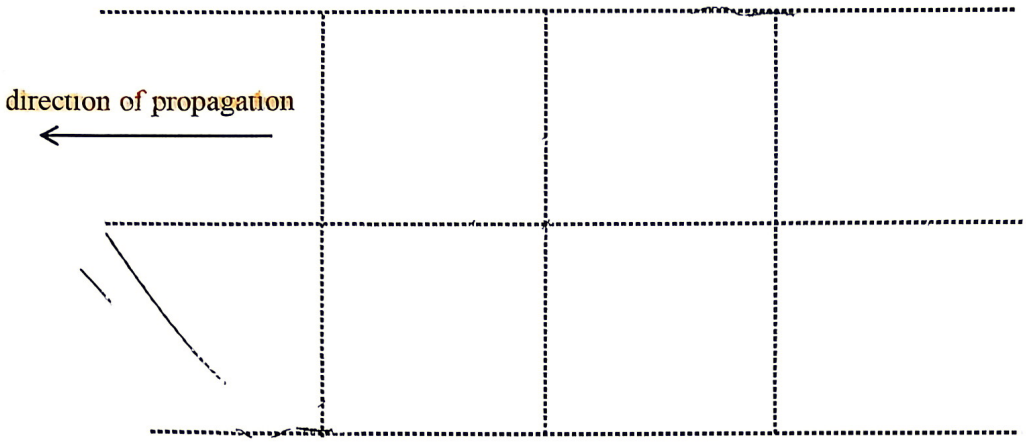


Exercise

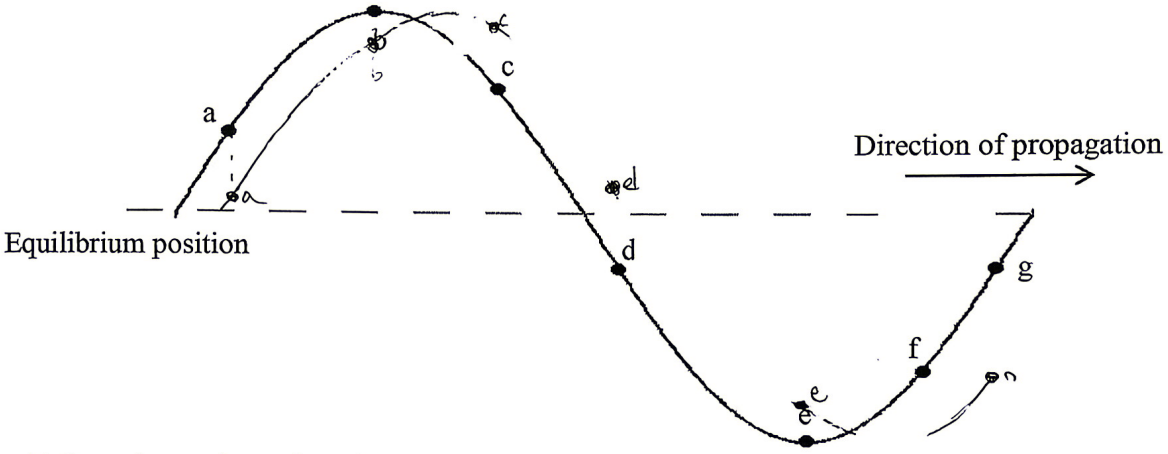
1) Draw the waveform at the next step.



2) Draw the waveform at the next step.



3) The waveform below shows the waveform of a wave at a certain instant. It's like a photo taken at an instant.
   (a) Draw the waveform at the next step.
   (b) Label the positions of particles *a* to *g* at the next step.



(c) State the motions of particle *a* to *g*.

a: _____ *e*: _____ (Turning around)

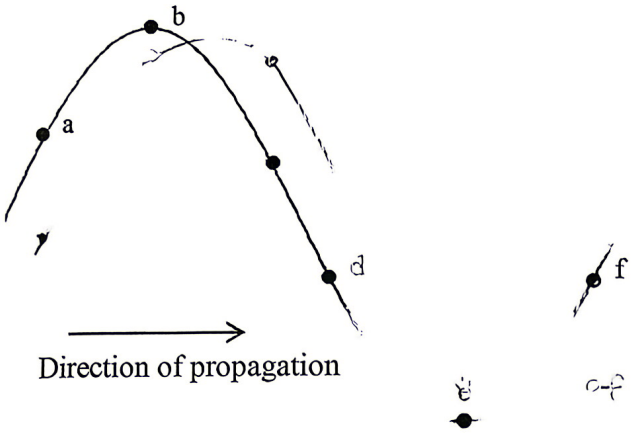
b: _____ (Turning around)

c: _____ *f*: _____

d: _____ *g*: _____

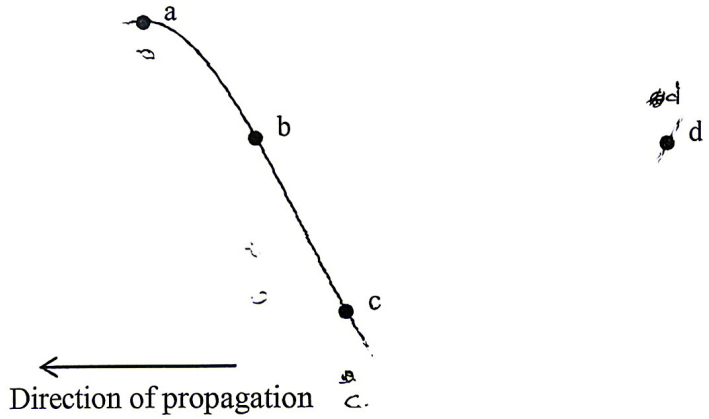
Particles at crests or troughs are momentarily at rest.

4. State the motion of each particle in the figure below.



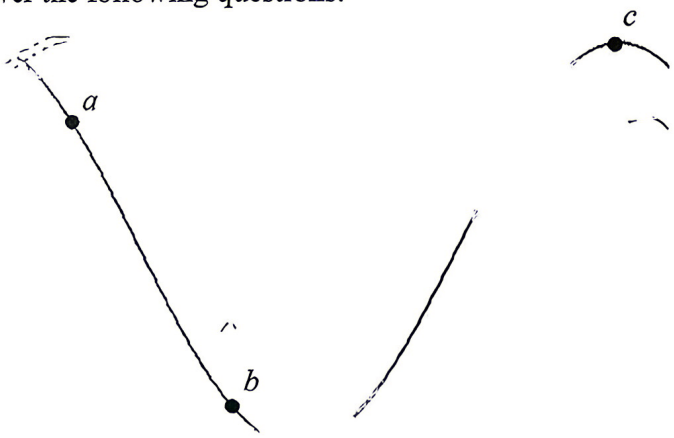
Particle	Motion
a	
b	
c	
d	
e	
f	

5. State the motion of each particle in the figure below.



Particle	Motion
a	
b	
c	
d	

6. Answer the following questions.



If particle *a* is moving upward, which direction does the wave travel?

_____

State the motions of particles *b* and *c*.

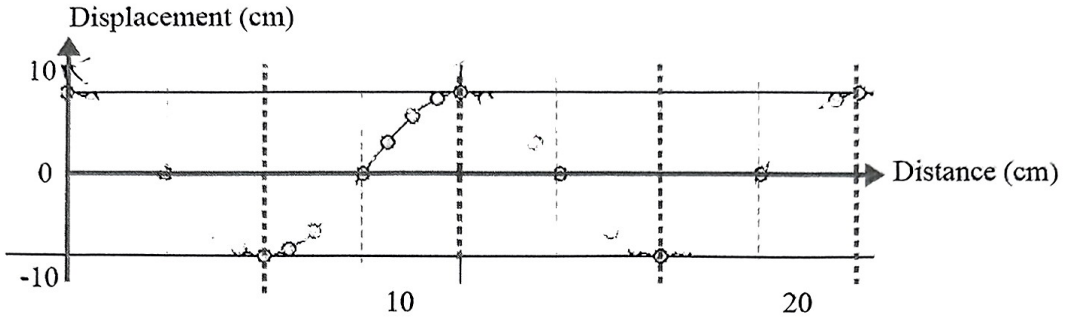
b: _____

c: _____

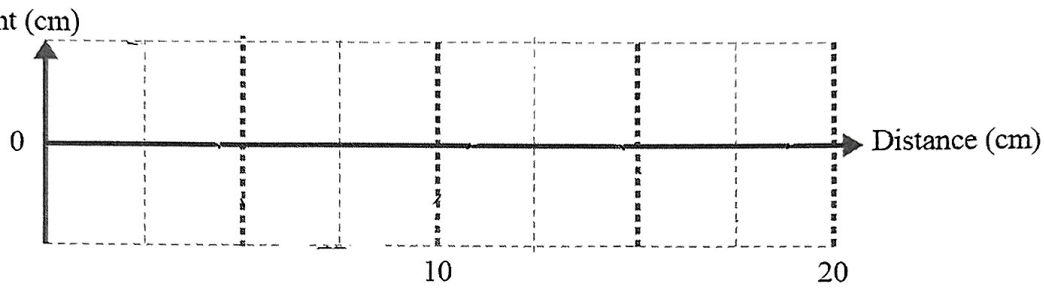
Displacement - Distance Graph

A wave with **period of 2 s** is travelling from left to right. The figure below shows the waveform when $t = 0$ s. Draw the waveform when $t = 0.5$ s, $t = 1.0$ s, $t = 1.5$ s and $t = 2.0$ s.

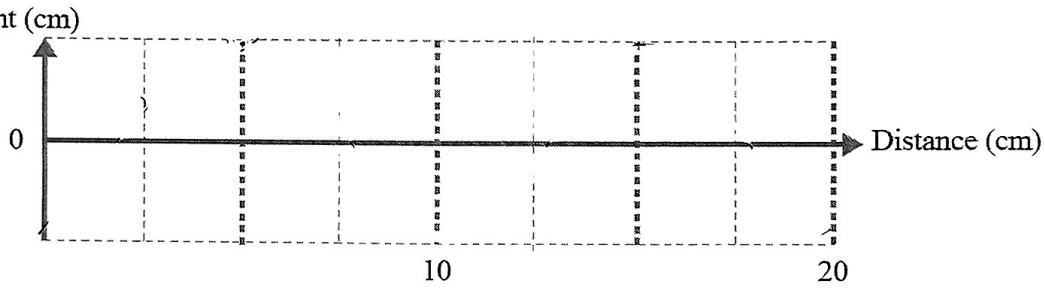
Simulating string wave:



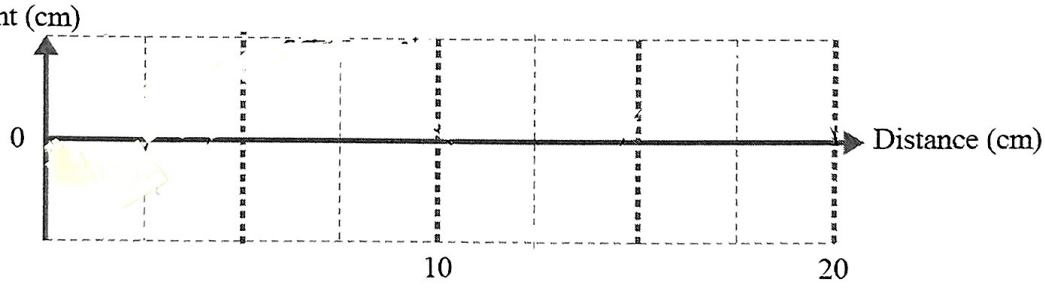
t = 0.5s
(____ period)



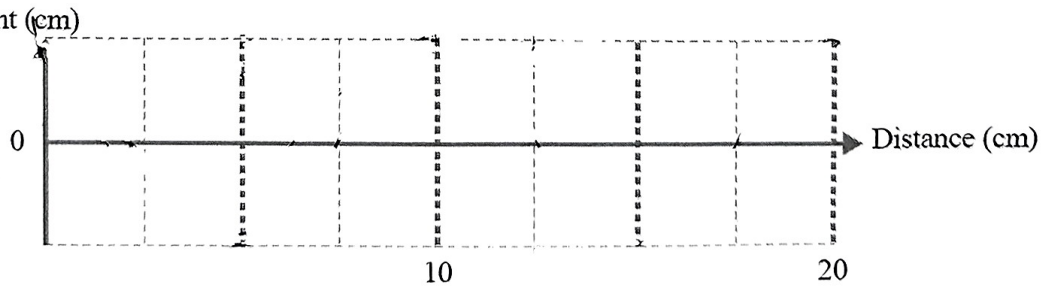
t = 1.0s
($\frac{1}{2}$ period)



t = 1.5s
(____ period)



t = 2.0s
(____ period)



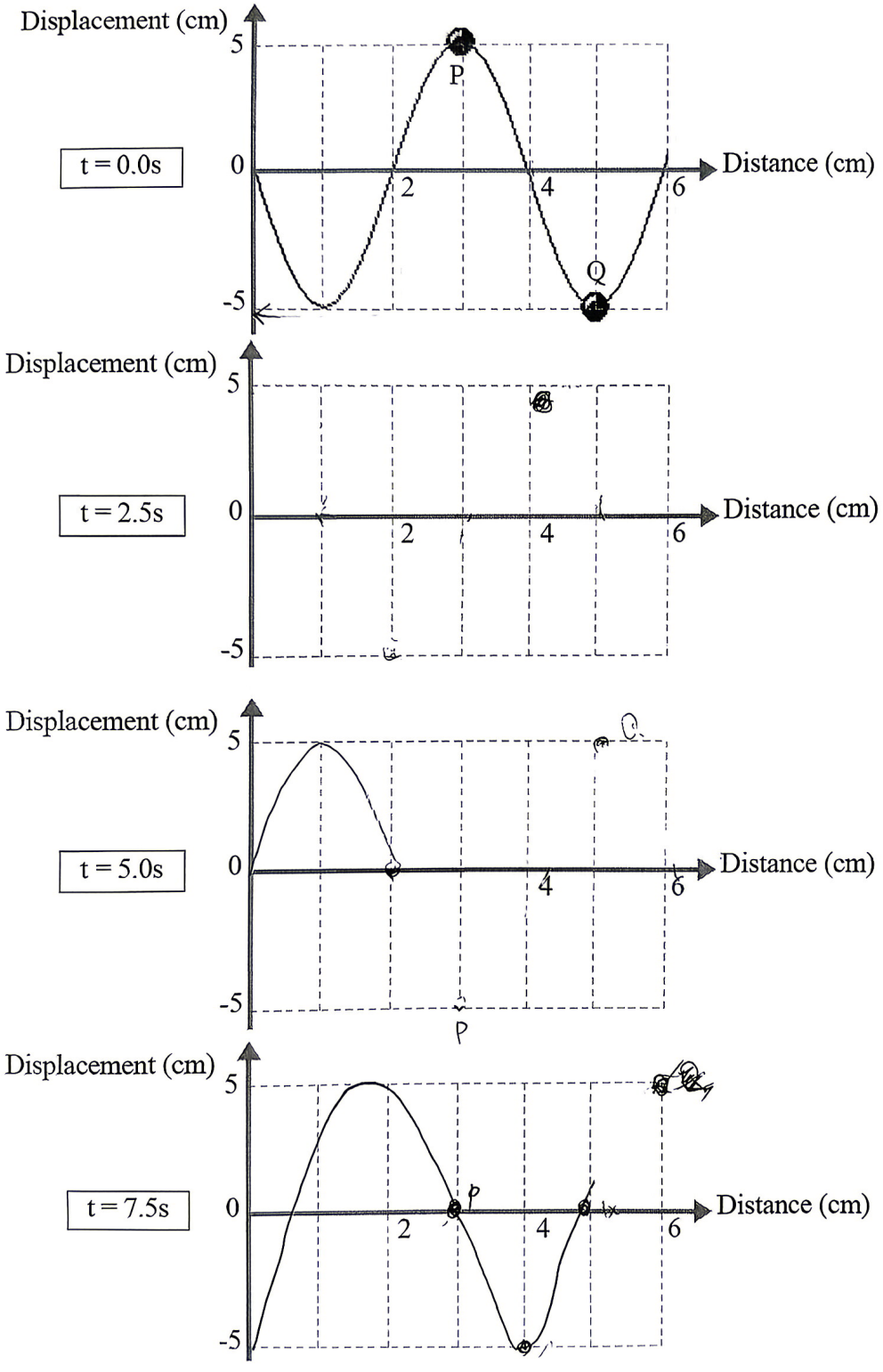
1 wave in 10s

Exercise

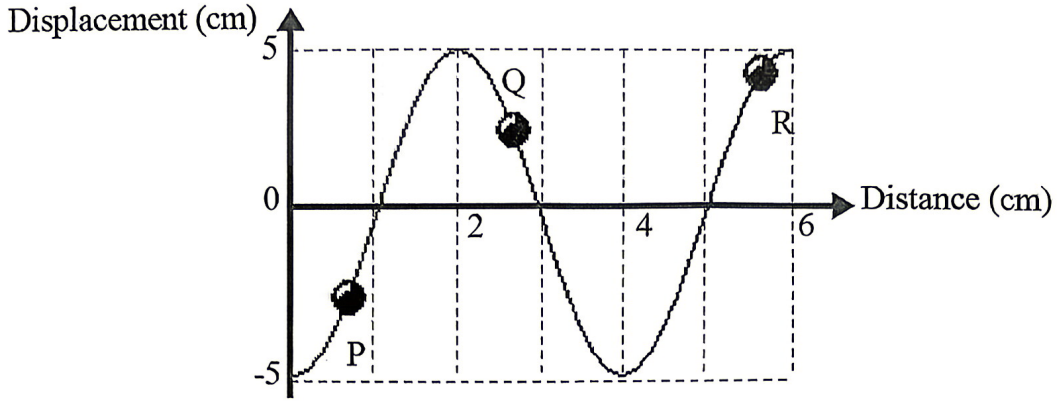
1. A wave with **period of 10 s** is travelling from left to right.

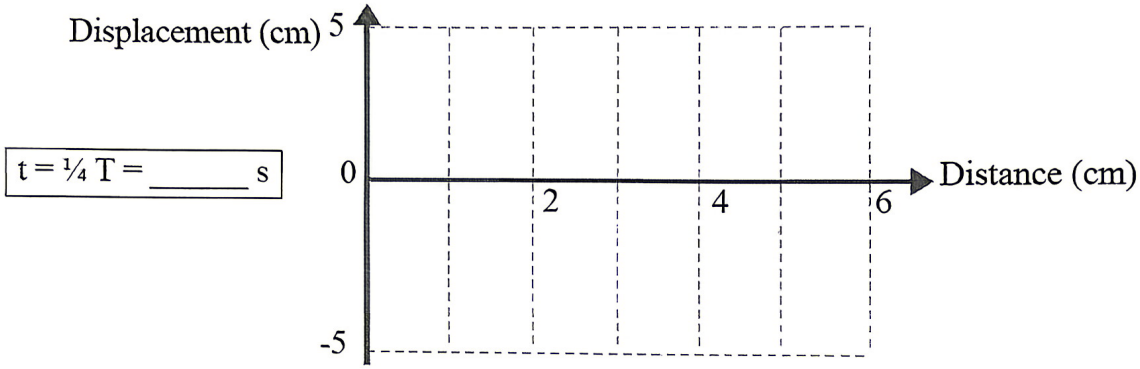
(1) Draw the waveform when $t = 2.5$ s, $t = 5.0$ s and $t = 7.5$ s.

(2) Point out the position of particles P and Q.

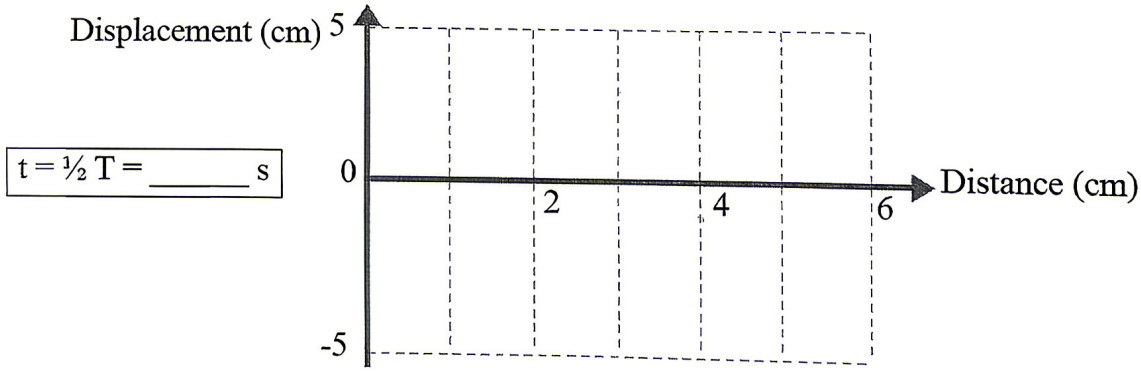


2. A wave with **period T = 20 s** is travelling from left to right.
(1) Draw the waveform when $t = \frac{1}{4}$ T, $t = \frac{1}{2}$ T and $t = \frac{3}{4}$ T.
(2) Point out the position of particles *P*, *Q* and *R*.

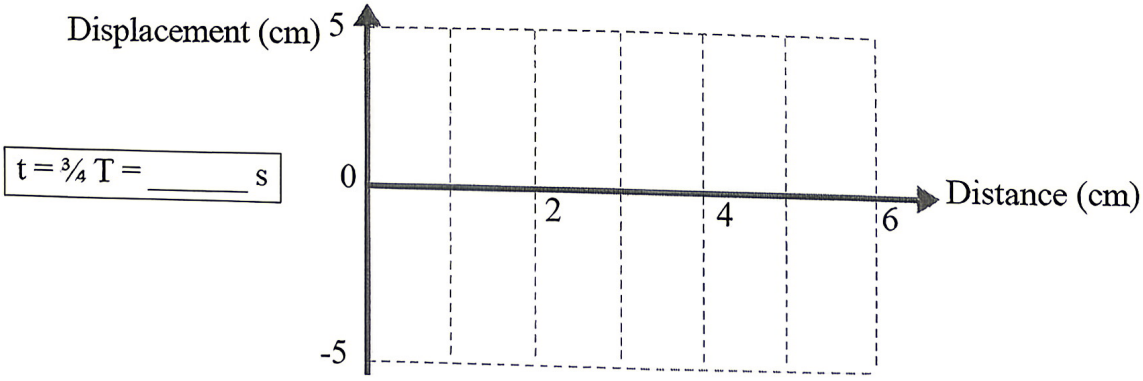




t = ¼ T = _____ s



t = ½ T = _____ s



t = ¾ T = _____ s

Investigative Study

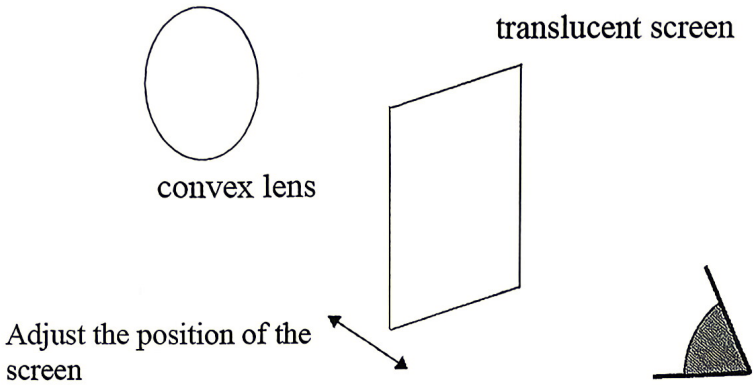
Finding the Focal Length of a Convex Lens

Aim: to find out the focal lengths of two convex lenses.

Equipment: convex lenses, translucent screen, ray box

Procedures:

1. Hold the convex lens *A* (thicker) and look at the image formed from a very far object, outside the school.
2. Place a translucent screen between the convex lens and your eyes.



3. Adjust the position of the screen so that an image is formed on it. Measure the distance between the lens and the screen
4. Repeat the experiment using convex lens *B* (thinner).

Results:

Distance between the lens *A* (thicker) and the screen: _____

Distance between the lens *B* (thinner) and the screen: _____

Conclusion:

The focal lengths of the convex lenses *A* & *B* are _____ and _____ respectively.

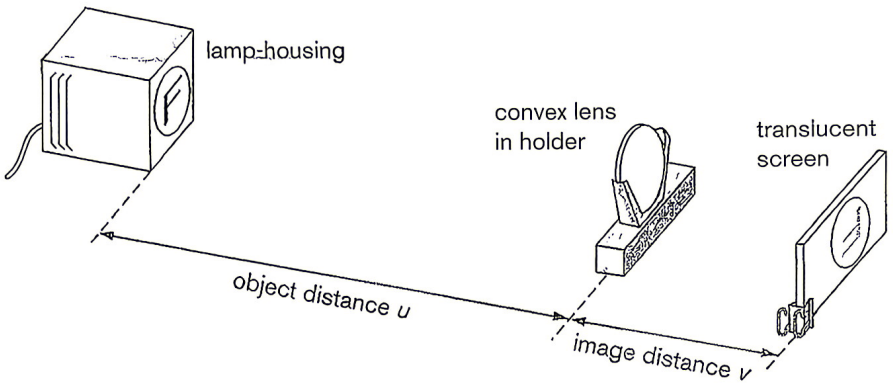
Image Formed by a Convex Lens

Aim: to find out the position and the nature of the image formed by a convex lens

Equipment: lamp, translucent screen, convex lens, meter rule

Procedures:

1. Set up the equipment as follow. Set object distance $u = 15$ cm.



2. Adjust the position of the translucent screen so that the image is formed on it.
3. Measure image distance v and observe the image size.
4. Repeat the procedures with larger values of u.

Results:

u (cm)	v (cm)	Image size (larger / the same size / smaller)
20		
25		
30		
40		
50		

Special cases

u (cm)	Clear image on the screen?	Image size (larger / the same size / smaller)
5		
8		

Discussion:

1. As u increases from 20 cm to 50 cm, how does the image size change?

2. For the cases of u = 5 cm or 8 cm

   (a) Can you locate a clear image using the screen?

   (b) See the image directly through the lens. Describe the image formed.

   (c) If u increases from 5 cm to 8 cm, how does the image change?

3. Estimate the focal length of the convex lens.
   Hints: Think about the condition that $u = v$ (the image has the same size as the object).

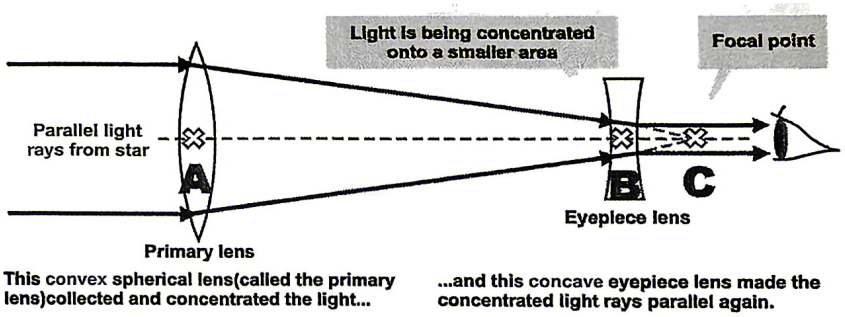
Making Your Own Telescope

Aim: To make a telescope using the kit supplied and understand the working principle of a telescope.

Equipment: A telescope kit

Principle: Telescopes allow us to see more in two ways:

- the telescope aperture is bigger than the pupil of a human eye, so more light is collected, making dim objects visible.
- the telescope magnifies the objects being viewed, making distant objects appear bigger.



Discussion:

1. Where is the principal focus of the primary lens / objective lens?

   Using *A, B, C* to represent your answer: _____

2. Where is the principal focus of the concave eyepiece?

   Using *A, B, C* to represent your answer: _____

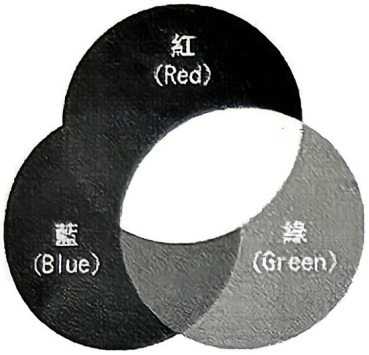
3. Slide the tubes to look at distant objects. What is the nature of the image observed?

   Magnified / Diminished Inverted / Erect

4. This telescope system is known as Galilean telescope. You can find out more at:

Mixing light in the three primary colours

In the following table, record the colors of the three color lights after mixing on the screen.



Colours of light	Observed colour of the mixed light
red, green and blue	
red and green	
red and blue	
green and blue	

Colours of objects under different colors of light

Objective: Study the color of objects under different colors of light

Equipment: (1) White, red, green and blue cardboards (2) Red, blue, green LED torches

Steps:

1. Prepare four cardboards in white, red, green and blue respectively.
2. Switch off all lights and close all curtains in the laboratory to keep the laboratory dark.
3. (a) Switch on an LED torch that gives off white light and put it in front of each cardboard in turn. Record the observed colour of each cardboard.
   (b) Repeat step (a) using a torch that gives off red light.
   (c) Repeat step (a) using a torch that gives off green light.
   (d) Repeat step (a) using a torch that gives off blue light.

Result:

	Colour of cardboard in			
	white light	**red light**	**green light**	**blue light**
White cardboard				
Red cardboard				
Green cardboard				
Blue cardboard				

2024-2025 Second Term Examination Past Paper

S3 Second Term Examination (2024-2025)

Physics

(1 hour)

Date: 3rd June 2025 Name: _____

Time: 10:15 a.m. – 11:15 a.m. Class: _____ No.: _____

Instructions to students:

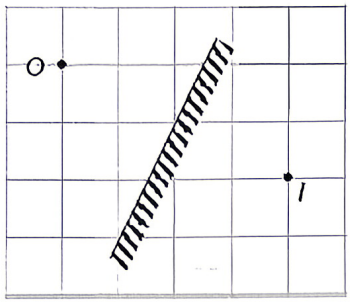
1. Write your name, class and class number on both the question paper and the answer sheets.
2. Answer ALL questions.
3. Write down all the answers on the answer sheets.
4. Hand in the question paper and the answer sheets at the end of the examination.
5. The total mark of the paper is 60.
6. The paper consists of two sections: Section A Multiple Choice Questions (20 marks) and Section B Structured Questions (40 marks).
7. The numerical answers should be either exact or correct to 3 significant figures.

Section A: Multiple Choice Questions (20 marks)

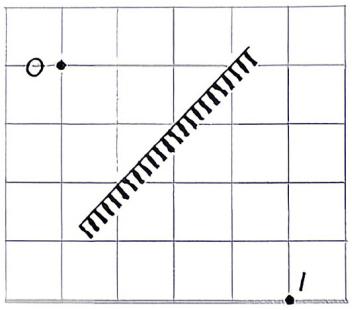
1. Which of the following statements about the reflection of light is/are correct?
   (1) It only occurs on smooth surfaces.
   (2) It always follows the laws of reflection.
   (3) When incident rays are parallel, clear images will be formed.
   A. (1) only
   B. (2) only
   C. (2) and (3) only
   D. (1), (2) and (3)

2. Which of the following diagrams shows the correct position of image *I* of object *O* formed by the plane mirror?

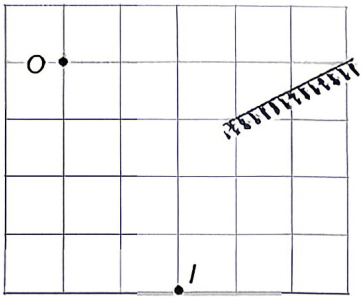
(1)



(2)

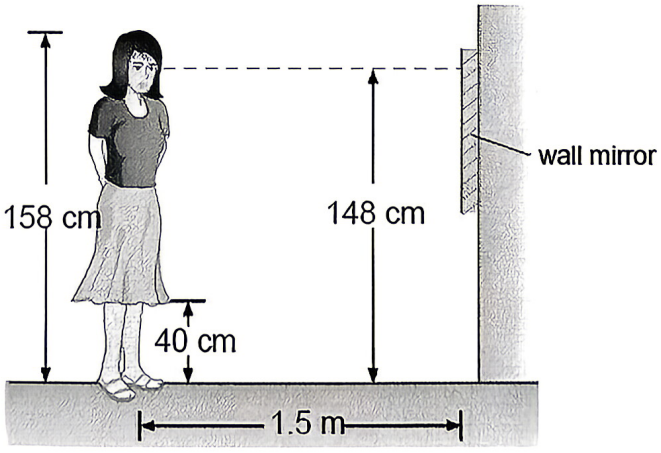


(3)



A. (1) only
B. (2) only
C. (1) and (3) only
D. (1), (2) and (3)

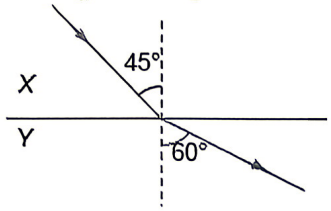
3. A 158 cm tall girl stands 1.5 m from a wall mirror as shown below. Her eyes are 148 cm above the floor. The girl can just see the bottom of her skirt, which is 40 cm above the floor, in the mirror. What is the height of the bottom edge of the mirror above the floor?



A. 40 cm
B. 54 cm
C. 80 cm
D. 94 cm

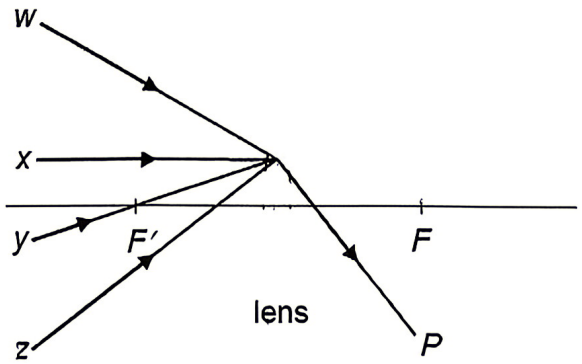
4. A light ray bends towards the normal when it travels from medium P to medium Q. Which of the following statements is **incorrect**?
   A. The light speed in medium P is higher than that in medium Q.
   B. The refractive index of medium P is greater than that of medium Q.
   C. With respect to vacuum, the critical angle of medium P is larger than that of medium Q.
   D. Total internal reflection will not occur no matter how large the angle of incidence in medium P is.

5. A ray of light travels from medium X to medium Y as shown below. Which of the following gives the ratio of the speed of light in X to that in Y?



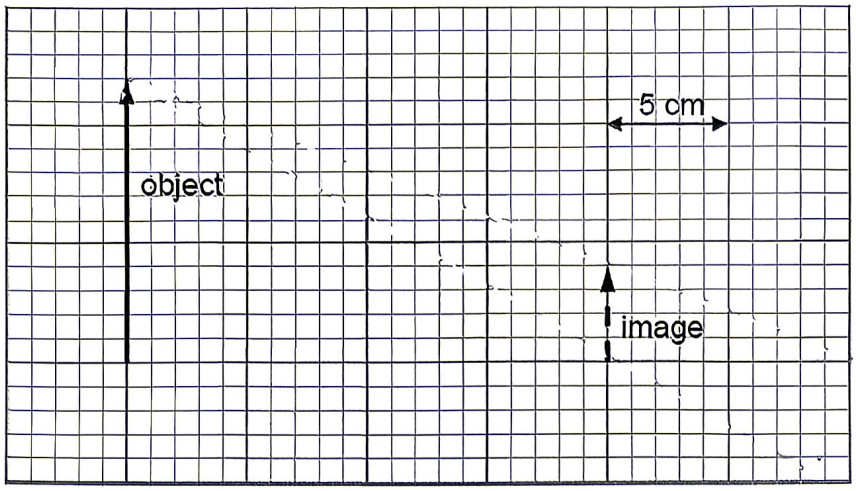
   A. 3 : 4
   B. $\sqrt{3} : \sqrt{2}$
   C. 4 : 3
   D. $\sqrt{2} : \sqrt{3}$

6. P is an emergent ray from a lens as shown below. F and F' are the principal foci of the lens. Which of the following rays is a possible incident ray?



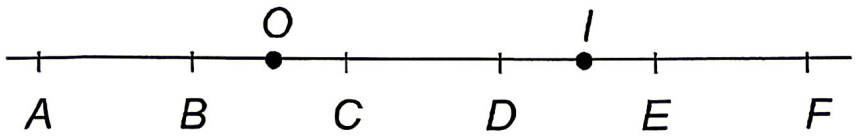
   A. Ray w
   B. Ray x
   C. Ray y
   D. Ray z

7. An object is put in front of a lens and a virtual image is formed. The figure below shows the positions of the object and the image. What is the focal length of the lens?



A. 5 cm
B. 10 cm
C. 15 cm
D. 20 cm

8. In the diagram below, intervals *AB*, *BC*, *CD*, *DE* and *EF* are of equal length. An object is placed at *O*. When a lens is put in front of the object, an image of the object is formed at *I*.



Which of the following show(s) the possible position(s), type(s) and focal length(s) of the lens?

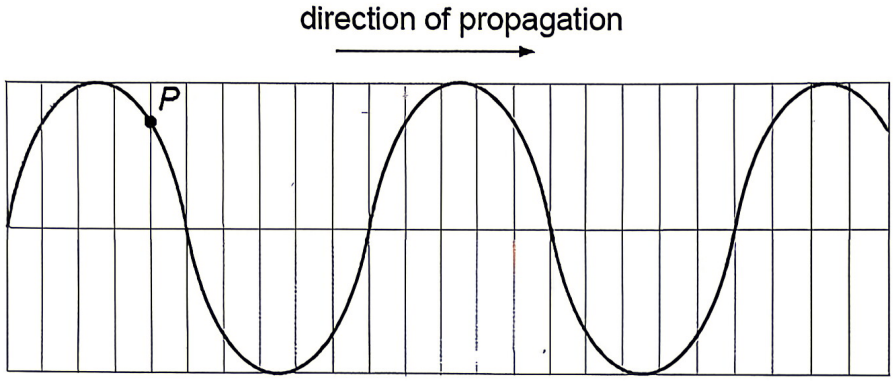
	Position	Type	Focal length
(1)	*F*	concave lens	about 2 intervals
(2)	*C*	convex lens	about 1 interval
(3)	*D*	convex lens	about 1 interval

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

9. A cork floating on the water surface vibrates up and down 12 times in 4 s when a wave passes through it. The distance between two successive troughs of the wave is 12 cm. What is the speed of the wave?

   A. $0.04\ m\ s^{-1}$
   B. $0.36\ m\ s^{-1}$
   C. $0.48\ m\ s^{-1}$
   D. $1.44\ m\ s^{-1}$

10. A transverse wave is travelling from left to right in a medium. The frequency of the wave is 0.2 Hz. The figure below shows the waveform at time $t = 0$.



When will particle P return to its position as shown above for the first time.

A. $t = 1.5$ s
B. $t = 2.5$ s
C. $t = 3.5$ s
D. $t = 5$ s

End of Section A

Section B: Structured Questions (40 marks)

1. A small point object O is in front of a plane mirror. Figure 1 on the answer sheet shows the reflected rays of two light rays travelling from O to the mirror.
   (a) Locate the image of O in Figure 1. (2 marks)
   (b) Shade the largest region in which an observer can see the image of O in Figure 1. (2 marks)

2. Figure 2.1 shows a well illuminated dining room. There is a clock hanging on the wall at C. Samson stands at point S and faces the window which is fitted with a clear glass pane from the ceiling to the floor. It is dark outside. Samson can see the clock's image in the window.

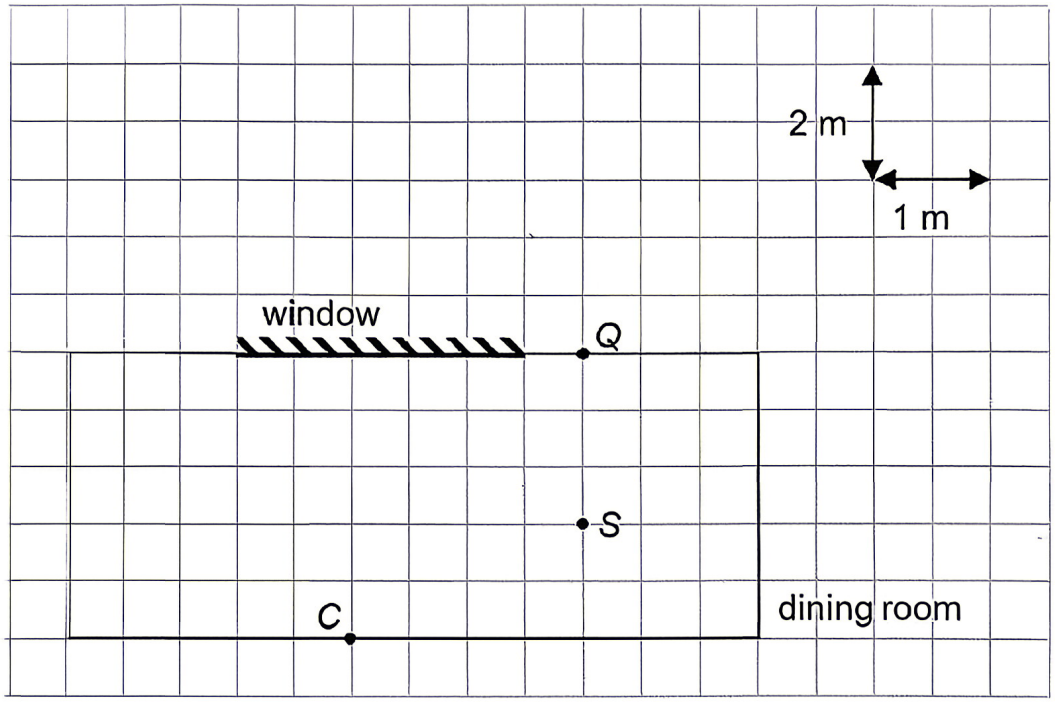


Figure 2.1

(a) Figure 2.2 shows the image of the clock. What is the true time shown by the digital clock? (1 mark)

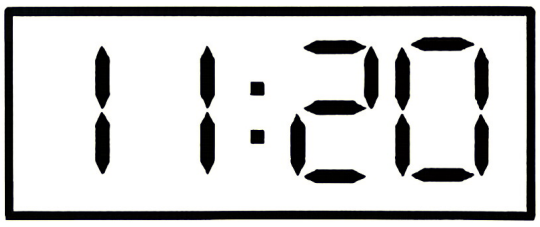


Figure 2.2

(b) Is the image of the clock real or virtual? **(1 mark)**

(c) Then Samson walks from S towards Q along a straight line. What is the minimum distance of Samson from Q such that he can still see the clock's image in the window? **(3 marks)**

3. An object O is put in medium X. Figure 3 on the answer sheet shows one light ray from O travelling towards medium Y. The refractive index of medium Y is 1.2.
   (a) Find the refractive index of medium X. (2 marks)
   (b) Sketch a light ray in Figure 3 to show how an observer at P can see object O. (1 mark)

4. As shown in Figure 4 on the answer sheet, a monochromatic light beam is directed from air to a glass prism. It makes an angle of 67° to side AB of the prism.
   (a) Find the refractive index of the prism. (2 marks)
   (b) Find the angle of incidence when the light beam hits side AC. (2 marks)
   (c) Determine whether some of the light escapes side AC. (2 marks)
   (d) In Figure 4, draw all the possible path(s) of the light beam just after it hits side AC. (1 mark)

5. As shown in Figure 5 on the answer sheet, an object is placed in front of lens L and light ray from the object is refracted by L.
   (a) What type of lens is L? (1 mark)
   (b) By adding one suitable light ray to Figure 5, find and label the image formed. (2 marks)

6.

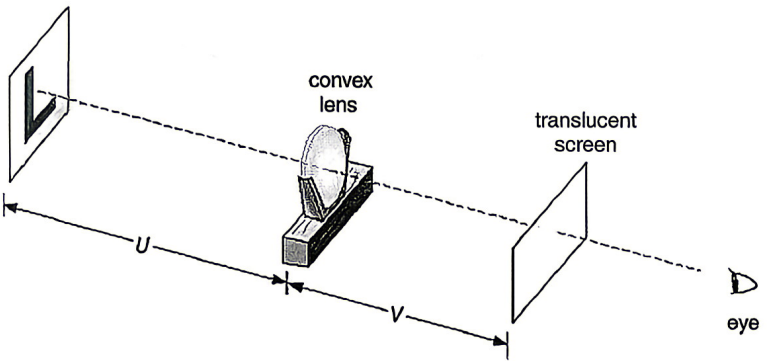


Figure 6.1

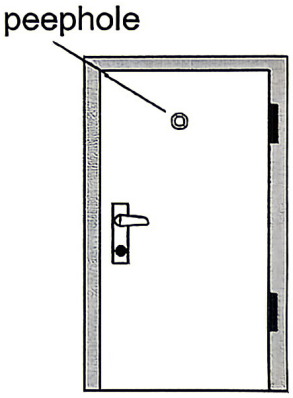


Figure 6.2

   (a) In Figure 6.1, an illuminated letter 'L' is placed 30 cm in front of a convex lens and its image formed by the lens is caught by a translucent screen. The image is half as large as the object.
      (i) Sketch the shape of the image seen by the observer. (1 mark)
      (ii) Find the image distance and the focal length of the lens. (3 marks)
   (b) Figure 6.2 shows a peephole that is usually installed on the main door of a house.
      (i) Which kind of lens is used in a peephole? (1 mark)
      (ii) By considering the image nature, give two advantages of using this kind of lens in a peephole. (2 marks)

7. Radio waves and X-rays belong to a family of waves that can travel at the speed of light in vacuum.

(a) State the full name of this family of waves. (1 mark)

(b) Which wave in this family is used in the following cases? (2 marks)

(i) Radiotherapy for killing cancer cells

Figure 7.1

(ii) Examining the duodenum (十二指腸) with an endoscope (內窺鏡)

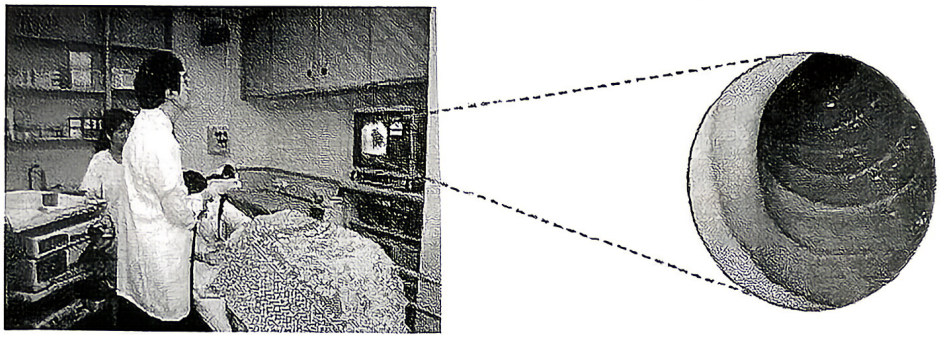


Figure 7.2

(c) State and explain the observed colour of a blue object under red light. (2 marks)

8. A transverse wave is travelling to the left along a string. Figure 8 on the answer sheet shows the snapshot of a section of the wave at time $t = 0$. P and Q are two particles on the string. The period and wavelength of the wave are 2 s and 2.5 cm respectively.

(a) State the motion of particles P and Q at time $t = 0$. (2 marks)

(b) Draw the waveform at $t = 1$ s. Mark the positions of P and Q at $t = 1$ s. (2 marks)

(c) If the period of the string wave is shortened, how does the wave speed and wavelength change? (2 marks)

End of Section B

END OF PAPER

S3 Final Examination (2024–2025)

Physics

Answer Sheet

(1 hour)

Date: 3rd June 2025

Time: 10:15 a.m. – 11:15 a.m.

Name: _____

Class: _____ No.: _____

Section A: Multiple Choice Questions (20 marks)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.

Section B: Structured Questions (40 marks)

1. (a), (b)

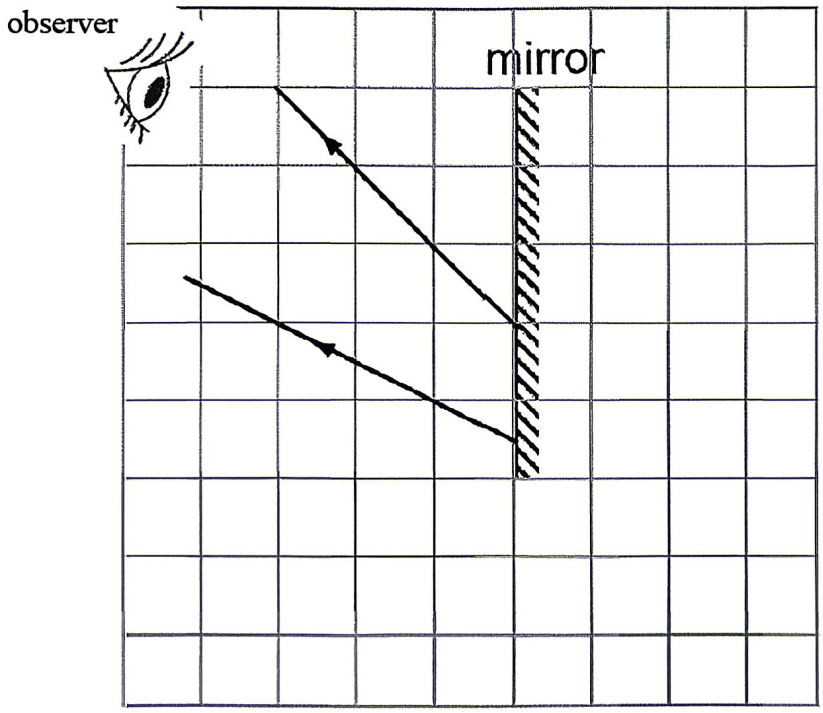


Figure 1

2. (a) _____

(b) _____

(c) _____

_____

_____

_____

3. (b)

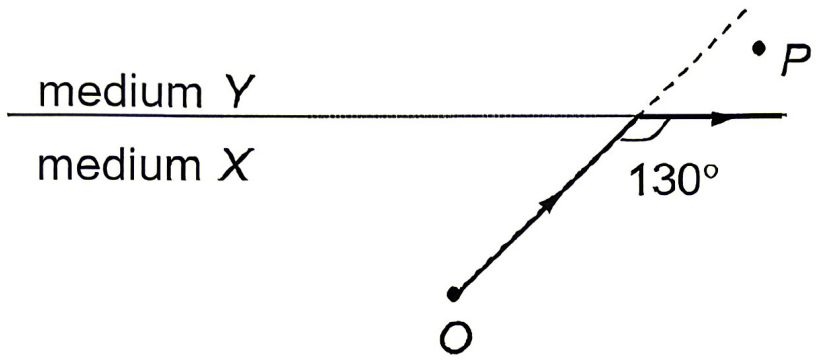


Figure 3

(a) _____

_____

_____

4. (d)

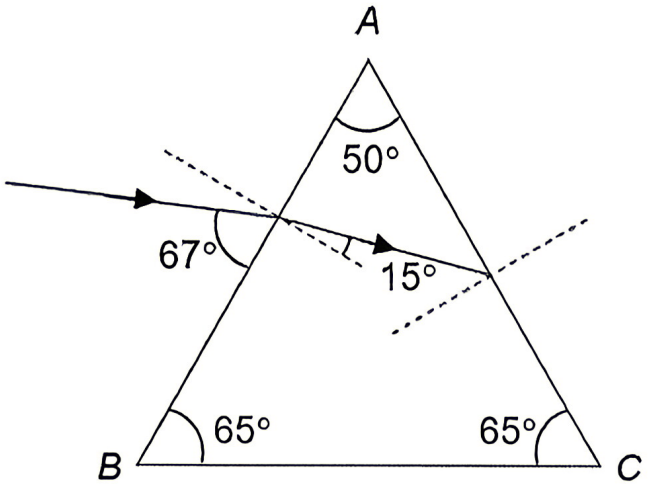


Figure 4

(a) _____

_____

_____

(b) _____

_____

_____

(c) _____

_____

_____

5. (b)

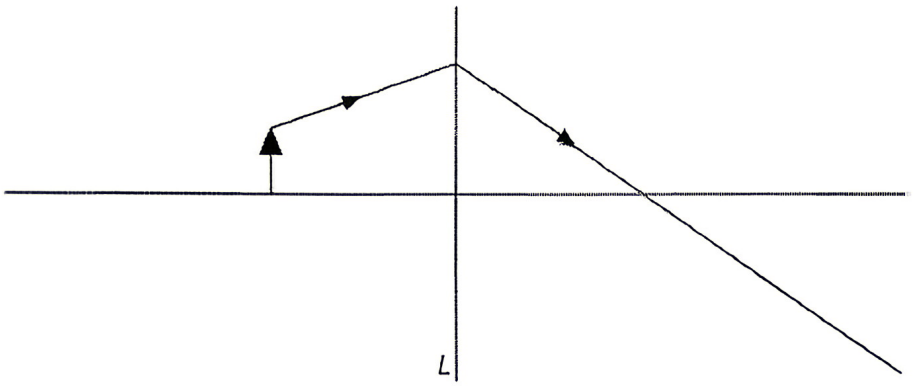
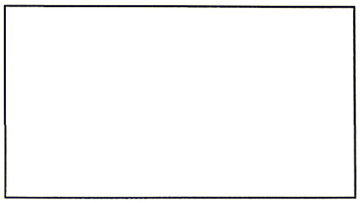


Figure 5

(a) _____

6. (a) (i)



(ii) _____

_____

_____

_____

_____

(b) (i) _____

(ii) _____

_____

_____

7. (a) _____

(b) (i) _____

(ii) _____

(c) _____

_____

_____

8. (b)

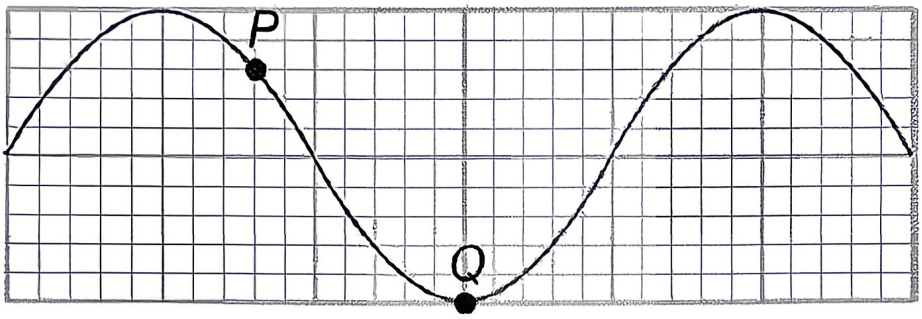


Figure 8

(a) _____

_____

(c) _____

_____

_____

_____

END OF ANSWER SHEET