Optics Revision
Topics: Reflection, Refraction & Lenses
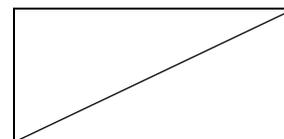
Name: …………………………… (   ) Class: 3/ ……… Date: ……………

Section A Questions

1   Which of the following **correctly** describes the image formed by a plane mirror?

   A   An image will be formed only when the object is put right in front of a plane mirror.
   B   The size of the image formed by a plane mirror is independent of the size of the mirror.
   C   The image formed by a plane mirror becomes smaller when the object is move further away from the mirror.
   D   The image formed by a plane mirror is real.

2   The diagram represents, the top view of a room **PQRS** which measures 3.0 m by 4.0 m. An observer stands at the centre of the room with his back to **RS**.
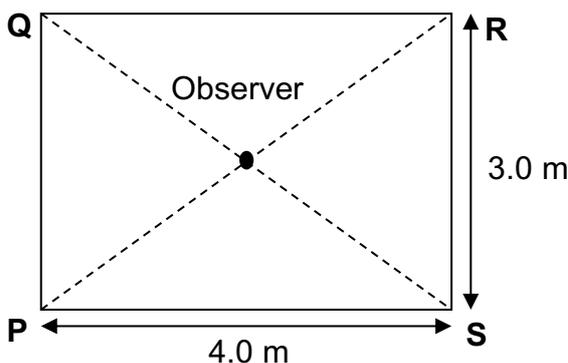
   In order for the observer to see the full width of the wall **RS**, what is the minimum length of a plane mirror placed at eye level on the wall **PQ**?

   A   1.0 m   **B**   1.5 m   **C**   2.0 m   **D**   2.5 m

3   The diagram shows the paths of diverging rays (1) and (2) after reflecting from 2 mirrors M_1 and M_2 which are perpendicular to each other.
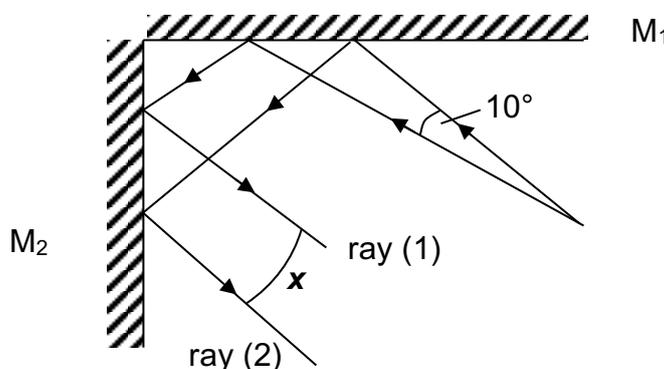
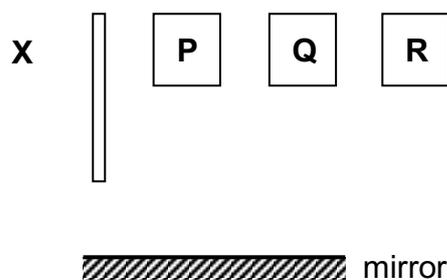   What is the angle, **x**, between the rays (1) and (2) after being reflected from M_2?

   A   10°   **B**   15°   **C**   20°   **D**   25°

4 Four objects **P**, **Q**, **R** and **S** are placed in front of a plane mirror MN. A viewer looks into the mirror as shown in the diagram below.

X **Q**

X **R**

P
X

⋀ eye

X **S**

M ▨▨▨▨▨▨▨▨▨▨▨▨▨ N
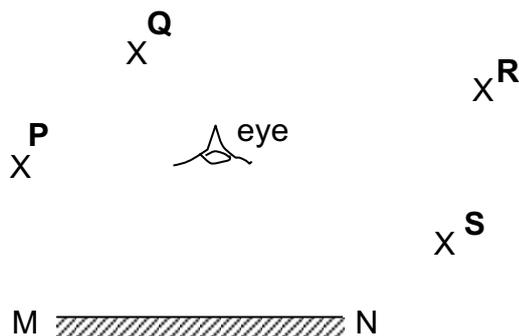
Which of the objects' images cannot be seen?

A P   **B** Q   **C** R   **D** S

**5** Which box(es) can be seen in the mirror by the observer at **X**?

X ‖ | P | | Q | | R |

▨▨▨▨▨▨▨▨▨▨▨ mirror

A **P** only
B **P** and **Q**
C **Q** and **R**
D **R** only

**6** A girl at **X** looks through a periscope at a mountain far away.

Which of the following descriptions about the final image of the mountain formed is/are true?

(1) The final image is laterally inverted.
(2) The final image is erect.
(3) The final image is diminished.

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

X ⊲◉
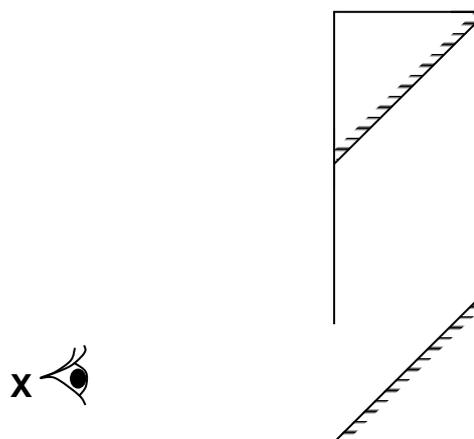
7   The diagram shows a light ray travelling through media X, Y and Z.



medium X   medium Y   medium Z
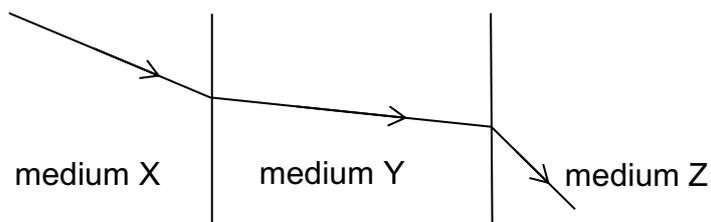
Which of the following statement(s) is/are correct?

(1)   Medium Y has the greatest refractive index.
(2)   Total internal reflection is possible for a light ray travelling from medium Y to medium X at some angles of incidence.
(3)   Medium X has a greater refractive index than medium Z.
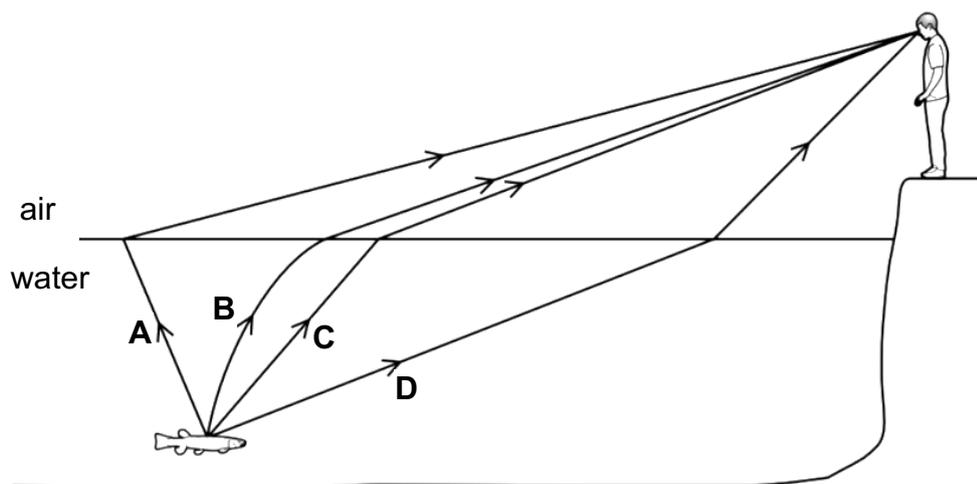
A   (1) only

B   (3) only

C   (2) and (3) only

D   (1), (2) and (3)

8   The following diagrams show rays of light passing from air through four pieces of glass with refractive index of 1.5.

Which diagram shows the ray of light travelling in the **correct** path?

A

B

45°

C

D
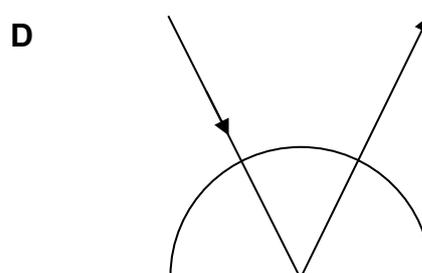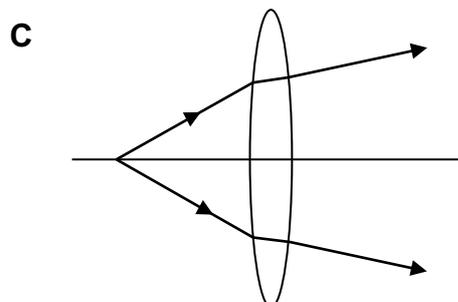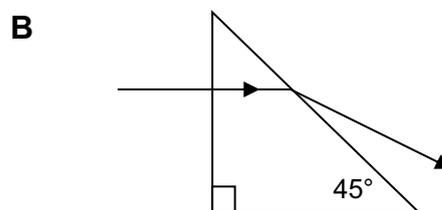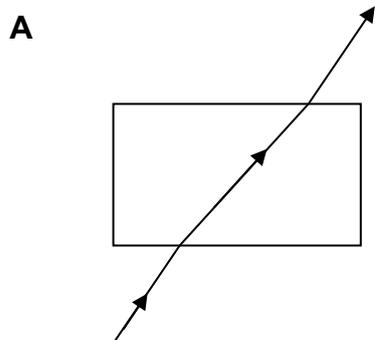
9 A man sees a fish in a pond.

Which is the correct path of the light ray travelling from the fish to the man's eye?


10 An intense light source S is placed at the bottom of a pool. The diagram shows the cone of light that could travel out of the pool into the air. The refractive index of water is 1.34.

What is the area of the circular patch of light on the surface of the pool seen above?

A 120 m²	
B 40 m²	
C 6.2 m²	
D 5.5 m²	
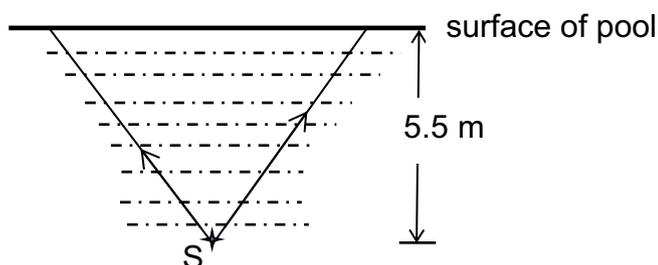
**11** The diagram below shows a semi-circular glass block with a pin placed at its centre **O**. **C** is the critical angle of the glass block.
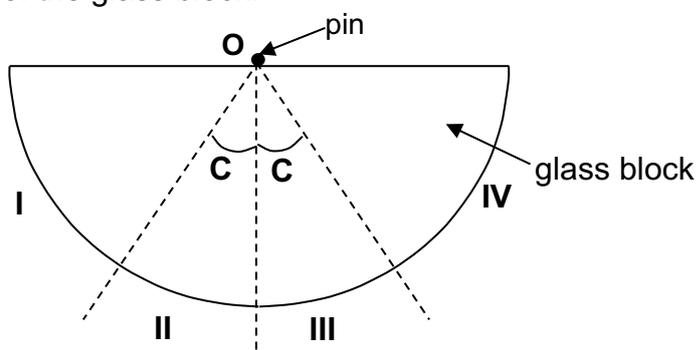
In which region **I**, **II**, **III** or **IV** of the curved side of the glass block should you view the pin, in order to see the pin clearly?

A   **I** and **II**   **B** **II** and **III**   **C** **III** and **IV**   **D** All of them

12 Two parallel rays of light pass through a 45° isosceles glass prism with refractive index 1.5 as shown below.
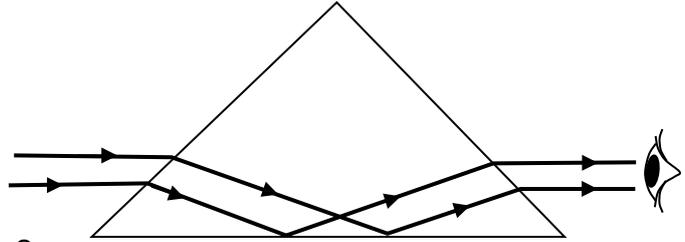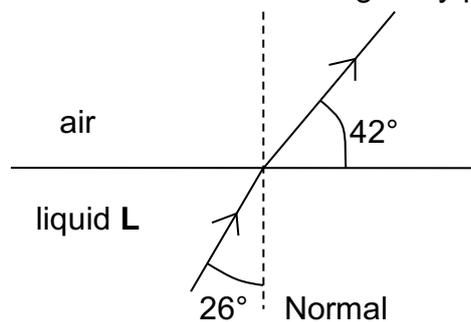

Which of the following is / are **true**?

I Total internal reflection occurs at the base of the prism.
II An object viewed through this prism in this way will appear upside down.
III An object viewed through this prism in this way will become smaller when the observer moves further from the prism.

A I,II and III
C II and III only
B I and III only
D I and II only

13 Which of the following diagrams correctly shows light travelling through a semi-circular glass block in air?

A   **B**   **C**   **D**
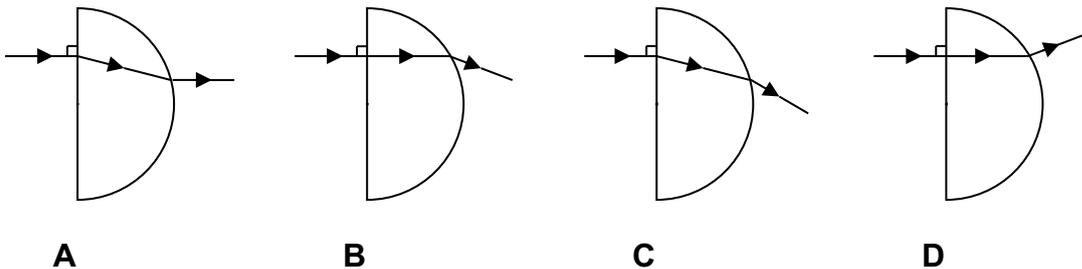
14 The diagram below shows the refraction of a light ray passing from liquid **L** to air.

The refractive index of liquid **L** is

A $\dfrac{\sin 42°}{\sin 26°}$ **B** $\dfrac{\sin 26°}{\sin 42°}$ **C** $\dfrac{\sin 48°}{\sin 26°}$ **D** $\dfrac{\sin 26°}{\sin 48°}$

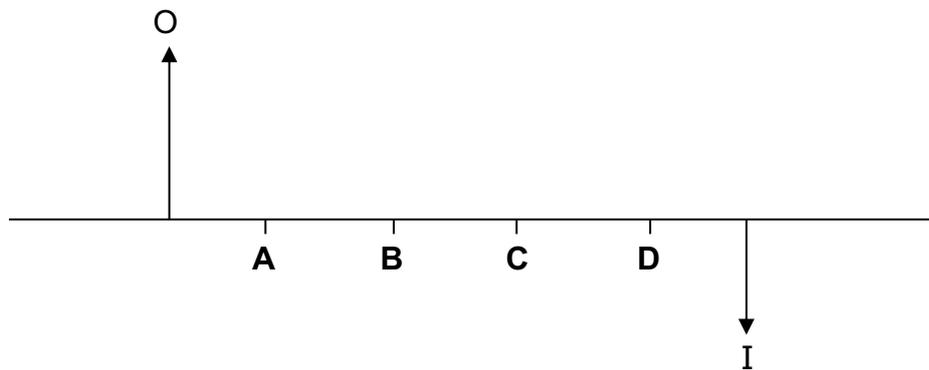**15** Which of the following equations does **not** correctly give the refractive index, **n**?

A $\quad n = \dfrac{\sin i}{\sin r}$ $\qquad\qquad$ B $\quad n = \dfrac{\text{real depth}}{\text{apparent depth}}$

C $\quad n = \dfrac{1}{\sin c}$ $\qquad\qquad\qquad$ D $\quad n = \dfrac{\text{speed of light in medium}}{\text{speed of light in vacuum}}$

16 Object O and its image I are shown in the incomplete ray diagram below.

Where is the convex lens located?

17 A ceiling electric lamp is 100 cm above a table. When a converging lens is held horizontally at 30 cm above the table, a sharp image of the ceiling electric lamp is formed on the tabletop. What is the focal length of this lens?

A $\quad$ less than 15 cm

B $\quad$ between 15 cm and 30 cm

C $\quad$ between 30 cm and 60 cm

D $\quad$ between 60 cm and 100 cm

18 Mary uses a magnifying glass to look at the squares on a sheet of paper. The pattern observed is shown below.
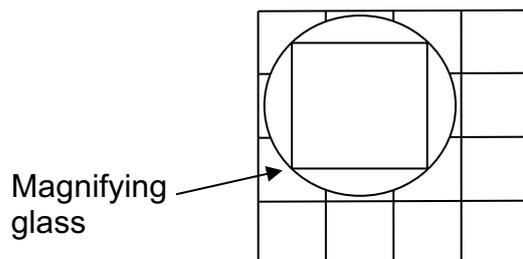
Magnifying glass

What is the linear magnification of this magnifying glass?

A $\quad$ 0.5 $\qquad$ B $\quad$ 1.0 $\qquad$ C $\quad$ 1.5 $\qquad$ D $\quad$ 2.0

19 Which of the following correctly shows the correct type of image formed by a **converging lens** for the object position used?

|	object position	type of image
A	less than f	virtual, magnified
B	between f and 2f	virtual, magnified
C	at 2f	real, diminished
D	greater than 2 f	real, magnified

20 The diagram below shows an experiment to determine the focal length of a thin converging lens. A sharp image of the hole in the card is formed on the card, directly above the hole.
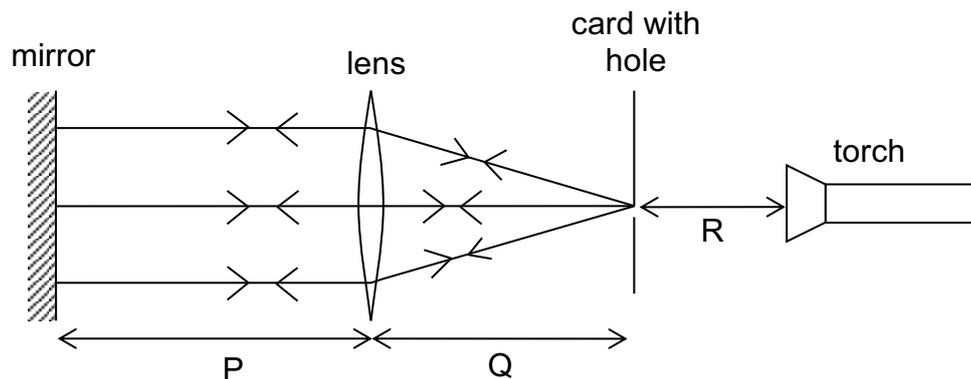

Which distance is the focal length of the lens?

A P   **B** Q   **C** R   **D** P + Q

21 An image formed by a convex lens is 20.0 cm from the object. If the image is the same size as the object, then the focal length of the lens is

A	5.0 cm	**B**	20.0 cm
C	10.0 cm	**D**	40.0 cm

22 Converging lenses **A** and **B** have the same focal length, but **B** is only half the diameter of **A**. Both lenses are used separately to form an image of a tree. Choose the correct statement about the images.

A The image **B** forms is closer to the lens than the image **A** forms.
B The images are both real and inverted.
C The image **B** forms is bigger than the image **A** forms.
D The images are of the same brightness.

23 The diagram below shows two rays emerging from a converging lens.
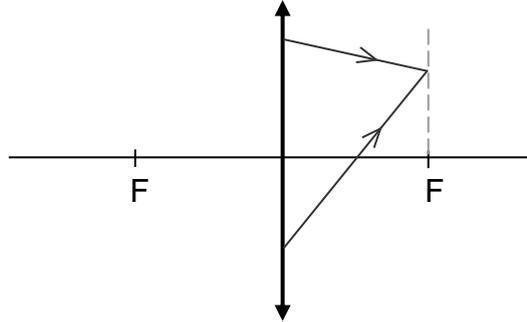

Which of the following incident rays could have produced them?

A

B

C

D
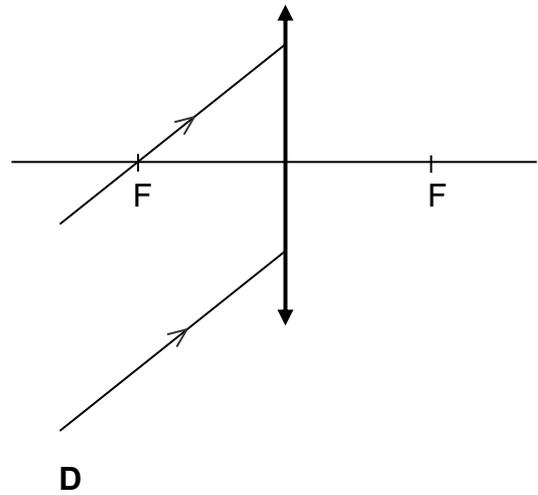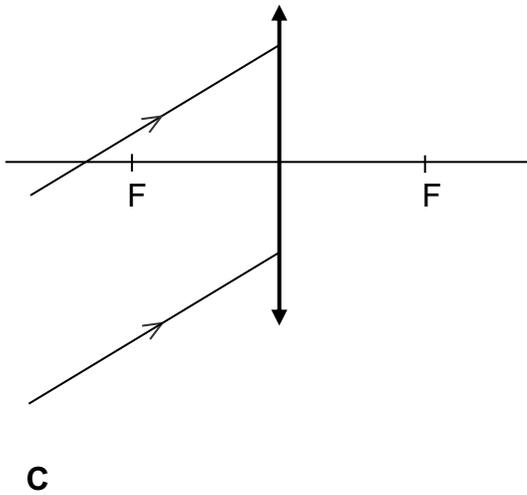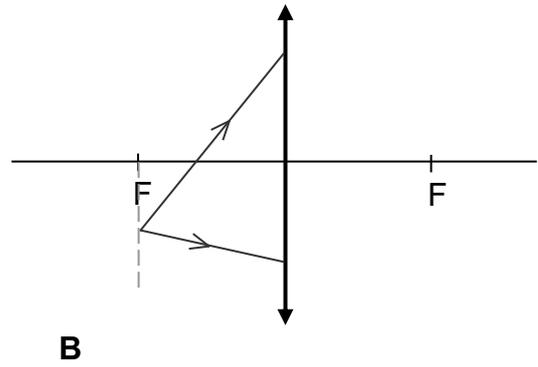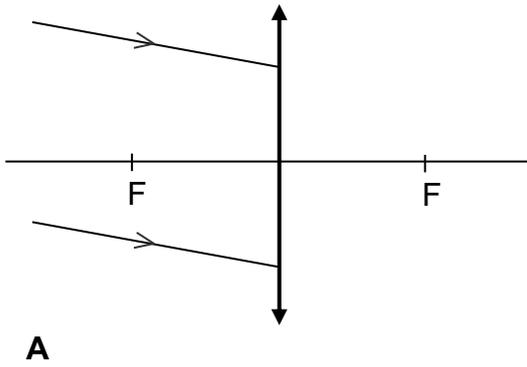
Section B Questions

Show all working steps in the space provided and present all answers to an appropriate number of significant figures.

1 The diagram below (**not** drawn to scale) shows a ray of light travelling in an opaque container filled with turpentine.

The ray of light strikes a hemispherical air bubble at an angle of incidence 45° to the normal as shown. The critical angle of light for turpentine is 43°. C is the centre of the hemisphere.
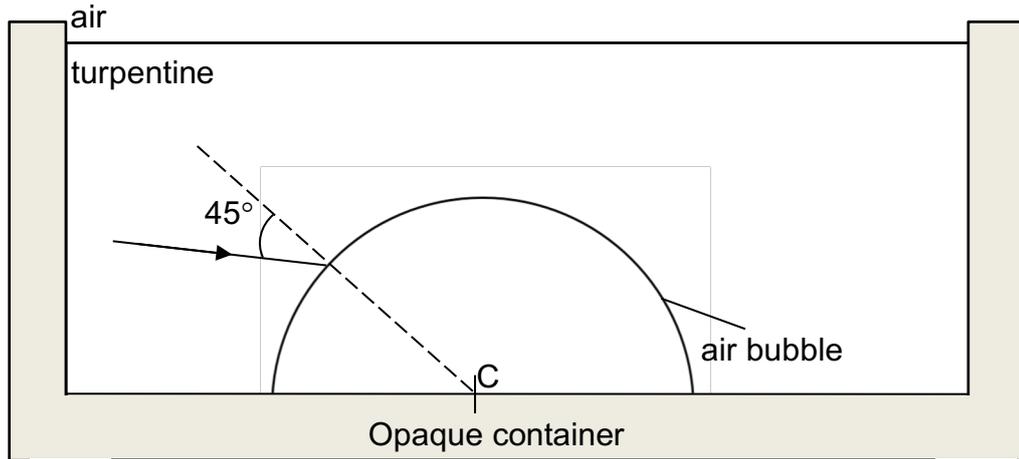
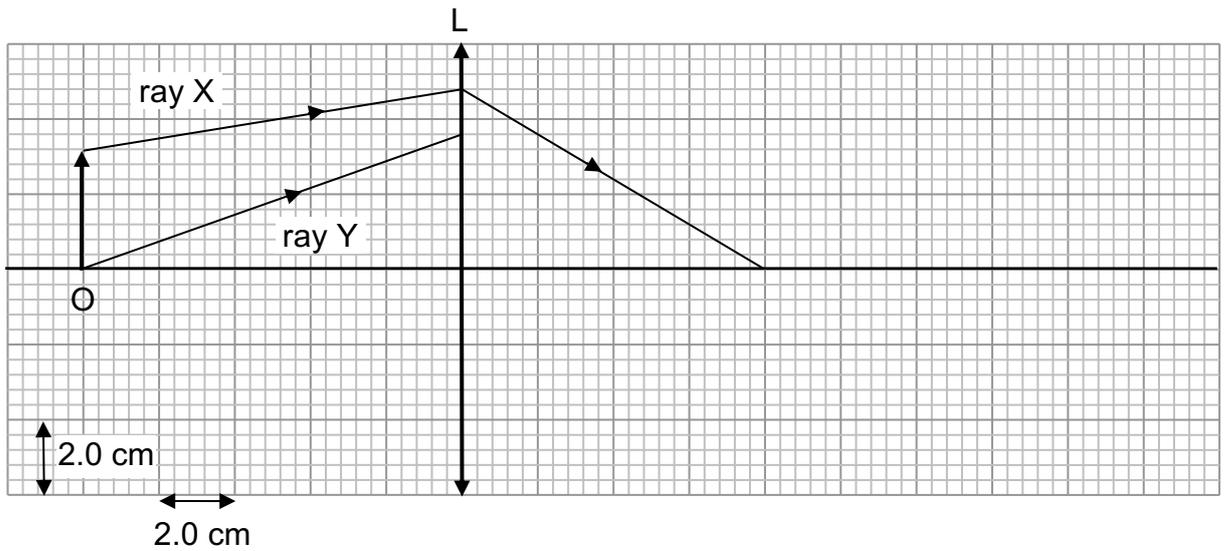**(a)** Calculate the refractive index of turpentine.

refractive index = ……………………… [1]

(b) Complete the path of the light ray in the diagram. [2]

(c) Suggest one reason why any light ray(s) emerging from the turpentine into the air is/are dimmer than the original light ray.

…………………………………………………………………………………………………

……………………………………………………………………………………………… [1]

2   The diagram shows an object O placed in front of a converging lens, L.

5 small squares on the grid represents 2.0 cm.

(a) The path of ray X from the object O is shown the diagram as it passes through the lens. Draw necessary ray(s) on the diagram above to determine the focal length of the lens.
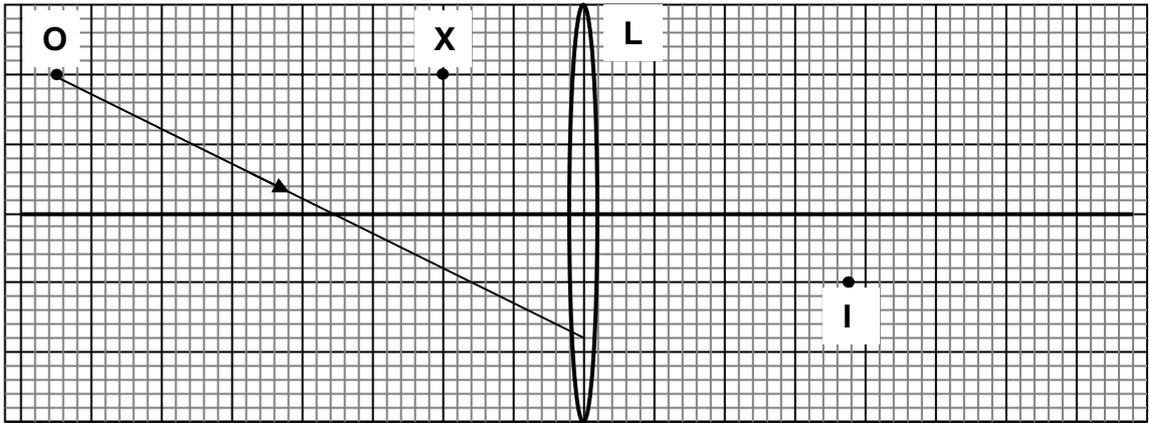
focal length = ……………………… [2]

(b) Draw necessary ray(s) on the diagram to complete the path of ray Y as it passes through the converging lens L.   [2]

(c) Hence or otherwise, complete the description of the image of the object O: [1]

The image is real, ……………………….. and ………………………………

3 The diagram below shows a ray of light from a point object **O** striking a converging lens **L**. The lens forms an image at point **I**.
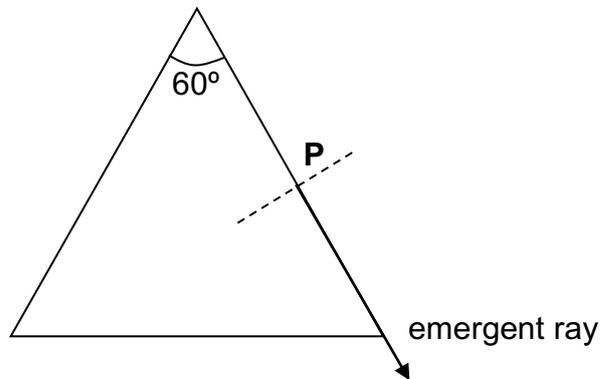

 (a) On the diagram, complete the path of the ray after passing through the lens. Draw a second ray which enables you to find the position of the principal focus. **Label** this point **F**. [3]

 (b) Explain the effect of moving object **O** to position **X** on the image formed? [2]

………………………………………………………………………………………………

………………………………………………………………………………………………

**4** The diagram below shows an emergent ray of light leaving a glass prism of refractive index 1.6.

emergent ray

 (a) Calculate the critical angle of the glass prism. [1]

 (b) Hence, draw on the diagram the path of the incident ray and the refracted ray in the glass prism that produces such an emergent ray at P. Label all relevant angles. All relevant calculation(s) must also be shown below. [3]

5 The diagram below shows the set-up for determining the critical angle for water. Water is placed in a semi-circular container of negligible thickness and a ray of light K is incident on the container as shown below.
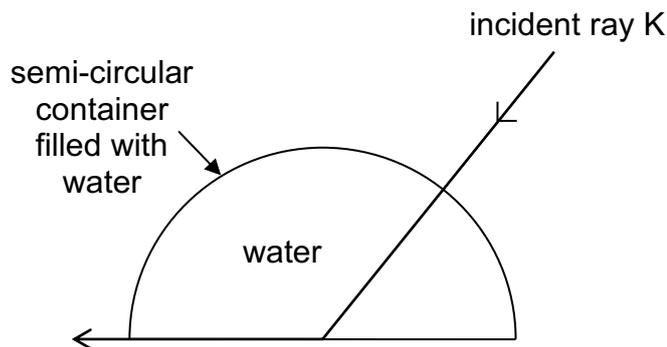
(a) Define the critical angle of an optical medium. [1]

……………………………………………………………………………………………………

……………………………………………………………………………………………………

(b) Determine the critical angle for water c_w and hence its refractive index.

critical angle = …………………………[2]

refractive index = …………………… [1]

(c) A narrow beam of monochromatic light PQ is directed at point Q on the surface of the water in a glass tank with a mirror M as shown below. Complete the path of PQ until it emerges from the tank and label the values of all the angles of incidence.[3]

6 The lens of a simple camera is adjusted to a distance of 12 cm from the film so that a sharp image of a distant object is focused.

(a) State the focal length of the lens. [1]

(b) The camera is now used to take a photograph of an object which is at a distance of 24 cm from the lens. Calculate the image distance. [2]

1	2	3	4	5	6	7	8	9	10
B	A	A	D	A	B	D	C	C	A

11	12	13	14	15	16	17	18	19	20
B	D	B	C	D	C	B	D	A	B

21	22	23
A	B	C

1 **(a)** Using $n = \dfrac{1}{\sin C} = \dfrac{1}{\sin 43°} = 1.47$ or 1.5 [1]

(b) Complete path of light ray:
Total internal reflection [1]
Emergent ray bends away from normal [1]

Note: Deduct 1 mark if no arrow at all.
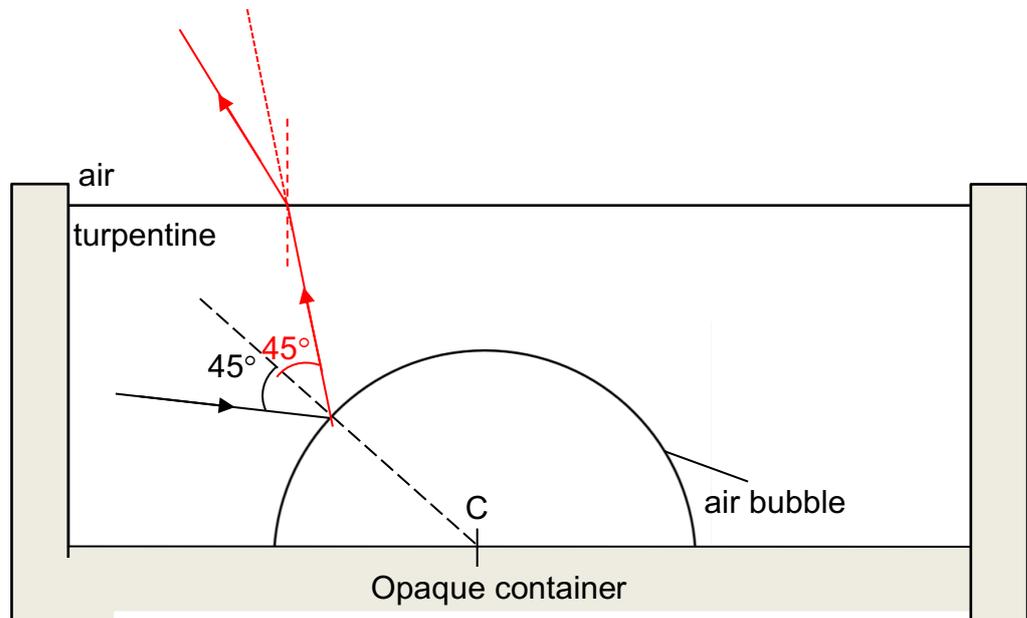
- *Accepted: Ray refracted towards left*
- *Accepted: Ray refracted vertically upwards*
- *Accepted: Ray refracted towards right – must label angle of reflection 45º*
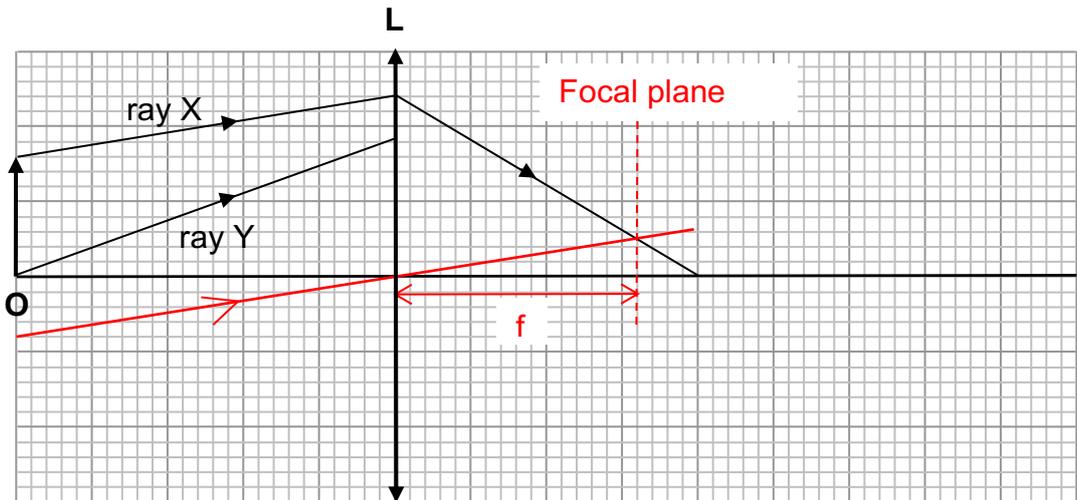- *Not accepted: Ray entering the air bubble – zero!*

(c) The light ray is partially reflected at a boundary.

OR some of the light is reflected back into the turpentine.

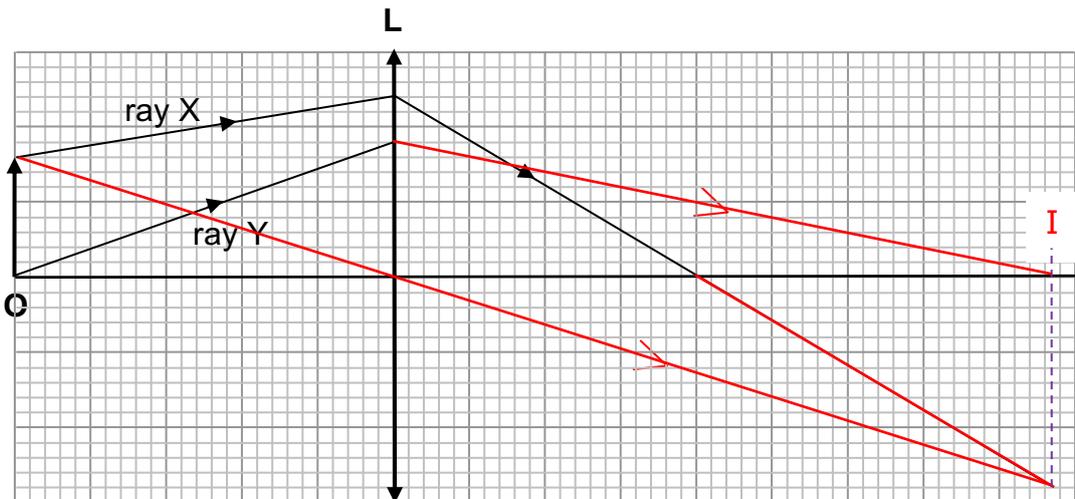OR some energy of the light ray is absorbed by turpentine. [1]

2(a)

Evidence of any correct rays used to locate F. [1]

Focal length = 16/5 x 2.0 = <u>6.4 cm</u> ± 0.6 cm [1]

- *Method 1: draw a ray parallel to ray X, meet X at focal plane, find F and f.*
- *Method 2: from (b), locate image I, draw a horizontal ray which passes F, find f.*

(b)

Evidence of any correct rays used to determine refracted ray of Y. [1]

Accurately completed ray Y. [1]

- *Method 1: draw a ray from top of object to pass through optical centre & extend ray X, to locate image I; extend ray Y to the base of image.*
- *Method 2: draw a ray parallel to ray Y, to meet extended ray Y at focal plane, extend Y.*

(c) <u>magnified</u> and <u>inverted</u>. [1]

Note: No ECF since given ray X and ray through optical centre will give image.
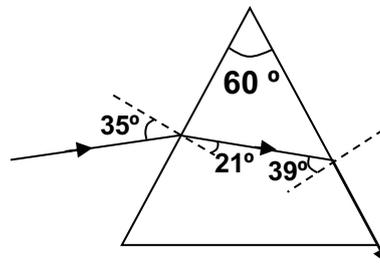
3   **(a)**
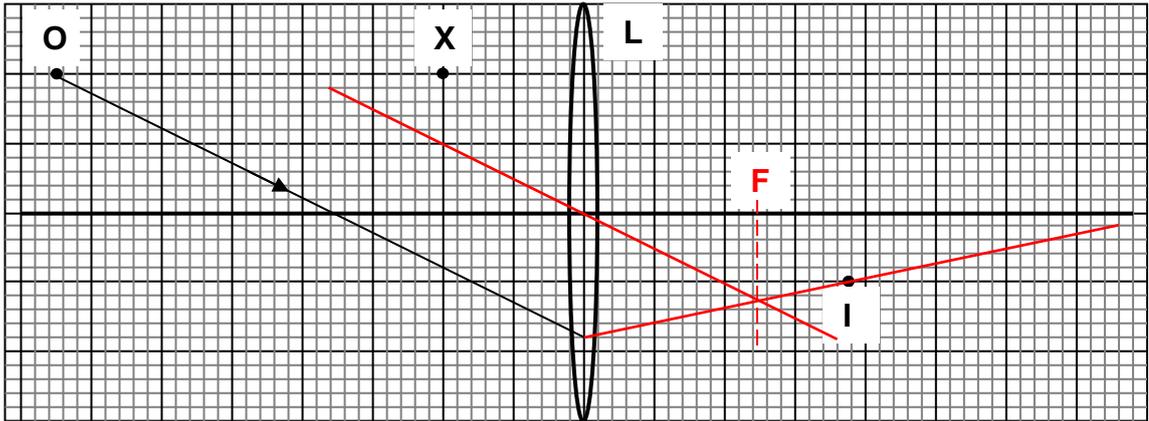
(b)   As **X** is closer to the lens than **F** (ie. object distance is shorter than the focal length) the image will be virtual, enlarged & on the same side of the lens as **O**.

4(a)
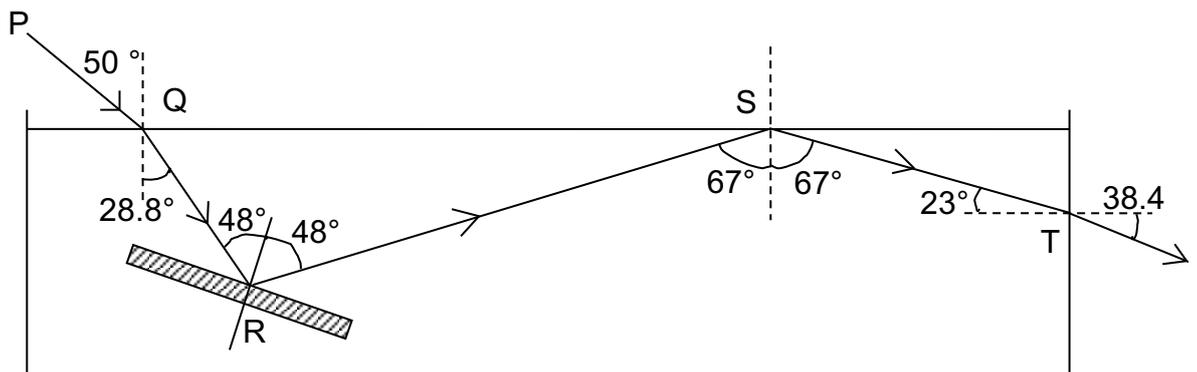n= 1/sin c
1.6 = 1/sin c
c= sin^{-1}(1/1.6) =39º

(b)
n = sin i /sin r
1.6 = sin i /sin 21º
i = sin^{-1} [1.6x sin 21º] = 35º
● Path of incident ray drawn correctly
● Path of refracted ray drawn with correct angle r

5   **(a)**   Critical angle is incidence angle in optically denser medium for which the angle of refraction is 90° / refracted ray emerges along the boundary of the 2 media. [1]
    (b) c_w = 39° [1]
        R.I. = 1/sin c_w [1] = 1.59 [1] (ignore s.f.)
    (c)   No penalty if angles not labelled. If angles labelled correctly but drawn wrongly, accept it as correct.
        1m for refraction at Q and T (correct angles of refraction determined)
        1m for reflection at R (i = r)
        1m for total internal reflection at S (i=r)

6(a) 12 cm

(b)
1/u + 1/v = 1/f

1/24 + 1/v = 1/12

v = 24 cm