



New Document 1

Name: _____

Class: _____

Date: _____

Time: **188 minutes**

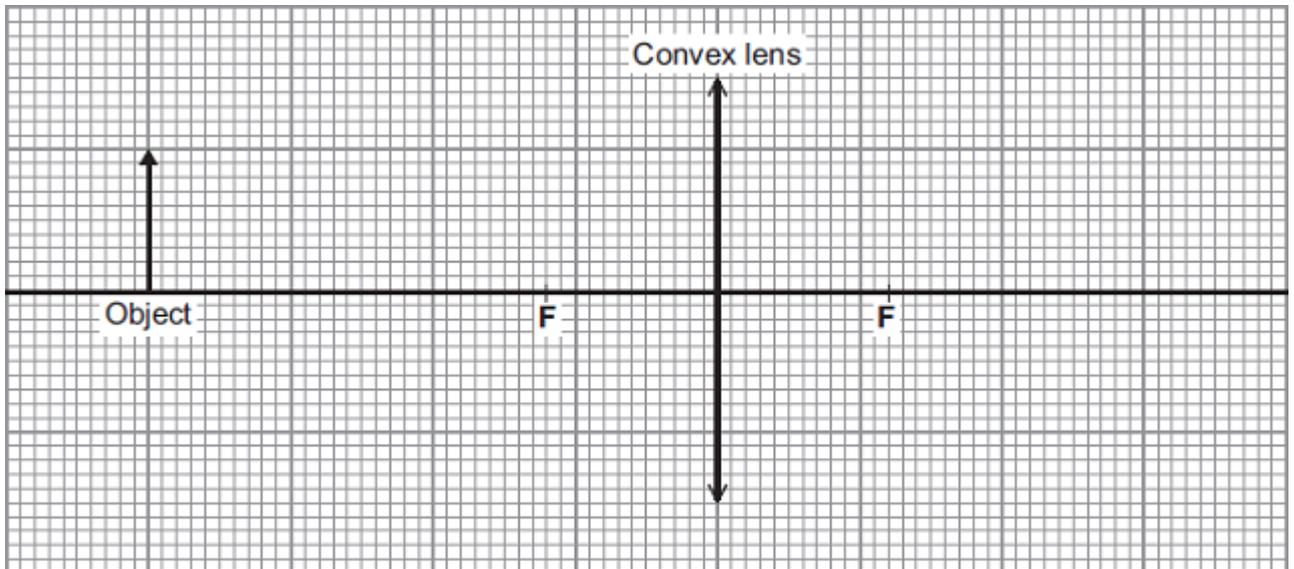
Marks: **188 marks**

Comments:

Q1.

- (a) A camera was used to take a photograph. The camera contains a convex (converging) lens.

Complete the ray diagram to show how the lens produces an image of the object.



F = Principal focus

(4)

- (b) State **two** words to describe the nature of the image produced by the lens in the camera.

1. _____
2. _____

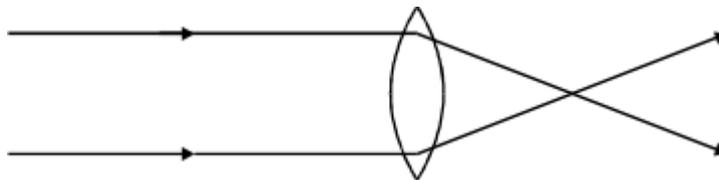
(2)

(Total 6 marks)

Q2.

- (a) The diagram shows how parallel rays of light pass through a convex lens.

- (i) Mark the position of the focus.



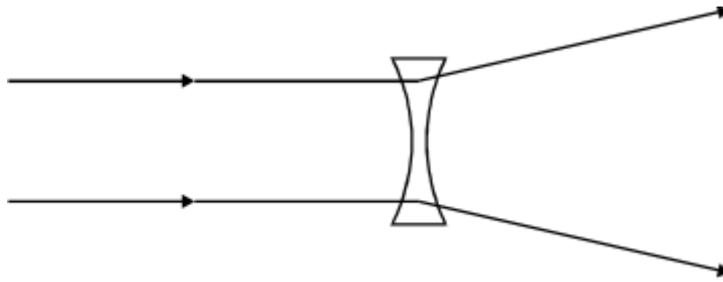
(1)

- (ii) Is this a **converging** lens, a **diverging** lens, **both** or **neither**?

(1)

- (b) The diagram shows how parallel rays of light pass through a concave lens.

(i) Mark the position of the focus.



(1)

(ii) Is this a **converging** lens, a **diverging** lens, **both** or **neither**?

(1)

(c) Complete these sentences by crossing out the **two** lines in each box that are wrong.

In a camera, a

converging
diverging
parallel

 lens is used to produce an image of an

object on a

film
lens
screen

.

The image is

larger than
smaller than
the same size as

 the object.

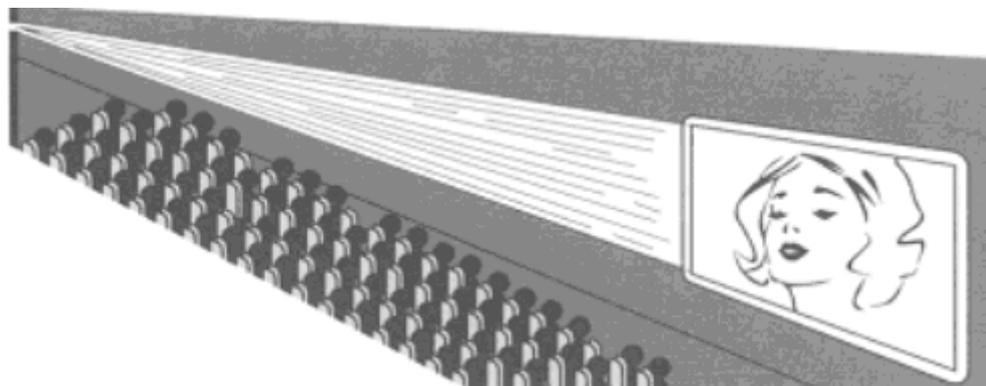
The image is

further from
nearer to
the same distance from

 the lens, compared to the distance of the object from the lens.

(4)

(d) In a cinema projector, a convex lens is used to produce a *magnified, real* image.



(i) What does *magnified* mean?

(1)

(ii) What is a *real* image?

(1)

(e) You are in a dark room. You have a box containing some lenses. Only **one** of them is a converging lens.

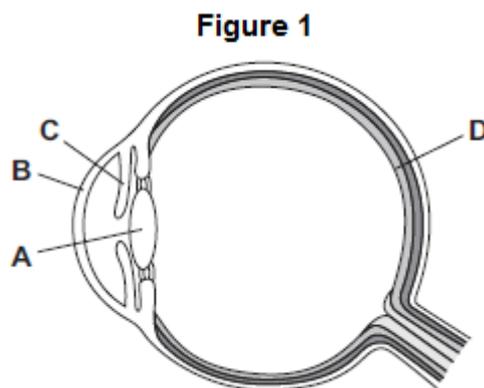
Describe how, by just feeling the lenses, you can pick out the converging lens.

(2)

(Total 12 marks)

Q3.

(a) **Figure 1** shows a section through a human eye.



Write the correct letter, **A**, **B**, **C** or **D**, in each empty box to identify the parts of the eye labelled in **Figure 1**.

Part of the eye	A, B, C or D
Cornea	
Lens	
Retina	

(3)

(b) The table shows how the mass of 1 cm³ of different materials varies with refractive index.

Material	Refractive index	Mass in g
Water	1.33	1.00
Glass X	1.52	2.54
Glass Y	1.70	2.93
Glass Z	1.81	3.37

(i) Describe the pattern shown in above table.

(1)

(ii) Lenses used for correcting visual defects often have a low refractive index.

State **one** advantage and **one** disadvantage of using lenses with a high refractive index for correcting visual defects.

Advantage _____

Disadvantage _____

(2)

(iii) The eyesight of a person can change throughout their lifetime. Scientists have designed cheap spectacles that allow the wearer to change the focal length of the lenses as their eyesight changes.

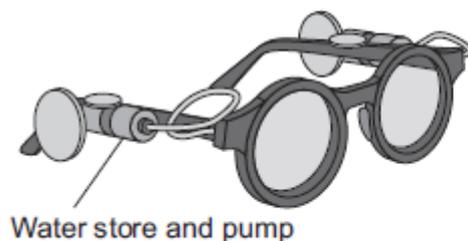
Two designs are:

- using water-filled lenses where water is pumped in or out of the lens to change its shape
- using a pair of specially shaped lenses for each eye that are able to slide across each other.

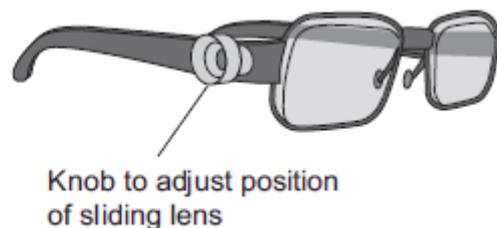
Figure 2 shows these two designs.

Figure 2

Spectacles with water-filled lenses



Spectacles with sliding lenses made from glass Z

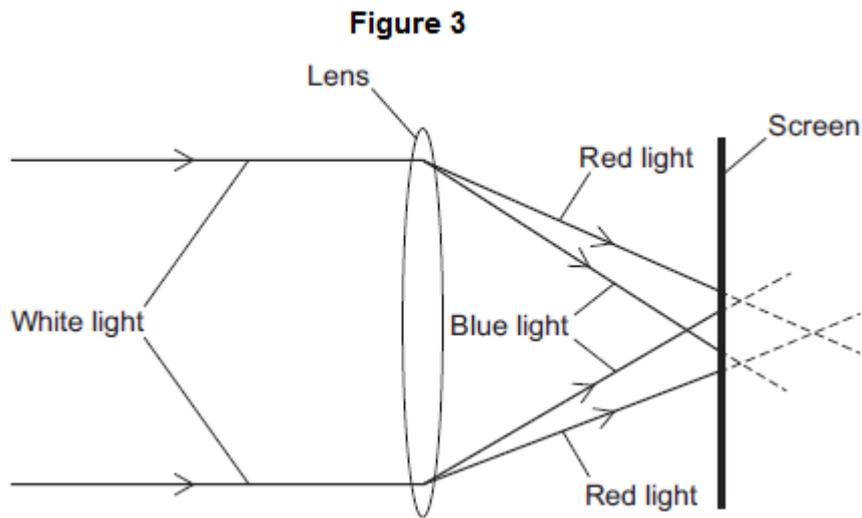


Suggest **one** advantage and **one** disadvantage of each design.

(4)

- (c) **Figure 3** shows parallel rays of white light from a distant point being refracted towards a screen by a lens.

The lens is made from a glass with a much greater refractive index than glass normally used for correcting visual defects.



What would you notice about the image on the screen?

State **two** observations.

1. _____
2. _____

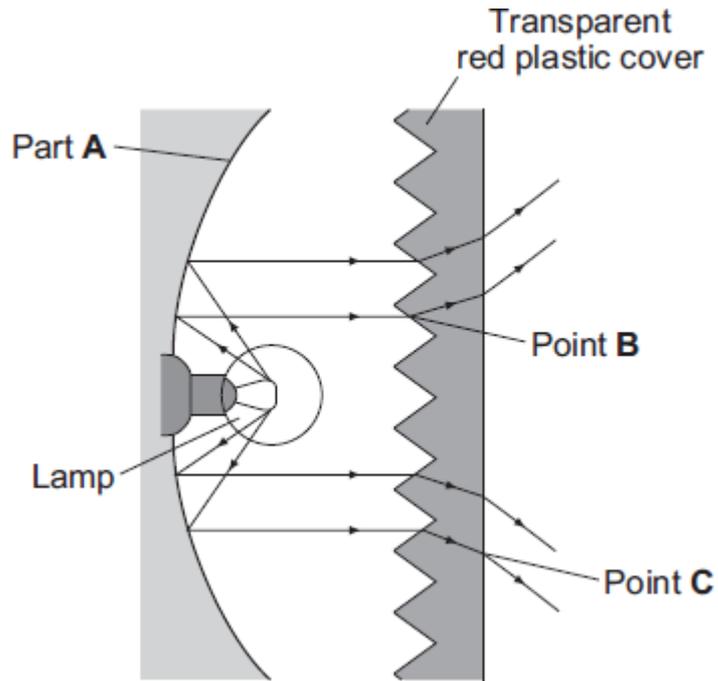
(2)

(Total 12 marks)

Q4.

At night, it is important that the lights of a car can be seen by other drivers but it is dangerous if these lights dazzle them.

The diagram shows a rear light of a car.



(a) (i) Name part **A**.

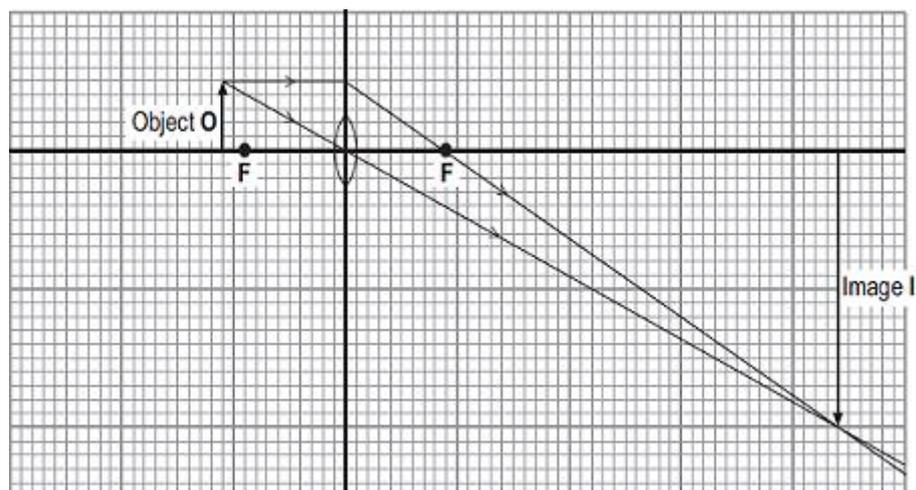
(1)

(ii) Name the process which occurs at point **B** and at point **C**.

(1)

(b) A headlamp of a car contains a lens.

The ray diagram shows the position and size of the image, **I**, of an object, **O**, formed by a lens similar to the one inside a car headlamp.



(i) What type of lens is shown in the ray diagram?

Draw a ring around your answer.

converging

diverging

plane

(ii) The ray diagram is drawn to scale.

Use the equation in the box to calculate the magnification produced by the lens.

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

Show clearly how you work out your answer.

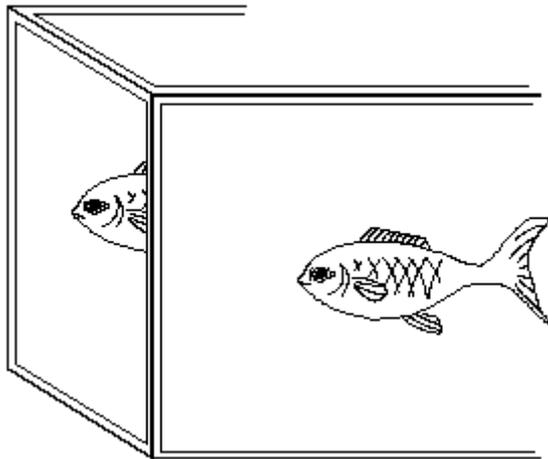
Magnification = _____

(2)

(Total 5 marks)

Q5.

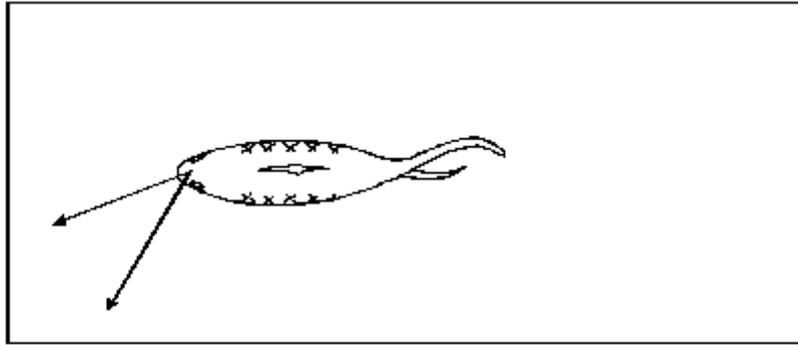
An aquarium contains only one fish. But if you look at the corner of the aquarium, there seem to be two fish.



The diagram below shows the top of the aquarium.

Two light waves have been drawn from the fish.

(a) Complete the diagram to show how the light waves reach the eye.



(2)

(b) Complete each sentence by using the correct words from the box.

colour	diffraction	longitudinal	reflection
refraction	speed	transverse	

When the light waves pass from glass into the air they change _____

This causes a change in direction called _____

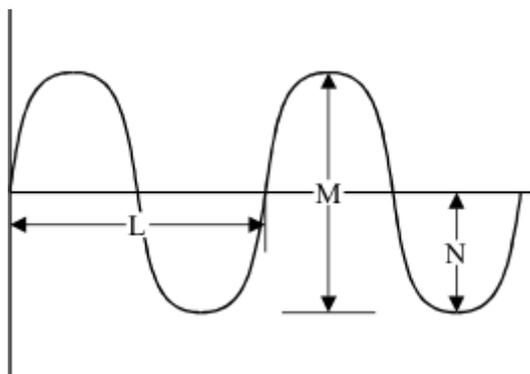
Light waves are _____ waves.

(3)

(Total 5 marks)

Q6.

(a) The diagram shows a wave pattern.



Which letter, **L**, **M** or **N** shows:

(i) the wavelength? _____

(ii) the amplitude? _____

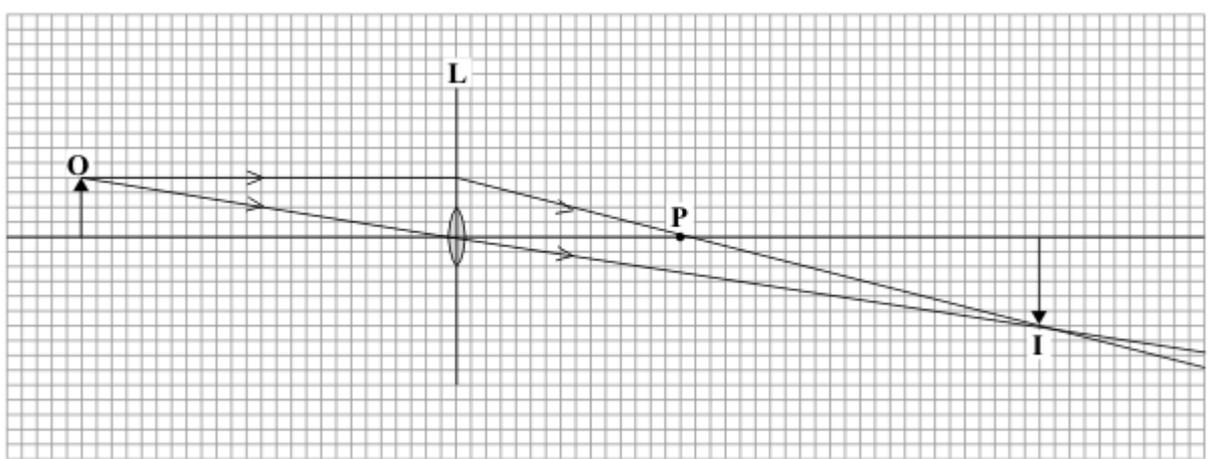
(2)

(c) Describe how you could show that visible light travels in straight lines. You may wish to draw a diagram to help explain your answer.

(2)
(Total 4 marks)

Q7.

The ray diagram shows the position and size of the image, **I**, of an object, **O**, formed by a lens, **L**.



(a) What type of lens is shown in the ray diagram?

(1)

(b) Name the point labelled **P**.

(1)

(c) The ray diagram has been drawn to scale.

Use the equation to calculate the magnification.

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

Show clearly how you work out your answer.

Magnification = _____

(2)

- (d) How can you tell from this ray diagram that the image is a real image?

(1)

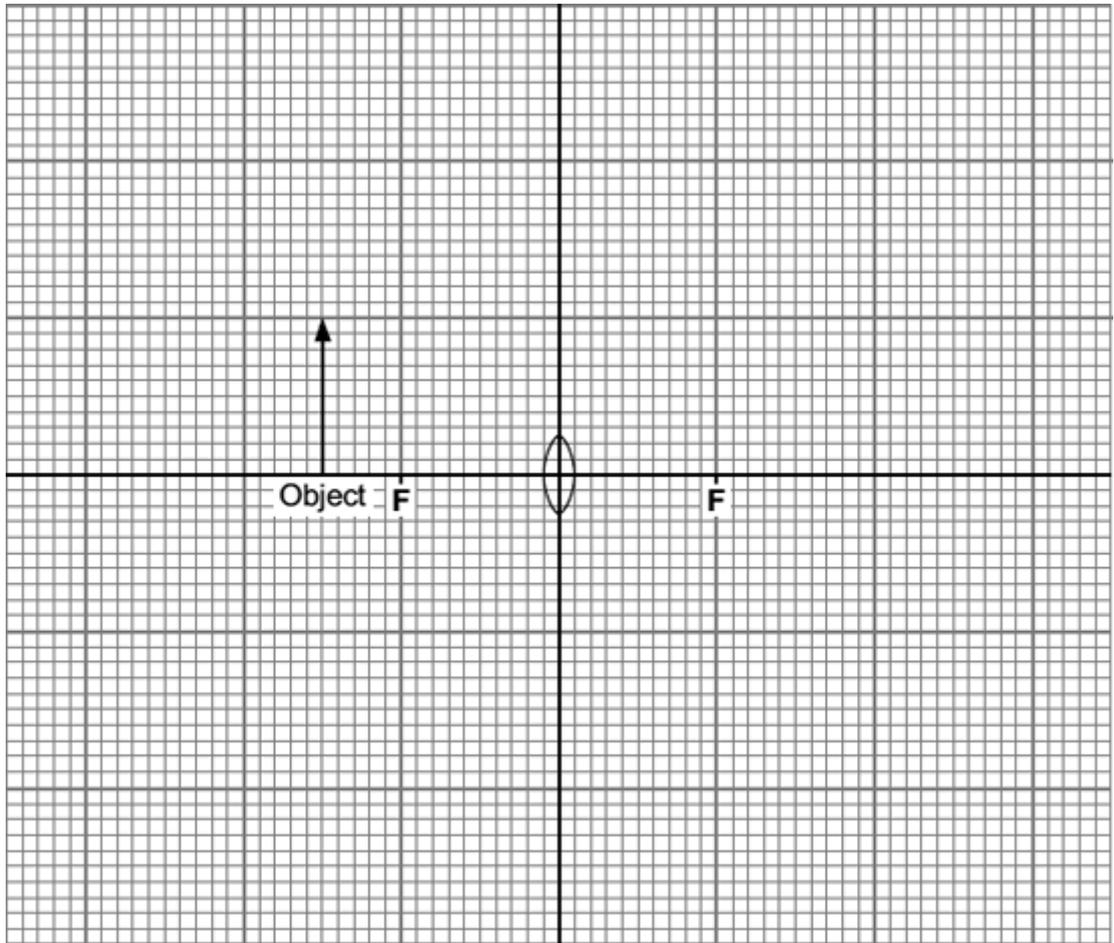
(Total 5 marks)

Q8.

A student investigated how the nature of the image depends on the position of the object in front of a large converging lens.

The diagram shows one position for the object.

- (a) Use a ruler to complete a ray diagram to show how the image of the object is formed.



Key: F = principal focus

(4)

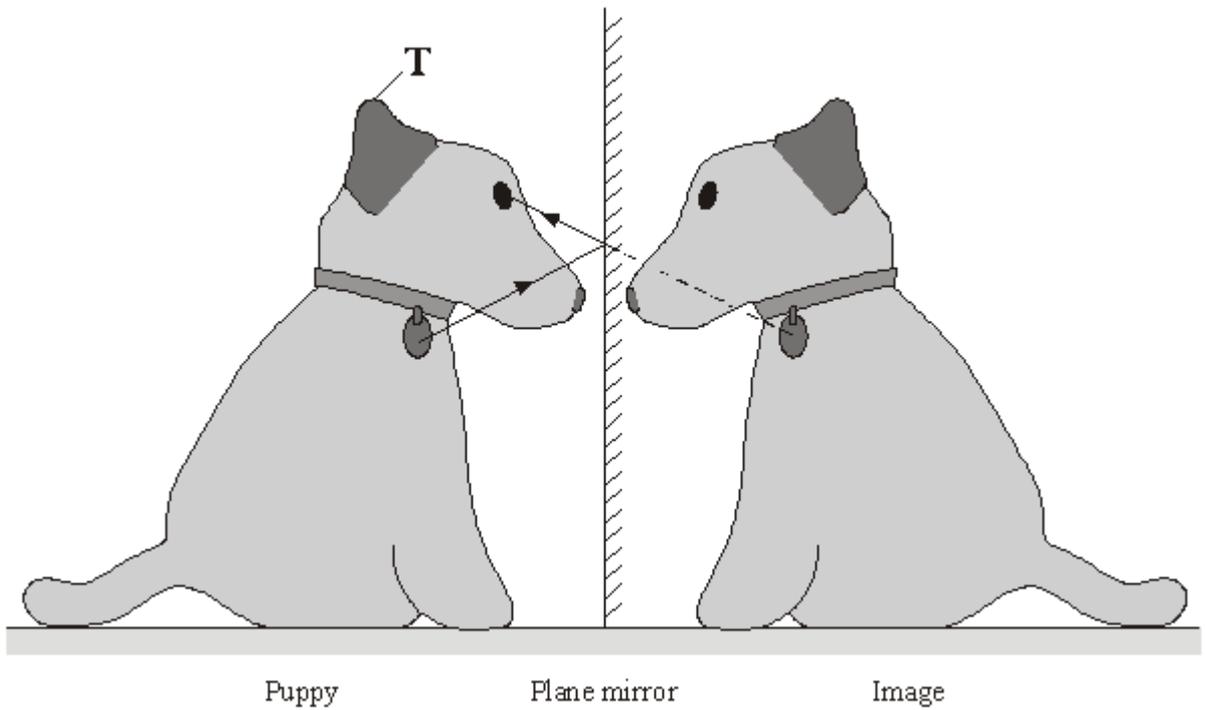
(b) Describe the nature of this image relative to the object.

(2)

(Total 6 marks)

Q9.

A puppy can see an image of himself in a plane mirror.



The diagram shows how the puppy can see his disc.

- (a) On the diagram, use a ruler to draw a ray to show how the puppy can see the top of his ear, which is marked as T.

(3)

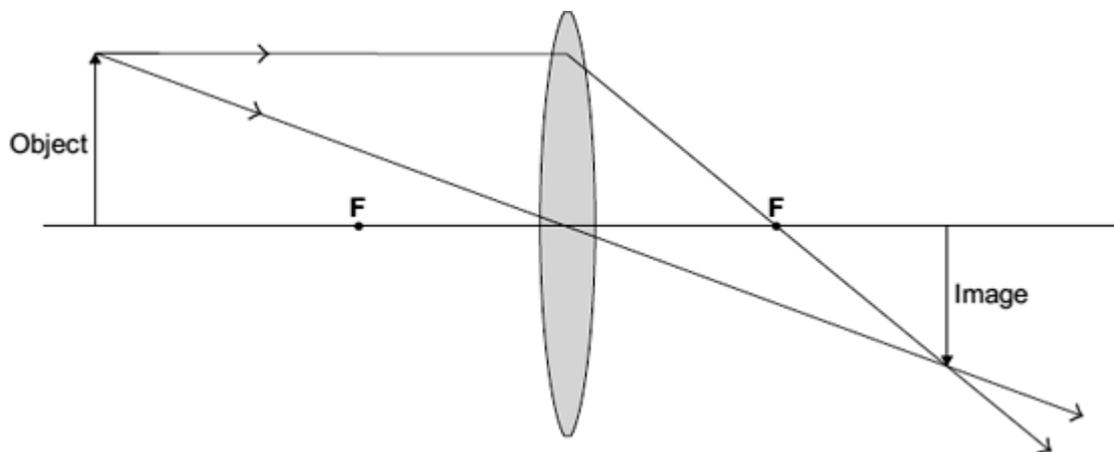
- (b) What is a plane mirror?

(1)

(Total 4 marks)

Q10.

The diagram shows a lens, the position of an object and the position of the image of the object.



- (a) What type of lens is shown?

(1)

(b) What is the name of the points, **F**, shown each side of the lens?

(1)

(c) (i) The image is real and can be put on a screen.

How can you tell **from the diagram** that the image is real?

(1)

(ii) Draw a ring around a word in the box which describes the image produced by the lens.

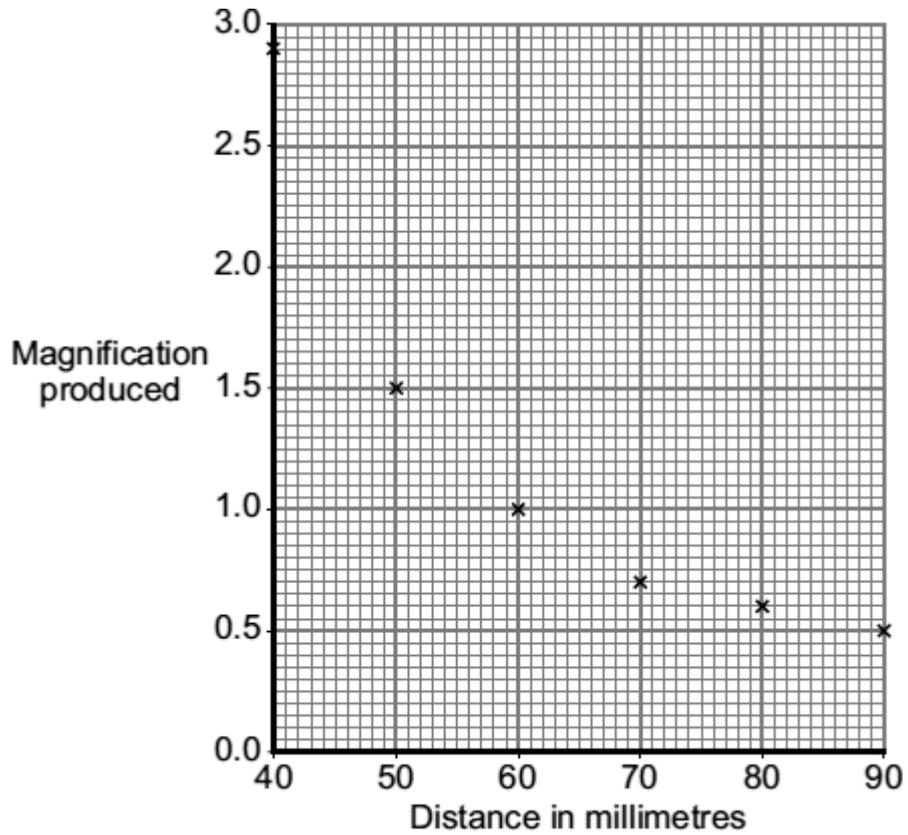
inverted	larger	upright
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(1)

(d) A student investigates the relationship between the distance from the object to the lens and the magnification produced by the lens.
The student's results are given in the table.
The student did not repeat any measurements.

Distance in millimetres	Height of object in millimetres	Height of image in millimetres	Magnification produced
40	20	58	2.9
50	20	30	1.5
60	20	20	1.0
70	20	14	0.7
80	20	12	0.6
90	20	10	0.5

The student plots the points for a graph of *magnification produced* against *distance*.



(i) Draw a *line of best fit* for these points.

(1)

(ii) Complete the following sentence by drawing a ring around the correct word in the box.

A line graph has been drawn because both variables are

described as being

<p>categoric.</p> <p>continuous.</p> <p>discrete.</p>

(1)

(iii) Describe the relationship between *magnification produced* and *distance*.

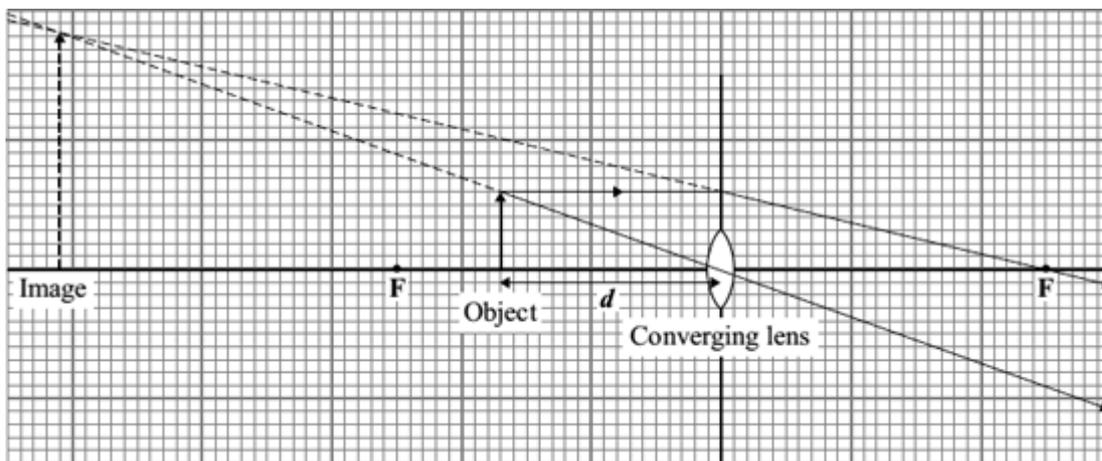
(2)

(Total 8 marks)

Q11.

A student investigates how the magnification of an object changes at different distances from a converging lens.

The diagram shows an object at distance d from a converging lens.



- (a) (i) The height of the object and the height of its image are drawn to scale.

Use the equation in the box to calculate the magnification produced by the lens shown in the diagram.

$\text{magnification} = \frac{\text{image height}}{\text{object height}}$

Show clearly how you work out your answer.

Magnification = _____

(2)

- (ii) The points **F** are at equal distances on either side of the centre of the lens.

State the name of these points.

(1)

- (iii) Explain how you can tell, **from the diagram**, that the image is virtual.

(1)

- (b) The student now uses a different converging lens. He places the object between the lens and point **F** on the left.

The table shows the set of results that he gets for the distance d and for the magnification produced.

Distance d measured in cm	Magnification
--------------------------------	---------------

5	1.2
10	1.5
15	2.0
20	3.0
25	6.0

His friend looks at the table and observes that when the distance doubles from 10 cm to 20 cm, the magnification doubles from 1.5 to 3.0.

His friend's conclusion is that:

The magnification is directly proportional to the distance of the object from the lens.

His friend's observation is correct but his friend's conclusion is **not** correct.

- (i) Explain, with an example, why his friend's conclusion is **not** correct.

(2)

- (ii) Write a correct conclusion.

(1)

- (iii) The maximum range of measurements for d is from the centre of the lens to **F** on the left.

The student **cannot** make a correct conclusion outside this range.

Explain why.

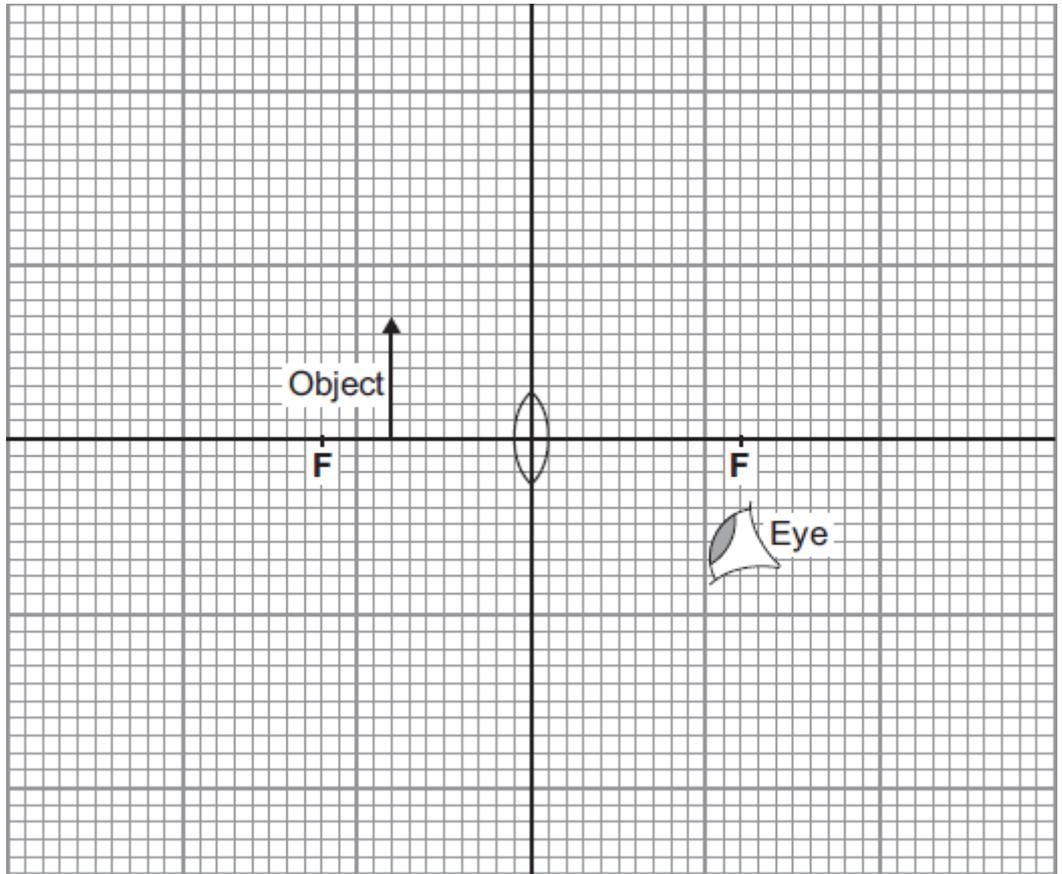
(1)

(Total 8 marks)

Q12.

- (a) The diagram shows a converging lens being used as a magnifying glass.

- (i) On the diagram, use a ruler to draw two rays from the top of the object which show how and where the image is formed. Represent the image by an arrow drawn at the correct position.



(3)

- (ii) Use the equation in the box to calculate the magnification produced by the lens.

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

Show clearly how you work out your answer.

Magnification = _____

(2)

- (b) A camera also uses a converging lens to form an image.

Describe how the image formed by the lens in a camera is different from the image formed by a lens used as a magnifying glass.

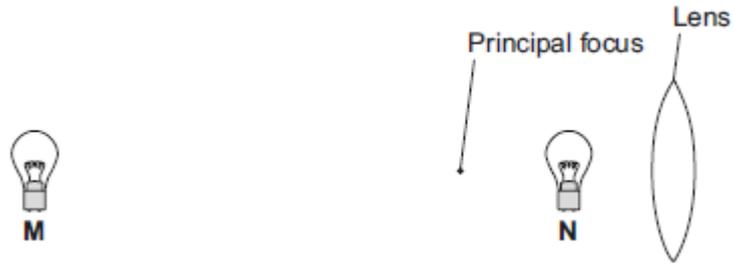
(2)

(Total 7 marks)

Q13.

- (a) A light bulb is placed between a convex lens and the principle focus of this lens, at position **N** shown in **Figure 1**. The light bulb is then moved to position **M**, a large distance from the lens.

Figure 1



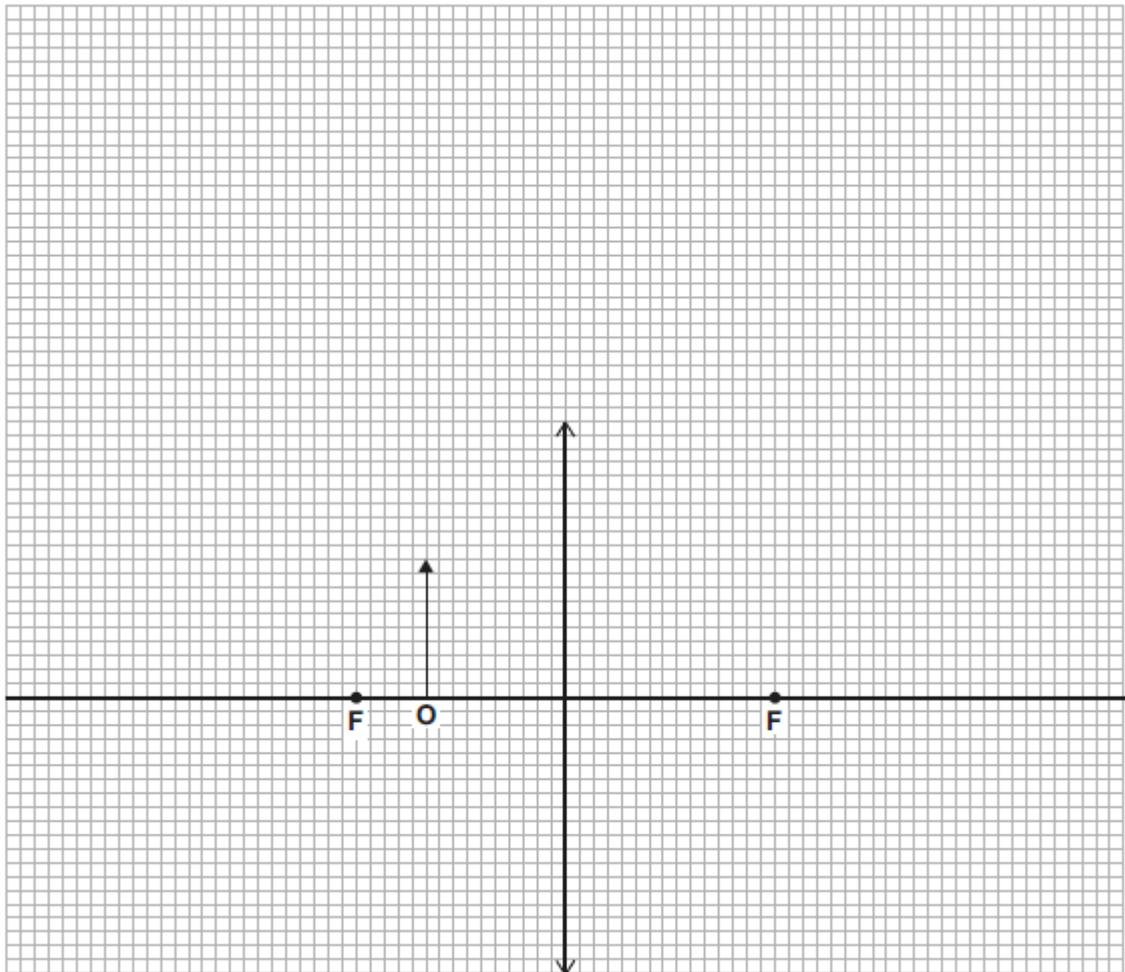
Describe how the nature of the image formed changes as the light bulb is moved from position **N** to position **M**.

(3)

- (b) An object, **O**, is very near to a convex lens, as shown in **Figure 2**.

Complete **Figure 2** to show how rays of light from the object form an image.

Figure 2

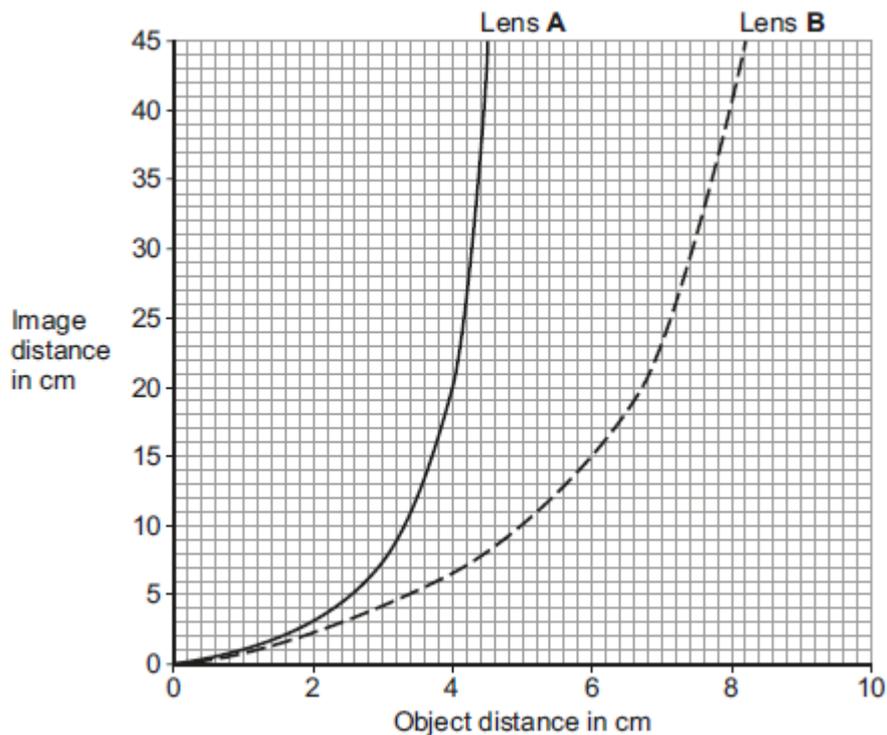


(3)

- (c) The object distance is the distance from an object to the lens. The image distance is the distance from the lens to the image.

Figure 3 shows how the image distance changes with the object distance, for two identically shaped convex lenses, **A** and **B**. Each lens is made from a different type of glass.

Figure 3



- (i) When the object distance is 4 cm, the image distance for lens **A** is longer than for lens **B**.

State why.

(1)

- (ii) When the object is moved between lens **B** and the principal focus, the image size changes. The table shows the magnification produced by lens **B** for different object distances.

Object distance in cm	Magnification
0.0	1
5.0	2
6.7	3
7.5	4
8.0	5

Using information from **Figure 3** and the table, describe the relationship between the **image** distance and the magnification produced by lens **B**.

(2)

- (iii) A third convex lens, lens **C**, is made from the same type of glass as lens **B**,

but has a shorter focal length than lens **B**.

Lens **B** is shown in **Figure 4**.

Complete **Figure 4** to show how lens **C** is different from lens **B**.

Figure 4



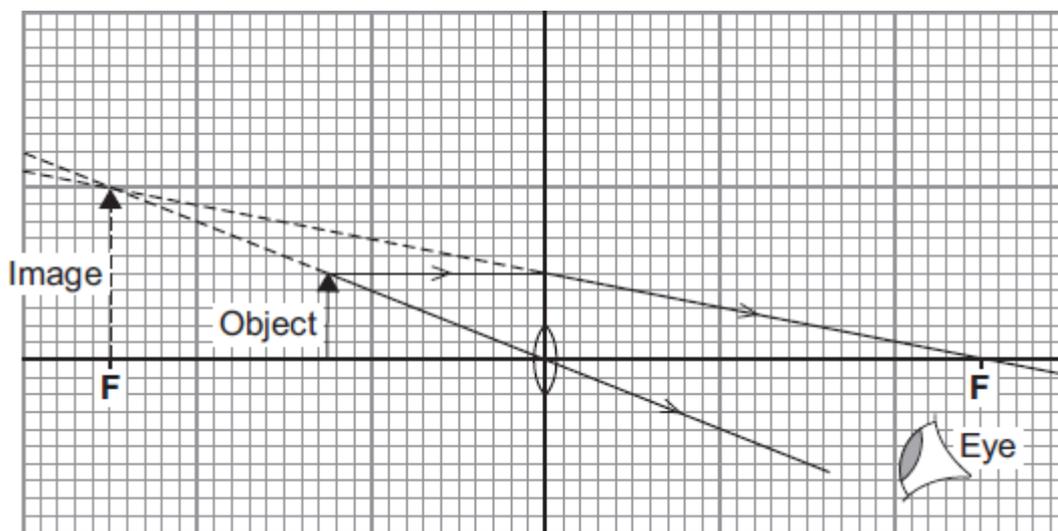
Lens **B**

Lens **C**

(1)
(Total 10 marks)

Q14.

The diagram shows a lens being used as a magnifying glass.



- (a) (i) What type of lens is shown in the diagram?

Draw a circle around your answer.

concave

converging

diverging

(1)

- (ii) Use the equation in the box to calculate the magnification produced by the lens.

The object and image in the diagram have been drawn to full size.

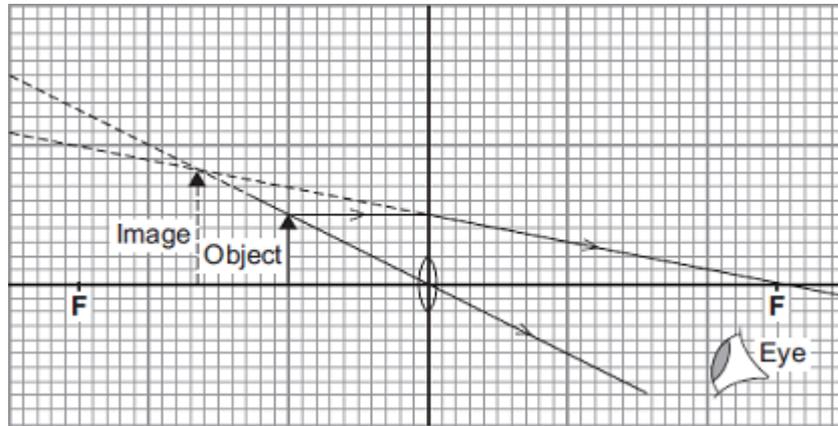
$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

Show clearly how you work out your answer.

Magnification = _____

(2)

- (b) The diagram shows how the image changes when the object has been moved closer to the lens.



Complete the following sentence by drawing a ring around the correct line in the box.

Moving the object closer to the lens

increases

does not change

decreases

the magnification

produced by the lens.

(1)

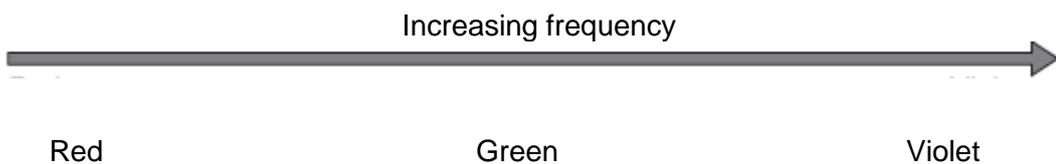
(Total 4 marks)

Q15.

- (a) The visible light spectrum has a range of frequencies.

Figure 1 shows that the frequency increases from red light to violet light.

Figure 1



Use the correct answers from the box to complete the sentence.

decreases

stays the same

increases

As the frequency of the light waves increases, the wavelength

of the light waves _____ and

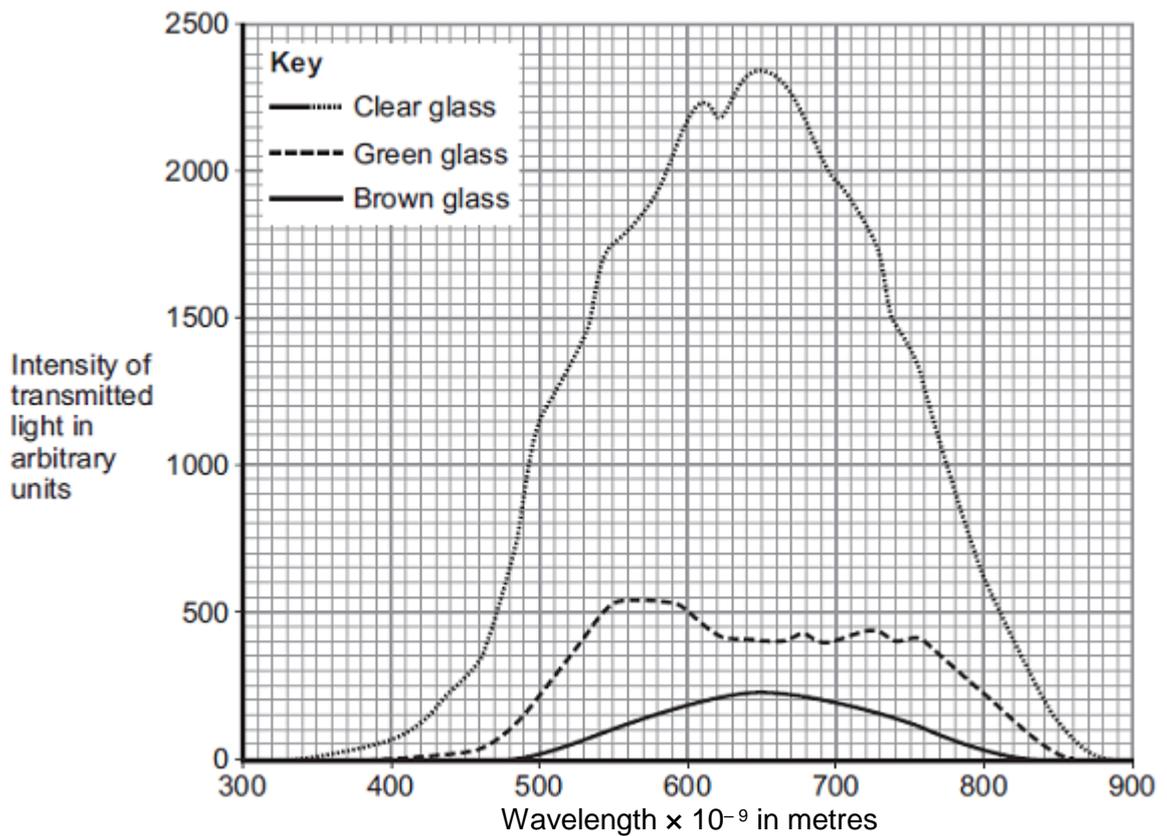
the energy of the light waves _____ .

(2)

- (b) Bottled beer will spoil if the intensity of the light passing through the glass bottle into the beer is too high.

Figure 3 shows the intensity of the light that is transmitted through three different pieces of glass.

Figure 3



- (i) The pieces of glass all had the same thickness.

Suggest why.

(1)

- (ii) Bottles made of brown glass are suitable for storing beer.

Suggest why.

(1)

(Total 4 marks)

In the diagram below, a frog sits on a rock in a pond.

(a) Complete the following sentences by drawing a ring around the correct line in the box.

(i) The frog can see its image in the pond because the surface of the pond acts

like a

concave
convex
plane

 mirror.

(1)

(ii) Draw a ring around each of **two** words from the box below to describe the image in the pond.

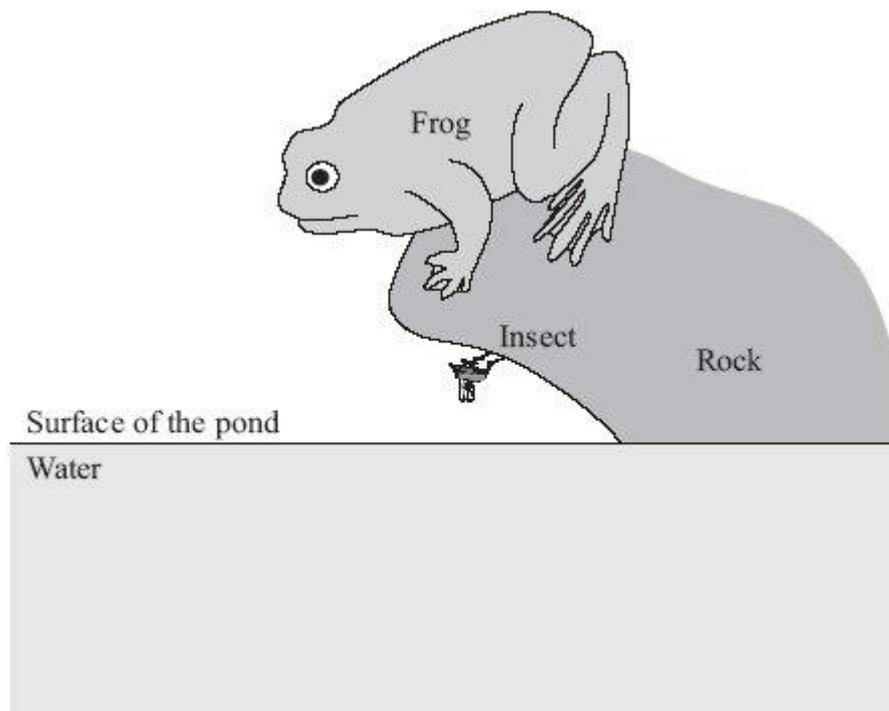
bigger inverted real smaller upright virtual
--

(2)

(b) There is an insect underneath the rock.

Use a ruler to draw rays of light on the diagram to show how the frog uses reflection to see the insect.

Mark the direction of the rays.



(3)

(Total 6 marks)

Q17.

The drawing shows someone ironing a shirt. The top of the ironing board is covered in a shiny silver-coloured material.



Explain why the shiny silver-coloured material helps to make ironing easier.

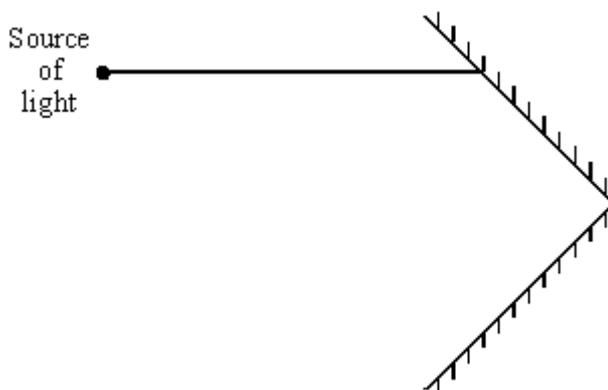
(Total 2 marks)

Q18.

- (a) The diagram shows two mirrors at right angles to each other. A ray of light shines onto one mirror as shown.

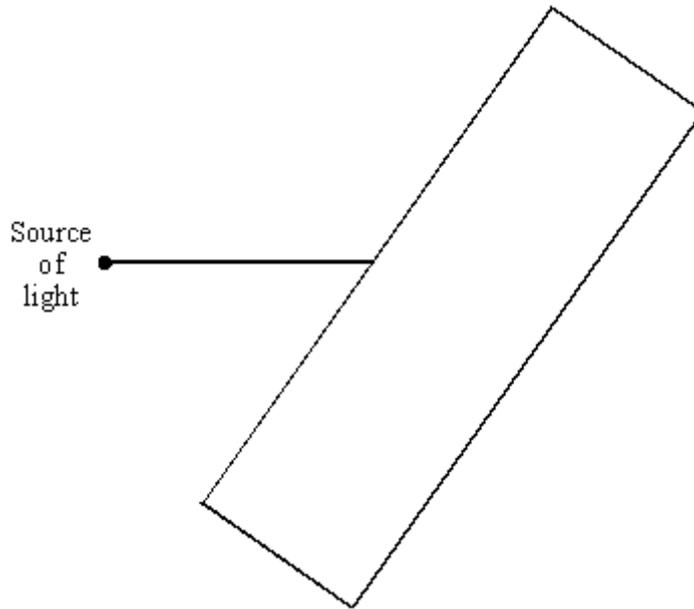
Carefully draw the path of the ray which is reflected from both mirrors.

Draw an arrow on the ray to show the direction of the light.



(3)

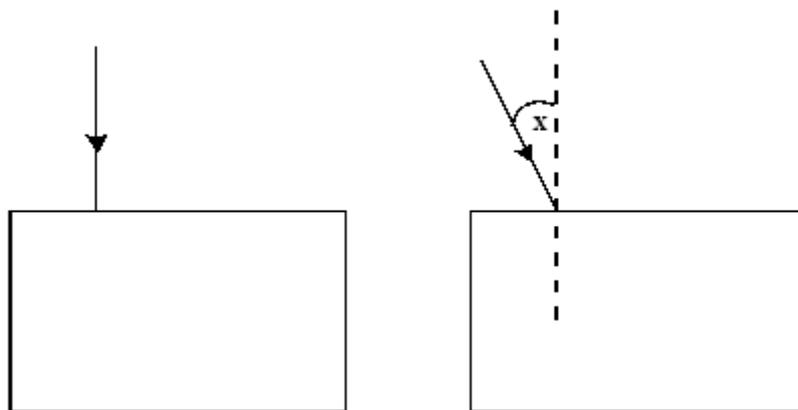
- (b) Light can also be made to change direction as it passes into and out from a block of glass. Complete the ray diagram below.



(2)
(Total 5 marks)

Q19.

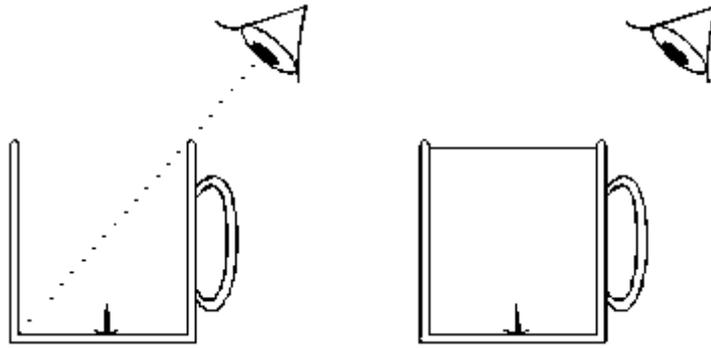
(a) The diagrams show rays of light. Each ray strikes a surface of a glass block.



- (i) On the diagram draw the path of each ray through the glass block and out into the air again.
- (ii) Label another angle on the diagram which is equal to the angle marked X. Label this angle Y.

(4)

(b) The diagrams show two beakers. Both beakers have a drawing pin inside as shown.



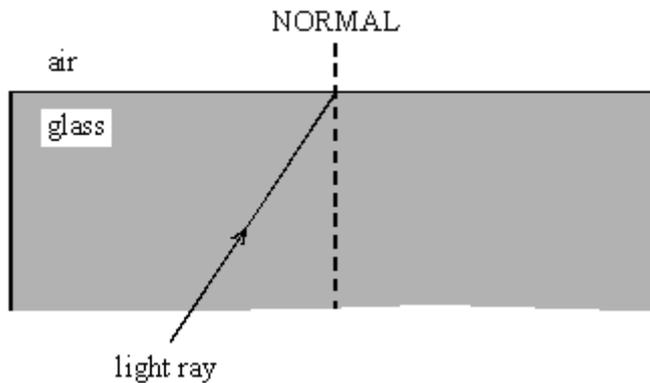
The first beaker is empty. The eye cannot see the drawing pin.
 The second beaker is full of water and the eye can see the drawing pin.

Explain how the eye is able to see the drawing pin in the second beaker. You may add to the diagram if it helps your answer.

(3)
 (Total 7 marks)

Q20.

The diagram shows a ray of light travelling through a glass block.



(a) Complete the diagram to show what happens to the ray of light when it comes out of the glass.

(2)

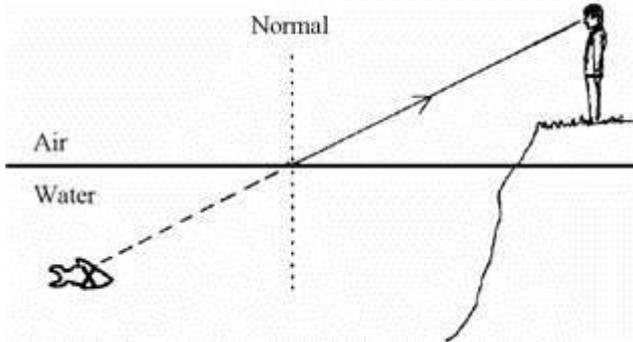
(b) Explain why this happens to the ray of light.

(2)
 (Total 4 marks)

Q21.

A man is walking along the bank of a river.

He sees a fish which seems to be at X.



- (a) Show, on the diagram, where the fish **really** is.

Complete the ray of light which goes from the fish into the man's eye.

(2)

- (b) Complete the sentence.

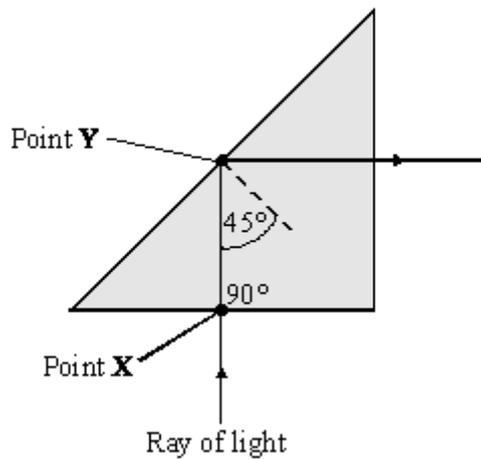
The ray of light is _____ as it passes from the water into the air.

(1)

(Total 3 marks)

Q22.

The diagram shows a glass prism.



- (i) Explain why refraction has **not** occurred at point X.

(1)

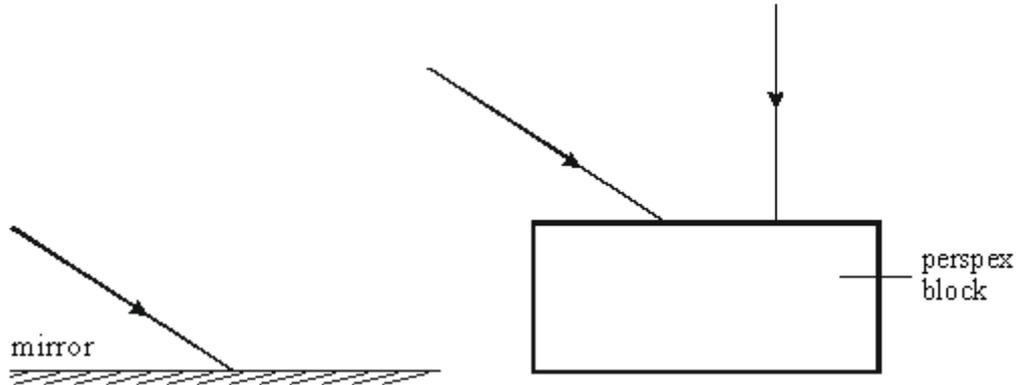
- (ii) (A) Give the full name for the process which has occurred at point Y.

(1)

- (B) Explain why this process has occurred.

Q23.

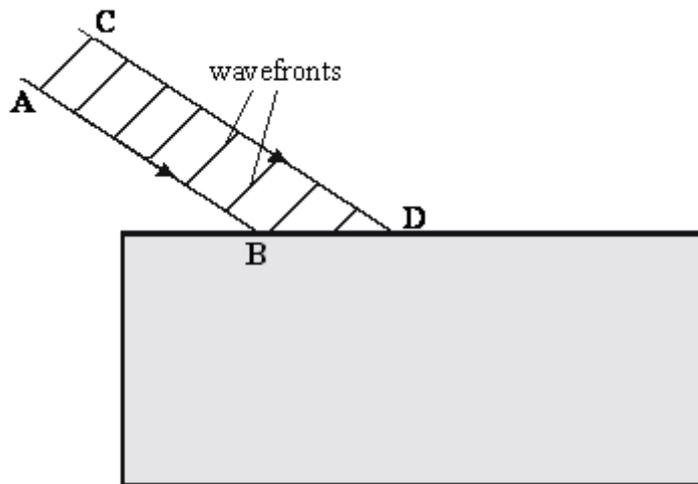
- (a) The diagrams below show rays of light striking a mirror and a perspex block.



Complete the paths of the three rays of light on the diagrams to show the rays leaving the mirror and the perspex block.

(4)

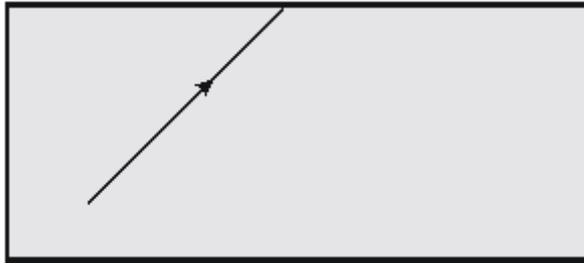
- (b) The diagram below shows a beam of light striking a perspex block.



- (i) Continue the paths of the rays AB and CD inside the perspex block.
(ii) Draw the wavefronts of the beam of light in the perspex.
(iii) Explain why the beam behaves in the way you have shown.

(7)

- (c) The diagram below shows a ray of light striking a perspex-air surface from inside the perspex. The critical angle is 45° .



Draw the path of the ray after it reaches the perspex-air boundary.

(2)

(Total 13 marks)

Q24.

The data given in the table below was obtained from an investigation into the refraction of light at an air to glass boundary.

Angle of incidence	Angle of refraction
20°	13°
30°	19°
40°	25°
50°	30°

- (a) Describe an investigation a student could complete in order to obtain similar data to that given in the table above.

Your answer should consider any cause of inaccuracy in the data.

A labelled diagram may be drawn as part of your answer.

(6)

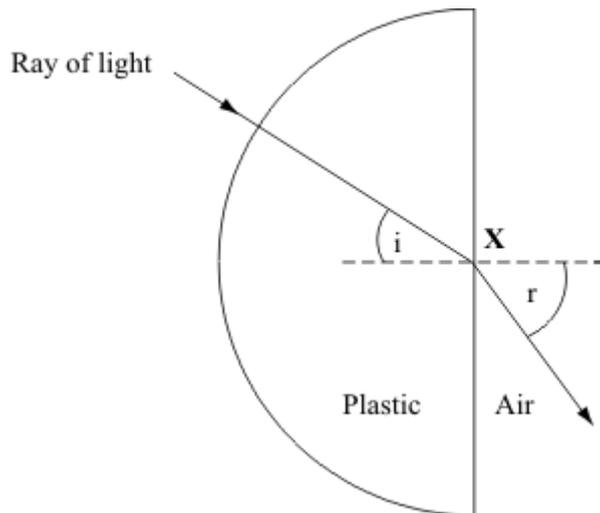
- (b) State the reason why light is refracted as it crosses from air into glass.

Q25.

- (a) A student investigated the refraction of light as it passes out of a transparent plastic block.

She aimed a ray of light at point **X**. She marked the position of the ray as it passed through the transparent plastic block and into the air.

The angle i is the angle of incidence.



- (i) What is the name of angle r ?

_____ (1)

- (ii) What is the name of the dashed line?

_____ (1)

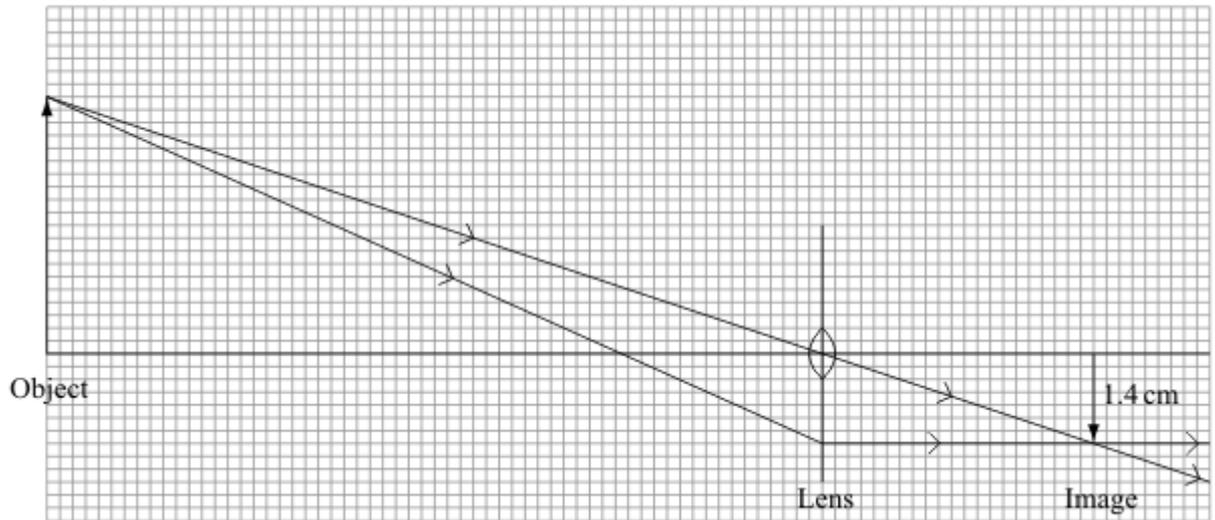
- (b) A camera uses a lens to produce an image which falls on a light detector.



Name a light detecting device which may be used in a camera.

(1)

(c) The diagram shows the position of an image formed in a camera.



(i) What type of lens is shown in the diagram?

(1)

(ii) Use the equation in the box to calculate the magnification.

$\text{magnification} = \frac{\text{image height}}{\text{object height}}$

Show clearly how you work out your answer.

Magnification = _____

(2)

(d) Why does the image formed in a camera have to be a real image?

(1)

(Total 7 marks)

Q26.

The data given in the table below was obtained from an investigation into the refraction of light at an air to glass boundary.

Angle of incidence	Angle of refraction
---------------------------	----------------------------

20°	13°
30°	19°
40°	25°
50°	30°

Describe an investigation a student could complete in order to obtain similar data to that given in the table above.

Your answer should consider any cause of inaccuracy in the data.

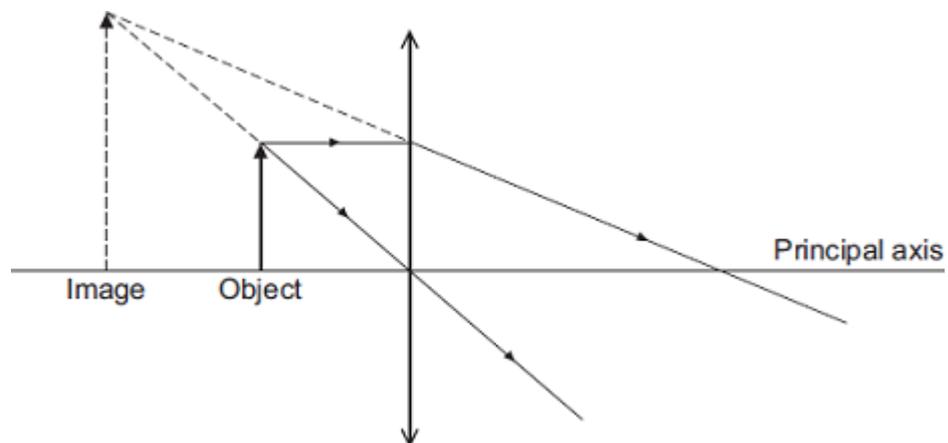
A labelled diagram may be drawn as part of your answer.

(Total 6 marks)

Q27.

- (a) The diagram shows how a convex lens forms an image of an object.

This diagram is **not** drawn to scale.



- (i) Which **two** words describe the image?

Draw a ring around each correct answer.

diminished inverted magnified real upright

(2)

(ii) The object is 4 cm from the lens. The lens has a focal length of 12 cm.

Calculate the image distance.

Image distance = _____ cm

(3)

(b) What does a minus sign for an image distance tell us about the nature of the image?

(1)

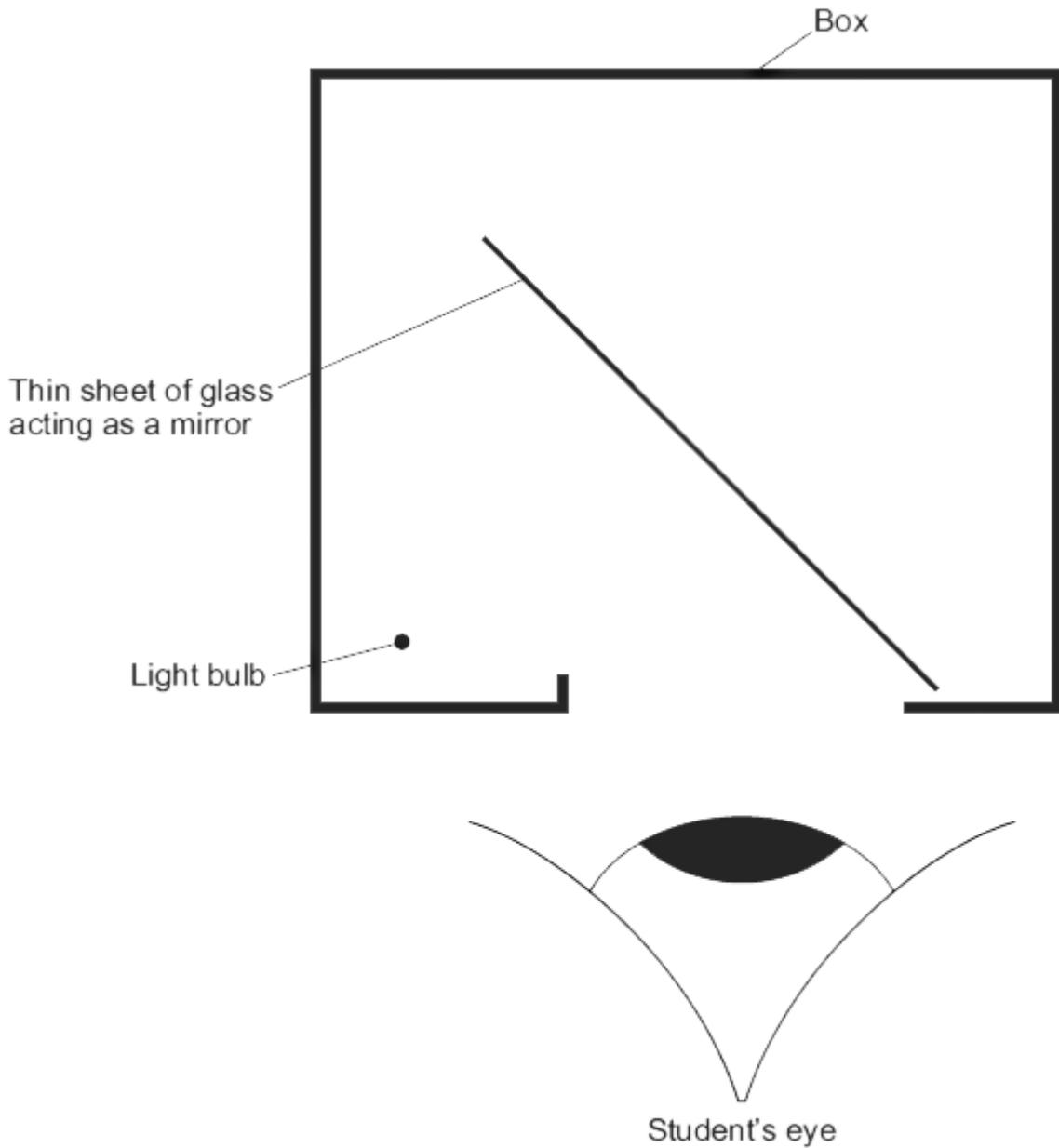
(Total 6 marks)

Q28.

The diagram shows a model used to demonstrate an illusion known as 'Pepper's Ghost'.

A small light bulb and thin sheet of glass are put inside a box. The thin sheet of glass acts as a mirror. Although the light bulb is switched on, a student looking into the box cannot see the bulb. What the student does see is a virtual image of the bulb.

View from above



- (a) Use a ruler to complete a ray diagram to show how the image of the light bulb is formed. Mark and label the position of the image.

(4)

- (b) The image seen by the student is virtual.

Why?

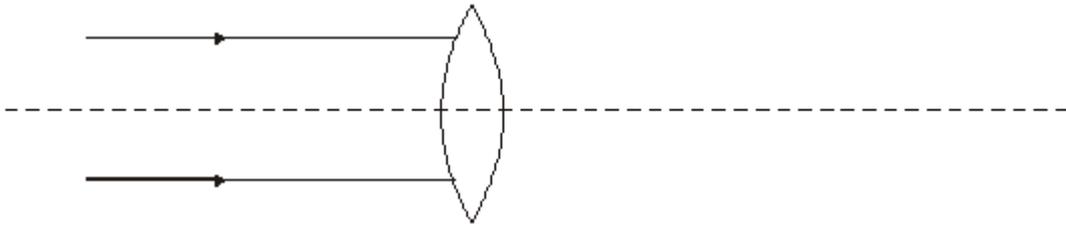
(1)

(Total 5 marks)

Q29.

- (a) The diagram shows two parallel rays of light, a lens and its axis.

- (i) Complete the diagram to show what happens to the rays.



(2)

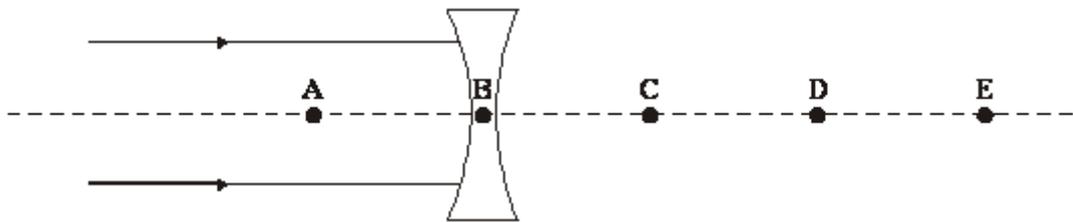
(ii) Name the point where the rays come together.

(1)

(iii) What word can be used to describe this type of lens?

(1)

(b) The diagram shows two parallel rays of light, a lens and its axis.



(i) Which point **A**, **B**, **C**, **D** or **E** shows the focal point for this diagram?

Point _____

(1)

(ii) Explain your answer to part (b)(i).

(1)

(iii) What word can be used to describe this type of lens?

(1)

(c) Complete the following **three** sentences by crossing out the **two** lines in each box which are wrong

In a camera a converging lens is used to produce an image on a

film
lens
screen

The image is

larger than

smaller than
the same size as

the object.

Compared to the distance of the image from the lens, the object is

further away from
nearer to
the same distance from

the lens.

(3)

(d) Explain the difference between a *real* image and a *virtual* image.

(3)

(Total 13 marks)

Mark schemes

Q1.

(a) any **two** correct construction lines:

if more than 2 construction lines treat as a list

2

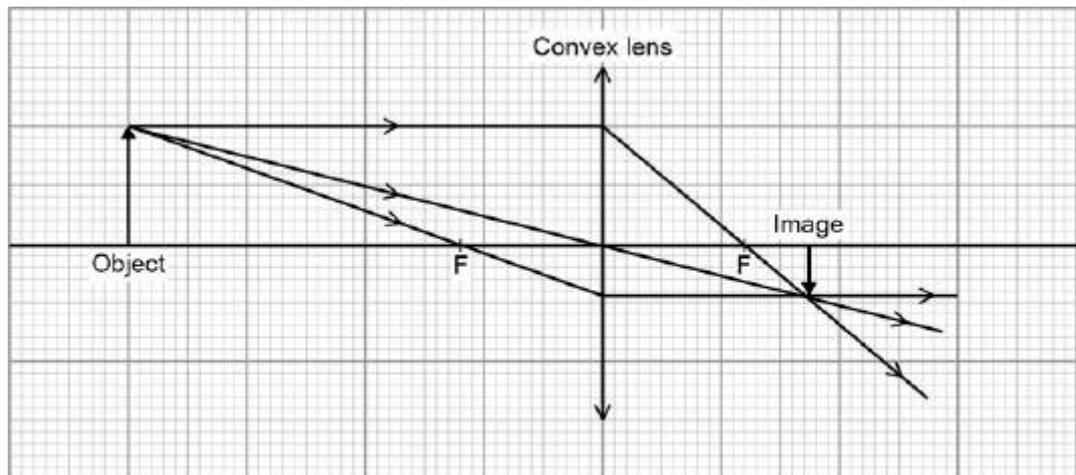
- line passing straight through centre of lens (& out other side)
- line travelling parallel to principal axis & then being refracted through principal focus (on RHS)
- line travelling through principal focus (on LHS) & then being refracted to be parallel to principal axis (on RHS)

inverted image drawn (with arrow) in correct location

1

one arrowhead from object to image on any construction ray

conflicting arrowheads negate this mark



F = Principal focus

1

(b) any **two** from:

- inverted
accept upside down
- real
- diminished / smaller
*allow ecf if ray diagram wrongly drawn but descriptions must relate to **their image***
a converse negates mark, eg real and virtual scores zero

2

[6]

Q2.

(a) (i) point where the rays cross

- do not credit if ambiguous* 1
- (ii) converging (lens)
do not accept convex 1
- (b) (i) point where the rays appear to diverge from
this should appear to be within 10mm in front of the back of the arrows on the approximate centre line
need not be accurately constructed using a ruler 1
- (ii) diverging (lens)
do not accept concave 1
- (c) converging 1
- film 1
- smaller than
- nearer to
accept any clear indication of the response e.g. ticking, ringing, writing in after a mistake 1
- (d) (i) (image) bigger than object enlarge
accept just 'made bigger' 1
- (ii) it / real image can be put on a screen **or** real image on the opposite side of the lens to the object
accept 'not an imaginary or virtual image'
assume 'it' refers to a real image
do not credit 'it can be seen' 1
- (e) **either** (the converging lens is) thick in the middle thin(ner) at the edge
thickest in the middle gains 2 marks 1
- or** (both) sides bend outwards (1) in the middle (1)
convex gains 2 marks
suitable diagrams gains 2 marks
- or** one side bends in the middle (1) more than the other side bends inwards (in the middle) (1) 1

[12]

Q3.

- (a) B
must be in correct order

		1
A		1
D		1
(b)	(i) mass increases as refractive index increases <i>accept weight / density increases as refractive index increases</i>	1
	(ii) thinner <i>accept thin</i>	1
	heavier <i>accept heavy</i>	1
	(iii) maximum one advantage and one disadvantage of each design	
	water-filled advantages:	
	• lenses are light	
	• wide range of focal length	
	• allows fine adjustment	
	• allows lenses to be altered independently.	1
	disadvantages:	
	• unattractive	
	• lens might burst	
	• lens might leak	
	• uncomfortable.	1
	sliding lenses advantages:	
	• hard-wearing	
	• look like conventional glasses	
	• easy to adjust	
	• allows lenses to be altered independently.	1
	disadvantages:	
	• heavy	
	• might slide out of position	
	• might get dirt between the lenses.	1
(c)	any two from: the image is	
	• blurred	
	• coloured	
	• inverted	
	• diminished.	
	<i>accept not focussed</i>	1
		1

Q4.

- (a) (i) (concave) mirror / reflector
*do **not** allow convex mirror / reflector* 1
- (ii) refraction 1
- (b) (i) converging 1
- (ii) 4
*allow 1 mark for correct substitution
ie 20 / 5 or 4 / 1
ignore any units* 2

[5]

Q5.

- (a) one mark for each ray correctly drawn straight to glass then bent towards pupil
*accept both rays hitting any part of eye
judge straightness by eye
accept dotted **or** dashed lines
ignore any arrows
N.B. the rays must reach the eye* 2
- (b) speed 1
- refraction 1
- transverse 1

[5]

Q6.

- (a) (i) L 1
- (ii) N 1
- (c) the answer should be in the form:
***not** inside the eye*

either for **both** marks an arrangement which could demonstrate visibly light travels in straight lines
full credit should be given for answer presented as a diagram

and
an explanation of how it shows the straightness

or for one mark

named device which uses principle of light travelling in straight lines to work

examples

light (from a street lamp) strikes an object producing a shadow

laser light travelling through (fine) dust shows a straight beam

three pieces of card with central holes need to be lined up to be able to see through the third hole from the first

ray box type experiment using mirrors/prisms, etc

beams on paper or in smoke

torch beams through smoke

example devices:-

-pinhole camera (qualification may get second mark)

-periscope

-optical fibre

*-reflection 'in a **mirror***

2

[4]

Q7.

(a) converging

or convex

1

(b) (principal) focus

or focal point

1

(c) **either** (x)1.5 **or** (x)1½ **or** 150%

*unambiguous evidence of appropriate measurements for 1 mark only eg 4 and 6 **or** 8 and 12 **or** 0.8 and 1.2*

2

(d) real rays cross to form it / formed at the intersection of real rays

accept 'image on the opposite side of the lens to the object'

accept 'can be put onto a screen'

1

[5]

Q8.

(a) any **two** for **1** mark each

deduct (1) from the first two marks if a ruler has not been used but the intention is clear

ray from the object's arrowhead

- through centre of lens
- parallel to the axis then, when it reaches the lens, through F on the right
- through F on the left then, when it reaches the lens parallel to the axis

example of a 4 mark response

if more than two construction lines have been drawn all must be correct to gain 2 marks

construction lines drawn as dashed lines do not score credit

2

image shown as vertical line from axis to where their rays intersect

image need not be marked with an arrowhead but, if it is, it must be correct

1

ray direction shown

only one correct direction

arrow needed but there must not be any contradiction

1

(b) any **two** from:

- inverted

accept 'upside down'

- magnified

accept 'bigger'

- real

accept 'not virtual / not imaginary'

one correct feature gains 1 mark

ignore any reference to position

an incorrect feature negates a correct response

2

[6]

Q9.

(a) reflection at the mirror of ray from tip of real puppy's ear to real puppy's eye (1)

may be drawn freehand

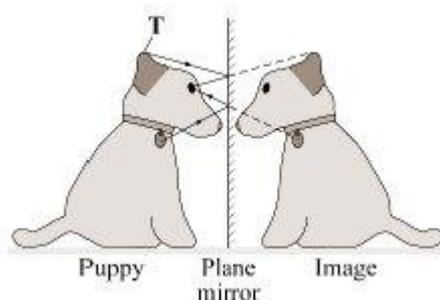
accurate (1)

ruler must have been used and the reflected ray is an extension of the straight line from point virtual ear however the virtual part of the line need not be shown

arrow to show correct direction (1)

only one arrow needs to be shown but there must be no contradiction

example of (3) mark response



(b) flat

accept 'it's not curved/bent'

accept 'it's straight'

1

[4]

Q10.

(a) converging (lens)

accept 'convex (lens)'

accept biconvex

1

(b) (principal) foci

accept 'focus' / 'focuses' / 'focis'

focal point(s)

1

(c) (i) formed where (real) rays (of light) intersect / meet / cross

accept rays (of light) pass through the image

accept 'image is on the opposite side (of the lens to the object)'

accept (construction) lines cross over

a response relating to a screen or similar is neutral

lines are solid and not dotted is neutral

1

(ii) inverted

accept any unambiguous correct indication

1

(d) (i) smooth curve which matches the points

*judge by eye but do **not** accept point to point by ruler or otherwise*

1

(ii) continuous

1

(iii) as distance increases, magnification decreases

accept negative correlation

a statement 'inversely proportional' is incorrect and limits maximum mark for this part question to 1

1

further detail eg magnification falls steeply between 40 and 50 cm
or

magnification begins to level out after / at 70 cm

1

[8]

Q11.

(a) (i) answer in the range 3.0 ↔ 3.1 inclusive

accept for 1

$3.6 \div 1.2$ or $3.7 \div 1.2$
or $36 \div 12$ or $37 \div 12$
or $18 \div 6$ or $18.5 \div 6$
or $10.2 \div 3.4$ or $102 \div 34$
or answer in the range but with a unit eg 3 cm

2

- (ii) (principal) focus / focal (point(s)) / foci / focus
accept 'focusses'
accept focals
do **not** accept focal length

1

- (iii) at the intersection of virtual / imaginary rays
or 'where virtual / imaginary rays cross'
or the rays of (real) light do not cross
or the image on the same side (of the lens) as the object
or the image is drawn as a dotted line
or the image is upright
do **not** accept 'cannot be put on a screen'
do **not** accept any response which refers to reflected rays

1

- (b) (i) another correct observation about relationship between values of **d** (1)
(but) not the same relationship between corresponding values for magnification (1)

example

15 is three times bigger than 5 but
2.0 is not three times bigger than 1.2

2

- (ii) when the distance / **d** increases the magnification increases
or the converse
accept 'there is a (strong) positive correlation'
do **not** accept any response in terms of proportion / inverse proportion

1

- (iii) (student has) no evidence (outside this range)
accept data / results / facts for 'evidence'

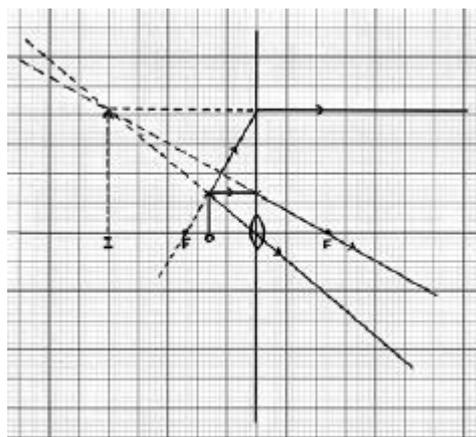
1

[8]

Q12.

- (a) (i) **two** correct rays drawn
1 mark for each correct ray
- ray parallel to axis from top of object **and** refracted through focus **and** traced back beyond object
 - ray through centre of lens **and** traced back beyond object
 - ray joining top of object to focus on left of lens taken to the lens

refracted parallel to axis **and** traced back parallel to axis beyond object



2

an arrow showing the position **and** correct orientation of the image for their rays

*to gain this mark, the arrow must go from the intersection of the traced-back rays to the axis **and** the image must be on the same side of the lens as the object and above the axis*

1

(ii) (x) 3.0

accept 3.0 to 3.5 inclusive

or

$$\frac{\text{their image height}}{\text{object height}}$$

correctly calculated

allow 1 mark for correct substitution into equation using their figures

ignore any units

2

(b) any **two** from:

in a camera the image is:

- real not virtual
- inverted and not upright
accept upside down for inverted

- diminished and not magnified
accept smaller and bigger
accept converse answers but it must be clear the direction of the comparison
both parts of each marking point are required

2

[7]

Q13.

(a) the image would decrease in size

1

the image would change (from virtual) to real
accept that the image (of bulb M) can be projected on to a screen

1

the image would change (from non-inverted) to inverted

1

- (b) a ray through the centre of the lens
rays should be drawn with a ruler
ignore arrows

1

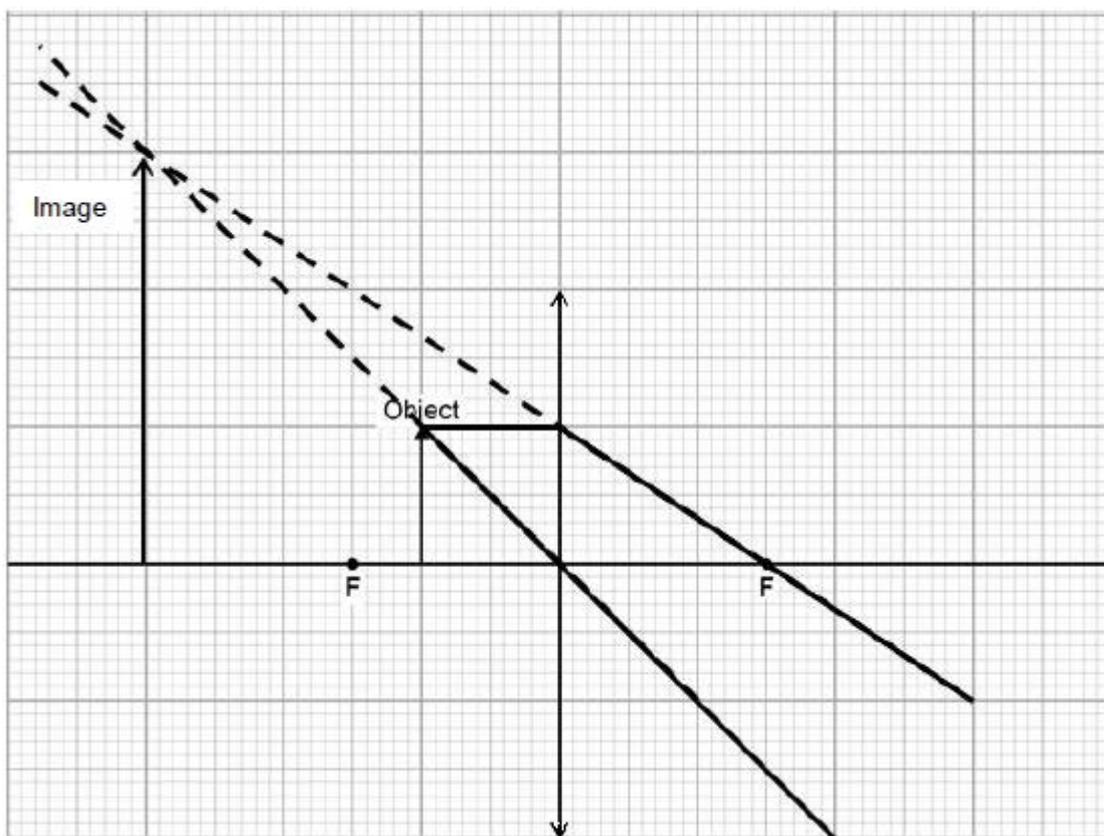
a ray parallel to the principal axis and passing through the principal focus to the right of lens

accept solid or dashed lines
accept a ray drawn as if from the principal focus to the left of the lens, emerging parallel to the principal axis

1

image drawn where rays cross
image should be to left of the lens

1



- (c) (i) (because the glass in) lens A has a greater refractive index
accept lens A is more powerful
accept lens A has a shorter focal length

1

- (ii) when the magnification increases by 1, the image distance increases by 10 cm
accept for 1 mark it is a linear pattern

or
as the image distance increases, the magnification increases
do **not** accept directly proportional

2

- (iii) diagram showing the surfaces of a convex lens C having greater curvature than lens B
the size of the lens drawn is not important

1

[10]

Q14.

- (a) (i) converging

1

- (ii) (x) 2

*allow 1 mark for correct substitution
ie 10/5 or 20/10 or 2/1
ignore any units*

2

- (b) decreases

1

[4]

Q15.

- (a) decreases

correct order only

1

increases

1

- (b) (i) intensity (of transmitted light) depends on thickness
or
to enable a valid comparison
or
it is a control variable

*accept absorption depends on thickness
it would affect the results is insufficient
fair test is insufficient*

1

- (ii) transmits the least light

or
absorbs the most light

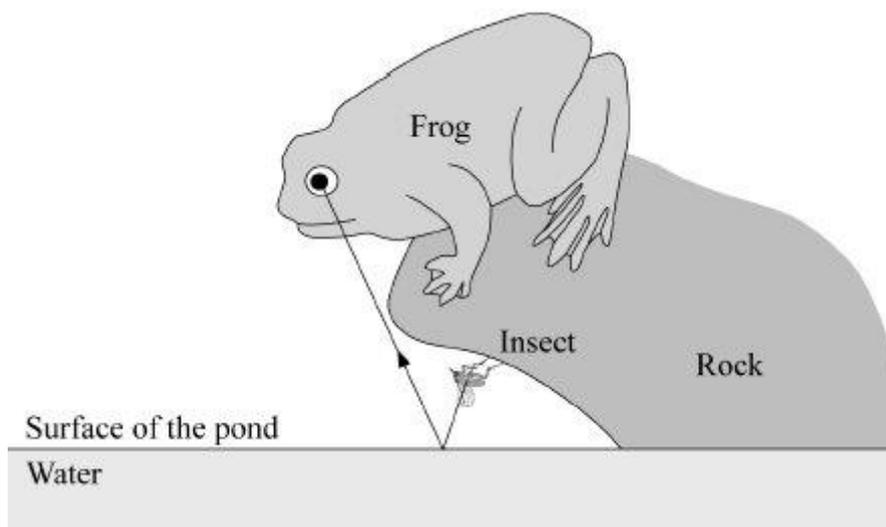
*accept very little light is transmitted
do **not** accept transmits none of the light
do **not** accept absorbs all of the light
any reference to heat negates this mark*

1

[4]

Q16.

- (a) (i) plane
accept any unambiguous indication 1
- (ii) inverted 1
- virtual
accept any unambiguous indication 1
- (b) reflection takes place at the surface of the pond and angle of incidence = angle of reflection
as judged by eye 1
- reflected ray is a straight line to frog's eye through the air 1
- correct direction arrow **either** from insect **or** to frog's eye
only one arrow essential but do not accept if either arrow contradicted example of a fully correct response



1

[6]

Q17.

silver is a (good) reflector of heat (radiation) **or** silver reflects the heat (radiation)

*fact
heat = infra red
ignore references to light
accept shiny for silver
good radiator negates the mark
ignore references to good conductor
do not accept bounce back*

1

less heat is lost through the board **or** more heat is retained by the shirt
explanation

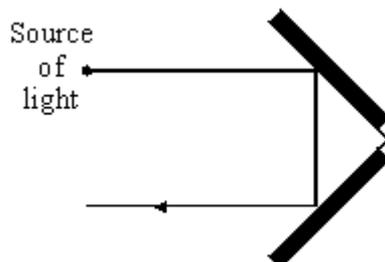
*accept both sides of shirt heated
reflects heat back up gets 1 mark only
ignore mention of friction*

1

[2]

Q18.

- (a) first reflection vertically down to the fourth hatch line or just to the left of it reaching mirror (must come from incident ray given)



1

second reflection back parallel to incident ray must be linked to first part of ray
1

appropriate arrow on a part of the ray (may be given if lines wrong)

(must come from source of light)

maximum of one mark to be lost for poor diagrams not using a ruler for straight lines

first time you come across wavy line, it is penalised

1

- (b) ray in block bent downwards, not beyond the normal
do not credit if exactly on normal

1

emergent ray parallel to incident ray

do not credit a continuation of the line straight through the block these are independent

1

[5]

Q19.

- (a) (i) Ignore arrows on rays
perpendicular rays goes straight in and out
other ray refracts towards normal (not along)
emerges parallel incident ray (by sight) if refraction correct (ignore reflections)

for 1 mark each

3

- (ii) emergent angle marked Y if emerges parallel to right of normal
for 1 mark

1

- (b) straight ray to water surface refracts/bends
straight to eye/towards surface on right image correctly shown

or states the same mark prose only of diagram incomplete
any 3 for 1 mark each

3

[7]

Q20.

- (a) ray shown refracted (to rhs or along normal)
gains 1 mark

but

ray shown refracted away from normal
gains 2 marks

2

- (b) *idea that*
travels at a different speed
gains 1 mark

(allow refracted / travels slower in air / air is less dense) (do not allow bent)

but

travels more quickly in air
gains 2 marks

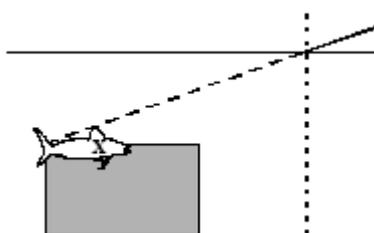
2

[4]

Q21.

- (a) line (from fish) to complete ray to eye
[mark awarded even if begins outside the box]
[credit only if fish shown to left of normal]

- fish within the region shown or X or start of ray
(i. e. not necessarily directly below x) each for 1 mark



2

- (b) bent/refracted/deviated/speeded up
for 1 mark

1

[3]

Q22.

- (i) (incident) ray along the normal
or (incident) ray at 90° (to the surface)

1

- (ii) (A) total internal reflection
all three words required do not credit total internal refraction

1

- (B) **EITHER**
 angle of incidence is greater than the critical angle
or angle of incidence is greater than 42°

2

OR
 angle of incidence is 45°

1

[4]

Q23.

- (a) Reflection correct
 Normal incidence correct in and out
 Correct refraction in
 Parallel ray out
each for 1 mark

4

- (b) (i) Each ray correctly refracted in
 $1 + 1 = 2$

7

- (ii) Wavefronts perp sides
 Wavefronts closer
(Cannot score wavefront marks if refracted rays clearly wrong)

- (iii) Speed reduces
 Starting at B
 Then D
each for 1 mark

- (c) TIR correct
gets 2 marks

Else rough reflection
gets 1 mark

2

[13]

Q24.

- (a) **Level 3 (5–6 marks):**
 A detailed and coherent plan covering all the major steps is provided. The steps in the method are logically ordered. The method would lead to the production of valid results.

A source of inaccuracy is provided.

Level 2 (3–4 marks):
 The bulk of a method is described with mostly relevant detail. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):
 Simple statements are made. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:

No relevant content.

Indicative content

place a glass block on a piece of paper

draw around the glass block and then remove from the paper

draw a line at 90° to one side of the block (the normal)

use a protractor to measure and then draw a line at an angle of 20° to the normal

replace the glass block

using a ray box and slit point the ray of light down the drawn line

mark the ray of light emerging from the block

remove the block and draw in the refracted ray

measure the angle of refraction with a protractor

repeat the procedure for a range of values of the angle of incidence

possible source of inaccuracy

the width of the light ray

which makes it difficult to judge where the centre of the ray is

6

- (b) velocity / speed of the light decreases

allow velocity / speed of the light changes

1

[7]

Q25.

- (a) (i) (angle of) refraction

*take care **not** to credit 'angle of reflection'*

1

- (ii) normal

*do **not** credit 'horizontal'*

1

- (b) **either**

(photographic) film

or CCD(s) (charge-coupled device(s)) / CMOS(s) (sensor(s)) / (active) pixel sensor(s)

accept 'LDR(s)' / 'light dependent resistor(s)'

***not** lux meter*

*do **not** accept light sensor(s)*

1

- (c) (i) converging

or 'convex'

1

(ii) **either**

(0).35

or (0).4(1...)

do not give any credit for an answer greater than 1

or

7 ÷ 20 for 1 mark

or

clear evidence that appropriate measuring / counting, has been made for 1 mark

2

(d) otherwise it will have no effect on the light detector

or otherwise no (real) light will fall on the light detector

or 'a virtual / imaginary image will have no effect on the light detector'

allow error carried forwards for 'light detector'

allow so it can be formed on the film

1

[7]

Q26.

Level 3 (5–6 marks):

A detailed and coherent plan covering all the major steps is provided. The steps in the method are logically ordered. The method would lead to the production of valid results.

A source of inaccuracy is provided.

Level 2 (3–4 marks):

The bulk of a method is described with mostly relevant detail. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):

Simple statements are made. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:

No relevant content.

Indicative content

place a glass block on a piece of paper

draw around the glass block and then remove from the paper

draw a line at 90° to one side of the block (the normal)

use a protractor to measure and then draw a line at an angle of 20° to the normal

replace the glass block

using a ray box and slit point the ray of light down the drawn line

mark the ray of light emerging from the block
 remove the block and draw in the refracted ray
 measure the angle of refraction with a protractor
 repeat the procedure for a range of values of the angle of incidence

possible source of inaccuracy

the width of the light ray

which makes it difficult to judge where the centre of the ray is

[6]

Q27.

(a) (i) magnified

1

upright

1

(ii) $v = -6(\text{cm})$

max 2 marks if no minus sign

6(cm) gains 2 marks

$$1/v = 1/12 - 1/4 = -1/6$$

gains 2 marks

$$1/12 = 1/4 + 1/v$$

gains 1 mark

$$-5.99(\text{cm})$$

using decimals gains 3 marks

3

(b) it is virtual

1

[6]

Q28.

(a) two rays drawn from the bulb and reflected by the glass

angle I = angle R judged by eye

allow 1 mark for one incident and reflected ray even if angle I doesn't equal angle R

2

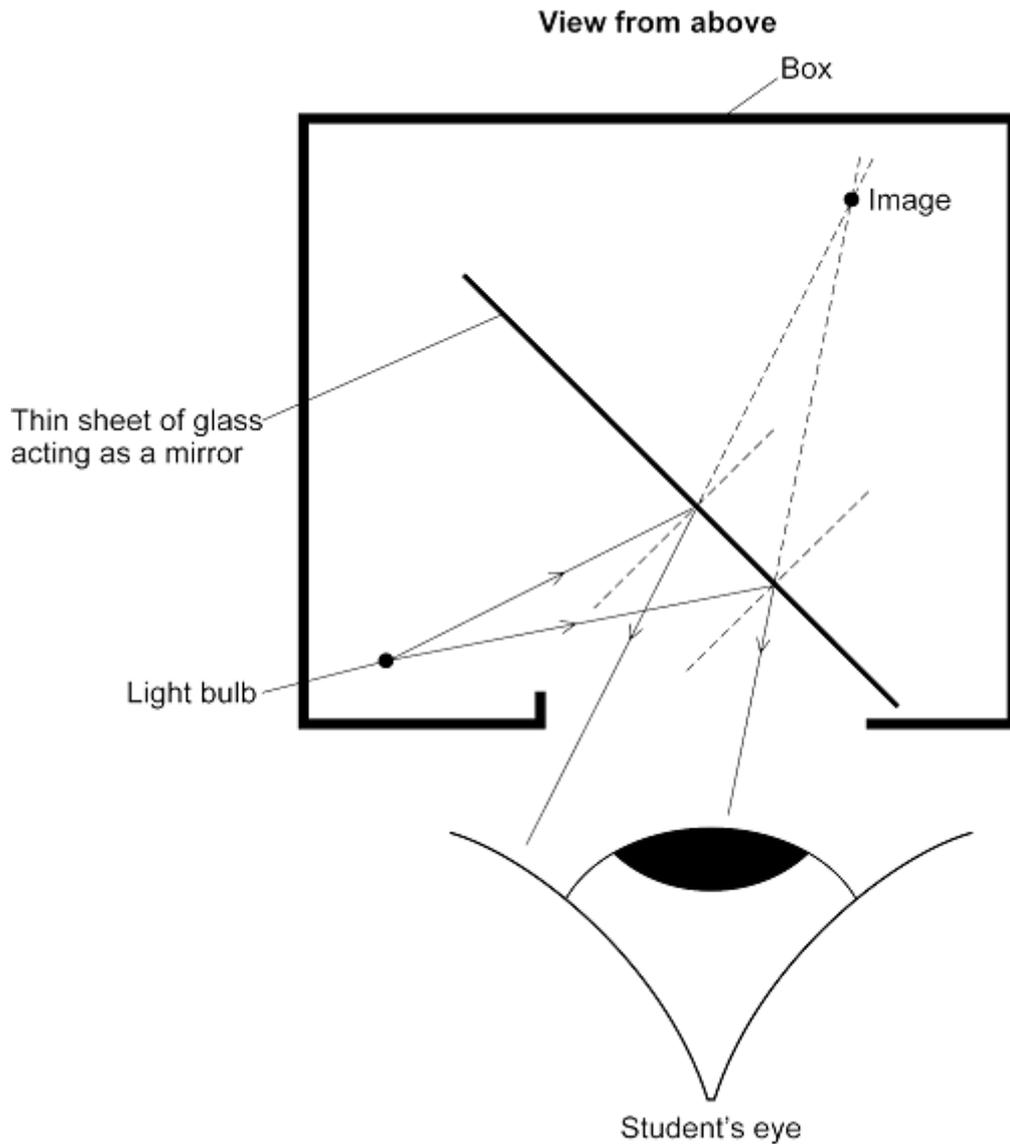
at least one arrow drawn in correct direction

any conflicting arrows negate this mark

ignore any arrows drawn on construction lines behind the glass

1

position of image correct



judged by eye

1

- (b) image is formed by virtual / imaginary rays crossing
accept construction lines only show where the light seems to come from
accept the image is behind the glass / mirror
accept image is seen through the glass / mirror
accept (real) rays of light do not pass through the image
accept (real) rays do not cross
accept the image is a reflection (of the object)
accept the image is formed by reflection
*do **not** accept a virtual image can't be formed on a screen*
*do **not** accept the object / image is reflected*

1

[5]

Q29.

- (a) (i) rays continued to meet on the right hand side of the lens and beyond
must be straight lines from the right hand side of the lens
ignore details through the lens

	<i>allow if no arrows</i>	1
	meet exactly on the axis <i>negate mark if contradictory arrow(s) added</i> <i>do not need to go beyond the focus for this mark</i>	1
(ii)	(principal) focus or focal (point)	1
(iii)	converging or convex	1
(b) (i)	A	1
(ii)	rays seem to come from this point or words to this effect or shows this on the diagram	1
(iii)	diverging or concave	1
(c)	film <i>accept any unambiguous method of showing the correct response</i>	1
	smaller than	1
	further away from	1
(d)	any three from: <ul style="list-style-type: none"> • real image can be put on a screen <i>allow film</i> • virtual image cannot be put on a screen / film • virtual image is imaginary • real image is formed where (real) rays cross / converge <i>allow real image has light travelling through it</i> • virtual image is where virtual / imaginary rays (seem to) come from or <i>virtual image is where rays seem to come from</i> • virtual image formed where virtual rays intersect / cross 	3