Optics

Mark Scheme

Name: _____

Class: _____

Date: _____

Time: **71 minutes**

Marks: **71 marks**

Comments:

Mark schemes

1

(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]

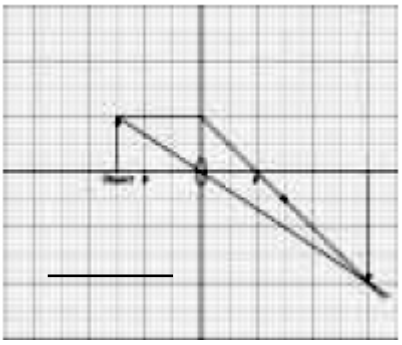
2 (a) any **two** for **1** mark each

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]

3 (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***

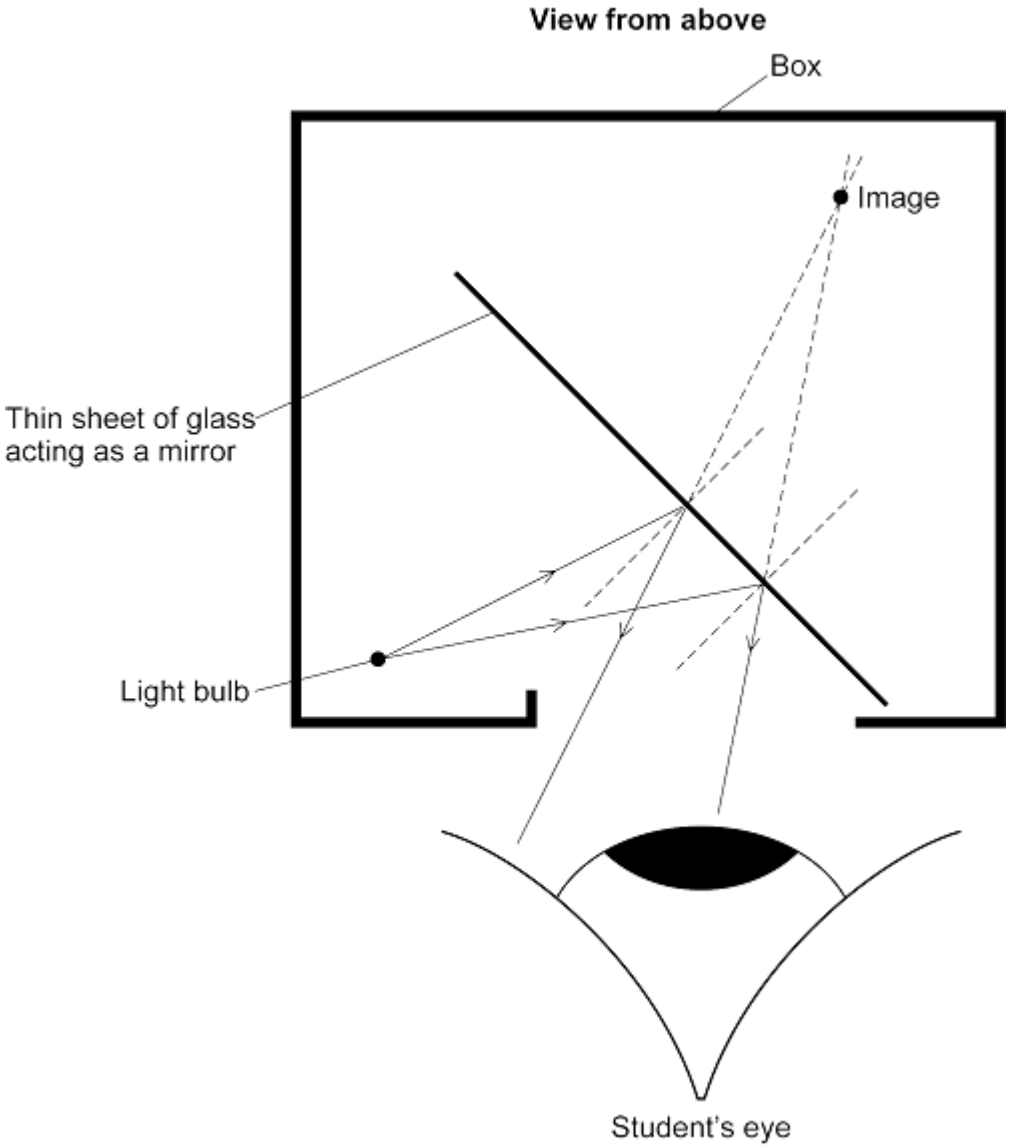
2

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]

4 (a) (i) microwave

1

(ii) refraction

1

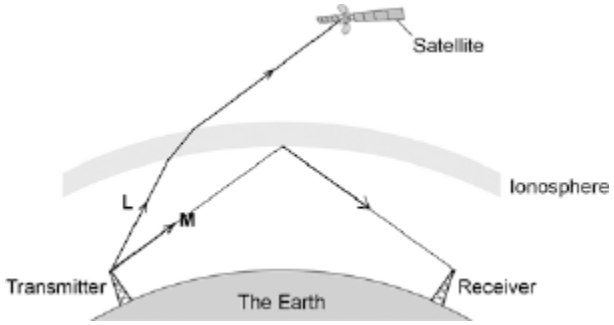
(b) (i) wave M continues as a straight line to the ionosphere and shown reflected

accept reflection at or within the ionosphere

1

correctly reflected wave shown as a straight line reaching the top of the receiver

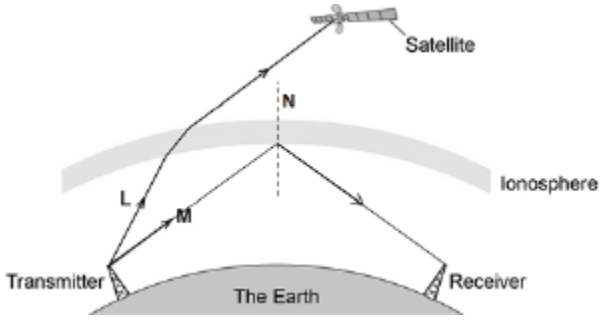
if more than 2 rays shown 1 mark maximum



ignore arrows

1

(ii) normal drawn at point where their **M** meets the ionosphere



1

(c) any **two** from:

- transverse
- same speed (through air)

  *accept speed of light **or** 3×10^8 m / s*
- can be reflected
- can be refracted
- can be diffracted
- can be absorbed
- transfer energy
- can travel through a vacuum

  *an answer travel at the same speed though a vacuum scores **2** marks*
- can be polarised
- show interference.

  travel in straight lines is insufficient

2

[7]

5 (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]

6 (a) (i) Image distance increases
Image size increases
Remains inverted
Remains real
for 1 mark each

2

(ii) Image distance decreases
Image size decreases
Becomes upright
Becomes virtual
for 1 mark each

2

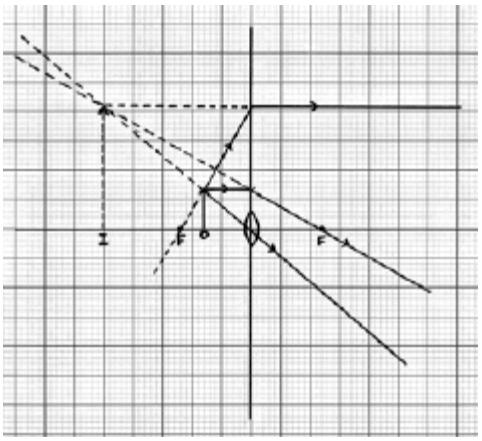
(b) Move lens with respect to film
Closer for distant objects
Further for near objects
for 1 mark each

3

[7]

7 (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]

8 (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

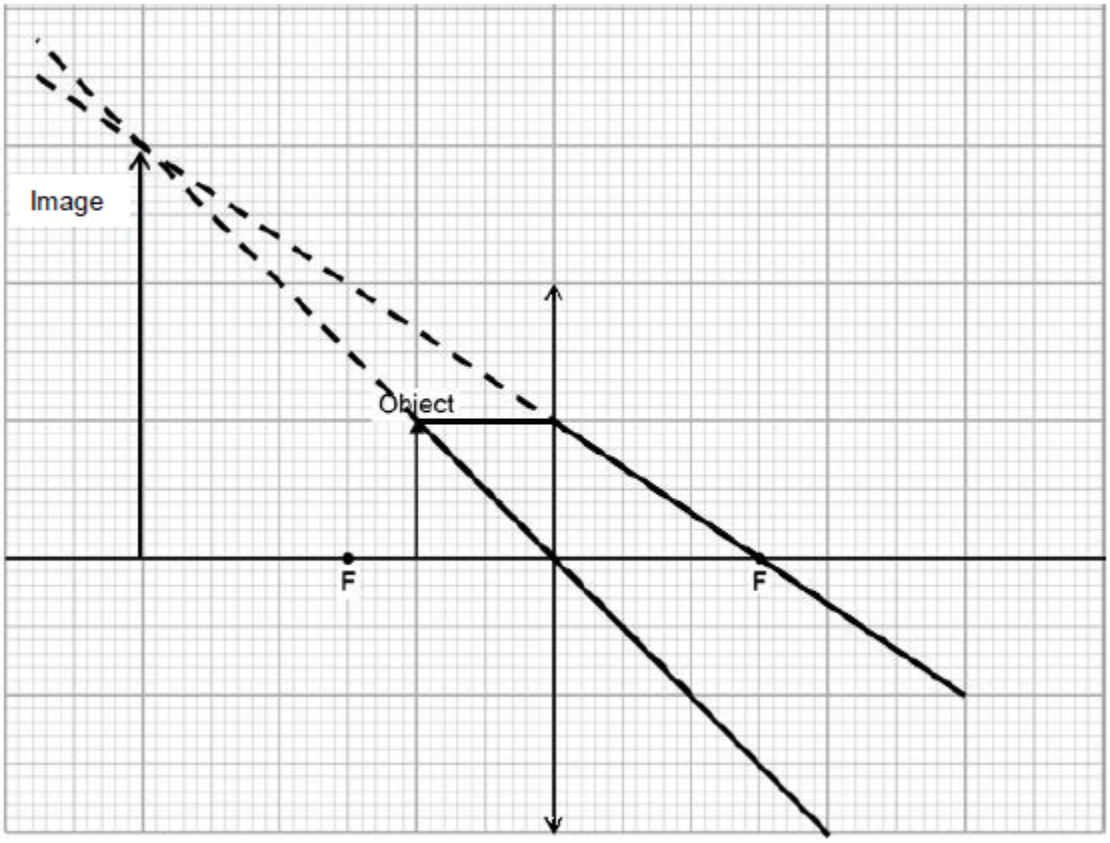
accept a ray drawn as if from the principal focus to the left of the lens, emerging parallel to the principal axis

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]

9 (a) (i) converging / convex / biconvex

1

(ii) focal (points) **or** foci

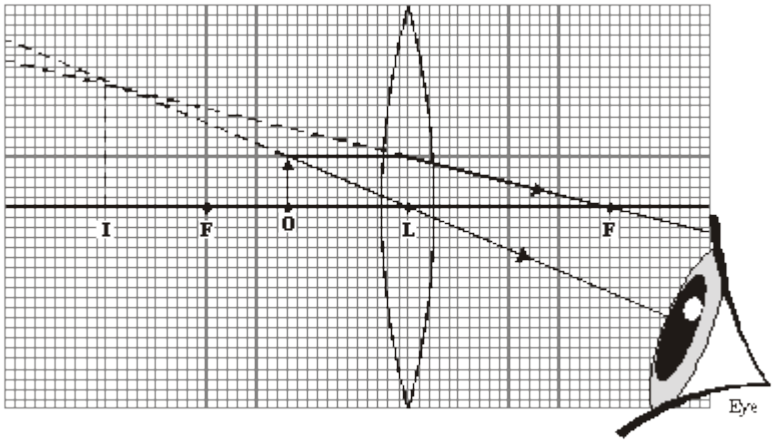
*accept focuses **or** focus (point)*

1

(iii) (principal) axis

1

(iv)



all lines drawn with a ruler for full marks

no ruler, penalise **1** mark from first four

last mark can still be awarded

double refraction drawn could get **4** out of 5 marks

ray that continues from the top of the object through L to the eye

1

horizontal ray from the top of the object, refracted by the lens and continued through F on the r.h.s. to the eye

1

back projections of these rays (shown as dotted lines)

1

image 25 mm high at 61 mm left of L
(tolerance 1 mm ± vertically, 2 mm ± horizontally)

1

at least one arrow shown on real ray and towards the eye
*but do **not** credit if contradicted by other arrow(s)*

1

(v) formed where imaginary rays intersect / cross **or** not formed by real rays

accept (virtual image) is imaginary
accept cannot be put on screen
*do **not** credit just '… is not real'*

1

(b) (the image) needs to fall on film / sensors / LDRs / CCDs

accept just 'charged couples'
*do **not** credit '… solar cells'*
*do **not** accept virtual image cannot be stored*

1

either to cause a (chemical) reaction **or** to be digitalised

for credit response must be appropriate to camera type

1

object (should be) on the far side of F / the focus (from the lens)

***or** … more than the focal length (away from the lens)*
allow 'beyond the focus'

or object should be more than twice the distance / 2F (from the lens) (2 marks)

***or** … more than twice the focal length (away from the lens)*
*(**2** marks)*

1

[12]