Past-paper walk-through

Light ▪ 3.2

eXercise

Questions in this set

- 0625/22 J24 Q20 ▪ 1 mark
- 0625/22 J24 Q21 ▪ 1 mark
- 0625/42 M24 Q6 ▪ 6 marks
- 0625/42 M23 Q5 ▪ 10 marks
- 0625/42 M22 Q5 ▪ 9 marks

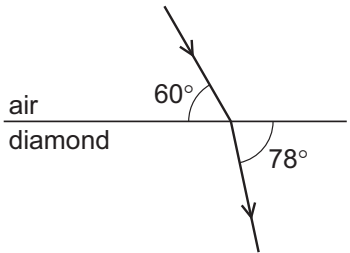
Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 20

0625/22 J24 ▪ Q20 ▪ 1 mark

20 The diagram shows a ray of light passing from air into diamond.



What is the refractive index of the diamond?

Question 20

A 0.89 **B** 1.1 **C** 2.4 **D** 2.5

Solution 20

Answer: **C**

Question 21

0625/22 J24 ▪ Q21 ▪ 1 mark

21 The ray diagrams show the formation of an image by two different converging lenses.

diagram 1

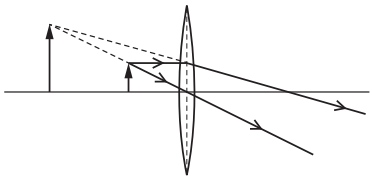
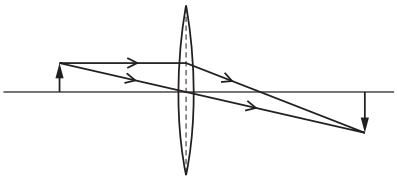


diagram 2



Which row describes the images produced?

	diagram 1	diagram 2
A	real	real

Question 21

A	real	real
B	real	virtual
C	virtual	real
D	virtual	virtual

Solution 21

Answer: **C**

Question 6

0625/42 M24 ▪ Q6 ▪ 6 marks

Fig. 6.1 shows a full-scale diagram of an object O and its image I produced by a converging lens. The lens and its position on the principal axis are not shown. O I principal axis Fig. 6.1

(a) On Fig. 6.1, draw: ▪ a single ray to locate the position of the centre of the converging lens ▪ a line to represent the position of the lens and label the line L. [2] **[2]**

(b) Determine the focal length of the lens by drawing another ray on Fig. 6.1.

focal length = ... [2] **[2]**

(c) The object is moved 2.0 cm closer to the lens.

State two changes to the characteristics of the image. 1

.....

2

Question 6

.....

[2] **[2]**

Solution 6

(a)

Worked steps

The one ray that never bends is the ray through the **centre of the lens**. So join the top of the object O to the tip of the image I with a straight line: where that line crosses the principal axis is the centre of the lens. Draw the lens as a line L through that crossing point, at right angles to the axis, and label it L.

Mark scheme

- ray from top of object to tip of image **M1**
- line labelled L drawn perpendicular to principal axis at its intersection with previous ray **A1**

Solution 6

(b)

Worked steps

Use the second standard ray. From the top of O draw a ray **parallel to the principal axis** as far as the line L. After the lens this ray must pass through the tip of I, so join the point on L to the tip of I and continue it. Where this refracted ray crosses the principal axis is the principal focus F. Measure from L to F with a ruler: on the full-scale diagram this is **2.1 cm**, so the focal length is 2.1 cm. (The reverse construction, a parallel ray from I refracted through the top of O, gives the same answer.)

Mark scheme

- ray from top of O parallel to principal axis to lens AND ray from lens to tip of I
- OR ray from tip of I parallel to principal axis to lens AND ray from lens to top of O **B1**
- 2.1 cm **B1**

Solution 6

(c)

Mark scheme

- virtual B1
- upright B1

Question 5

0625/42 M23 ▪ Q5 ▪ 10 marks

(a) Fig. 5.1 shows a semicircular transparent plastic block. semicircular transparent plastic block Fig. 5.1

A ray of light is incident normally on the curved surface of the block. The refractive index of the plastic is 1.5.

(i) Calculate the critical angle for the plastic.

critical angle = ... [2]

(ii) On Fig. 5.1, draw the path of the ray in the block and after the ray emerges from the block. [2]

(b) Fig. 5.2 is a full-scale diagram of a lens and an object O. F O lens Fig. 5.2

The point marked F shows the position of a principal focus of the lens.

(i) Determine the focal length of the lens.

focal length = ... [1]

Question 5

(ii) On Fig. 5.2, draw two rays from the object to locate the image. Label the image I. [3]

(c) Fig. 5.3 shows a simplified diagram of an eye with rays from a distant object and the path of the rays inside the eye of a person with short sight. retina lens Fig. 5.3

On Fig. 5.4, draw an additional lens outside the eye to correct short-sightedness and show the path of the rays inside the eye.

Fig. 5.4

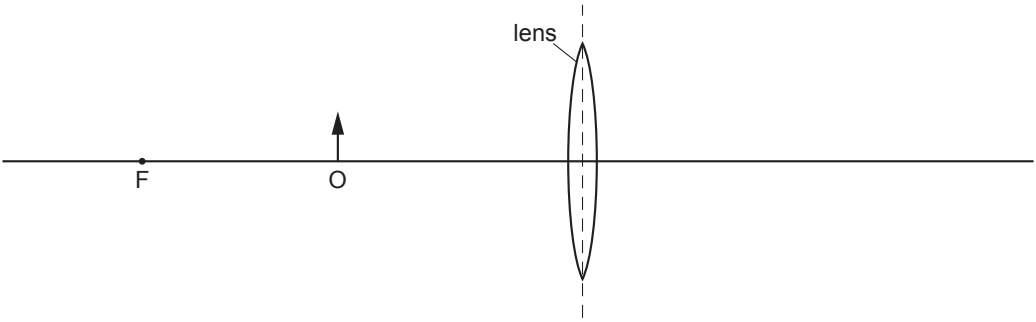
[2]

(a)(i) Calculate the critical angle for the plastic.

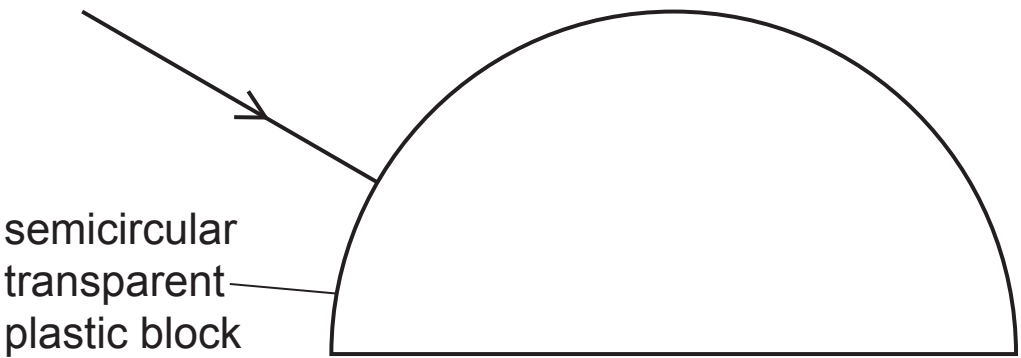
critical angle = ... [2] **[2]**

(a)(ii) On Fig. 5.1, draw the path of the ray in the block and after the ray emerges from the block. [2] **[2]**

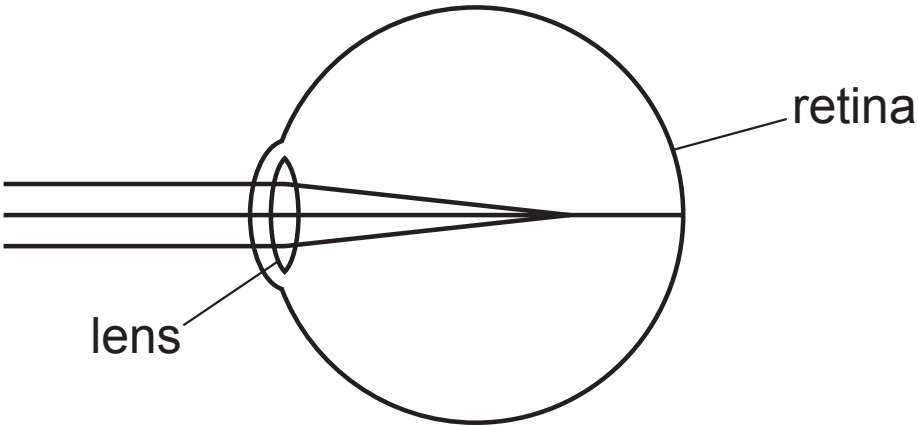
Question 5



Question 5



Question 5



Question 5

0625/42 M23 ▪ Q5 ▪ 10 marks

(a) Fig. 5.1 shows a semicircular transparent plastic block. semicircular transparent plastic block Fig. 5.1

A ray of light is incident normally on the curved surface of the block. The refractive index of the plastic is 1.5.

(i) Calculate the critical angle for the plastic.

critical angle = ... [2]

(ii) On Fig. 5.1, draw the path of the ray in the block and after the ray emerges from the block. [2]

(b) Fig. 5.2 is a full-scale diagram of a lens and an object O. F O lens Fig. 5.2

The point marked F shows the position of a principal focus of the lens.

(i) Determine the focal length of the lens.

focal length = ... [1]

(ii) On Fig. 5.2, draw two rays from the object to locate the image. Label the image I. [3]

Question 5

(c) Fig. 5.3 shows a simplified diagram of an eye with rays from a distant object and the path of the rays inside the eye of a person with short sight. retina lens Fig. 5.3
On Fig. 5.4, draw an additional lens outside the eye to correct short-sightedness and show the path of the rays inside the eye.
Fig. 5.4
[2]

(b)(i) Determine the focal length of the lens.

focal length = ... [1] **[1]**

(b)(ii) On Fig. 5.2, draw two rays from the object to locate the image. Label the image I. [3] **[3]**

Question 5

0625/42 M23 ▪ Q5 ▪ 10 marks

(a) Fig. 5.1 shows a semicircular transparent plastic block. semicircular transparent plastic block Fig. 5.1

A ray of light is incident normally on the curved surface of the block. The refractive index of the plastic is 1.5.

(i) Calculate the critical angle for the plastic.

critical angle = ... [2]

(ii) On Fig. 5.1, draw the path of the ray in the block and after the ray emerges from the block. [2]

(b) Fig. 5.2 is a full-scale diagram of a lens and an object O. F O lens Fig. 5.2

The point marked F shows the position of a principal focus of the lens.

(i) Determine the focal length of the lens.

focal length = ... [1]

(ii) On Fig. 5.2, draw two rays from the object to locate the image. Label the image I. [3]

Question 5

(c) Fig. 5.3 shows a simplified diagram of an eye with rays from a distant object and the path of the rays inside the eye of a person with short sight. retina lens Fig. 5.3
On Fig. 5.4, draw an additional lens outside the eye to correct short-sightedness and show the path of the rays inside the eye.
Fig. 5.4
[2]

(c) Fig. 5.3 shows a simplified diagram of an eye with rays from a distant object and the path of the rays inside the eye of a person with short sight. retina lens Fig. 5.3
On Fig. 5.4, draw an additional lens outside the eye to correct short-sightedness and show the path of the rays inside the eye.
Fig. 5.4
[2]

[2]

Solution 5

(a)(i)

Worked steps

Know: $n = 1.5$. Equation: $n = \dfrac{1}{\sin c}$, so $\sin c = \dfrac{1}{n}$. Substitute: $\sin c = \dfrac{1}{1.5} = 0.667$.
Answer: $c = \sin^{-1}(0.667) = 41.8^\circ \approx 42^\circ$.

Mark scheme

- 42° A2
- n = 1 / sin c OR c = sin–1 (1 / n) OR c = sin–1 (1 / 1.5)
- (C1)

Solution 5

(a)(ii)

Worked steps

The ray is incident **normally** on the curved surface, so it enters without bending and travels along the radius to the centre of the flat face. At the flat face its angle of incidence is larger than the critical angle of 42°, so it is **totally internally reflected**: draw the reflected ray inside the block with the angle of reflection equal to the angle of incidence. That reflected ray is again along a radius, so it leaves the curved surface **along the normal**, without bending.

Mark scheme

- ray continues along radius of semicircle within plastic **M1**
- ray reflected inside plastic on straight edge, with angle of reflection = angle of incidence AND emerges from block along the normal **A1**

Solution 5

(b)(i)

Worked steps

The principal focus F is marked on the axis. Measure from the centre of the lens to F with a ruler: **7.2 cm**. That distance is the focal length.

Mark scheme

- (focal length =) 7.2 cm B1

Solution 5

(b)(ii)

Worked steps

Draw two of the standard rays from the top of the object: the ray through the **centre of the lens** (undeviated) and the ray **parallel to the axis**, which refracts through F on the far side. Because the object is inside F, these rays diverge after the lens and never meet on the right. Extend both rays **backwards** (dashed) until they cross on the left of the object; that crossing is the top of the image. Draw the image from the axis up to that point and label it I. It is virtual, upright and enlarged.

Mark scheme

- two correct rays from:
- ▪ ray from top of object through centre of lens
- ▪ ray from top of object (that would pass through F on LHS of lens) refracted parallel to the principal axis
- ▪ ray from top of object to lens, parallel to principal axis, refracted through F (same distance on

Solution 5

(c)

Worked steps

In a short-sighted eye the rays from a distant object meet **in front of** the retina. Draw a **diverging lens** in front of the eye: it spreads the rays out a little before they enter, so the eye lens now brings them together **on the retina**. Show the rays inside the eye meeting exactly on the retina.

Mark scheme

- diverging lens in front of eye lens B1
- rays meeting on the retina B1

Question 5

0625/42 M22 ▪ Q5 ▪ 9 marks

A boy looks at the image of a clock in a plane mirror. Fig. 5.1 shows the mirror, the clock and the position of one of the boy's eyes. mirror boy's eye clock Fig. 5.1

(a)(i) On Fig. 5.1, draw a ray of light from the clock, reflected to the boy's eye. [2] **[2]**

(a)(ii) On Fig. 5.1, mark with an X the position of the image of the clock. [1] **[1]**

(a)(iii) State whether the image formed by the mirror is virtual or real.

Explain your answer. **[1]**

(a)(iv) Fig. 5.2 shows the image of the clock seen by the boy. Fig. 5.2

The boy now looks directly at the clock.

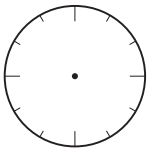
On Fig. 5.3, draw what the boy sees. Fig. 5.3 [1] **[1]**

Question 5

Fig. 5.2

The boy now looks directly at the clock.

On Fig. 5.3, draw what the boy sees.



Question 5

0625/42 M22 ▪ Q5 ▪ 9 marks

A boy looks at the image of a clock in a plane mirror. Fig. 5.1 shows the mirror, the clock and the position of one of the boy's eyes. mirror boy's eye clock Fig. 5.1

(b)(i) The clock is illuminated by a source of monochromatic green light.
State the meaning of monochromatic. **[1]**

(b)(ii) The green light has a wavelength of 5.6 × 10–7 m.
Calculate the frequency of this green light.
frequency = ... [3] **[3]**

Solution 5

(a)(i)

Worked steps

First mark where the image of the clock is: the same distance **behind** the mirror as the clock is in front, on the normal through the clock. Draw a straight line from that image position to the boy's eye; where it meets the mirror is the point of reflection. Now draw the real ray: from the clock to that point on the mirror, then from the mirror to the eye, with an arrow on each part. Check with a protractor that the angle of incidence equals the angle of reflection, both measured from the normal at the reflection point.

Mark scheme

- straight line from clock to mirror AND from mirror to eye with correct arrows **B1**
- Angle of incidence = angle of reflection **B1**

Solution 5

(a)(ii)

Mark scheme

- Correct position of image B1

(a)(iii)

Mark scheme

- Virtual (no mark)
- And
- Cannot be projected on a screen / light doesn't pass through image / AW B1

Solution 5

(a)(iv)

Worked steps

A plane mirror image is **laterally inverted**: left and right are swapped, top and bottom are not. The image in Fig. 5.2 is the mirror's view, so the clock the boy sees directly is that picture flipped left-to-right. Redraw the clock face with each hand swapped to the other side: a hand that pointed towards "3" in the image points towards "9" on the real clock.

Mark scheme

- B1

Solution 5

(b)(i)

Mark scheme

- (monochromatic light) is light of a single frequency B1

Solution 5

(b)(ii)

Worked steps

Know: wavelength $\lambda = 5.6 \times 10^{-7}$ m; the speed of light $v = 3.0 \times 10^{8}$ m/s (a value you must recall). Equation: $v = f\lambda$, so $f = \frac{v}{\lambda}$. Substitute: $f = \frac{3.0 \times 10^{8}}{5.6 \times 10^{-7}}$. Answer: $f = 5.4 \times 10^{14}$ Hz.

Mark scheme

- 5.4 × 1014 Hz **A3**
- (speed of light =) 3 × 108 (m / s)
- (C1)
- (f =) v / λ in any form OR 3.0 × 108 / 5.6 × 10–7
- (C1)