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EDEXCEL GCSE PHYSICS: QUESTIONS BY TOPIC

Light and the Electromagnetic Spectrum (5)

GCSE Physics (Foundation) Topic 5

14 questions · 116 marks · Mark schemes included

Pearson Edexcel GCSE (9-1) Physics 1PH0, Foundation Tier, June 2018 - June 2025

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HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

14 questions · 116 marks · lowest tariff first



6-MARK QUESTIONS

3 questions in this booklet



1 (a) Draw one line from each **use of wave** to the matching **electromagnetic wave**.

One line has been drawn for you.

(3)

use of wave

electromagnetic wave

to detect forged
banknotes

radio waves

microwaves

to detect broken bones

infrared waves

for night-vision
cameras

visible light

ultraviolet waves

to sterilise medical
equipment

X-rays

gamma rays



(b) Ultraviolet light has a higher frequency than infrared light.

Which of these colours of visible light has the highest frequency?

(1)

- ☒ A blue
- ☒ B green
- ☒ C orange
- ☒ D yellow

(c) Figure 1 shows how the brightness of a source of light changes with wavelength.

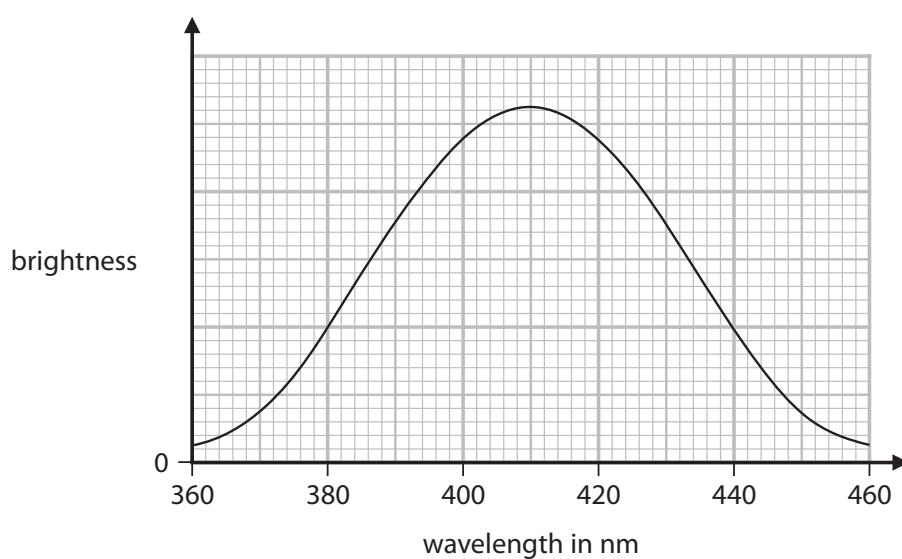


Figure 1

Describe how the brightness changes with wavelength.

(2)

.....

.....

.....

.....

(Total for Question 1 = 6 marks)

2 (a) Figure 1 shows the parts of the electromagnetic spectrum.

gamma rays	x-rays	J	visible	K	micro-waves	L
------------	--------	----------	---------	----------	-------------	----------

Figure 1

(i) Which row of the table names the parts **J**, **K** and **L** of the electromagnetic spectrum? (1)

	J	K	L
☐ A	infrared	radio	ultraviolet
☐ B	radio	infrared	ultraviolet
☐ C	ultraviolet	infrared	radio
☐ D	ultraviolet	radio	infrared

(ii) All electromagnetic waves can travel in a vacuum.

Which of these is the same for all electromagnetic waves travelling in a vacuum? (1)

- ☐ **A** amplitude
- ☐ **B** frequency
- ☐ **C** speed
- ☐ **D** wavelength

(b) X-rays can be useful and harmful to humans.

(i) State **one** way that x-rays are useful to humans. (1)

(ii) State **one** way that x-rays are harmful to humans. (1)



(c) A person warms their hands in front of a hot fire as shown in Figure 2.



(Source: © Andreas Saldavs/Shutterstock)

Figure 2

Use words from the box to complete the following sentences.

chemical infrared radio thermal ultraviolet

(2)

The electromagnetic waves that the fire mostly emits are waves.

These waves transfer energy to the hands.

(Total for Question 2 = 6 marks)

- 1 (a) Figure 1 shows how the visible spectrum of white light is shown on a screen.

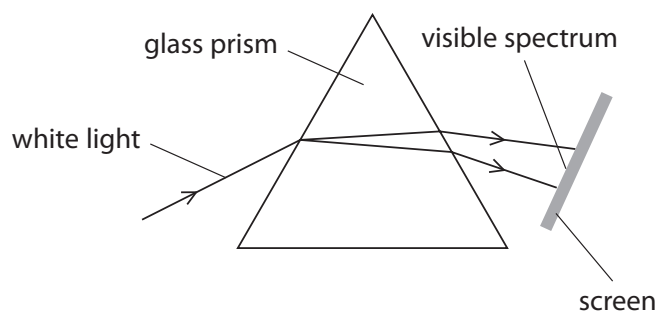


Figure 1

- (i) Which of these is the best piece of equipment to produce the white light?

(1)

- ☐ A ray box
- ☐ B ruler
- ☐ C measuring cylinder
- ☐ D ammeter

- (ii) Which colour is seen between yellow and blue in the spectrum on the screen?

(1)

- ☐ A red
- ☐ B orange
- ☐ C green
- ☐ D violet

(b) Figure 2 shows the main parts of the electromagnetic spectrum.

radio	microwaves	infrared	visible light	ultraviolet	x-rays	gamma rays
-------	------------	----------	---------------	-------------	--------	------------

Figure 2

Complete the following sentences using information from Figure 2. Each part of the electromagnetic spectrum may be used once, more than once or not at all.

(i) The part of the electromagnetic spectrum used to detect broken bones is (1)

.....

(ii) The part of the electromagnetic spectrum used in thermal imaging is (1)

.....

(iii) The part of the electromagnetic spectrum that

- is used to cook food

AND

- has a shorter wavelength than microwaves is

(1)

.....

(iv) The part of the electromagnetic spectrum that

- is used to sterilise medical equipment

AND

- has a shorter wavelength than x-rays is

(1)

.....

(Total for Question 1 = 6 marks)



7-MARK QUESTIONS

4 questions in this booklet



2 (a) Figure 3 shows a ray of light striking a mirror.

The angle of incidence is 30° and the ray of light is reflected.

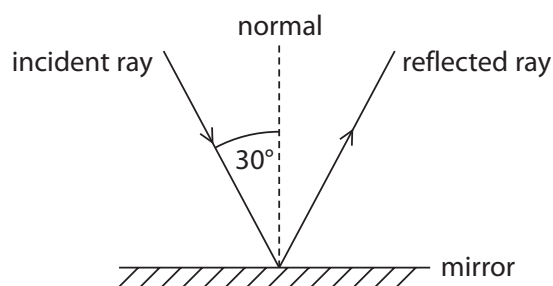


Figure 3

The angle of reflection is the angle between

(1)

- ☐ A the mirror and the incident ray
- ☐ B the mirror and the normal
- ☐ C the reflected ray and the incident ray
- ☐ D the reflected ray and the normal

(b) Figure 4 shows two lenses, P and Q, arranged to form a simple telescope.

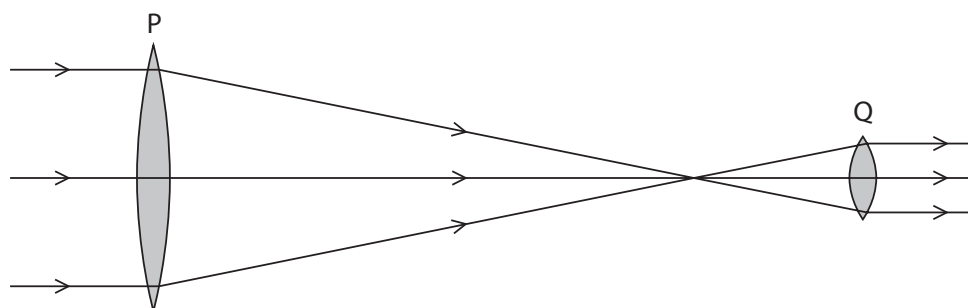


Figure 4

(i) State **one** use for a telescope.

(1)

.....

.....

(ii) Which of these describes the lenses?

(1)

- ☐ **A** P is converging, Q is diverging
- ☐ **B** P is diverging, Q is converging
- ☐ **C** P and Q are both converging
- ☐ **D** P and Q are both diverging

(iii) The focal length of lens Q is 0.14 m.

Calculate the power of the lens.

(2)

Use the equation

$$\text{power} = \frac{1}{\text{focal length in m}}$$

power of lens = ... diopetre

(c) A student is in a laboratory that has windows.

The student is given a converging lens, and a sheet of paper.

Describe how the student can produce an image of the window frame on the sheet of paper.

(2)

.....

.....

.....

.....

(Total for Question 2 = 7 marks)



1 This question is about the electromagnetic spectrum.

(a) X-rays and microwaves are both parts of the electromagnetic spectrum.

Use words from the box to complete the sentences.

(3)

amplitude frequency longitudinal speed transverse wavelength

X-rays and microwaves are both waves.

In a vacuum, x-rays and microwaves always have the same

X-rays always have a higher than microwaves.



(b) Figure 1 shows the full electromagnetic spectrum.

Figure 2 gives information about four of the types of electromagnetic radiation shown in Figure 1.

radio waves	microwaves	infrared	visible light	ultraviolet	x-rays	gamma rays
-------------	------------	----------	---------------	-------------	--------	------------

Figure 1

State the name of each type of radiation next to its information.

(4)

Information	Type of electromagnetic radiation
emitted by bright objects and can be detected by the human eye	
emitted by radioactive nuclei and can be used to treat cancer	
produced in an aerial and can be used for communication	
can cause skin cancer in humans and can be used to detect forged banknotes	

Figure 2

(Total for Question 1 = 7 marks)

2 (a) A flag has three colours in daylight.

The flag is taken into a dark room.

Figure 3 shows the flag when a torch shines white light on to the flag.

Figure 4 shows the same flag when the torch is covered with a coloured filter.

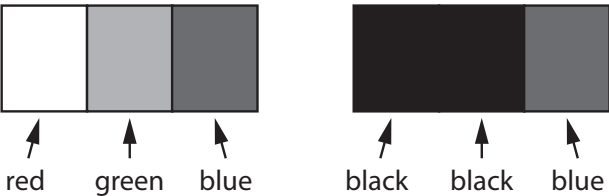


Figure 3

Figure 4

State the colour of the filter that has covered the torch.

(1)

(b) A student uses a converging lens to produce an image of a tree on a screen.

The image of the tree on the screen is shown in Figure 5.

The student is asked to describe the image of the tree.

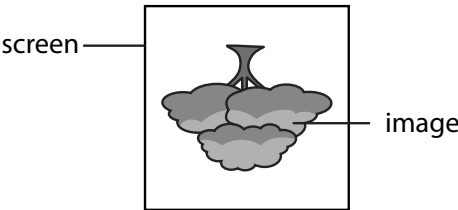


Figure 5

The student's descriptions are shown in the table.

student's descriptions of the image		correction
upside down	✓	
bigger than the actual tree	✗	
virtual	✗	

The first description is correct, the image is upside down.

Complete the table by adding the correct descriptions of the image.

(2)

(c) A student uses a ray box to investigate two lenses, P and Q.

Figure 6 shows the student's drawings of rays of light before and after passing through the lenses.

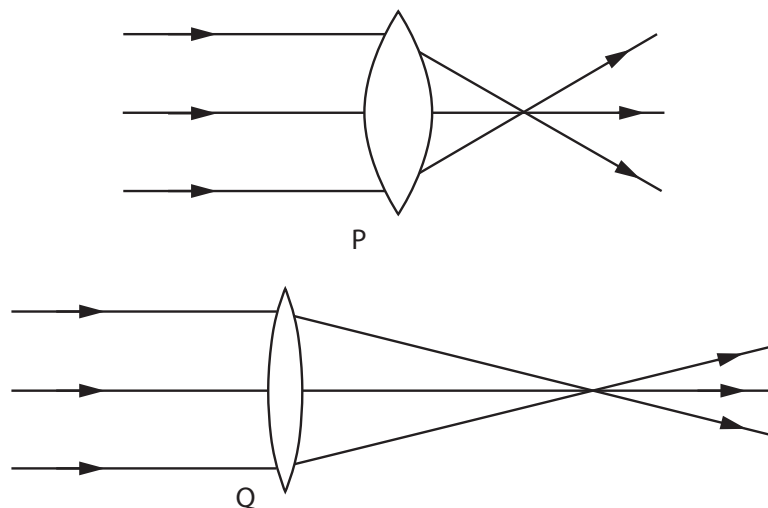


Figure 6

Complete the following sentences.

(2)

The focal length of lens P is than the focal length of lens Q.

The power of lens P is than the power of lens Q.

(d) Figure 7 shows light reflecting from two mirrors in a bathroom.

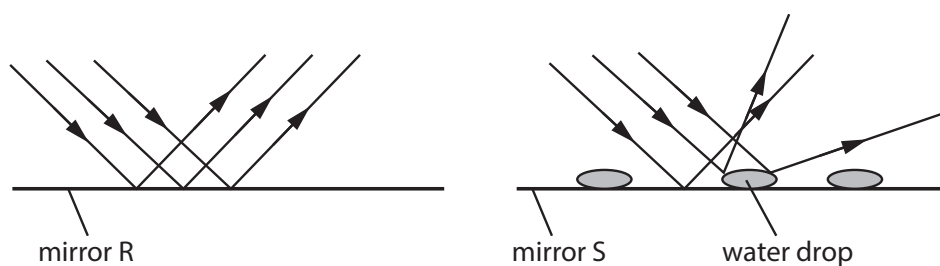


Figure 7

Mirror R has a dry surface.

Mirror S has lots of small drops of water on the surface.

A person looks into each mirror.

Explain the difference between the image seen in mirror R and the image seen in mirror S.

(2)

(Total for Question 2 = 7 marks)

- 1 (a) Figure 1 shows a ray of light incident on a mirror.

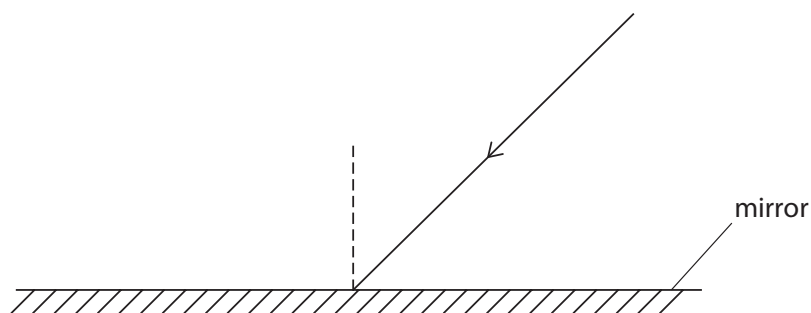


Figure 1

- (i) Draw the reflected ray on Figure 1.

(1)

- (ii) On Figure 1, label the angle of incidence with the letter **i** and the angle of reflection with the letter **r**.

(2)

(b) A lens has a focal length of 17 cm.

Calculate the power of the lens in dioptries.

Use the equation

$$\text{power (in dioptries)} = \frac{1}{\text{focal length (in metres)}}$$

(3)

power = ... dioptries

(c) Which of these is the best reason for explaining why a leaf appears green in daylight?

(1)

- ☐ **A** the leaf absorbs green light only
- ☐ **B** the leaf absorbs yellow and blue light only
- ☐ **C** the leaf reflects green light only
- ☐ **D** the leaf reflects yellow and blue light only

(Total for Question 1 = 7 marks)



8-MARK QUESTIONS

1 question in this booklet



1 This question is about waves in the electromagnetic (e-m) spectrum.

- (a) (i) Figure 1 shows some types of radiation that form part of the e-m spectrum and some uses of e-m radiation.

Draw **one** straight line from each type of e-m radiation to its use.

One line has been drawn for you.

(3)

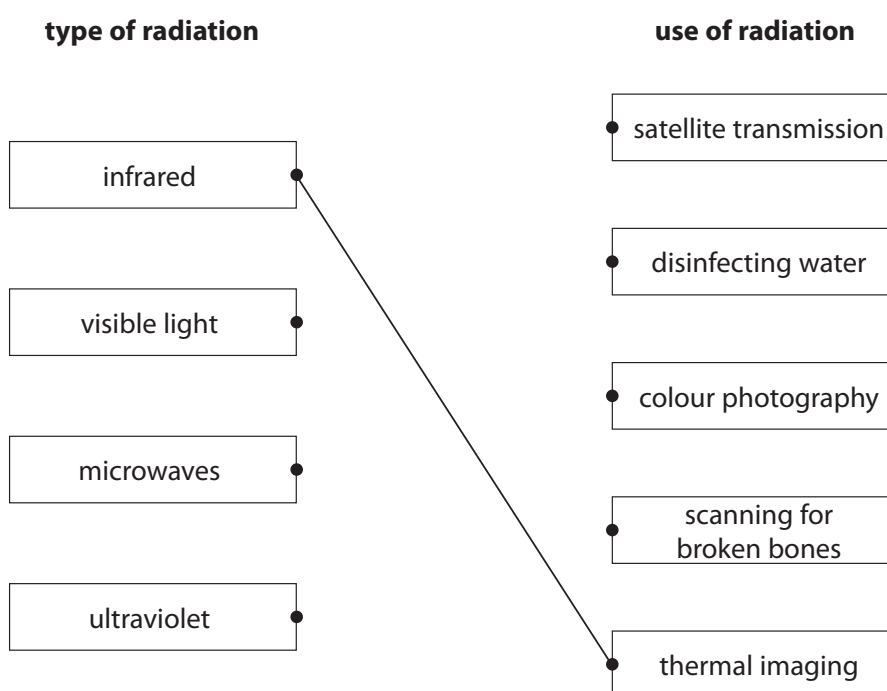


Figure 1

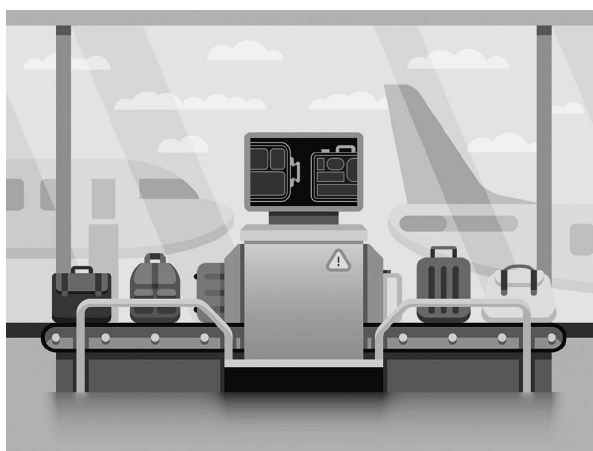
- (ii) Which of these waves has the highest frequency?

(1)

- ☐ A infrared
- ☐ B microwaves
- ☐ C ultraviolet
- ☐ D visible light

(b) X-rays are also part of the e-m spectrum.

Figure 2 shows an airport security scanner using X-rays to scan passengers' bags.



(Source: © Net Vector/Shutterstock)

Figure 2

(i) Explain why X-rays are used to scan passengers' bags.

(2)

.....

.....

.....

.....

(ii) Explain why passengers are **not** scanned with X-rays.

(2)

.....

.....

.....

.....

(Total for Question 1 = 8 marks)

9-MARK QUESTIONS

3 questions in this booklet



- 4 (a) (i) Figure 4 shows two light rays hitting a glass lens.

On Figure 4, draw the two light rays after they leave this lens.

(1)

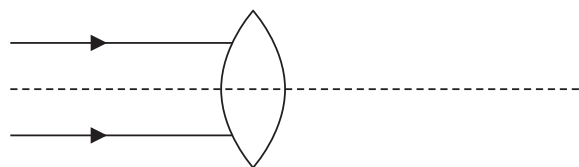


Figure 4

- (ii) Figure 5 shows two light rays hitting a different glass lens.

On Figure 5, draw the two light rays after they leave this lens.

(1)

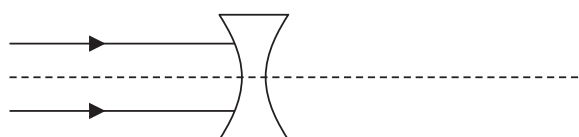


Figure 5

- (iii) A lens has a focal length of 25 cm.

Calculate the power of the lens.

Use the equation

$$\text{power in dioptres} = \frac{1}{\text{focal length in metres}}$$

(2)

power of the lens = ... dioptres

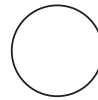
(b) Figure 6 shows two solid metal balls, **P** and **Q**.

ball painted black

ball painted white



P



Q

Figure 6

P and **Q** are made from the same metal and have the same radius.

P is painted black and **Q** is painted white.

Each ball is heated to a different temperature.

The balls then cool in the same room.

The graph in Figure 7 shows how the temperature of each ball changes with time.

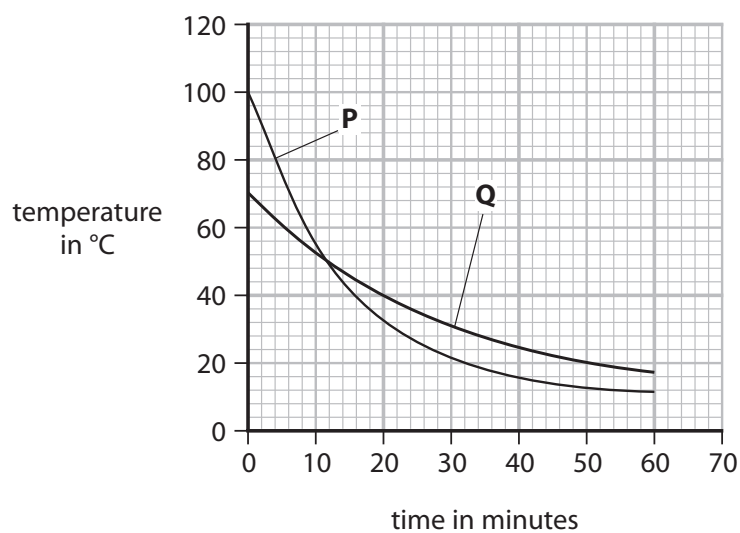


Figure 7

- (i) Use the graph in Figure 7 to determine the time when **P** and **Q** were at the same temperature.

Show your working on the graph.

(2)

time = ... minutes

(ii) Which of these temperatures is most likely to be room temperature, as shown by the graph in Figure 7?

(1)

☐ **A** 100°C

☐ **B** 70°C

☐ **C** 10°C

☐ **D** 0°C

(iii) Explain why the curve for **P** is different from the curve of **Q**. Use information from Figure 6 and Figure 7 to help your answer.

(2)

.....

.....

.....

.....

.....

.....

(Total for Question 4 = 9 marks)

3 This question is about reflection and refraction of light.

(a) (i) Figure 4 shows a ray of light travelling to a plane mirror.

On Figure 4, draw the ray of light after it **reflects** off the mirror surface.

(2)

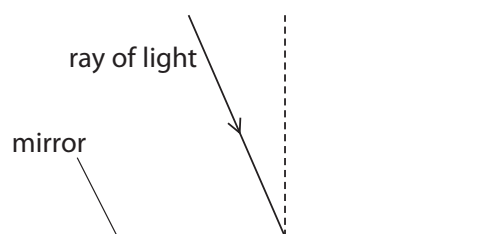


Figure 4

(ii) Figure 5 shows a ray of light in air travelling to a glass block.

On Figure 5, draw the ray of light after it **refracts** at the surface of the glass block.

(2)

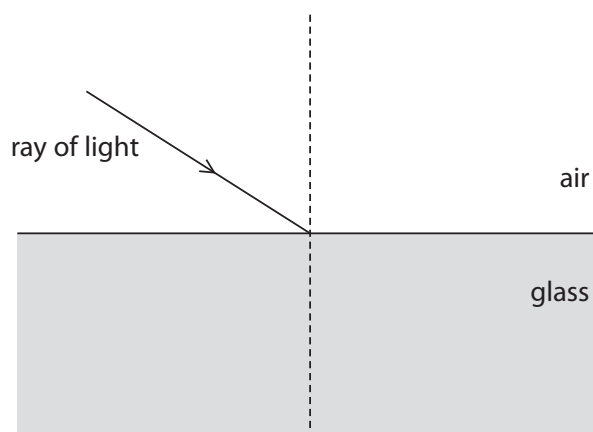


Figure 5

(iii) Figure 6 shows a ray of light in water, travelling to the surface of the water.

The angle marked **X** is greater than the critical angle.

On Figure 6, draw the ray of light after it reaches the surface of the water.

(2)

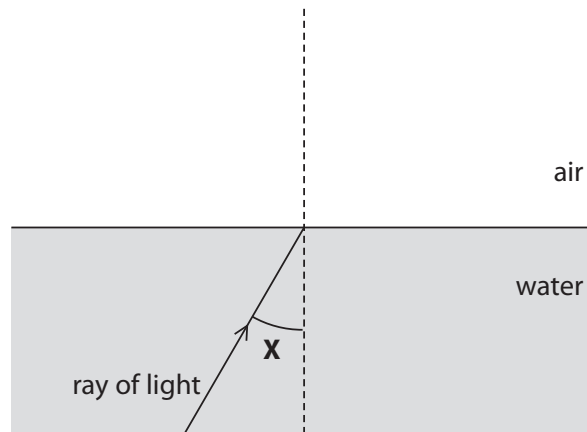


Figure 6

(b) A converging lens has a focal length of 40 cm.

Calculate the power of this lens in dioptres.

Use the equation

$$\text{power in dioptres} = \frac{1}{\text{focal length in metres}}$$

(3)

power of the lens = ... dioptres

(Total for Question 3 = 9 marks)

- 2 (a) Draw **one** straight line from each electromagnetic radiation to its correct description.

(3)

electromagnetic radiation

description

infrared

used in night vision cameras

gamma

the least dangerous radiation

ultraviolet

may damage eyes, so
sunglasses worn as protection

radio waves

the most dangerous radiation

- (b) Different colours of light have different frequencies.

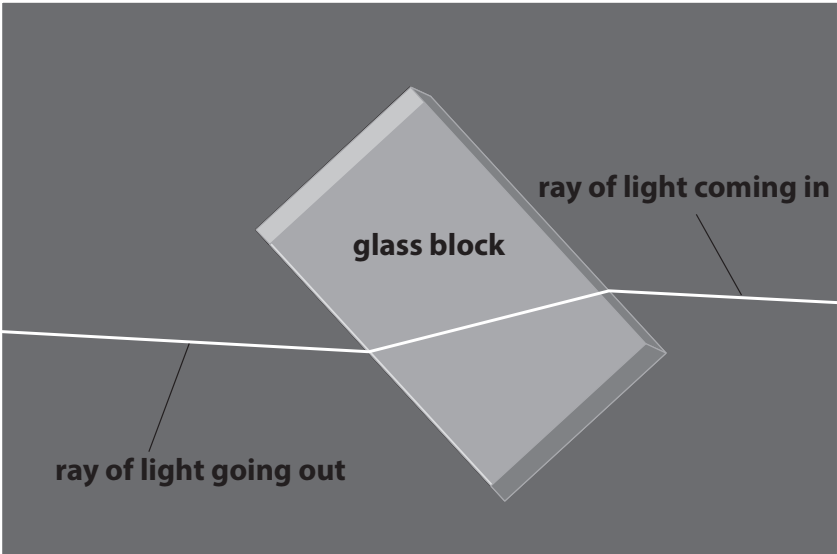
Which of these colours has the highest frequency?

(1)

- ☐ **A** blue
- ☐ **B** green
- ☐ **C** red
- ☐ **D** yellow



(c) Figure 2 is a diagram of a glass block being used to investigate the refraction of light.



(Source: © ajizai/docstoc.com)

Figure 2

The angle of incidence was varied and the angle of refraction was measured each time.

Figure 3 shows the results in a table.

angle of incidence in degrees	angle of refraction in degrees
20	13
30	20
40	25
50	31
60	35
70	39
80	41

Figure 3

Figure 4 shows a graph of these results.

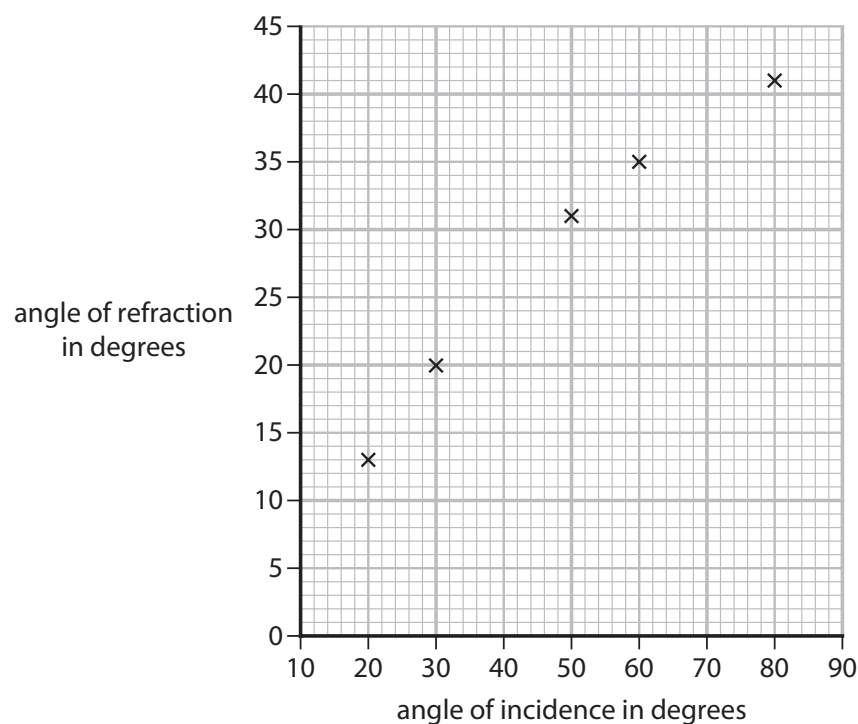


Figure 4

- (i) The two shaded rows in Figure 3 are not plotted on the graph in Figure 4.

Plot these missing results on the graph in Figure 4.

(2)

- (ii) Draw a curve of best fit through the points on the graph in Figure 4.

(1)

- (iii) Using Figure 4, describe the relationship between the angle of refraction and the angle of incidence.

(2)

.....

.....

.....

.....

(Total for Question 2 = 9 marks)



11-MARK QUESTIONS

2 questions in this booklet



7 (a) Figure 12 is a diagram showing a lens, with some light rays passing through it.

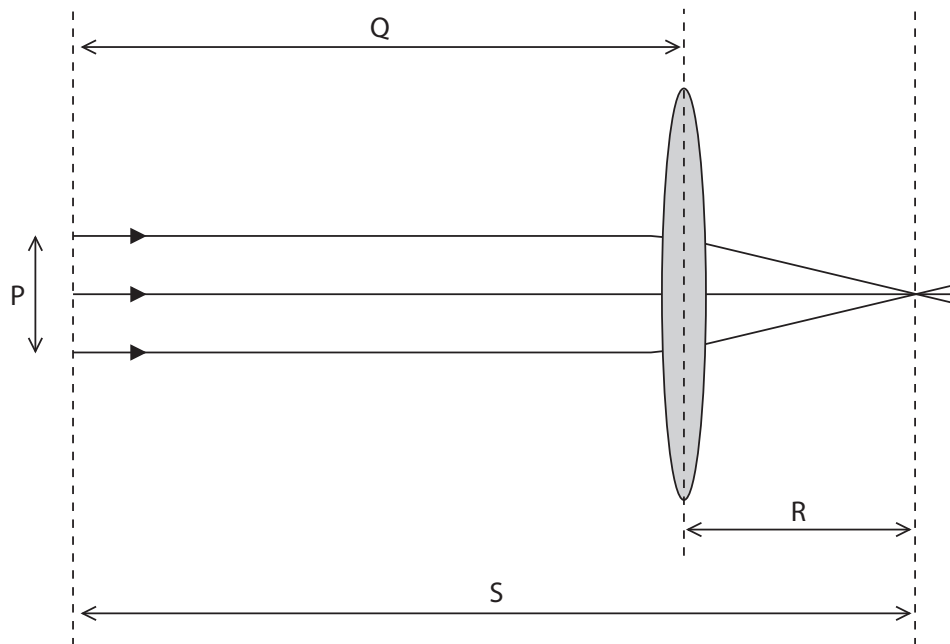


Figure 12

(i) This diagram shows a

- ☐ A converging lens forming a real image
- ☐ B diverging lens forming a real image
- ☐ C converging lens forming a virtual image
- ☐ D diverging lens forming a virtual image

(1)

(ii) Which length, labelled on Figure 12, shows the focal length of the lens?

- ☐ P
- ☐ Q
- ☐ R
- ☐ S

(1)

(b) Calculate the power of a lens of focal length 17 cm.

Use the equation

$$\text{power (in dioptres)} = \frac{1}{\text{focal length (in metres)}}$$

Give the answer to 2 significant figures.

(3)

power = ... dioptres



*(c) More than two thousand years ago the Earth was believed to be at the centre of the universe as shown in Figure 13.

The planets, the Moon and the Sun were believed to be in orbit around the Earth.

In 1543 Nicolaus Copernicus proposed that the Earth was a planet, and that the Earth and the other planets orbit around the Sun.

This model is shown in Figure 14.

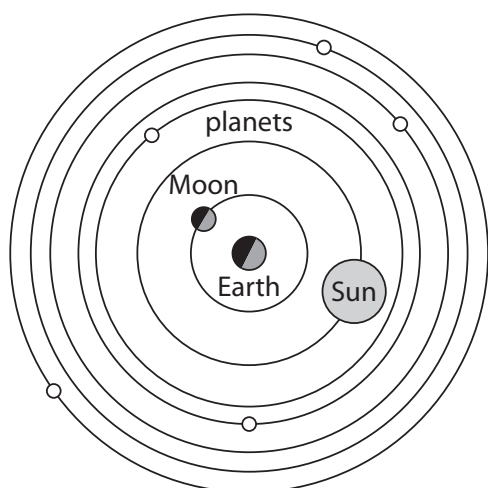


Figure 13

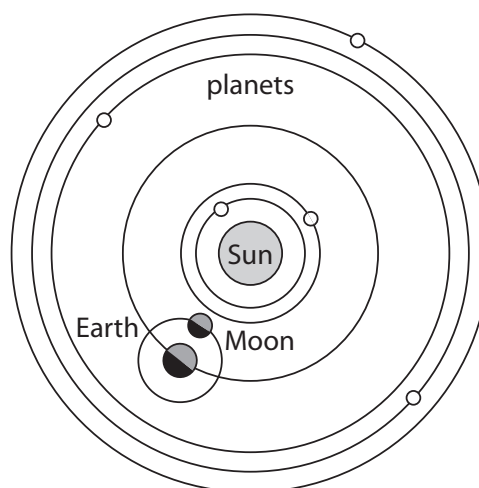


Figure 14

Discuss how evidence has changed our views of the universe.

(6)

(Total for Question 7 = 11 marks)



- 8 (a) A student investigates what happens when light travels from air to glass.

Figure 15 shows some of the apparatus used in the investigation.

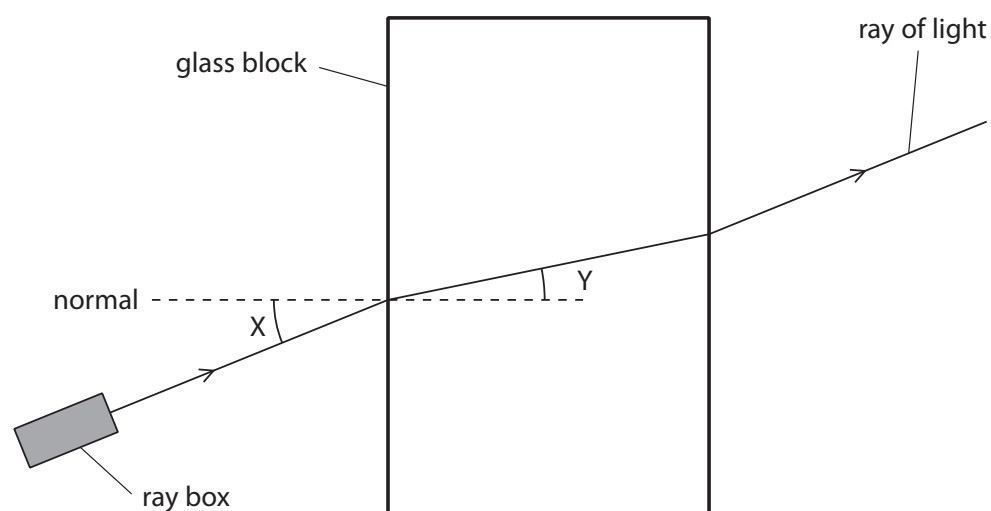


Figure 15

- (i) In Figure 15, angle Y is the angle of

- ☐ A deflection
- ☐ B incidence
- ☐ C reflection
- ☐ D refraction

(1)

(ii) Figure 16 is a graph of the student's results.

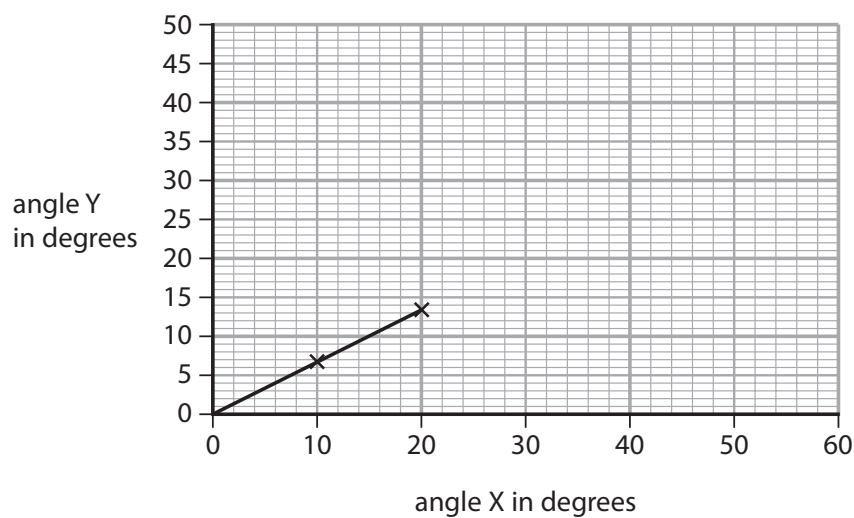


Figure 16

Use the graph to calculate a value for

$$\frac{\text{angle Y}}{\text{angle X}}$$

(2)

$$\frac{\text{angle Y}}{\text{angle X}} = \dots\dots\dots$$

(iii) The student concludes that angle Y is directly proportional to angle X.

Explain what the student must do to test this conclusion in more detail.

(3)

.....

.....

.....

.....

.....

.....



(b) The speed of light is $3.0 \times 10^8 \text{ m/s}$.

The wavelength of yellow light is $5.8 \times 10^{-7} \text{ m}$.

Calculate the frequency of yellow light.

State the unit.

Use the equation

$$\text{frequency} = \frac{\text{speed}}{\text{wavelength}}$$

(3)

frequency = ... unit

(c) (i) Give **one** colour of light that has a longer wavelength than yellow light.

(1)

(ii) Give **one** colour of light that has a higher frequency than yellow light.

(1)

(Total for Question 8 = 11 marks)



13-MARK QUESTIONS

1 question in this booklet



7 This question is about light.

(a) White light includes all the colours in the visible spectrum.

A beam of white light is the only light that shines on a book.

The book appears green.

A red filter is placed between the source of white light and the book.

What colour does the book appear now?

(1)

- ☐ A black
- ☐ B blue
- ☐ C green
- ☐ D red

(b) Figure 8 shows a shiny metal ball.



(Source: © frerd/Shutterstock)

Figure 8

A clear image of a building can be seen on the surface of the ball.

(i) This clear image is an example of

(1)

- ☐ A diffuse reflection
- ☐ B diffuse refraction
- ☐ C specular reflection
- ☐ D specular refraction

- (ii) Explain why the surface of the metal ball gives a **clear** image.
You may draw diagrams to help with your answer.

(2)

.....

.....

.....

.....

- (c) Figure 9a and Figure 9b show rays of light before and after passing through different lenses.

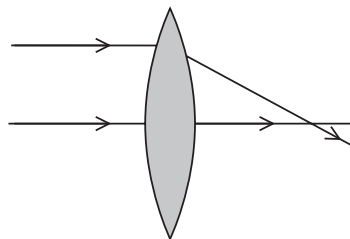


Figure 9a

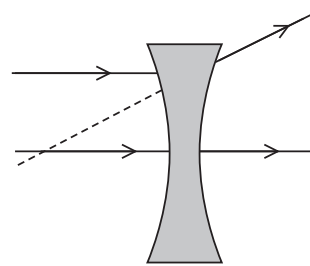


Figure 9b

- (i) State **one** similarity and **one** difference in the way the rays of light pass through the lenses.

(2)

similarity.....

.....

difference.....

.....

(ii) Figure 10 shows two glass lenses P and Q.

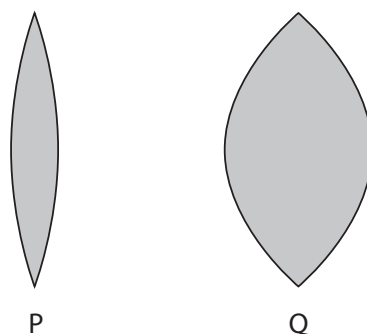


Figure 10

State how the power of P is different from the power of Q.

(1)

MARK SCHEMES

official Pearson Edexcel mark schemes



Question number	Answer	Additional guidance	Mark
1(a)		award 1 mark for each line from the three left-hand boxes more than one line from a box loses the mark for that box	(3)

Question number	Answer	Mark
1(b)	☒ A blue Green, orange and yellow all have a lower frequency than blue	(1)

Question number	Answer	Additional guidance	Mark
1(c)	a description to include two of the following: increases (at first) (1) reaches a peak (1) (then) decreases (1)	is <u>brightest</u> at 410 (nm)	(2)

(Total for Question 1 = 6 marks)



Question number	Answer	Additional guidance	Mark			
2a(i)	C <table><tr><td>ultraviolet</td><td>infrared</td><td>radio</td></tr></table> A is incorrect infrared should be in K, radio should be in L and ultraviolet in J, B is incorrect radio should be in L and ultraviolet should be in K D is incorrect radio should be in L and infrared in K	ultraviolet	infrared	radio		(1) AO1
ultraviolet	infrared	radio				

Question number	Answer	Additional guidance	Mark
2a (ii)	C speed amplitude, frequency and wavelength are not the same for all EM waves		(1) AO1

Question number	Answer	Additional guidance	Mark
2(b) (i)	One from: seeing (broken) bones (1) radiotherapy (1) detecting cracks in metals (1) airport security (1) observing the internal structure of objects(1)	seeing inside the body	(1) AO1

Question number	Answer	Additional guidance	Mark
2(b) (ii)	One from: can cause cancer (1) can cause burns(1) {damage/kills/harms} cells/tissue (1) mutates DNA/cells (1)	harms organ(s) / foetus allow (highly) ionising	(1) AO1

Question number	Answer	Additional guidance	Mark
2(c)	infrared (1) thermal (1)	must be in first sentence space must be in second sentence space award 2 marks for answers in this order	(2) AO2

Total marks for question 2 = 6 marks

Question Number	Answer	Mark
1(a)(i)	A ray box <i>B is not correct because a ruler does not produce a beam of white light</i> <i>C is not correct because a measuring cylinder does not produce a beam of white light</i> <i>D is not correct because an ammeter does not produce a beam of white light</i>	(1) AO1

Question Number	Answer	Mark
1(a)(ii)	C green <i>A is not correct because red appears at the start of the spectrum</i> <i>B is not correct because orange appears in the middle of the spectrum</i> <i>D is not correct because violet appears at the end of the spectrum</i>	(1) AO1

	Answer	Additional guidance	Mark
1(b)(i)	x-ray(s)	allow X x no mark if more than one wave given e.g. x-rays and gamma rays scores 0	(1) AO1

	Answer	Additional guidance	Mark
1(b)(ii)	infrared	allow any recognisable spelling IR ir no mark if more than one wave given e.g. infrared and gamma rays scores 0	(1) AO1



	Answer	Additional guidance	Mark
1(b)(iii)	infrared	allow any recognisable spelling IR ir no mark if more than one wave given e.g. infrared and gamma rays scores 0	(1) AO1

	Answer	Additional guidance	Mark
1(b)(iv)	gamma (rays)	allow any recognisable spelling γ no mark if more than one wave given e.g. gamma rays and UV scores 0	(1) AO1

(Total for Question 1= 6 marks)

	Answer	Additional guidance	Mark
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Question Number	Answer	Mark
2 (a)	D the reflected ray and the normal A, B and C do not describe the angle of reflection	(1) AO1

Question Number	Answer	Additional guidance	Mark
2 (b)(i)	Any one from:- to view distant objects /things far away (1) looking at planets /stars / space/ galaxies (1) bird watching (1)	accept magnify distant objects accept other named astronomical objects	(1) AO2

Question Number	Answer	Mark
2 (b)(ii)	C P and Q are both converging A is incorrect the lens Q is not diverging B is incorrect the lens P is not diverging D is incorrect neither lens is diverging	(1) AO3

Question Number	Answer	Additional guidance	Mark
2 (b)(iii)	substitution (1) (power =) $\frac{1}{0.14}$ evaluation (1) 7.1 (D)	7.14(28...) allow 7 award 1 mark for 7.1 to any other power of ten award 1 mark for correct answer as a fraction award full marks for the correct answer with no working	(2) AO2

Question Number	Answer	Additional guidance	Mark
2 (c)	a description including any two from window/light (from outside), lens and paper in correct order (1) move lens/paper (1) to focus (image) / to get a clear image (1)	accept lens in front/behind window and paper in front/behind lens	(2) AO2

Total for question 2 = 7marks

Question number	Answer	Additional guidance	Mark
1 (a)	transverse (1) speed (1) frequency (1)	must be in correct order. allow any recognisable spelling.	3 AO1.1

Question number	Answer	Additional guidance	Mark
1 (b)	(visible) light (1) gamma (rays) (1) radio (waves) (1) ultraviolet (waves) (1)	 γ (rays) allow microwaves UV (rays)	4 AO3.3

Total for question 1 =7 marks

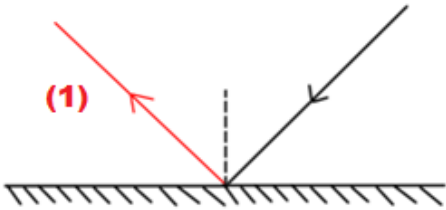
Question number	Answer	Additional guidance	Mark
2(a)	blue		1 AO3.2

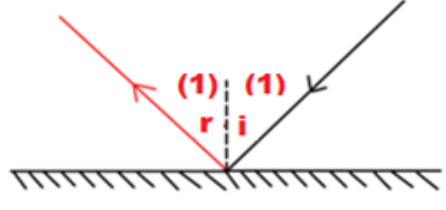
Question number	Answer	Additional guidance	Mark
2 (b)	diminished/smaller (1) real (1)	accept recognisable spellings e.g. reel do not credit not virtual	2 AO2.2

Question number	Answer	Additional guidance	Mark
2 (c)	shorter / less / smaller (1) greater / larger / more / stronger (1)	lower higher	2 AO1.1

Question number	Answer	Additional guidance	Mark
2 (d)	an explanation linking blurred / fuzzy/ distorted (1) rays are reflected in different directions / randomly (from mirror S) (1)	allow reverse arguments (reflection in mirror) S is diffuse allow light for rays (reflection in mirror) R is specular rays reflected from R are parallel	2 AO3.2

Total for question 2 =7 marks

Question number	Answer	Additional guidance	Mark
1(a) (i)		judge by eye whether 'i' = 'r' ignore any arrow	(1) A02.1

Question number	Answer	Additional guidance	Mark
1(a) (ii)		'i' only needs to be between the incident ray and the normal 'r' only needs to be between the reflected ray and the normal ignore any rays below the mirrored surface	(2) A02.1

Question number	Answer	Additional guidance	Mark
1 (b)	substitution (1) (power) = $\frac{1}{(0.17)}$ conversion (1) cm to m seen evaluation (1) 5.9 (diopres)	1.7 in denominator to any power of 10 here 0.17 seen accept 5.88(235. . .) etc award full marks for correct answer without working.	(3) A02.1

Question number	Answer	Additional guidance	Mark
1 (c)	C the leaf reflects green light only (1) B is wrong because it does not absorb yellow and blue light only A is wrong because the leaf does not absorb green light D is wrong because grass does not reflect yellow and blue light		(1) AO1.1

Total for Question 1 = 7 mark



Question Number	Answer	Additional guidance	Mark
1 (a) (i)	type of radiation use of radiation	award one mark for each correct line up to three marks reject for a mark two lines starting or ending at the same box	(3) AO1

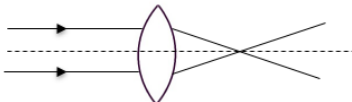
Question Number	Answer	Mark
1 (a)(ii)	C ultraviolet A (infrared), B (microwaves) and D (visible light) all have frequencies below that of ultraviolet	(1) AO1

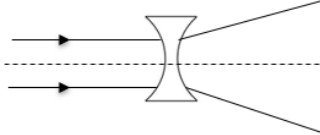
Question Number	Answer	Additional guidance	Mark
1 (b)(i)	an explanation linking (X-rays/they) pass through/penetrate (the bags/cases) (1) to see contents/to show objects of greater density (1)	accept see through accept look/see inside accept check contents/dangerous items	(2) AO1

Question Number	Answer	Additional guidance	Mark
1 (b)(ii)	an explanation linking X-rays/they are ionising (1) cause cancer/mutations (of cells/DNA) (1)	accept harmful/dangerous accept a description of ionising accept high energy accept kill/damage cells	(2) AO2

Total for question 1 = 8mark



Question number	Answer	Additional guidance	Mark
4(a)(i)	rays converging	 arrows not needed	(1)

Question number	Answer	Additional guidance	Mark
4(a)(ii)	rays diverging	 arrows not needed award 1mark if convergence and divergence are shown but with the wrong lenses	(1)

Question number	Answer	Additional guidance	Mark
4(a)(iii)	substitution (1) $\frac{1}{25(\times 10^{-2})}$ evaluation (1) 4(.0)	or 0.04 seen ignore powers of ten until evaluation award full marks for the correct answer without working	(2)

Question number	Answer	Additional guidance	Mark
4(b)(i)	line shown on graph from intersection of two curves (1) answer in range 11 – 13 (minutes) inclusive (1)	award full marks for the correct answer without working	(2)

Question number	Answer	Mark
4(b)(ii)	☒ C 10 °C	(1)

Question number	Answer	Additional guidance	Mark
4(b)(iii)	an explanation linking: the gradient for P is greater/steeper than the gradient for Q (1) (because) P/black is a better emitter (of radiation) (than Q/white) (1)	P cools quicker than Q P loses thermal energy/heat quicker than Q allow reverse arguments credit answers in terms of absorption in this context	(2)

(Total for Question 4 = 9 marks)

3(a)(i)	diagram to include: a reflected ray drawn (1) angle of reflection = angle of incidence (1)	judge by eye	(2) AO2
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	Answer	Additional guidance	Mark
3(a)(ii)	diagram to include: a refracted ray drawn (1) angle of refraction < angle of incidence (1)	Ray drawn in bottom right quadrant of diagram ignore reflected rays judge by eye	(2) AO2

	Answer	Additional guidance	Mark
3(a)(iii)	diagram to include: ray drawn showing total internal reflection (1) angle of reflection = angle of incidence (1)	REJECT any refracted ray for this mark judge by eye	(2) AO2

	Answer	Additional guidance	Mark
3(b)	substitution (1) evaluation without correct unit change (1) evaluation including unit change (1) 2.5 (dioptries)	(power) = $\frac{1}{0.40}$ allow 4 to any power of 10 in the substitution allow 2.5 to any power of 10 (dioptries) 2.5 to any other power of 10 scores 2 marks award full marks for the correct answer without working	(3) AO2

(Total for Question 3 = 9 marks)

	Answer	Additional guidance	Mark
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Question number	Answer	Additional guidance	Mark
2 (a)	electromagnetic radiation description infrared gamma ultraviolet radio waves used in night vision cameras the least dangerous radiation may damage eyes, so sunglasses worn as protection the most dangerous radiation	1 mark for one line correct 2 marks for two or three lines correct 3 marks for four lines correct. if more than one line is drawn from or to a box, do not credit any of those lines	(3) AO1.1

Question number	Answer	Additional guidance	Mark
2 (b)	☒ A blue (1) B, C and D have lower frequencies		(1) AO1.1

Question number	Answer	Additional guidance	Mark
2 (c) i	coordinate (40, 25) plotted $\pm$ half a square (1) coordinate (70, 39) plotted $\pm$ half a square (1)	judge by eye judge by eye	(2) AO2.1

Question number	Answer	Additional guidance	Mark
2 (c) ii	best fit curve touching at least four of the points (1)	do not accept tramlining (multiple curves) ignore slight shakiness in drawing ignore any curves/lines drawn before the first point or after the last point	(1) A02.1

Question number	Answer	Additional guidance	Mark
2 (c) iii	A description to include as angle of incidence increases angle of refraction increases (1) idea of non-linear (relationship) (1)	positive correlation not proportional / not directly proportional curve gets less steep (as angle of incidence increases) ignore curve unqualified	(2) A03.2

Total for Question 2 = 9 marks

Question Number	Answer	Mark
7(a)(i)	A converging lens forming a real image The only correct answer is A B 'diverging lens forming a real image' is incorrect since the lens drawn in the diagram is not diverging C 'converging lens forming a virtual image' is incorrect, since the diagram shows rays coming to a focus (on a screen if placed there) D 'diverging lens forming a virtual image' is incorrect, since the diagram shows neither a diverging image or the formation of a virtual image	(1) AO 3 1a

Question Number	Answer	Mark
7(a)(ii)	C 'R' The only correct answer is 'R' 'P' is incorrect, being a distractor, showing a width of rays 'Q' is incorrect, being a distractor showing an arbitrary distance to the lens distance 'S' is incorrect, being a distractor showing an overall distance	(1) AO 3 1b

Question Number	Answer	Additional guidance	Mark
7(b)	substitution (1) <u>1</u> 17 or 0.17 evaluation (1) 5.882... evaluation to 2sf (1) 5.9 (any answer to 2 sf for this mark, but not if wrong rounding is seen)	lose this mark if there is any other power of 10 error but then apply ecf (e.g. 1/1.7) so 0.588 then = 1 mark for that ecf independent mark award full marks for the correct answer without working	(3) AO 2 1

Question Number	Answer	Mark
7(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive, and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 strand 1 (6) • idea that telescopic evidence supported the heliocentric model e.g. observing the moons of Jupiter supported a sun-centred solar system • detail e.g. it was Galileo's observations of the moons of Jupiter • the moons rotate around Jupiter i.e. not everything rotates about the earth • other observations by telescope – discoveries of the planets Uranus and Neptune + the asteroid belt • (detailed) photographic evidence • use of computer modelling • satellite observations • heliocentric model verified by Voyager missions (space probes)	(6) AO 1 1

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

(Total for Question 7 = 11 marks)



Question Number	Answer	Mark
8(a)(i)	D refraction The only correct answer is D <i>A 'deflection' is an incorrect distracting description</i> <i>B 'incidence' is incorrect, that would be angle X</i> <i>C 'reflection' is incorrect, no reflection being shown in the diagram</i>	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
8(a)(ii)	any pair of coordinates selected from the line (1) in range → 0.6(0) to 0.7(0) (1)	e.g. 20 and (13 or 14) or 10 and (6 or 7) ignore any units given award full marks for a correct answer without working	(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
8(a)(iii)	an explanation linking: repeat (1) different angles / more values of X (1) for larger angles / values of X (1)	allow 'more measurements' / 'repeat experiment' / collect more data > 20°	(3) AO 3 3a

Question Number	Answer	Additional guidance	Mark
8(b)	substitution (1) $\frac{3.0 (\times 10^8)}{5.8 (\times 10^{-7})}$ evaluation (1) 5.2×10^{14} unit (1) Hz	 answers that round to 5.2×10^{14} award 2 marks for a correct answer without working allow 1 mark for answers that round to 5.2 to any power of ten independent mark accept hz or s^{-1} or per sec(ond) or hertz accept kHz, MHz etc with correct power (10^{11} kHz, 10^8 MHz)	(3) AO 2 1

Question Number	Answer	Mark
8(c)(i)	red or orange	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
8(c)(ii)	green or blue or indigo or violet		(1) AO 1 1

(Total for Question 8 = 11 marks)

Question number	Answer	Mark
7(a)	A black B is incorrect as no blue light shines on the object C is incorrect as no green light shines on the object D is incorrect as no red light is reflected from the object	(1) AO3

Question number	Answer	Additional guidance	Mark
7 (b)(i)	C specular reflection A is incorrect as the reflection is not diffuse B is incorrect as it is not refraction D is incorrect as it is not refraction		(1) AO1

Question number	Answer	Additional guidance	Mark
7 (b)(ii)	An explanation linking: (the surface/metal ball) is smooth/shiny (1) (for each ray of light) the angle of incidence is equal to the angle of reflection (1)	like a mirror the reflection is even / there is no scattering full marks can be awarded for labelled diagrams	(2) AO2

Question number	Answer	Additional guidance	Mark
7 c(i)	similarity (both) change direction /bend/refract (rays of light) (1) OR (rays of light/they) pass/go (straight) through the (optical) centre / focus(1) difference one converges the other diverges (1)	accept ray through centre described as 'bottom ray' accept 'top ray' accept refracts/bends in different ways do not allow 'change in direction of top ray' this is a similarity	(2) AO3

Question number	Answer	Additional guidance	Mark
7c(ii)	(the power of) P is less than (the power of) Q	ORA allow Q is greater /bigger	(1) AO2

Question number	Indicative content	Mark
7d *	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Refraction • Angle of incidence marked • Angle of refraction marked • Angles are measured from the normal • Angle of refraction is bigger than the angle of incidence • Rays of light travel in straight lines • Refraction occurs at a boundary between two materials of different (optical) density • The angle of incidence is less than the angle of refraction when light passes into a less dense medium (glass into air) • Refraction is a change in direction of a light ray. • Refracted rays bend away from the normal when light passes into a less dense medium (glass into air) • The ray in the more dense medium (glass) travels more slowly ORA Total Internal Reflection • Possible critical angle marked • Light stays inside the glass • Only occurs when the incident light is in the more dense medium • Only occurs when the incident angle is equal to greater than the critical angle • Critical angle for glass is about 42° • Angle of incidence is equal to the angle of reflection	(6) AO1



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3–4	Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5–6	Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> isolated fact(s) about refraction or total internal reflection(TIR)	<u>Possible candidate responses</u> naming of any rays of light or any angles in text or on diagrams light changes direction/bends TIR ray stays inside the glass / does not go into air refracted ray goes through glass and air
Level 2	3–4	<u>Additional guidance</u> simple description of refraction and TIR or facts about one and more detail of the other	<u>Possible candidate responses</u> Angle or ray identified For refraction light changes direction from glass into air or TIR angles are equal inside the glass
Level 3	5–6	<u>Additional guidance</u> detailed description of refraction and TIR	<u>Possible candidate responses</u> For refraction light changes direction from glass into air AND TIR angles are equal inside the glass

Total marks for question 7 = 13