Waves GCSE AQA Higher Physics Past Papers Answers

01.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	$magnification = \dfrac{image\ height}{object\ height}$ dividing by an object height of 1 cm gives the same (numerical) value		1 1	AO3/1b 4.6.2.5
2	accept anything practical that would work eg: use a taller object use a (travelling) microscope attach a scale to the screen and used a magnifying glass		1	AO3/3b 4.6.2.5 WS2.3/7
3	both points plotted correctly correct line of best fit drawn	a curve passing through all points (within ½ square), judge by eye	1 1	AO2/2 4.6.2.5 WS3.1/2
4	values of 1.4 and 0.6 extracted from the graph 2.33 times bigger	accept any number between 2.3 and 2.5 inclusive	1 1	AO2/2 4.6.2.5 WS3.5
5	by dividing the distance between the lens and the image by the distance between the lens and the object at least one correct calculation and comparison eg 100÷25 = 4 which is the same as the measured magnification		1 1	AO3/1a AO2/2 4.6.2.5 WS3.5
6	any two correct construction lines upright image drawn correctly	construction lines can be dotted or solid the image line can be dotted or solid but must show correct orientation ignore any arrows drawn on construction lines	2 1	AO2/2 4.6.2.5
Total			12	

02.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	**Level 3:** 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.	5-6	6	AO1/2 4.6.2.2
	Level 2: 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.	3–4		
	Level 1: Simple statements are made. The response may lack a logical structure and would not lead to the production of valid results.	1–2		
	No relevant content	0		
	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			
2	velocity/speed of the light decreases	allow velocity/speed of the light changes	1	AO1/1 4.6.2.2
Total			7	

03.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	P-waves are longitudinal and S-waves are transverse		1	AO1 4.6.1.5
03.2	0.4		1	AO2 4.6.1.2
03.3	wave speed = frequency × wavelength	allow v = f λ	1	AO1 4.6.1.2
03.4		an answer 18 000 scores **3** marks		AO2 4.6.1.2
	$7200 = 0.4 \times$ wavelength		1	
	wavelength $= \dfrac{7200}{0.4}$		1	
	wavelength = 18 000 (m)	allow up to full marks for ecf using their answer to question **03.2** a method shown as $7200 \times 2.5 = 18\ 000$ scores **0** marks	1	
03.5	because S-waves cannot travel through a liquid and S-waves do not travel through the (outer) core	allow some (seismic) waves cannot travel through a liquid and do not go through the core for **1** mark	1 1	AO1 4.6.1.5
03.6	magnetic field around the coil changes **or** the magnetic field (lines) cut by the coil	allow the generator effect	1	4.7.3.1 AO2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7	because the magnet changes direction		1	4.7.3.1 AO2
8	stationary		1	4.7.3.1 AO2
9	any **two** from: • stronger magnetic field • more turns on the coil • turns pushed closer together • spring with a lower spring constant	allow stronger magnet allow heavier magnet bigger magnet is insufficient bigger coil is insufficient do **not** accept more coils of wire allow less stiff spring allow weaker spring do **not** accept add an iron core	2	4.7.3.1 AO2
Total			13	

04.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	random	human error is insufficient	1	AO3 4.6.1.3
2	accept any practical suggestion that could cause a range of values eg misjudging the centre of the ray eg not replacing mirror / ray box in the same position	measuring the angle incorrectly is insufficient moving the mirror / ray box is insufficient	1	AO2 4.6.1.3
3	range = 10 or mean of 51 calculated 5(°)	an answer of 5(°) scores 2 marks	1 1	AO3 4.6.1.3
4	within experimental accuracy the angle of incidence and the angle of reflection are the same or the angle of reflection is usually different to the angle of incidence relevant use of data eg at 20° / 30° / 40° there is at least one measurement of angle of reflection that is exactly the same or at 50° there are big differences	allow the angle of incidence is nearly the same as the angle of reflection allow only a few of the values are the same / similar allow the idea of a range of values allow 50° includes anomalous results an answer in terms of calculated mean(s) may score both marks eg mean calculated for one or more angle of reflection (1) conclusion correctly stating angle i = / ≠ angle r (1)	1 1	AO3 4.6.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5	results could be collected for angles (of incidence) not yet measured	allow a stated angle of incidence eg 10° or 60° changing the mirror is insufficient ignore repeat the measurements	1	AO3 4.6.1.3
6	replace the mirror with an irregular reflecting surface	allow use an irregular reflecting surface replace mirror with paper is insufficient do **not** accept use a glass block	1	AO3 4.6.1.3
Total			**8**	

05.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	an idea used to explain observations and data		1	AO1 key ideas
2	different models may be appropriate in different situations	allow one particular model may not be able to explain all observations	1	AO1 key ideas
3	new (experimental) evidence / data		1	AO1 key ideas
	evidence cannot be explained using an existing model **or** predictions made using old model are shown to be incorrect	allow old model based on data now shown to be incorrect	1	
	new model explains new evidence **or** predictions made with new model are shown to be correct		1	
	a suitable example given eg nuclear model of the atom replacing the plum pudding model	allow tectonic plates replacing static land masses	1	
	big bang theory replacing other theories for the creation of the universe	allow heliocentric model of solar system replacing geocentric model		
4	velocity / speed is slower in shallow water		1	AO2 4.6.2.2
	so edge of wave (front) entering shallow water slows down		1	
	but the part of the wave (front) in deeper water continues at a higher speed (leading to a change in direction of the wave fronts)	allow one part of the wave (front) changes speed before other parts allow an answer in terms of wave (front) travelling from shallow to deep water	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5	every point on the wave (front) enters / hits the shallow water at the same time		1	AO2 4.6.2.2
	and so every point slows down at the same time	allow changes speed for slows down allow an answer in terms of wave (front) travelling from shallow to deep water	1	
Total			**11**	

06.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	focal length	this answer only	1	AO1/1 4.6.2.5
2	one correct line drawn from the top of the object, passing through the lens and crossing or meeting given line	ignore any arrow drawn on the line if two lines are drawn, both must be correct	1	AO2/2 4.6.2.5
	inverted image drawn at the correct position and length	arrowhead required	1	
3	similarity (both are) diminished	allow smaller for diminished	1	AO3/2a 4.6.2.5
	difference concave is <u>virtual</u> and convex is <u>real</u> **or** concave is upright and convex is inverted	a comparison must be made ignore reference to positions of images	1	
4		an answer of 1.5 (mm) scores **3** marks		AO2/1 4.6.2.5
	$6.0 = \dfrac{9.0}{\text{object height}}$		1	
	$\text{object height} = \dfrac{9.0}{6.0}$		1	
	object height = 1.5 (mm)	provided working can be seen, an attempt to convert 9.0 mm to cm or m with all other steps correct scores **2** marks	1	
Total			**8**	

07.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	metre rule	allow metre ruler allow tape measure do not accept ruler do not accept metre stick	1	AO1/2 4.6.1.2 RPA8
2	(wave) speed = frequency × wavelength	allow v = f λ	1	AO1/1 4.6.1.2 RPA8
3		an answer of 44 (m/s) scores **3** marks		AO2/1 4.6.1.2 RPA8
	80cm = 0.8m		1	
	v = 55 × 0.8	this mark may be awarded if wavelength is incorrectly or not converted	1	
	v = 44 (m/s)	allow correct calculation using an incorrectly or not converted wavelength an answer of 4400 (m/s) scores **2 marks**	1	
4	move the (wooden) bridge		1	AO2/2 4.6.1.2 RPA8
	to the right OR change the mass/weight (on the string) scores **1 mark** add more masses/weights (to the string) scores both marks	dependent on 1st mp being scored	1	

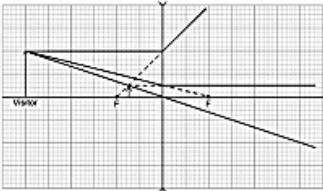| 5	**Level 2:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4	AO3/3a 4.6.1.2 RPA8
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content add or take away masses from the string (ignore any stated values) adjust frequency using the signal generator and/or move the wooden bridge observe a steady / stationary pattern measure the wavelength calculate wave speed from frequency and wavelength a Level 1 answer should include a way of changing tension a complete Level 2 answer would include either changing frequency and/or moving the bridge		
Total		11	

08.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	The frequency increases and the wave speed in air stays the same		1	AO1/1 4.6.2.1 iso
2	pass through soft tissue	allow penetrate for pass through allow skin/muscle/etc… for soft tissue pass through tissue is insufficient	1	AO1/1 4.6.2.4
	(but) absorbed by bone	allow do not pass through bone do not accept reflected by bone	1	
3	accept a sensible practical suggestion eg • complete the investigation standing up • use (slightly) cooler water • do not touch the hot cube	do not accept use cold water pour water in carefully is insufficient ignore wear safety goggles or gloves	1	AO2/2 4.6.2.2 WS2.4
4	distance between each side (of the cube) and the (infrared) detector	allow distance between cube and detector	1	AO1/2 4.6.2.2 WS2.2
5	measurements (for each surface) have not been repeated (to show that they cluster closely)	do not accept any answer for measurement should be repeated for any reason other than to show they cluster eg to show accuracy / average / anomalies would be wrong	1	AO3/3b 4.6.2.2 WS3.7
6	(the student) could not conclude that black surfaces always emit more (infrared) than a white surface	a (matt) white surface (appears to) emit(s) the same amount (of infrared) as a (shiny) black surface the conclusion is wrong is insufficient	1	AO3/1a/2b 4.6.2.2 WS2.2
	(as) the reading for the matt white and shiny black would both be 66 (°C)	allow (as) the reading for the matt white and shiny black would be the same	1	
7	0.0	allow 0 allow zero	1	AO1/1 4.6.3.1

8	at night, more radiation is emitted from the Earth than absorbed from space		1	AO1/1 4.6.3.2
	cloud reflects radiation (towards the Earth)	allow solar radiation for radiation	1	
	at A, (there is no cloud cover so) a larger proportion of radiation will be emitted into space		1	
Total			**12**	

09.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	it is harder to judge where the centre of a wider ray is		1	AO3 4.6.1.3 RPA9
	causing a larger uncertainty (in the measurements)	allow increasing <u>random</u> errors (in the measurements)	1	
2	line of best fit drawn and extrapolated to 80 degrees		1	AO3 4.6.1.3 RPA9
	41 (degrees)	allow 40 to 43 (degrees)	1	
3	**Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		5–6	AO1 4.6.1.3 RPA9
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.		3–4	
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	
	No relevant content		0	

Indicative content:

- place a glass block on a piece of paper
- draw around the glass block
- use the ray box to shine a ray of light through the glass block
- mark the ray of light entering the glass block
- mark the ray of light emerging from the glass block
- join the points to show the path of the complete ray through the block
- and draw a normal line at 90 degrees to the surface
- use a protractor to measure the angle of incidence
- use a protractor to measure the angle of refraction
- use a ray box to shine a ray of light at a range of different angles (of incidence)
- increase the angle of incidence in 10 degree intervals
- from an angle of incidence of 10 degrees to an angle of incidence of 70 degrees.

allow use of optical pins instead of a ray box

4.	$\dfrac{(28 + 25 + 22)}{3} = 25$ 3 (degrees)		1 1	AO3 4.6.1.3
		allow alternative method $28 - 22 = 6$ (1) $= 3$ (degrees) (1)		
5	Velocity		1	AO1 4.6.2.2
Total			13	

10.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	any **two** correct lines drawn from the top of the visitor and passing through the lens	allow construction lines that are not dashed	2	AO2 4.6.2.5
	image drawn at the correct position and with the correct orientation	mark only scores if first two marks scored.	1	
		a convex lens diagram scores **0** marks		

11.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2	Decreases		1	AO3 4.6.2.5

12.
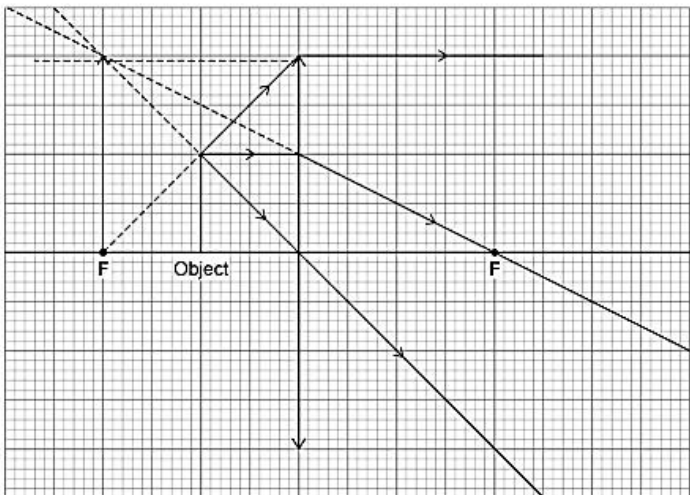
Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	320 MHz = 3.2 × 10⁸ Hz	allow 320 000 000	1	AO2
	$3.0 \times 10^8 = 3.2 \times 10^8 \times \lambda$	this mark may be awarded if frequency is incorrectly/not converted	1	AO2
	$\lambda = \dfrac{3.0 \times 10^8}{3.2 \times 10^8}$	this mark may be awarded if frequency is incorrectly/not converted	1	AO2
	wavelength = 0.9375	allow correct calculation using an incorrectly/not converted frequency allow an answer that rounds to 0.94	1	AO2
	metres **or** m		1	AO1 4.6.1.2
2	(alternating) current <u>induced</u> (in the electrical circuit)	allow <u>electrons</u> vibrate / oscillate (in the electrical circuit)	1	AO1 4.6.2.3
	with the same frequency as the radio wave		1	
3	Any **two** from: • (radio waves are) transverse • (radio waves) travel at a higher speed • (radio waves) don't need a medium • (radio waves are) electromagnetic	allow sound waves are longitudinal allow a description of transverse/longitudinal waves allow (only) radio waves travel through a vacuum allow sound waves are mechanical	2	AO1 4.6.1.1 4.6.1.2
4	accelerating	allow speeding up	1	AO3 4.5.6.1.4

5	appropriate tangent drawn		1	AO2 4.5.6.1.4
	correct reading from graph for change in distance and change in time (eg 5.6 (m) and 20 (s))	allow correct reading from their tangent for change in distance and change in time	1	
	gradient of tangent shown (eg 5.6/20)	allow correct gradient from their tangent	1	
	0.28 (m/s)	this answer only allow 0.25 to 0.30 (m/s) if the tangent is appropriate allow 2.8 / 20 = 0.14 (m/s) for **1** mark	1	
6	$0.52^2 - 0.12^2 = 2 \times 0.04 \times s$		1	AO2 4.5.2 4.5.6.1.5
	$s = \dfrac{0.52^2 - 0.12^2}{2 \times 0.04}$		1	
	$s = 3.2$ (m)		1	
	$0.48 = F \times 3.2$	this mark may be awarded if the displacement is incorrectly calculated	1	
	$F = \dfrac{0.48}{3.2}$	this mark may be awarded if the displacement is incorrectly calculated	1	
	$F = 0.15$ (N)	allow a correctly calculated F using an incorrectly calculated displacement	1	
	OR			

Alternative method 1

$t = \dfrac{0.52 - 0.12}{0.04}$ (1)

$t = 10$ (s) (1)

$s = 0.32 \times 10$
$\quad = 3.2$ (m) (1) allow a correctly calculated displacement from an incorrectly calculated t

$0.48 = F \times 3.2$ (1) this mark may be awarded if the displacement is incorrectly calculated

$F = \dfrac{0.48}{3.2}$ (1) this mark may be awarded if the displacement is incorrectly calculated

$F = 0.15$ (N) (1) allow a correctly calculated F from incorrectly calculated values for displacement and / or t

OR

Alternative method 2

$0.48 = (0.5 \times m \times 0.52^2) - (0.5 \times m \times 0.12^2)$ (1)

$0.48 = 0.1352m - 0.0072m$ (1)

$0.48 = 0.128m$ (1)

$m = 3.75$ (1)

$F = 3.75 \times 0.040$ (1) allow their calculated m

$F = 0.15$ (N) (1) allow correctly calculated F using an incorrectly calculated m

7	there is a maximum forward force (provided by the motor)	allow driving force for forward force - throughout the car has a maximum acceleration is insufficient	1	AO1 4.5.6.1.5
	as the speed of the car increases air resistance increases	allow friction / drag for air resistance - throughout	1	
	until air resistance is equal in size to forward force	allow (until) the resultant force is zero allow forces are in equilibrium / balanced	1	
	so the car can no longer accelerate	allow the car travels at terminal velocity	1	
Total			24	

13.

Question	Answers	Extra information	Mark	AO/ Spec. Ref
1	**both** answers correct virtual diminished	answers may be in either order allow a description of diminished (eg smaller / reduced)	1	AO3 4.6.2.5
2	any **two** correct lines drawn from the top of the object, passing through the lens and traced backwards image drawn in the correct position and with the correct orientation	allow construction lines that are not dashed allow 1 mark for **two** correct lines drawn from the top of the object, passing through the lens BUT not traced backwards mark only scores if first two marks score	2 1	AO2 4.6.2.5

3	(increasing the object distance) decreases the image distance more rapidly at small (object) distances / more gradually at larger (object) distances	do **not** accept inversely proportional	1	AO3 4.6.2.5
4	$\dfrac{(2.2 - 1.4)}{2}$ uncertainty = (±) 0.4 (cm)		1 1	AO3 4.6.2.5
		allow $\dfrac{1.9 + 1.7 + 2.2 + 1.4}{4} = 1.8$ (1) (2.2 − 1.8 =) (±) 0.4 (cm) (1)		
5	only red is transmitted by the filter red is absorbed by the (blue) object (so) no light is reflected by the (blue) object		1 1 1	AO1 4.6.2.6
Total			10	

14.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	any one from: • (sun) tan • energy efficient lamps	allow • (invisible) security coding • detecting forged bank notes • kill microbes • attract insects • sterilise (surgical) equipment • cause the body to produce vitamin D • increasing the growth rate of plants • water purification	1	AO1 4.6.2.4
2	3×10^{-7} m		1	AO1 4.6.2.1
3	$3.0 \times 10^8 = \text{frequency} \times 3 \times 10^{-7}$ $\text{frequency} = \dfrac{3.0 \times 10^8}{3 \times 10^{-7}}$ frequency = 1×10^{15} (Hz)	allow ecf from question **05.2**	1 1 1	AO2 4.6.1.2
4			1	AO3 4.6.2.1

Wave   **Name**

Wave E		Infrared
Wave F		Visible light
Wave G		X-rays

all three lines correct for **1** mark

| 5 | in a transverse wave, the oscillations / vibrations are perpendicular to the direction of energy transfer | allow direction of wave travel for direction of energy transfer | 1 | AO1 4.6.1.1 |
| | in a longitudinal wave, the oscillations / vibrations are parallel to the direction of energy transfer | | 1 | |

| Total | | | 8 | |

15.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	to reduce the effect of random errors	allow gives a more accurate mean ignore reference to anomalous results ignore measurements are more accurate	1	AO1 4.6.1.2
2	$\dfrac{(8.4+7.8+8.1)}{3} = 8.1$ (s)		1	AO2 4.6.1.2
	$\dfrac{8.1}{10} = 0.81$ (s)		1	
	frequency = $\dfrac{1}{0.81}$	allow a correct substitution of an incorrectly calculated value for time	1	
	frequency = 1.2345...	this mark may be awarded if the time is incorrectly calculated	1	
	frequency = 1.2 (Hz)	allow a calculated value correctly rounded to 2 sig figs	1	
3	measure the distance travelled by a wave using a metre rule	allow measure the length of the (ripple) tank using a metre rule	1	AO1 4.6.1.2
	measure the time taken (for the wave to travel the measured distance) with a timer / stopwatch		1	
	divide the distance by the time	dependant on scoring the first two mark points	1	

Total			9

16.

Question	Answers	Mark	AO / Spec. Ref.
1	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 4.6.1.3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content Some indicative content could be indicated within a labelled diagram • place a glass block on a piece of paper • draw around the glass block • use the ray box to shine a ray of light through the glass block • mark the ray of light entering the glass block • mark the ray of light emerging from the glass block • join the points to show the path of the complete ray through the block • and draw a normal line at 90 degrees to the surface • use a protractor to measure the angle of incidence • use a protractor to measure the angle of refraction • use a ray box to shine a ray of light at a range of different angles (of incidence) • increase the angle of incidence in 10 degree intervals • from an angle of incidence of 10 degrees to an angle of incidence of 80 degrees Methods involving mirrors and reflection score zero		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2	angle of incidence in degrees / ° on *x*-axis **and** angle of refraction in degrees / ° on *y*-axis		1	AO2 4.6.1.3
	all points plotted correctly	allow **1** mark if 3 or 4 points plotted correctly allow tolerance of half a small square	2	
	curved line of best fit	allow line of best fit from their incorrectly plotted points	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3	normal drawn at 90° at the point where the incident ray strikes the mirror		1	AO2 4.6.1.3
	straight line drawn with a ruler **and** angle of incidence = angle of reflection	ignore any arrows	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4	(the protractor drawn on the paper means you) do not have to move the mirror (to measure the angles)	allow do not have to mark the position of the rays of light allow protractor does not need to be repositioned	1	AO3 4.6.1.3
	(so) more likely to record the correct angle of incidence and / or reflection	allow reducing random error allow more accurate	1	
	ray in method A does not diverge	allow ray in method A is thin(ner)	1	
	(making it) easier to judge the centre (position) of the ray	allow more accurate if not already awarded allow converse answers in terms of method B being worse than method A	1	

Total Question ☐		16	

17.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	perpendicular		1	AO1 4.6.1.1

Question	Answers	Mark	AO / Spec. Ref.
2	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5-6	AO3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3-4	AO1
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1-2	AO1
	No relevant content	0	
	Indicative content **Method:** • heat the water / kettle • add an equal volume of (hot) water to each flask • insert a thermometer into each flask • record the initial temperature from both flasks OR • place an IR detector near each flask • the distance between the IR detector and the flask should be the same each time • record initial reading from IR detectors • (and) start a stop clock • record the temperatures / readings after 10 minutes from both flasks • calculate the change in temperatures / readings during the 10 minutes • compare the results to test the hypothesis to access level 3 the method must allow the correct consideration of a temperature decrease for both flasks or the correct comparison of IR detected from both flasks		4.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3	during the 1st minute		1	AO2
	there is the greatest temperature difference (between the hot water and the surroundings)	allow highest temperature or hottest	1	AO1
				4.6.3.1
		MP 2 dependent on scoring MP 1		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4	the temperature (increase / change after 10 minutes)	allow the final temperature	1	AO1 4.6.2.2
		do not allow temperature decrease		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5	black surfaces absorb more (infrared than white surfaces)	allow black surfaces have a greater temperature increase (than white surfaces)	1	AO3 4.6.2.2 4.6.3.1
	matt surfaces absorb more (infrared) than shiny surfaces of the same colour	allow matt surfaces have a greater temperature increase than shiny surfaces of the same colour	1	
		if no other marks scored, allow 1 mark for matt black surface is the best absorber and shiny white surface is the worst absorber		
		if no other marks scored, allow 1 mark for matt black has the greatest temperature increase and shiny white has the smallest temperature increase		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6	pressure = $\dfrac{\text{force}}{\text{area}}$		1	AO1 4.5.5.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7	area of base = 0.0144 (m²)	do not allow this or subsequent marks unless base area is used	1	AO2 4.5.5.1.1
	$1500 = \dfrac{F}{0.0144}$	this mark may be awarded if base area is incorrectly calculated	1	
	$F = 1500 \times 0.0144$	this mark may be awarded if base area is incorrectly calculated	1	
	$F = 21.6$ (N)	this mark may be awarded if base area is incorrectly calculated allow 22 (N)	1	

Total Question		17

18.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
	12.5 cm = 0.125 m		1	AO2 4.6.1.2
	$3 \times 10^8 = f \times 0.125$	this mark may be awarded for an incorrectly / not converted value for wavelength	1	
	$f = \dfrac{3 \times 10^8}{0.125}$	this mark may be awarded for an incorrectly / not converted value for wavelength	1	
	$f = 2\,400\,000\,000$ (Hz)	this mark may be awarded for an incorrectly / not converted value for wavelength	1	
	$f = 2.4 \times 10^9$ (Hz)	this mark may be awarded for an incorrectly calculated value for frequency in standard form using the given data	1	

19.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1	specular (reflection)		1	AO1 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2	the angle of incidence = the (mean) angle of reflection		1	AO3 4.6.1.3 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3	random		1	AO3 4.6.1.3 RPA9
	any **one** from: • the student's eye / head might not be in the same position each time • the centre of the ray may not have been marked correctly • the mirror / ray box may not have been (re)placed correctly	allow parallax allow protractor not in the correct position incorrect measurement of the angle(s) is insufficient	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4	all points on a wavefront enter the glass at the same time	allow incident ray (of light) is along the normal	1	AO1 4.6.1.3 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5	the resolution (of the protractor) is 1(°)		1	AO3 4.6.1.3 RPA9
	(so) could not be used to measure the difference between the results	allow (so) could not be used to measure to 1 decimal place	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6	different parts of the wavefront enter the glass at different times		1	AO1 4.6.2.2
	the velocity / speed (of light) is less in glass		1	
	(so) one part of the wave front changes speed before other parts		1	

Total Question		10