

Mark Scheme

Q1.

	Answer	Acceptable answers	Mark
(i)	☒ A on the finger		(1)
(ii)	infrared (1)	red light	(1)
(iii)	89/60 (1) 1.5 (beats/second) (1)	1.48 (beats/second) Allow 1.49 1.483333etc Accept correct answer no working for 2 marks	(2)
(iv)	1/1.5 (1) 0.67(s) (1)	ecf 1/ 89 one mark only Accept correct answer no working for 2 marks	(2)

Q2.

Question Number	Answer	Acceptable answers	Mark
	conversion of time 4×60 (1) substitution (1) $1608 / (4 \times 60)$ ecf if conversion shown evaluation (1) 6.7 (m/s)	award full marks for correct answer with no working [1608 / 4 for 1 mark for these two] allow 402 for 2 marks accept for 2 marks: 5.36 (t=300 s $60 \rightarrow 120 \rightarrow 180 \rightarrow 240 \rightarrow 300$, i.e. 4 steps of 60) 4.02 (t=400 s based on the misconception of 100 s to 1 minute) allow maximum of 1 mark for any other power of 10 error if no working	(3)

Q3.

Question number	Answer	Additional guidance	Mark
	two minutes = 120 s (1) substitution (1) $26\,400 \div 120$ answer (1) 220 (m/s)	ecf unit change award full marks for correct numerical answer without working	(3)

Q4.

Question number	Answer	Additional guidance	Mark
	substitution (x) = 330 x 4.0 evaluation 1300 (m)	accept 1320 (m) award full marks for correct answer without working.	(2) AO2

Q5.

	Answer	Acceptable answers	Mark
	Substitution into correct equation(1) $v = 15 \times 125$ Evaluation (1) 1875 Unit (1) m/s	Power of 10 error max 1 mark for numerical answer 2 marks for correct numerical answer even with no working shown ms^{-1} not mps 1.875 km/s or 6750 km/h gain 3 marks If numerical answer incorrect, accept any correctly-written unit of speed: eg k m/s or km/hr or miles per hour / mph	(3)

Q6.

Question Number	Answer	Additional guidance	Mark
	recall and substitution (1) ($v =$) 0.25×1.5 evaluation (1) 0.38 (m/s)	accept 0.375 or 0.37 (m/s) accept 37.5, 37 or 38 for 1 mark only award full marks for the correct answer without working	(2)

Q7.

Question number	Answer	Additional guidance	Mark
	uses data taken from x axis (1) 28(cm) (1)	award full marks for correct answer without working	(2) A03

Q8.

	Answer	Acceptable answers	Mark
	transposition $\lambda = v/f$ (1) substitution $\lambda = 3 \times 10^8 / 7 \times 10^9$ (1) evaluation 0.043 (m) (1)	Subst. and transform. either order 1 mark only can be scored for correct substitution after incorrect transposition. $3 \times 10^8 / 7 \times 10^9$ gains 2 marks Accept any number of sig.figs. that rounds to 0.04	(3)

	Ignore any unit given by candidate	0.04 , 0.0428 (m) (1) Give full marks for correct answer with no working. 0.04 × any other power of 10 = 2 marks	
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Q9.

Question Number	Answer	Mark
(i)	<p>A longitudinal yes</p> <p><i>B is not correct because sound waves can transfer energy</i></p> <p><i>C is not correct because sound waves are longitudinal</i></p> <p><i>D is not correct because sound waves are longitudinal and sound waves can transfer energy</i></p>	(1) AO1

	Answer	Additional guidance	Mark
(ii)	<p>select wave equation (1)</p> <p>$(v =) f \times \lambda$</p> <p>evaluation (1)</p> <p>(speed =) 330(m/s)</p>	<p>(speed =) freq(ueency) × wavelength</p> <p>(speed =) 440 × 0.75</p> <p>award full marks for the correct answer without working.</p>	(2) AO2

Q10.

	Answer	Acceptable answers	Mark
(i)	Substitution $v = 1920/6.0$ (1) Evaluation (1) 320 (m/s)	300 (m/s) give full marks for correct answer, no working (2) Power of 10 error max. 1 mark.	(2)
(ii)	Suggestions including the following: <ul style="list-style-type: none"> • recognition of any difference in speed / velocity (1) • correct difference in speed (1) 	e.g. sound travels faster / quicker than light (1) $c > v$ / $v < c$ / $c > 320$ (m/s) Light travels (much) faster (2) RA Ignore 'sound takes longer' or other references to time.	(2)

Q11.

Question number	Answer	Mark
	An answer that combines the following points of understanding to provide a logical description: <ul style="list-style-type: none"> • use a stopwatch (1) • start timing when flash is seen and stop when bang is heard (1) 	(2)

Q12.

Question number	Answer	Additional guidance	Mark
	An answer that combines the following points to provide a method: <ul style="list-style-type: none"> • use a stop watch (1) • count number of waves that reach the bank in a given time (1) 		(2)

Q13.

Question Number	Answer	Additional guidance	Mark
	<p>a description to include:</p> <ul style="list-style-type: none"> • longitudinal – (vibrations) parallel to (direction of travel) (1) • transverse – (vibrations) at right angles to (direction of travel) (1) • (connection between) direction of travel with (direction of) vibrations (1) 	<p>back and forth (oscillations)/ compressions or rarefactions</p> <p>up and down (oscillations)</p>	<p>(3)</p> <p>AO 1 1</p>

Q14.

Question Number	Answer	Acceptable answers	Mark
(a)	A longitudinal : yes		(1)

Question Number	Answer	Acceptable answers	Mark
(b)	An explanation linking any two of: 1. A cause or description of earthquakes (1) 2. why timing of earthquake is uncertain / complex (1) 3. we cannot see {what is happening deep inside the Earth / where the plates are rubbing} (1)	The release of {energy / pressure/friction force} (in Earth's surface) (caused when tectonic) plates slide past each other any idea of relative movement of plates e.g. move over each other, collide (movement of plates is) {sudden / random / jerky} it is too difficult to {work out / measure} when release of energy will happen "it is difficult to measure when the plates will collide" = 2 marks	(2)

Q15.

	Answer	Acceptable answers	Mark
(a)(i)	Gamma/ γ (wave(s)/ ray(s)/radiation)	X-rays/ radiation	(1)
(a)(ii)	Any two from It fluoresces (1) UV (radiation) transfers/gives energy to ink/ink absorbs energy from UV (radiation) (1) (energy from UV is)(re-)radiated/(re)- emitted by ink at lower frequency/as (visible) light (1)	fluorescent Ink/it absorbs UV (light/radiation) Ignore UV is reflected as visible light Ignore luminous emits visible light	(2)
(b)	transposition $\lambda = v/f$ substitution (1)	Subst. and transform. either order 1 mark only can be scored for correct substitution after incorrect transposition.	(3)

	$\lambda = 3 \times 10^8 / 7 \times 10^9$ (1) evaluation 0.043 (m) Ignore any unit given by candidate	(1) 3 × 10 ⁸ /7 × 10 ⁹ gains 2 marks Accept any number of sig.figs. that rounds to 0.04 0.04 , 0.0428 (m) (1) Give full marks for correct answer with no working. 0.04 × any other power of 10 = 2 marks	
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		Indicative Content	
QWC		*c	A discussion including some of the following points Possible dangerous e-m radiations Microwaves Infrared Ultraviolet (UV) X-rays gamma rays Correctly linked to Internal heating of body cells (microwaves) Skin burns (infrared) Damages skin cells/sunburn (UV) Damages eyes (UV) Can cause skin cancer (UV) Can cause cataracts (UV) Damage to cells inside the body(X-rays) Mutate/ kill cells in the body (gamma) Damages DNA (X-rays and gamma rays) Link to frequency As the frequency increases/wavelength decreases (microwave -> gamma) the waves become more penetrating and do more damage/danger as they h more energy.
Level	0	No rewardable content	
1	1 - 2	<ul style="list-style-type: none"> • a limited description e.g. gives at least 2 correct radiations and links both to correct damage OR at least 2 correct radiations named with link to correct damage from one and idea that frequency is linked to damage OR just has link between higher frequency and more damage/dangerous e.g. infrared burns your skin and X-rays can damage cells. OR X-rays have a higher frequency than microwaves and can cause cancer OR Higher frequencies cause more damage to cells. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy 	
2	3 - 4	<ul style="list-style-type: none"> • a simple description e.g. gives most of the correct radiations and links to correct damage, at least one with detail of the damage that is caused OR links two to detail of the damage, AND has a link between frequency and energy/danger e.g. Microwaves are absorbed by water 	

		<p>in body cells. UV can cause skin cancer and damages your eyes. Xrays and gamma rays can damage cells inside your body OR Gamma and X-rays can penetrate deep into the body. Gamma does most damage as it has the highest frequency.</p> <ul style="list-style-type: none"> • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 - 6	<ul style="list-style-type: none"> • a detailed description e.g. gives most of the correct radiations with links to detail of the damage AND explains the link between frequency and energy/danger. e.g Microwaves heat up the water in cells. UV can cause cataracts. Gamma rays are the most penetrating and can mutate cells inside the body because they have the highest frequency. • The answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q16.

Question number	Answer	Additional guidance	Mark
	<p>an explanation to include two from: waves cannot be seen (on arrival) (1)</p> <p>person will need another way of detecting the waves (1)</p> <p>(as) a person cannot count to 12 in one second / at a rate of 12 per second (1)</p> <p><u>frequency</u> too high (1)</p>	<p>idea of coming too fast to count / easy to lose count</p>	(2)

Q17.

Question Number	Answer	Additional guidance	Mark
	substitution (1) $\frac{3.0 (\times 10^8)}{5.8 (\times 10^{-7})}$		(3) AO 2 1
	evaluation (1) 5.2×10^{14}	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	
	unit (1)	independent mark	
	Hz	accept hz or s^{-1} or per sec(ond) or hertz accept kHz, MHz etc with correct power (10^{11} kHz, 10^8 MHz)	

Q18.

Question number	Answer	Additional guidance	Mark
(i)	one from: radio(wave) (1) micro(wave) (1) infrared (1) visible (light) (1) ultraviolet (1) X(-ray) (1) gamma (rays) (1) electromagnetic/em wave(s) seismic S (-wave)	Do not credit if sound waves also mentioned γ earthquake S (-wave)	(1)

Question number	Answer	Additional guidance	Mark
(ii)	$\frac{32}{10}$ number of wavelengths (1) $\frac{32}{10}$ evaluation (1) 3.2 (m)	accept 9 or 11 for 10 no ecf from mp1 3.6 (3.5r) or 2.9(1) award full marks for the correct answer without working	(2)

Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) $\frac{12}{15}$ evaluation (1) 0.8(0) (Hz)	award full marks for the correct answer without working	(2)

Q19.

Question number	Answer	Additional guidance	Mark
(i)	electromagnetic wave	allow any named e.m. wave/seismic S wave	(1)

Question number	Answer	Additional guidance	Mark
(ii)	sound wave	allow ultrasound/infrasound/seismic P wave	(1)

Q20.

Question number	Answer	Mark
(i)	A	(1)

Question number	Answer	Mark
(ii)	C	(1)

Q21.

Question number	Answer	Additional guidance	Mark
(i)	C wave front is longer		(1)

Question number	Answer	Additional guidance	Mark
(ii)	substitution and rearrangement (1) $t = 4.0 / 0.70$ evaluation (1) 5.7 (s)	accept 6 (s)	(2)

Question number	Answer	Additional guidance	Mark
(iii)	2/3 0.67 m		(1)

Question number	Answer	Additional guidance	Mark
(iv)	An explanation that combines identification - application of knowledge (1 mark) and reasoning/justification - application of understanding (1 mark): the cork is oscillating at right angles / perpendicular (1) to the direction of travel of the wave / transfer of energy(1)		(2)

Q22.

Question Number	Answer	Additional guidance	Mark
	an explanation linking: <ul style="list-style-type: none"> • measure across more than one (wavelength) (1) • divide by the number of wavelengths (1) 	use a more accurate device (finer divisions) use a camera / picture/strobe(light) (so the waves are not moving) count the number of wavelengths must be talking about measuring , NOT changing the wavelength etc.	(2) AO 3 3b

Q23.

	Answer	Acceptable answers	Mark
	relevant values 110 and 10 seen anywhere(1) 100 (s) (1) acceptable range 95 to 105 (s)	(could be on chart) tolerance +/- 5 s give full marks for correct answer, no working	(2)

Q24.

	Answer	Acceptable answers	Mark
(a)(i)	☒ A on the finger		(1)
(a)(ii)	infrared (1)	red light	(1)
(a)(iii)	89/60 (1) 1.5 (beats/second) (1)	1.48 (beats/second) Allow 1.49 1.483333etc Accept correct answer no working for 2 marks	(2)
(a)(iv)	1/1.5 (1) 0.67(s) (1)	ecf 1/ 89 one mark only Accept correct answer no working	(2)


		Indicative Content
QWC	*(b)	<p>A description including some of the following points:</p> <p>what the information / signal is</p> <ul style="list-style-type: none"> • electrical signals • small difference in potential (mV) between one body and another • signal changes as the heart beats • are started in the heart (right atria) • caused by nervous impulse • action potentials <p>signal in</p> <ul style="list-style-type: none"> • electrodes attached to the skin • water in the body conducts electricity / signal • at least two electrodes used • electrodes conduct electricity / contain gel <p>signal out</p> <ul style="list-style-type: none"> • shows heart rate on a screen / paper • shows a waveform on a screen / paper • receives small signals which have to be amplified
Level	0	No rewardable content
1	1 - 2	<ul style="list-style-type: none"> • a limited explanation e.g. it shows your heart beat on a screen • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	<ul style="list-style-type: none"> • a simple explanation e.g. it shows if your heart is working properly by measuring heart beat which you can see on a screen • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 - 6	<ul style="list-style-type: none"> • a detailed explanation e.g. connects electrodes/wires on the skin to measure (electrical) signals of the heart in order to assess the heart beat/heart performance/heart condition • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q25.

Answer	Acceptable answers	Mark
Substitution		(2)

1.7 × 8 (1)		
Evaluation 14 (cm/s) (1)	13.6 (cm/s)	
	give full marks for correct answer, no working	
	Power of 10 error max. 1 mark.	

Q26.

Question number	Answer	Additional guidance	Mark
(i)	at least one arrow in the direction QS (1) two arrows in opposite directions (1)	allow arrows parallel to QS independent mark  scores 2 marks two arrows in opposite directions but perpendicular to QS scores 1 mark maximum	(2)

Question number	Answer	Additional guidance	Mark
(ii)	converts 7 km/s to 7000 m/s (1) substitution (1) $\frac{7(\times 10^3)}{12}$ evaluation (1) 580 (m)	7000 seen (1) allow numbers that round down to 580 such as 583.33.... 5.8 to any incorrect power of ten scores 2 marks award full marks for the correct answer without working	(3)

Q27.

Question Number	Answer	Additional guidance	Mark
(i)	recall speed = $\frac{\text{distance}}{\text{time}}$	accept any correct rearrangement or use of s, d and t may use v for speed and x for distance ignore use of triangles	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
(ii)	substitution (1) (speed) = $\frac{220}{0.7(0)}$ evaluation (1) 310 (m/s)	allow ecf from part (i) for this mark only allow any numbers that round to 310 e.g. 314 award full marks for the correct answer without working	(2) AO 2 1

Q28.

	Answer	Additional guidance	Mark
(i)	12		(1) AO1

	Answer	Additional guidance	Mark
(ii)	$\frac{42}{12}$ (1) 3.5(cm) (1)	ecf from 2ai allow 0.035 for 1 mark award full marks for the correct answer without working	(2) AO1

	Answer	Additional guidance	Mark
(iii)	A description to include: either time a crest/ripple/wavefront (1) (moving) between P and Q (1) use (wave speed =) $\frac{\text{distance}}{\text{time}}$ (1) or count number of crests /ripples /wavefronts passing (eg P) (1) in a given time (to find f) (1) use ($v =$) $f\lambda$ (1)	allow 'how long it takes' allow 'wave' for crest allow - over the 42 cm over a (set) distance allow waves if no other mark scored measure frequency for 1 mark	(3) AO1

Q29.

Question number	Answer	Additional guidance	Mark
	wavelength gets shorter / decreases		(1)

Q30.

	Answer	Acceptable answers	Mark
(i)	B seismic waves (1)		(1)
(ii)	(there is a) difference/change in density (1)	more/less/too dense (reach a) boundary (between different materials) Ignore 'the waves cannot travel through liquids/oil'	(1)

Q31.

Question Number	Answer	Additional guidance	Mark
(i)	evidence of use of scale on horizontal distance axis only (1) 12 (cm) (1)	may be seen on the diagram range 11.5 to 12.5 (cm) award full marks for the correct answer without working 6 (cm) or 30(cm) scores 1 mark (evidence of use)	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	a description to include: moves up and down (1) at right angles / normal / perpendicular to (direction of) wave/travel (1)	independent marking points vertical (oscillations) not in the (direction of) wave / travel accept 'transverse wave' for 2nd MP	(2)

Q32.

	Answer	Acceptable answers	Mark
(b)(i)	A description including the following: <ul style="list-style-type: none"> • magnifies • the image • <u>refracts</u> the light 	brings nearer / zooms in / looks closer / makes bigger / enlarges intermediate / real image	(2)
(b)(ii)	<input checked="" type="checkbox"/> B energy		(1)

Q33.

	Answer	Acceptable answers	Mark
	$2100/500 = 4.2$ (1) $4.2 \times 150 = 630$ (million km) (1) Accept ratios as speed is constant $150/500 = \text{distance to Jupiter}/2100$ OR Distance to Jupiter = $(150/500) \times 2100$ Either for 1 mark	Power of 10 error maximum of 1 mark (speed of light) about $150\,000\,000 \div 500 = 300\,000$ (km/s) (1) (distance to Jupiter)= $300\,000 \times 2$ 100 = 630 000 000 / = 630 (million km) An answer with no calculation of 630	(2)

	(million km) gains 2 marks If an answer of 630 million/ 630 000 000 is given with correct working award both marks	
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Q34.

Question number	Answer	Additional guidance	Mark
(i)	<p>a description to include</p> <p>count the number of waves(1)</p> <p>(arriving/passing a point) in a specific time(1)</p> <p>use $\text{frequency} = \frac{\text{number of waves}}{\text{time}} \quad (1)$</p>	<p>ignore in one second</p> <p>count the number of waves in one second scores 2 marks (MP1 and MP3)</p> <p>find the time between one wave and the next scores 2 marks (MP1 and MP2)</p>	(3) A01

Question number	Answer	Additional guidance	Mark
(ii)	substitution (1) 1.5 = 0.7 x λ rearrangement and evaluation 2.1(4) m	$\frac{1.5}{0.7}$ allow $\frac{0.7}{1.5}$ for 1 mark award full marks for correct answer without working. $\lambda = v/f$ scores 1 mark	(2) AO2

Question number	Answer	Additional guidance	Mark
(iii)	A description to include: mention of oscillations/vibrations (1) EITHER transverse – (oscillations) perpendicular to direction of wave (travel) (1) OR longitudinal – (oscillations) in same direction as wave (travel) (1)	up and down OR side to side (movements) OR back and forth transverse movement up and down but longitudinal is side to side (1 mark only)	(2) AO1

Q35.


	Answer	Acceptable answers	Mark
(i)	5 (cm) (1) 8 (cm) (1)	+5 -5 0.08 m 80 mm	(2)
(ii)	B		(1)

Q36.

	Answer	Acceptable answers	Mark
	<input checked="" type="checkbox"/> D both transverse and longitudinal waves		(1)

Q37.

Question Number	Answer	Acceptable answers	Mark
(i)	X amplitude (1) Y wavelength (1)		(2)

Question Number	Answer	Acceptable answers	Mark
(ii)	A  (1)		(1)