2007 Physics

Advanced Higher

Finalised Marking Instructions

Detailed Marking Instructions – AH Physics 2007

1. **Numerical Marking**

   (a) The fine divisions of marks shown in the marking scheme may be recorded within the body of the script beside the candidate's answer. If such marks are shown they must total to the mark in the inner margin.

   (b) Negative marks or marks to be subtracted should not be shown. An inverted vee may be used instead.

   (c) The number recorded should always be the marks being awarded.
   The number out of which a mark is scored SHOULD NEVER BE SHOWN AS A DENOMINATOR. (½ mark will always mean one half mark and never 1 out of 2.)

   (d) Where square ruled paper is enclosed inside answer books it should be clearly indicated that this item has been considered. Marks awarded should be transferred to the script booklet inner margin and marked G.

   (e) Fractional marks, if awarded to individual questions, should be recorded in the grid, but the total script mark must be rounded up to the next whole number when transferred to the box at the top of the script.

2. **Other Marking Symbols which may be used**

TICK	–	Correct point as detailed in scheme, includes data entry.
SCORE THROUGH	–	Any part of answer which is wrong. (For a block of wrong answer indicate zero marks.)
INVERTED VEE	–	A point omitted which has led to a loss of marks.
WAVY LINE	–	Under an answer worth marks which is wrong only because a wrong answer has been carried forward from a previous part.
"G"	–	Reference to a graph on separate paper. You MUST show a mark on the graph paper and the SAME mark on the script.
"X"	–	Wrong Physics
✳	–	Wrong order of marks

3. **Marking Symbols which may <u>not</u> be used.**

"WP"	–	Marks not awarded because an apparently correct answer was due to the use of "wrong physics".
"ARITH"	–	Candidate has made an arithmetic mistake.
"SIG FIGS or SF"	–	Candidate has made a mistake in the number of significant figures for a final answer.

4. **General Instructions (Refer to National Qualifications Booklet)**

(a) No marks are allowed for a description of the wrong experiment or one which would not work.
Full marks should be given for information conveyed correctly by a sketch.

(b) Surplus answers: where a number of reasons, examples etc are asked for and a candidate gives more than the required number then wrong answers may be treated as negative and cancel out part of the previous answer.

(c) Full marks should be given for a correct answer to a numerical problem even if the steps are not shown explicitly. The part marks shown in the scheme are for use in marking partially correct answers.

(d) Where 1 mark is shown for the final answer to a numerical problem ½ mark may be deducted for an incorrect unit.

(e) Where a final answer to a numerical problem is given in the form 3^{-6} instead of 3×10^{-6} then deduct ½ mark.

(f) Deduct ½ mark if an answer is wrong because of an arithmetic slip.

(g) No marks should be awarded in a part question after the application of a wrong physics principle (wrong formula, wrong substitution) unless specifically allowed for in the marking scheme.

(h) In certain situations, a wrong answer to a part of a question can be carried forward within that part of the question. This would incur no further penalty provided that it is used correctly. Such situations are indicated by a horizontal dotted line in the marking instructions.

Wrong answers can always be carried forward to the next part of a question, over a solid line without penalty.

(i) ½ mark should be awarded for selecting a formula.

(j) Where a triangle type "relationship" is written down and then not used or used incorrectly then any partial ½ mark for a formula should not be awarded.

(k) In numerical calculations, if the correct answer is given then converted wrongly in the last line to another multiple/submultiple of the correct unit then deduct ½ mark.

(l) Significant figures.
Data in question is given to 3 significant figures.
Correct final answer is 8·16J.
Final answer 8·2J <u>or</u> 8·158J <u>or</u> 8·1576J – No penalty.
Final answer 8J <u>or</u> 8·15761J – Deduct ½ mark.
Candidates should be penalised for a final answer that includes:

- three or more figures too many
  or
- two or more figures too few.
  ie accept two higher and one lower.

Max ½ mark deduction per question.
Max 2½ deduction from question paper.

(m) Squaring Error

$E_K = ½ mv^2 = ½ \times 4 \times 2^2 = 4J$ (-½, ARITH)

$E_K = ½ mv^2 = ½ \times 4 \times 2 = 4J$ (½, formula) Incorrect substitution.

The General Marking Instructions booklet should be brought to the markers' meeting.

Physics − Marking Issues

The current in a resistor is 1·5 amperes when the potential difference across it is 7·5 volts. Calculate the resistance of the resistor.

	Answers	Mark + comment	Issue
1.	V=IR 7·5=1·5R R=5·0Ω	(½) (½) (1)	Ideal Answer
2.	5·0Ω	(2) Correct Answer	GMI 1
3.	5·0	(1½) Unit missing	GMI 2(a)
4.	4·0Ω	(0) No evidence/Wrong Answer	GMI 1
5.	_____Ω	(0) No final answer	GMI 1
6.	$R=\frac{V}{I}=\frac{7\cdot5}{1\cdot5}=4\cdot0\Omega$	(1½) Arithmetic error	GMI 7
7.	$R=\frac{V}{I}=4\cdot0\Omega$	(½) Formula only	GMI 4 and 1
8.	$R=\frac{V}{I}=$ _____Ω	(½) Formula only	GMI 4 and 1
9.	$R=\frac{V}{I}=\frac{7\cdot5}{1\cdot5}=$ _____Ω	(1) Formula + subs/No final answer	GMI 4 and 1
10.	$R=\frac{V}{I}=\frac{7\cdot5}{1\cdot5}=4\cdot0$	(1) Formula + substitution	GMI 2(a) and 7
11.	$R=\frac{V}{I}=\frac{1\cdot5}{7\cdot5}=5\cdot0\Omega$	(½) Formula but wrong substitution	GMI 5
12.	$R=\frac{V}{I}=\frac{75}{1\cdot5}=5\cdot0\Omega$	(½) Formula but wrong substitution	GMI 5
13.	$R=\frac{I}{V}=\frac{7\cdot5}{1\cdot5}=5\cdot0\Omega$	(0) Wrong formula	GMI 5
14.	V=IR 7·5=1·5 x R R=0·2Ω	(1½) Arithmetic error	GMI 7
15.	V=IR $R=\frac{I}{V}=\frac{1\cdot5}{7\cdot5}=0\cdot2\Omega$	(½) Formula only	GMI 20

Data Sheet

Common Physical Quantities

Quantity	*Symbol*	*Value*	*Quantity*	*Symbol*	*Value*
Gravitational acceleration on Earth	g	$9{\cdot}8\ \text{ms}^{-2}$	Mass of electron	m_e	$9{\cdot}11 \times 10^{-31}\text{kg}$
Radius of Earth	R_E	$6{\cdot}4 \times 10^{6}\text{m}$	Charge on electron	e	$-1{\cdot}60 \times 10^{-19}\text{C}$
Mass of Earth	M_E	$6{\cdot}0 \times 10^{24}\text{kg}$	Mass of neutron	m_n	$1{\cdot}675 \times 10^{-27}\text{kg}$
Mass of Moon	M_M	$7{\cdot}3 \times 10^{22}\text{kg}$	Mass of proton	m_p	$1{\cdot}673 \times 10^{-27}\text{kg}$
Radius of Moon	R_M	$1{\cdot}7 \times 10^{6}\text{m}$	Mass of alpha particle	$m_{\propto}$	$6{\cdot}645 \times 10^{-27}\text{kg}$
Mean Radius of Moon Orbit		$3{\cdot}84 \times 10^{8}\text{m}$	Charge on alpha particle		$3{\cdot}20 \times 10^{-19}\text{C}$
Universal constant of gravitation	G	$6{\cdot}67 \times 10^{-11}\text{m}^3\text{kg}^{-1}\text{s}^{-2}$	Planck's constant	h	$6{\cdot}63 \times 10^{-34}\text{Js}$
Speed of light in vacuum	c	$3{\cdot}0 \times 10^{8}\text{ms}^{-1}$	Permittivity of free space	ε_0	$8{\cdot}85 \times 10^{-12}\text{Fm}^{-1}$
Speed of sound in air	v	$3{\cdot}4 \times 10^{2}\text{ms}^{-1}$	Permeability of free space	μ_0	$4\pi \times 10^{-7}\text{Hm}^{-1}$

Refractive Indices

The refractive indices refer to sodium light of wavelength 589 nm and to substances at a temperature of 273 K.

Substance	*Refractive index*	*Substance*	*Refractive index*
Diamond	2·42	Glycerol	1·47
Glass	1·51	Water	1·33
Ice	1·31	Air	1·00
Perspex	1·49	Magnesium Fluoride	1·38

Spectral Lines

Element	*Wavelength/nm*	*Colour*	*Element*	*Wavelength/nm*	*Colour*
Hydrogen	656	Red	Cadmium	644	Red
	486	Blue-green		509	Green
	434	Blue-violet		480	Blue
	410	Violet	*Lasers*		
	397	Ultraviolet	*Element*	*Wavelength/nm*	*Colour*
	389	Ultraviolet			
Sodium	589	Yellow	Carbon dioxide	9550 10590	Infrared
			Helium-neon	633	Red

Properties of selected Materials

Substance	*Density/ kg m^{-3}*	*Melting Point/K*	*Boiling Point/K*	*Specific Heat Capacity/ Jkg^{-1} K^{-1}*	*Specific Latent Heat of Fusion/ Jkg^{-1}*	*Specific latent Heat of Vaporisation/ Jkg^{-1}*
Aluminium	$2{\cdot}70 \times 10^3$	933	2623	$9{\cdot}02 \times 10^2$	$3{\cdot}95 \times 10^5$	….
Copper	$8{\cdot}96 \times 10^3$	1357	2853	$3{\cdot}86 \times 10^2$	$2{\cdot}05 \times 10^5$	….
Glass	$2{\cdot}60 \times 10^3$	1400	….	$6{\cdot}70 \times 10^2$	….	….
Ice	$9{\cdot}20 \times 10^2$	273	….	$2{\cdot}10 \times 10^3$	$3{\cdot}34 \times 10^5$	….
Gylcerol	$1{\cdot}26 \times 10^3$	291	563	$2{\cdot}43 \times 10^3$	$1{\cdot}81 \times 10^5$	$8{\cdot}30 \times 10^5$
Methanol	$7{\cdot}91 \times 10^2$	175	338	$2{\cdot}52 \times 10^3$	$9{\cdot}9 \times 10^4$	$1{\cdot}12 \times 10^6$
Sea Water	$1{\cdot}02 \times 10^3$	264	377	$3{\cdot}93 \times 10^3$	….	….
Water	$1{\cdot}00 \times 10^3$	273	373	$4{\cdot}19 \times 10^3$	$3{\cdot}34 \times 10^5$	$2{\cdot}26 \times 10^6$
Air	$1{\cdot}29$	….	….	….	....	….
Hydrogen	$9{\cdot}0 \times 10^{-2}$	14	20	$1{\cdot}43 \times 10^4$	....	$4{\cdot}50 \times 10^5$
Nitrogen	$1{\cdot}25$	63	77	$1{\cdot}04 \times 10^3$	….	$2{\cdot}00 \times 10^5$
Oxygen	$1{\cdot}43$	55	90	$9{\cdot}18 \times 10^2$	….	$2{\cdot}40 \times 10^5$

The gas densities refer to a temperature of 273 K and pressure of $1{\cdot}01 \times 10^5$ Pa.

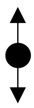
2007 AH Physics			
Sample answer and mark allocation	**Notes**	**Margin**	
1. (a) $\frac{ds}{dt} = v$ $\int ds = \int (u + at) \cdot dt$ (½) $s = ut + ½ at^2 + c$ (½) at $t = 0$, $s = 0$, so $c = 0$ (½) $\therefore s = ut + ½ at^2$ (½)	No c or limits $\Rightarrow$ max (½) If first line is W.P. – (0) eg WP = $\int s$, $\int \frac{ds}{dt}$, $\int v$ OR $\int_o^s ds = \int_o^t (u + at) dt$ (½) equation (½) limits $[s]_o^s = [ut + ½ at^2]_o^t$ (½) $s = ut + ½ at^2$ (½)	2	6
(b) $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$ (½) $= \frac{1 \cdot 673 \times 10^{-27}}{\sqrt{1 - \frac{(2 \cdot 8 \times 10^8)^2}{(3 \cdot 0 \times 10^8)^2}}}$ (½) (½) $= 4 \cdot 66 \times 10^{-27} (kg)$ (½) - $E = mc^2$ (½) $= 4·66 \times 10^{-27} \times (3·0 \times 10^8)^2$ (½) $= 4·2 \times 10^{-10}$ J (1)	data (½) 1.673×10^{-27} data (½) 3×10^8	4	

Sample answer and mark allocation	Notes	Margin	
2. (a) (i) $I = \frac{1}{2}mr^2$ (½) $= \frac{1}{2} \times 0{\cdot}60 \times 0{\cdot}15^2$ (½) $= 6{\cdot}8 \times 10^{-3}$ kgm^2 (1)		2	12
(ii) A $\omega = \frac{\text{no. of revs}}{60} \times 2\pi$ (½) $= \frac{45}{60} \times 2\pi$ (½) $= (4{\cdot}7$ rads$^{-1})$		1	
B $\alpha = \frac{\omega - \omega_o}{t}$ (½) $= \frac{4{\cdot}7}{1{\cdot}5}$ (½) $= 3{\cdot}1$ rads^{-2} (1)		2	
(iii) $I_{mass} = mr^2$ (½) $= 0{\cdot}20 \times 0{\cdot}10^2$ (½) $= 0{\cdot}0020$ (kgm^2) – $I_1\omega_1 = I_2\omega_2$ (½) $6{\cdot}8 \times 10^{-3} \times 4{\cdot}7 = (6{\cdot}8 \times 10^{-3} + 2 \times 10^{-3})\omega_2$ (½) $\omega_2 = 3{\cdot}6$ rads^{-1} (1)	$2{\cdot}0 \times 10^{-3}$ kgm^2	3	
(iv) centripetal force is supplied by friction (1) Force of friction is less than the required centripetal force (1)	Outward force – (0)	2	
(b) ω increases (½) r (of arms and legs) decreases (½) (⇒) I decreases (accept inertia) (½) Iω is constant (½)		2	

Sample answer and mark allocation	Notes	Margin	
3. (a) (i) $F = \frac{GMm}{r^2}$ (½) $= \frac{6{\cdot}67 \times 10^{-11} \times 6{\cdot}0 \times 10^{24} \times 7{\cdot}3 \times 10^{22}}{(3{\cdot}84 \times 10^{8})^2}$ (½) $= 2{\cdot}0 \times 10^{20}$ N (1)		2	13
(ii) $F = \frac{mv^2}{r}$ (½) $2{\cdot}0 \times 10^{20} = \frac{7{\cdot}3 \times 10^{22} \times v^2}{3{\cdot}84 \times 10^{8}}$ (½) $v = 1{\cdot}0 \times 10^{3}$ ms^{-1} (1)		2	
(iii) work done in bringing unit mass from infinity (to a point in space) (1)	1 or 0	1	
(iv) $E_P = -\frac{GMm}{r}$ (½) $= \frac{-6{\cdot}67 \times 10^{-11} \times 6{\cdot}0 \times 10^{24} \times 7{\cdot}3 \times 10^{22}}{3{\cdot}84 \times 10^{8}}$ (½) $= -7{\cdot}6 \times 10^{28}$ J (1)	missing –ve sign in formula – (0) missing –ve = wrong substitution (max ½)	2	
(v) $E_T = E_K + E_P$ **or** $E_T = ½\, mv^2 - 7{\cdot}6 \times 10^{28}$ J (½) $= ½ \times 7{\cdot}3 \times 10^{22} \times (1{\cdot}0 \times 10^{3})^2 - 7{\cdot}6 \times 10^{28}$ (½) $= -4{\cdot}0 \times 10^{28}$ J (1)	**Or** $E_T = -\frac{GMm}{2r}$ $= -3.8 \times 10^{28}$ J	2	

Sample answer and mark allocation		Notes	Margin
(b) (i) $E_P + E_K = 0$ $-\frac{GMm}{r} + \frac{1}{2} mv^2 = 0$ $\frac{1}{2} \cancel{m}v^2 = \frac{GM\cancel{m}}{r}$ $v = \sqrt{\frac{2GM}{r}}$	(½) (½) (½) (½)	$E_P = E_K \Rightarrow (0)$ Wrong Physics	2
(ii) $v = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 7.3 \times 10^{22}}{1.7 \times 10^{6}}}$ data for r of moon $= 2{\cdot}4 \times 10^{3}\ \text{ms}^{-1}$	(½) (½) (1)		2

Sample answer and mark allocation			Notes	Margin	
4.	(a)	force (or acceleration) is proportional to displacement (½) and directed towards centre (½)	$F = -ky$ (1) $F\alpha - y$	1	9
	(b)	$y = A \cos \omega t$ (½) $A = 0{\cdot}10 \div 2 = 0{\cdot}050$ (½) $\omega = 2\pi f = 628 = 200\pi$ (½) $y = 0{\cdot}050 \cos 628\, t$ (½)	accept sine function A or ω wrong $\Rightarrow$ max (1)	2	
	(c)	$a = (\pm)\, \omega^2 y$ (½) $= 628^2 \times 0{\cdot}050$ (½) $= 2{\cdot}0 \times 10^4\ \text{ms}^{-2}$ (1)		2	
	(d)	$F = ma$ (½) $= 0{\cdot}48 \times 2{\cdot}0 \times 10^4$ (½) $= 9{\cdot}6 \times 10^3$ N (1)	accept ±	2	
	(e)	$E_K = \frac{1}{2} m\omega^2(A^2 - y^2)$ (½) $= \frac{1}{2} \times 0{\cdot}48 \times 628^2 \times 0{\cdot}050^2$ (½) $= 240$ J (1)		2	

Sample answer and mark allocation	Notes	Margin	
5. (a) (i) $V = \dfrac{Q}{4\pi\varepsilon_0 r}$ (½) $= \dfrac{5\cdot1\times10^{-9}}{4\times3\cdot14\times8\cdot85\times10^{-12}\times0\cdot2}$ (½) = (230 V)	accept $\dfrac{1}{4\pi\varepsilon_0} = 9\times10^{9}$	1	11
(ii) potential difference = $V_A - V_B$ $= 230 - \dfrac{Q}{4\pi\varepsilon_0 r}$ (½) $= 230 - \dfrac{5\cdot1\times10^{-9}}{4\times3\cdot14\times8\cdot85\times10^{-12}\times0\cdot5}$ = 230 – 92 (½) = 140 V (1)	(½) for subtraction Accept 138 V	2	
(b) bring rod close (or touching) (1) earth (touch) sphere (1)	If rod removed before the earth, deduct 1 mark	2	
(c) (i)  electric force (½) weight (or mg) (½)	**not** gravity	1	

Sample answer and mark allocation	Notes	Margin	
(ii) EQ= mg (½) + (½) E = V/d (½) $Q = \frac{mgd}{V}$ $= \frac{1\cdot 2\times 10^{-14}\times 9\cdot 8\times 0\cdot 08}{4900}$ (½) $= 1\cdot 92 \times 10^{-18}$ C (1)	± accept	3	
(iii) no. of electrons = $\frac{1.92\times 10^{-18}}{1.6\times 10^{-19}}$ = 12 (1)		1	
(d) not an integer multiple of e (1)		1	

Sample answer and mark allocation		Notes	Margin	
6. (a) $B_{\perp} = B \sin 69$	(½)			8
$= 5 \times 10^{-5} \times \sin 69$	(½)			
$= 4{\cdot}7 \times 10^{-5}$ T		deduct ½ if wrong unit	1	
(b) (i) $F = BIL \sin\theta$	(½)			
$= 4{\cdot}7 \times 10^{-5} \times 3 \times 1{\cdot}5$	(½)			
$= 2{\cdot}1 \times 10^{-4}$ N	(1)		2	
(ii) EAST	(1)		1	
(c) 0 (N)	(1)	unit not needed	1	
(d) (i) $B = \dfrac{\mu_0 I}{2\pi r}$	(½)			
$r = \dfrac{\mu_0 I}{2\pi B}$				
$= \dfrac{4 \times 3{\cdot}14 \times 10^{-7} \times 3{\cdot}0}{2 \times 3{\cdot}14 \times 5{\cdot}0 \times 10^{-5}}$	(½)	$1{\cdot}2 \times 10^{-2}$m		
$= 1.2 \times 10^{-2}$ m	(1)		2	
(ii) circular	(1)	accept cylindrical	1	

Sample answer and mark allocation	Notes	Margin	
7. (a) (i) changing current (½) causes changing magnetic field (1) producing back emf (½)		2	9
(ii) $I = \frac{P}{V}$ $= \frac{1 \cdot 5}{6}$ $= 0 \cdot 25$ A (1)	(½)	1	
(iii) $E = \frac{1}{2} LI^2$ (½) $L = \frac{E}{0 \cdot 5 I^2}$ $= \frac{75 \times 10^{-3}}{0 \cdot 5 \times (0 \cdot 25)^2}$ (½) $= 2 \cdot 4$ H (1)		2	
(iv) (A) smaller current (1) (B) longer time (1)		2	
(b) B collapses (rapidly) **or** $\frac{dI}{dt}$ is large (1) large (back) emf induced **or** emf > 80V (1)	S closed, energy stored (1) S open, energy released (1)	2	

Sample answer and mark allocation	Notes	Margin	
8. (a) (i) (A) $V_H = V\cos\theta$ $= 9{\cdot}5 \times 10^7 \times \cos 60$ $= 4{\cdot}8 \times 10^7\ ms^{-1}$ (1)		1	12
(B) $V_V = V\sin\theta$ $= 9{\cdot}5 \times 10^7 \times \sin 60$ $= 8{\cdot}2 \times 10^7\ ms^{-1}$ (1)		1	
(ii) perpendicular (component) – results in circular motion <u>or</u> central force (1) parallel (component) – constant velocity or no horizontal force or equivalent (1)		2	
(b) (i) $\frac{mv^2}{r} = Bqv$ (½) + (½) $\frac{m(v\sin\theta)^2}{r} = Bqv\sin\theta$ (½) $r = \frac{mv\sin\theta}{Bq}$ $= \frac{9{\cdot}11 \times 10^{-31} \times 9{\cdot}5 \times 10^7 \times \sin 60}{0{\cdot}22 \times 1{\cdot}6 \times 10^{-19}}$ (½) $= 2{\cdot}1 \times 10^{-3}m$	Accept $r = \frac{mv}{Bq}$ (1)	2	
(ii) Time $= \frac{2\pi r}{v\sin\theta}$ (½) $= \frac{2 \times 3{\cdot}14 \times 2{\cdot}1 \times 10^{-3}}{8{\cdot}2 \times 10^7}$ (½) $= 1{\cdot}6 \times 10^{-10}s$ (1)		2	

Sample answer and mark allocation	Notes	Margin	
(iii) pitch $= v\cos\theta \times$ time for 1 rev (½) $= 4{\cdot}75 \times 10^{7} \times 1{\cdot}6 \times 10^{-10}$ (½) $= 7{\cdot}6 \times 10^{-3}$m (1)		2	
(c) bigger radius spirals in opposite sense (direction) bigger pitch	any 2 for 1 mark each greater period − (0) fewer loops − (0)	2	

Sample answer and mark allocation	Notes	Margin	
9. (a) $f = \frac{v}{\lambda}$ $= \frac{0{\cdot}06}{0{\cdot}02}$ $= 3$ (Hz) (1) $y = 0{\cdot}05 \sin 2\pi \left(3t - \frac{x}{0\cdot 02}\right)$	(½) for 0·05; (1) for 3; (½) for 0·02	2	5
(b) $y = 0{\cdot}05 \sin 2\pi \left(3t + \frac{x}{0\cdot 02}\right)$		1	
(c) $I \alpha A^2$ (½) A^2 falls by 0.5 **or** A falls by $\sqrt{0\cdot 5}$ (½) new amplitude = $\sqrt{0\cdot 5} \times 0\cdot 05$ $= 0{\cdot}04$m (1)	Accept 0·035m	2	

Sample answer and mark allocation	Notes	Margin	
10. (a) (i) (A) π (½) (B) π (½)		1	8
(ii) (reflected rays) interfere destructively(1) if optical path difference = $\frac{\lambda}{2}$ (1)		2	
(iii) so more light is transmitted (through the lens) (1)	brighter image – (1)	1	
(iv) $d = \frac{\lambda}{4n}$ (½) $\lambda = 4dn$ $= 4 \times 1{\cdot}05 \times 10^{-7} \times 1{\cdot}38$ (½) $= 5{\cdot}80 \times 10^{-7}$m (1)		2	
(b) fringe separation (½) length of glass plates (½) wavelength of sodium light (½) $\Delta x = \frac{\lambda \ell}{2d}$ (½)		2	

Sample answer and mark allocation	Notes	Margin
11. (a) $\lambda = 2 \times 0{\cdot}15$ (1) $v = f\lambda$ (½) $= 250 \times 0{\cdot}3$ (½) ($= 75\ ms^{-1}$)	numbers alone, no formula – (0)	2
(b) % uncertainty in $\lambda = \frac{0.005}{0{\cdot}150} \times 100$ $= 3{\cdot}3\%$ (½) % uncertainty in f $= \frac{10}{250}$ x 100 $= 4\%$ (½) % uncertainty in v $= \sqrt{4^2 + 3\cdot3^2}$ (½) $= 5\%$ (½) — — — — — — — — — — — — — — — — absolute uncertainty $= 75 \times \frac{5}{100}$ (½) $= 4\ ms^{-1}$ $v = (75 \pm 4)\ ms^{-1}$ (½)		3
(c) (i) % uncertainty in λ will increase (1)	accept distance between nodes in place of wavelength	1
(ii) measure the distance over several nodes and take an average (1)		1

[END OF MARKING INSTRUCTIONS]