2009 Physics

Advanced Higher

Finalised Marking Instructions

Detailed Marking Instructions – AH Physics 2009

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. **(Can indicate by line through number).**
"SIG FIGS or SF"	−	Candidate has made a mistake in the number of significant figures for a final answer. **(Can be indicated by a line through additional figures).**

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.

However, when the numerical answer is given or a derivation of a formula is required every step **must** be shown explicitly.

(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.

The exceptions to this are:

- where the numerical answer is given
- where the required equation is given.

(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 or 8·158J or 8·1576J – No penalty.
Final answer 8J or 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

$E_K = \frac{1}{2} mv^2 = \frac{1}{2} \times 4 \times 2^2 = 4\text{J}$ (–½, ARITH)

$E_K = \frac{1}{2} mv^2 = \frac{1}{2} \times 4 \times 2 = 4\text{J}$ (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.	$V=IR$ $7{\cdot}5=1{\cdot}5R$ $R=5\cdot0\Omega$	(½) (½) (1)	Ideal Answer
2.	$5\cdot0\Omega$	(2) Correct Answer	GMI 1
3.	5·0	(1½) Unit missing	GMI 2(a)
4.	$4\cdot0\Omega$	(0) No evidence/Wrong Answer	GMI 1
5.	_____Ω	(0) No final answer	GMI 1
6.	$R=\frac{V}{I}=\frac{7{\cdot}5}{1{\cdot}5}=4{\cdot}0\,\Omega$	(1½) Arithmetic error	GMI 7
7.	$R=\frac{V}{I}=4{\cdot}0\,\Omega$	(½) Formula only	GMI 4 and 1
8.	$R=\frac{V}{I}=$ _____Ω	(½) Formula only	GMI 4 and 1
9.	$R=\frac{V}{I}=\frac{7{\cdot}5}{1{\cdot}5}=$ _____Ω	(1) Formula + subs/No final answer	GMI 4 and 1
10.	$R=\frac{V}{I}=\frac{7{\cdot}5}{1{\cdot}5}=4{\cdot}0$	(1) Formula + substitution	GMI 2(a) and 7
11.	$R=\frac{V}{I}=\frac{1{\cdot}5}{7{\cdot}5}=5{\cdot}0\,\Omega$	(½) Formula but wrong substitution	GMI 5
12.	$R=\frac{V}{I}=\frac{75}{1{\cdot}5}=5{\cdot}0\,\Omega$	(½) Formula but wrong substitution	GMI 5
13.	$R=\frac{I}{V}=\frac{7{\cdot}5}{1{\cdot}5}=5{\cdot}0\,\Omega$	(0) Wrong formula	GMI 5
14.	$V=IR \quad 7{\cdot}5=1{\cdot}5\times R$ $R=0{\cdot}2\,\Omega$	(1½) Arithmetic error	GMI 7
15.	$V=IR$ $R=\frac{I}{V}=\frac{1{\cdot}5}{7{\cdot}5}=0{\cdot}2\,\Omega$	(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*
Hydrogen	656	Red
	486	Blue-green
	434	Blue-violet
	410	Violet
	397	Ultraviolet
	389	Ultraviolet
Sodium	589	Yellow

Element	*Wavelength*/nm	*Colour*
Cadmium	644	Red
	509	Green
	480	Blue

Lasers

Element	*Wavelength*/nm	*Colour*
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	1·29	….	….	….	....	….
Hydrogen	$9{\cdot}0 \times 10^{-2}$	14	20	$1{\cdot}43 \times 10^4$	....	$4{\cdot}50 \times 10^5$
Nitrogen	1·25	63	77	$1{\cdot}04 \times 10^3$	….	$2{\cdot}00 \times 10^5$
Oxygen	1·43	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.

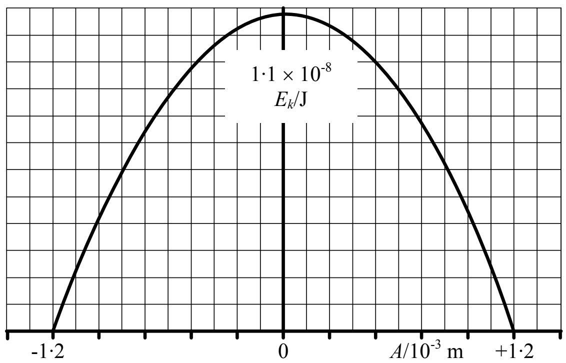
2009 AH Physics			
Sample answer and mark allocation	**Notes**	**Margin**	
1. (a) (i) $v = \frac{ds}{dt}$ (½) $= 6{\cdot}2t + 4{\cdot}1$ (½)		1	13
(ii) $72 = 6{\cdot}2t + 4{\cdot}1$ (½) $t = \frac{72 - 4\cdot 1}{6\cdot 2}$ (½) $= 11$ s (1)	10.9 s - incorrect rounding - ½	2	
(iii) $a = \frac{dv}{dt}$ (½) $= 6\cdot 2\ \mathrm{m\,s^{-2}}$ (½)	Accept $a = \frac{v-u}{t}$ (½), but u = 0 is a wrong substitution and gives $a = 6.6\ \mathrm{m\,s^{-2}}$	1	
(b) (i) Escape velocity greater than c or $3 \times 10^8\ \mathrm{m\,s^{-1}}$ **or** no light can escape (1)	Ignore 'loose' language	1	
(ii) The escape velocity is the (minimum) velocity an object must have which would allow it to escape the gravitational field. (1)		1	
(iii) $E_P + E_K = 0$ (½) $\frac{-GMm}{r} + \frac{1}{2}mv^2 = 0$ (½) $\frac{1}{2}\not{m}v^2 = \frac{GM\not{m}}{r}$ (½) $v = \sqrt{\frac{2GM}{r}}$ (½)	$E_P = E_K \Rightarrow$ (0) $\frac{1}{2}mv^2 = -Vm$ is ok for starting. Can start here for (1½)	2	

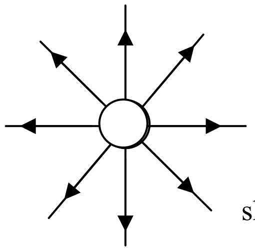
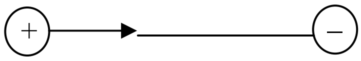
Sample answer and mark allocation		Notes	Margin	
(iv) $v_e = c = \sqrt{\frac{2GM}{r}}$ (No equation (½)) **Data (½) for G** $3 \cdot 0 \times 10^8 = \sqrt{\frac{2 \times 6 \cdot 67 \times 10^{-11} \times 4 \cdot 58 \times 10^{30}}{r}}$ $r = 6 \cdot 8 \times 10^3$ m	(½) (1)	Can carry forward a wrong equation derived in part (iii) $v = \sqrt{\frac{GM}{r}}$ gives r = 3.4 x 10^3 m	2	
(v) $\rho = \frac{M}{V}$ (½) $V = \frac{4}{3}\pi r^3$ (½) $\rho = \frac{4 \cdot 58 \times 10^{30}}{\frac{4}{3}\pi \times (6 \cdot 8 \times 10^3)^3}$ (½) sub (½) volume $= 3 \cdot 5 \times 10^{18}$ kg m^{-3}	(1) (1)	V = 1.317 x 10^{12} If use wrong formula for volume then max (½) for density equation If r = 3.4 x 10^3 m, ρ = 2.8 x 10^{19} kg m^{-3}	3	

Sample answer and mark allocation					Notes	Margin	
2.	(a)	(i)	$\omega = (48 \times 5{\cdot}8) - 12 = 266$ rpm or from the graph taking $\omega = 265$ rpm $\omega = \frac{266 \times 2\pi}{60} = 28$ rad s^{-1}	(½) (½)	**"SHOW" question** **Must show 2π and 60**	 1	12
		(ii)	$\omega = (48 \times 1{\cdot}6) - 12 = 65$ (rpm) $\omega = \frac{65 \times 2\pi}{60} = 6{\cdot}8$ (rad s^{-1}) - - - - - - - - - - - - - - - - $\alpha = \frac{\omega - \omega_0}{t}$ $\alpha = \frac{6{\cdot}8 - 28}{8}$ $\alpha = \frac{6{\cdot}8 - 28}{8} = -2{\cdot}7$ rad s^{-2}	(½) (½) (½) (½) (1)	Graph value 62 or 63 gives $\omega = 6.5$ or 6.6 final answer could be -2.6 OK with care **+ 2.7 rad s^{-2} by wrong substitution max (1½) for question**	 3	

Sample answer and mark allocation		Notes	Margin
(b) (i) $I = \frac{1}{3} ml^2$ $= \frac{1}{3} \times 11 \times 10^{-3} \times (76 \times 10^{-3})^2$ $= 2{\cdot}1 \times 10^{-5}$ kg m^2	(½) (½) (1)	Care with units	2
(ii) $I_{total} = 3I + I_{cylinder}$ $= (3 \times 2{\cdot}1 \times 10^{-5}) + 1{\cdot}1 \times 10^{-6}$ $= 6{\cdot}4 \times 10^{-5}$ kg m^2	(½) (½) (1)	$I_t = 3 \times I$ – (0) Accept 6.5 x 10^{-5} kg m^2	2
(c) $T = I\alpha$ $= 6{\cdot}4 \times 10^{-5} \times 2{\cdot}7$ $= 1{\cdot}7 \times 10^{-4}$ N m	(½) (½) (1)	Failure to multiply by 3 in (ii) gives I = 2.2 x 10^{-5} and T = 5.9 x 10^{-5} N m Accept $T < 0$	2
(d) (Moment of) inertia would increase and then one from the following: greater time to stop/α would decrease/ speed (of rotation) would be less	(1) (1)	Must have 'I increases' or equivalent for 1st mark. More mass at a distance implies this. Incorrect statement about I or no statement, (0) marks Any mention of angular momentum – zero for 2nd mark	2

Sample answer and mark allocation	Notes	Margin	
3. (a) (i) $\omega = 2\pi f$ (½) $= 2 \times \pi \times 33 = 210$ (½) $\boldsymbol{y = A \sin \omega t}$ **or** $\boldsymbol{y = A \cos \omega t}$ (½) $y = 2{\cdot}1 \times 10^{-3} \sin 210t$ (½)	Ignore –ve signs. equation can be implied with incorrect "A". Accept 207t also 66 π t Wrong "A" max (1½)	2	10
(ii) $v_{max} = \pm\omega A$ (½) $v_{max} = \pm 210 \times 2{\cdot}1 \times 10^{-3}$ (½) $v_{max} = \pm 0{\cdot}44\ \text{m s}^{-1}$ (1)	$v = \pm\omega\sqrt{A^2 - y^2}$ with y = 0 (½) Accept 0·43 m s^{-1} for ω = 207 v = 0.88 m s^{-1} for A = 4.2 x 10^{-3}	2	

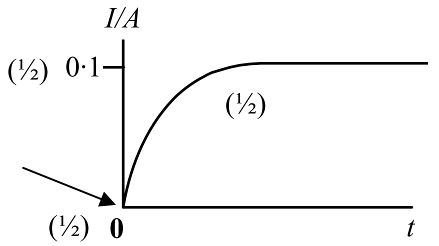
Sample answer and mark allocation	Notes	Margin	
(b) $\omega = 77 \text{ rad s}^{-1}$ (½) $A\omega = 9{\cdot}2 \times 10^{-2}$ (½) $\therefore A = \frac{9\cdot 2\times 10^{-2}}{77} = 1{\cdot}2 \times 10^{-3}$ m (1)	Accept $a = (-)\omega^2 A$ (½)	2	
(c) (i) $E_{k\,max} = \frac{1}{2}\, m\omega^2 A^2$ From equation $\omega = 77 \text{ rad s}^{-1}$, $A = 1{\cdot}2 \times 10^{-3}$ m $E_{k\,max} = \frac{1}{2}\times 2\cdot 5\times 10^{-6}\times 77^2\times\left(1\cdot 2\times 10^{-3}\right)^2$ $E_{k\,max} = 1{\cdot}1 \times 10^{-8}$ J	$E_k = ½m\omega^2(A^2 - y^2)$ with y = 0 (½) Can use $E_k =$ ½ mv^2 with v = 9.2 x 10^{-2} m s^{-1} Can use $E_k =$ ½ $m(r\omega)^2$ with r = 1.2 x 10^{-3} m from (b), not the radius of the 'head'	2	
(ii)  (1 for shape and symmetry about zero) (½ for *A*) (½ for $E_{k\,max}$)	**(-½) if labels/units not given on both axes**	2	

Sample answer and mark allocation	Notes	Margin	
4. (a) (i)  shape + arrows (1)	Must be neat Majority of lines must touch at right angles Use judgement. Minimum 4 lines. **1 or 0 for question.**	1	10
(ii) *E* field/force from *A* and from *B* (1) are in same direction/add up/don't cancel (1) Or Diagram showing field lines running between A and B – must have arrow (1) Direction of arrow + to - (1) 	(Test) charge between charges experiences a force (1) E or F from each charge act in the same direction / add up / don't cancel (1)	2	
(iii) $E_A = \frac{q}{4\pi\varepsilon_0 r^2}$ (½) $= \frac{4\times10^{-6}}{4\times3\cdot14\times8\cdot85\times10^{-12}\times0\cdot34^2}$ sub - (½) r = 0.34 (½) $= 3\cdot1\times10^5$ (N C^{-1}) (½) $E_B = \frac{q}{4\pi\varepsilon_0 r^2}$ $= \frac{-2\times10^{-6}}{4\times3\cdot14\times8\cdot85\times10^{-12}\times0\cdot24^2}$ $= -3\cdot1\times10^5$ (N C^{-1}) (½) $\Rightarrow E_{total} = 0$ (N C^{-1}) (½) If not rounded, E = $-1\cdot1 \times 10^{-3}$ N C^{-1} (1081)	 (½) is **not** a data mark (½) for numerical value If miss out "-ve" then WP - max 2 marks - unless subsequently corrected by indicating direction eg arrows (½) for numerical value (½) for numerical value	3	

Sample answer and mark allocation		Notes	Margin
(b) The strong force Balances/greater than the repulsive/electrostatic force **or** This force acts over a short range.	(1) (1)	Must get first (1) before second mark becomes available	2
(c) (i) charge $2 \times \frac{2}{3} + 1 \times -\frac{1}{3} = e$ **or** baryon $2 \times \frac{1}{3} + 1 \times \frac{1}{3} = 1$ (this is a proton)	(1)	If both methods attempted then deduct (½) for each error.	1
(ii) Down quark & anti up quark	(1)	No need for justification (1)/(0)	1

Sample answer and mark allocation		Notes	Margin	
5. (a) $F = q\,v\,B$ (½) **(1) Data** (½) $5\times10^{-11} = 3\cdot2\times10^{-19} \times v \times 6\cdot8$ ($v = 2\cdot3 \times 10^{7}$ m s^{-1})		**"SHOW" question** <u>Must</u> start with equation (1) data mark for charge of alpha particle. If q wrong, max (½) Deduct ½ if unit incorrect	2	10
(b) $v = \frac{E}{B}$ (½) $2\cdot3 \times 10^{7} = \frac{E}{6\cdot8}$ (½) $E = 1\cdot6 \times 10^{8}$ V m^{-1} (1) **Or** $E = \frac{F}{q}$ (½) $E = \frac{5\cdot0\times10^{-11}}{3\cdot2\times10^{-19}}$ (½) $E = 1\cdot6 \times 10^{8}$ N C^{-1} (1)		Must use v = 2.3 x 10^{7} or unrounded equivalent from part (a) Allow wrong value of q to be carried through from part (a) without penalty	2	

Sample answer and mark allocation		Notes	Margin
(c) $F = \frac{mv^2}{r}$ (½) **(½) data** $5{\cdot}0 \times 10^{-11} = \frac{6 \cdot 645 \times 10^{-27} \times \left(2 \cdot 3 \times 10^{7}\right)^2}{r}$ sub (½) r = 0·070 (m) (½) alpha particle hits at position *B*/0·14 m (1)		Can use $r = \frac{mv}{qB}$ or $d = \frac{2mv}{qB}$ Data (½) mark If answer is 0·070 (m) then lose (1) mark for not stating *B*	3
(d) Electron will be deflected in the opposite direction (½) Due to opposite charge (1) Radius of semicircle smaller (½) Due to (much) <u>smaller</u> mass (1) or greater $\frac{q}{m}$		Explanatory (1) mark only given if path statement (½) is awarded Decrease in q is less significant so no mark available for this change in q. If mention 'F is constant' then (0) for last mark	3

Sample answer and mark allocation	Notes	Margin	
6. (a) (i) 	(½) for origin (½) for shape (½) for all labels (t, I, A) (½) for 0·1 (A) If shape wrong: max of (½) for 0·1 (A) No need for unit on t axis	2	13
(ii) Max voltage is 3 V (1) **or** Back emf too small	Any implication of V not big enough. "voltage through" (0)	1	
(iii) Magnetic field <u>collapse/falls quickly</u> (1) Large (back) emf (110 V produced) (1)	Not large $\frac{dI}{dt}$ statement alone Independent marks	2	
(iv) $E = Pt$ (½) $= 1{\cdot}2 \times 10^{-3} \times 0{\cdot}25$ $= 3 \times 10^{-4}$ (J) (½) - - - - - - - - - - $E = \frac{1}{2} L I^2$ (½) $3 \times 10^{-4} = \frac{1}{2} \times L \times 0{\cdot}1^2$ (½) $L = 0{\cdot}060$ H (1)	Watch for $E = I\,t\,V$, $V = 110$ V gives $E = 2{\cdot}75$ J. WP -(0) gives L = 550 H (2 marks)	3	

Sample answer and mark allocation	Notes	Margin	
(b) (i) Voltmeter is to monitor (supply) voltage/ voltage across inductor remains <u>constant</u> (1)	Any statement regarding maintaining a constant V.	1	
(ii) Draw a graph of *I* against *1/f* or Check $I \times f$ remains constant for all values (1)	Graph of I v f (0 marks) Credit for implied variables.	1	
(iii) $I \times f$ = constant or $I \alpha 1/f$ (1)		1	
(c) LS1 will produce low frequency sounds (woofer) (1) **<u>or</u>** LS2 will produce high frequency sounds (tweeter) At high frequency capacitive reactance is low (½) At low frequency inductive reactance is low (½)	Only one statement required, but if both given and one wrong, max (0).	2	

Sample answer and mark allocation					Notes	Margin	
7.	(a)	(i)	$L = \frac{nh}{2\pi}$ $= \frac{1 \times 6 \cdot 63 \times 10^{-34}}{2\pi}$ $L = 1{\cdot}06 \times 10^{-34}$ kg m^2 s^{-1} or kg m^2 rad s^{-1} or J s	(½) (½) (1)	Alternative: $F = k\frac{Q_1 Q_2}{r^2} = \frac{mv^2}{r}$ to find v, then $L = mvr$	2	8
		(ii)	$mv = \frac{nh}{2\pi r}$ $mv = \frac{1 \times 6 \cdot 63 \times 10^{-34}}{5 \cdot 3 \times 10^{-11} \times 2\pi}$ $mv = 2{\cdot}0 \times 10^{-24}$ kg m s^{-1} **OR** $mv = \frac{L}{r}$ $mv = \frac{1 \cdot 06 \times 10^{-34}}{5 \cdot 3 \times 10^{-11}}$ $mv = 2{\cdot}0 \times 10^{-24}$ kg m s^{-1}	(½) (½) (1) (½) (½) (1)	**Care with penalising rounding through question** Accept $2 \cdot 1 \times 10^{-24}$	2	
		(iii)	$\lambda = \frac{h}{p}$ $= \frac{6 \cdot 63 \times 10^{-34}}{2 \cdot 0 \times 10^{-24}}$ $= 3{\cdot}3 \times 10^{-10}$ m	(½) (½) (1)	Accept $3 \cdot 2 \times 10^{-10}$	2	
	(b)	(i)	The electrons would (spiral) inwards towards the nucleus. **or** Orbit decays / decreases	(1)	Do not accept implying energy levels or jumps. Not "collapses".	1	
		(ii)	Quantum mechanics.	(1)	Not quantum physics.	1	

Sample answer and mark allocation		Notes	Margin	
8. (a) $B = \frac{\mu_0 I}{2\pi r}$	(½)			5
$1{\cdot}7 \times 10^{-7} = \frac{4\times\pi\times10^{-7}\times I}{2\times\pi\times0{\cdot}25}$	(½)	substitution (½) is for all values, no data value. Watch for acceptable cancellation of π before substitution.		
$I = 0{\cdot}21$ A	(1)	If left as μ_0, then cannot get subst. (½) if final answer incorrect.	2	
(b) One tesla is the magnetic induction of a magnetic field in which a conductor of length **<u>one metre</u>**, carrying a current of **<u>one ampere</u>** (perpendicular) to the field is acted on by a force of **<u>one newton</u>**. (Content statement 2.2.4)	(1)	Must be in words and numbers. Cannot use equation with only letters eg $B = F/Il$	1	
(c) $F = BIl$	(½)	$F=BIl\sin\theta$ not acceptable unless $\sin\theta = 1$		
$F/l = 1{\cdot}7 \times 10^{-7} \times 2$	(½)	If $I = 0{\cdot}21$ A used in first method, then WP max (½)		
$= 3{\cdot}4 \times 10^{-7}$ N (m^{-1})	(1)			
or				
$F/l = \frac{\mu_0 I_1 I_2}{2\pi r}$	(½)			
$= \frac{4\times\pi\times10^{-7}\times0{\cdot}21\times2}{2\times\pi\times0{\cdot}25}$	(½)			
$= 3{\cdot}4 \times 10^{-7}$ N (m^{-1})	(1)		2	

Sample answer and mark allocation	Notes	Margin	
9. (a) (i) Division of amplitude is when some of the light **<u>reflects</u>** from the top of the air wedge and some is **<u>transmitted/refracted</u>** into the air. **or** Some of the light is **<u>reflected</u>** from a surface of a new material/medium and some of the light is **<u>transmitted/refracted</u>** into the new material/medium. (1)	Question does not specify in relation to the air wedge.	1	12
(ii) $10\,\Delta x = 6{\cdot}0 \times 10^{-4}$ $\Delta x = 6{\cdot}0 \times 10^{-5}$ (m) (1) - - - - - - - - - - $\Delta x = \frac{\lambda l}{2d}$ (½) $6 \cdot 0 \times 10^{-5} = \frac{580 \times 10^{-9} \times 4 \cdot 0 \times 10^{-2}}{2 x d}$ (½) d = $1{\cdot}9 \times 10^{-4}$ m (1)	If $\Delta x = 6{\cdot}0 \times 10^{-4}$ used in equation, then max (2). Lose first mark If (10-1) fringes, d = 1.74 x 10^{-4} m (max 2)	3	
(iii) $\% \Delta (\Delta x) = \frac{0 \cdot 5 \times 100}{6 \cdot 0} = 8 \cdot 3$ (%) (½) $\% \Delta\ \lambda = \frac{10 \times 100}{580} = 1 \cdot 7$ (%) (½) $\% \Delta\ l = \frac{0 \cdot 1 \times 100}{4 \cdot 0} = 2 \cdot 5$ (%) (½) $\% \Delta\ d = 8{\cdot}3$ (%) (½)	No need to show combination or state that $\% \Delta (\Delta x)$ is more than 3 times any other % Δ. However, do not penalise if combined correctly, gives 8·9% If left as fractional uncertainty, deduct (½)	2	

Sample answer and mark allocation	Notes	Margin
(b) (i) Light is reflected from both surfaces of the soap film. (1) The two (reflected) waves meet out of phase (by π or $\lambda/2$). (1)	This could be shown by a diagram. **Second mark dependent on first mark being correct**. Any argument implying standing waves, (0) marks	2
(ii) *opd.* = $2 \times thickness \times n$ (½) = $2 \times 4{\cdot}00 \times 10^{-6} \times 1{\cdot}45$ (½) = $1{\cdot}16 \times 10^{-5}$ m (1)	$11 \cdot 6$ μm	2
(iii) The next point giving destructive interference must have:- an optical path difference of one λ more than that at *X*. (1) *New opd* = $1{\cdot}16 \times 10^{-5} + 580 \times 10^{-9}$ (½) = $1{\cdot}22 \times 10^{-5}$ m (½)	Evidence of adding one wavelength on to any figure is equivalent to first mark. $20\lambda \rightarrow 21\lambda$ $12 \cdot 2$ μm	2

Sample answer and mark allocation				Notes	Margin	
10.	(a)	A stationary wave is caused by **<u>interference</u>** effects	(½)	"Nodes/antinodes" or "superposition" imply interference. **Not** "combine".		7
		between the incident and **<u>reflected</u>** sound.	(½)	Not "bounce", "rebound" etc	1	
	(b)	The antinodes of the pattern are areas of **<u>maximum</u>** displacement/amplitude/disturbance	(½)	Diagram alone (0) marks		
		The nodes of the pattern are areas of **<u>minimum/zero</u>** displacement/amplitude/disturbance	(½)		1	
	(c)	The beads accumulate at the nodes - the vibrations at the antinodes pushes them to side.	(1) (1)	"Fresh start". No carry through of wrong definitions of nodes/antinodes.	2	
	(d)	$\lambda = 2 \times 85 \times 10^{-3}$	(½)			
		$= 170 \times 10^{-3}$ (m)	(½)			
		$v = f\lambda$	(½)			
		$= 1950 \times 170 \times 10^{-3}$	(½)			
		$v = 330 \text{ m s}^{-1}$	(1)	Accept 332 m s^{-1} 331 m s^{-1} rounding error. If $\lambda = 85 \times 10^{-3}$ m, max ½	3	

[END OF MARKING INSTRUCTIONS]