National
Qualifications
2017

2017 Physics

Advanced Higher

Finalised Marking Instructions

SQA ©

General marking principles for Advanced Higher Physics

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in the paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the detailed marking instructions for this assessment.

(b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.

(c) If a specific candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.

(d) There are no half marks awarded.

(e) Where a wrong answer to part of a question is carried forward and the wrong answer is then used correctly in the following part, the candidate should be given credit for the subsequent part or 'follow on'.

(f) Unless a numerical question specifically requires evidence of working to be shown, full marks should be awarded for a correct final answer (including units if required) on its own

(g) Credit should be given where a diagram or sketch conveys correctly the response required by the question. It will usually require clear and correct labels (or the use of standard symbols).

(h) Marks are provided for knowledge of relevant relationships alone, but when a candidate writes down several relationships and does not select the correct one to continue with, for example by substituting values, no mark can be awarded.

(i) Marks should be awarded for non-standard symbols where the symbols are defined and the relationship is correct, or where the substitution shows that the relationship used is correct. This must be clear and unambiguous.

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

(k) **Significant figures**
Data in question is given to 3 significant figures.
Correct final answer is 8·16 J
Final answer 8·2 J or 8·158 J or 8·1576 J – Award the final mark.
Final answer 8 J or 8·15761 J – Do not award the final mark
Candidates should not be credited for a final answer that includes:

- three or more figures too many
  or
- two or more figures too few, ie accept two more or one fewer

(l) The incorrect spelling of technical terms should usually be ignored and candidates should be awarded the relevant mark, provided that answers can be interpreted and understood without any doubt as to the meaning. Where there is ambiguity, the mark should not be awarded. Two specific examples of this would be when the candidate uses a term that might be interpreted as 'reflection', 'refraction' or 'diffraction' (eg 'defraction') or one that might be interpreted as either 'fission' or 'fusion' (eg 'fussion').

(m) Marks are awarded only for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **describe**, they must provide a statement or structure of characteristics and/or features;
- **determine** or **calculate**, they must determine a number from given facts, figures or information;
- **estimate**, they must determine an approximate value for something;
- **explain**, they must relate cause and effect and/or make relationships between things clear;
- **identify**, **name**, **give**, or **state**, they need only name or present in brief form;
- **justify**, they must give reasons to support their suggestions or conclusions, eg this might be by identifying an appropriate relationship and the effect of changing variables;
- **predict**, they must suggest what may happen based on available information;
- **show that**, they must use physics [and mathematics] to prove something eg a given value – *all steps, including the stated answer, must be shown*;
- **suggest**, they must apply their knowledge and understanding of physics to a new situation. A number of responses are acceptable: marks will be awarded for any suggestions that are supported by knowledge and understanding of physics;
- **use your knowledge of physics or aspect of physics to comment on**, they must apply their skills, knowledge and understanding to respond appropriately to the problem/situation presented (for example by making a statement of principle(s) involved and/or a relationship or equation, and applying these to respond to the problem/situation). They will be rewarded for the breadth and/or depth of their conceptual understanding.

(n) Marking in calculations

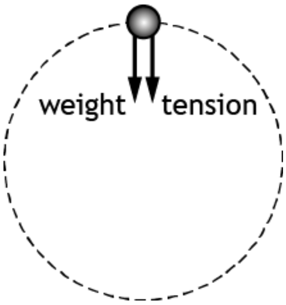
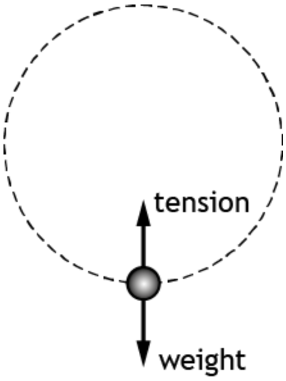
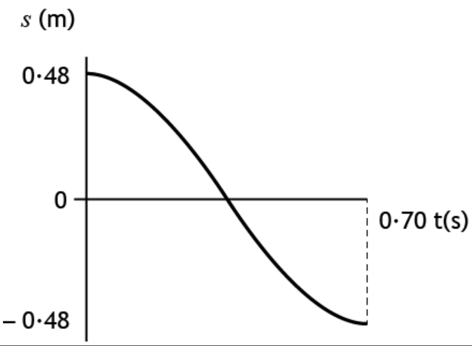
Question:

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. (3 marks)

Candidate answer	**Mark + Comment**
1. $V = IR$	1 mark: formula
$7{\cdot}5 = 1{\cdot}5R$	1 mark: substitution
$R = 5{\cdot}0\ \Omega$	1 mark: correct answer
2. $5{\cdot}0\ \Omega$	3 marks: correct answer
3. $5{\cdot}0$	2 marks: unit missing
4. $4{\cdot}0\ \Omega$	0 marks: no evidence, wrong answer
5. $\_\_\ \Omega$	0 marks: no working or final answer
6. $R = \frac{V}{I} = \frac{7{\cdot}5}{1{\cdot}5} = 4{\cdot}0\ \Omega$	2 marks: arithmetic error
7. $R = \frac{V}{I} = 4{\cdot}0\ \Omega$	1 mark: formula only
8. $R = \frac{V}{I} = \_\_\ \Omega$	1 mark: formula only
9. $R = \frac{V}{I} = \frac{7{\cdot}5}{1{\cdot}5} = \_\_\ \Omega$	2 marks: formula & subs, no final answer
10. $R = \frac{V}{I} = \frac{7{\cdot}5}{1{\cdot}5} = 4{\cdot}0$	2 marks: formula & subs, wrong answer
11. $R = \frac{V}{I} = \frac{1{\cdot}5}{7{\cdot}5} = 5{\cdot}0\ \Omega$	1 mark: formula but wrong substitution
12. $R = \frac{V}{I} = \frac{75}{1{\cdot}5} = 5{\cdot}0\ \Omega$	1 mark: formula but wrong substitution
13. $R = \frac{I}{V} = \frac{7{\cdot}5}{1{\cdot}5} = 5{\cdot}0\ \Omega$	0 marks: wrong formula
14. $V=IR$	2 marks: formula & subs, arithmetic error
$7{\cdot}5 = 1{\cdot}5 \times R$	
$R = 0{\cdot}2\ \Omega$	
15. $V=IR$	
$R = \frac{I}{V} = \frac{1{\cdot}5}{7{\cdot}5} = 0{\cdot}2\ \Omega$	1 mark: formula correct but wrong rearrangement of symbols

Detailed Marking Instructions for each question

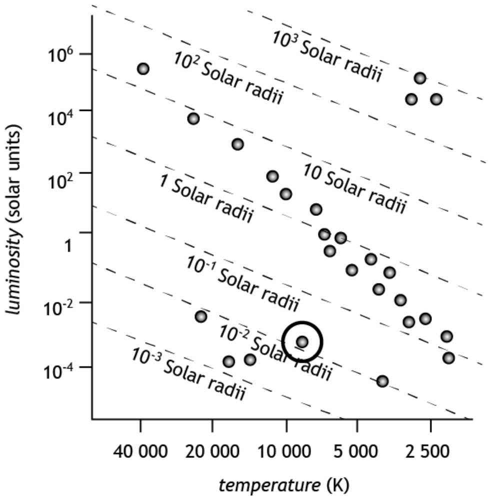
Question			Answer	Max mark	Additional guidance
1.	(a)		$v = 0{\cdot}4t^2 + 2t$ $v = (0{\cdot}4 \times 3{\cdot}10^2) + (2 \times 3{\cdot}10)$ 1 $v = 10{\cdot}0\ \text{m s}^{-1}$ 1 Accept: 10, 10·04, 10·044	**2**	
	(b)		$s = \int (0{\cdot}4t^2 + 2t).dt$ $s = \frac{0{\cdot}4}{3}t^3 + t^2 (+c\ )$ 1 $s = 0$ when $t = 0,\ c = 0$ $s = \frac{0{\cdot}4}{3} \times (3{\cdot}10)^3\ + 3{\cdot}10^2$ 1 $s = 13{\cdot}6\ \text{m}$ 1 Accept: 14, 13·58, 13·582	**3**	Solution with limits also acceptable. $s = \int_0^{3.10} (0{\cdot}4t^2 + 2\,\text{t}).dt$ $s = \left[\frac{0{\cdot}4 \times t^3}{3} + t^2\right]_{(0)}^{(3.10)}$ 1 $s = \left(\frac{0{\cdot}4 \times 3{\cdot}10^3}{3} + 3{\cdot}10^2\right) - 0$ 1 $s = 13{\cdot}6\ \text{m}$ 1

Question			Answer	Max mark	Additional guidance
2.	(a)	(i)		**1**	If centripetal force is included and in the downward direction – ignore If centripetal force is included and in any other direction – award 0 marks Any mention of centrifugal force - award 0 marks.
		(ii)		**1**	If centripetal force is included and in the upward direction – ignore. If centripetal force is included and in any other direction – award 0 marks Any mention of centrifugal force - award 0 marks.
		(iii) (A)	$T + (0{\cdot}35 \times 9{\cdot}8) = 4{\cdot}0$ 1 $T = 0{\cdot}57$ N 1 Accept: 0·6, 0·570, 0·5700	**2**	
		(B)	$T = 7{\cdot}4$ N 1 Accept: 7, 7·43, 7·430	**1**	
	(b)		the tension reduces (to zero) 1 weight is greater than the central force that would be required for circular motion. 1	**2**	Independent marks.
	(c)		Shape 1 0·48 and -0·48 for amplitude 1 0·7(0) time for half cycle 1 	**3**	Marks independent.

Question			Answer	Max mark	Additional guidance
3.	(a)		$I = \frac{1}{2}mr^2$ 1 $I = \frac{1}{2} \times 0\cdot40 \times \left(290 \times 10^{-3}\right)^2$ 1 $I = 0\cdot017\ \text{kg}\,\text{m}^2$ 1 Accept: 0·02, 0·0168, 0·01682	3	
	(b)	(i)	$T = Fr$ 1 $T = 8\cdot0 \times 7\cdot5 \times 10^{-3}$ 1 $T = 0\cdot060\ \text{N}\,\text{m}$ 1 Accept: 0·06, 0·0600, 0·06000	3	
		(ii)	$T = I\alpha$ 1 $0\cdot060 = 0\cdot017 \times \alpha$ 1 $\alpha = 3\cdot5\ \text{rad}\,\text{s}^{-2}$ 1 Accept: 4, 3·53, 3·529	3	Or consistent with (a) and (b)(i)
		(iii)	$\theta = \frac{s}{r}$ 1 $\theta = \frac{0\cdot25}{7\cdot5 \times 10^{-3}}$ 1 $\omega^2 = \omega_0{}^2 + 2\alpha\theta$ 1 $\omega^2 = 0^2 + 2 \times 3\cdot5 \times \frac{0\cdot25}{7\cdot5 \times 10^{-3}}$ 1 $\omega = 15\,\text{rad}\,\text{s}^{-1}$ 1 Accept: 20, 15·3, 15·28	5	Or consistent with (a), (b)(i) and (b)(ii) $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ and $\alpha = \frac{\omega - \omega_0}{t}$ 1
	(c)		$I_{cube} = mr^2$ 1 $I_{cube} = 25 \times 10^{-3} \times (220 \times 10^{-3})^2$ 1 $I_1\omega_1 = (I_1 + I_{cube})\omega_2$ 1 $0\cdot017 \times 12 = (0\cdot017 +$ $(25 \times 10^{-3} \times (220 \times 10^{-3})^2))\omega_2$ 1 $\omega_2 = 11\,\text{rad}\,\text{s}^{-1}$ 1 Accept: 10, 11·2, 11·20	5	Or consistent with (a)

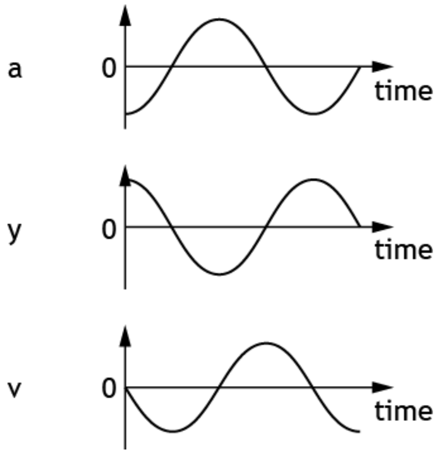
Question			Answer	Max mark	Additional guidance
4.	(a)	(i)	$F = \frac{mv^2}{r}$ 1 $24 \cdot 1 = \frac{1240 \times v^2}{(263 \times 10^3 + 680 \times 10^3)}$ 1 $v = 135\,\text{m s}^{-1}$	2	SHOW question $\frac{mv^2}{r} = \frac{GMm}{r^2}$ 1 $v = \sqrt{\frac{GM}{r}}$ $v = \sqrt{\frac{6 \cdot 67 \times 10^{-11} \times 2 \cdot 59 \times 10^{20}}{(263 + 680) \times 10^3}}$ 1 $v = 135\ \text{m s}^{-1}$ If final answer not shown a maximum of 1 mark can be awarded.
		(ii)	$v_c = \frac{2\pi r}{T}$ 1 $135 = \frac{2\pi(263 \times 10^3 + 680 \times 10^3)}{T}$ 1 $T = 4 \cdot 39 \times 10^4\,\text{s}$ 1 Accept: 4·4, 4·389, 4·3889	3	
	(b)	(i)	The work done in moving unit mass from infinity (to that point). 1	1	
		(ii)	$V_{low} - V_{high} = -3 \cdot 22 \times 10^4 - \left(-1 \cdot 29 \times 10^4\right)$ 1 $V_{low} - V_{high} = -1 \cdot 93 \times 10^4$ $(\Delta)E = (\Delta)Vm$ 1 $(\Delta)E = -1 \cdot 93 \times 10^4 \times 1240$ 1 $(\Delta)E = -2 \cdot 39 \times 10^7\,\text{J}$ 1 Accept: 2·4, 2·393, 2·3932	4	Can also be done by calculating potential energy in each orbit and subtracting. 1 for relationship 1 for all substitutions 1 for subtraction 1 for final answer including unit

Question			Answer	Max mark	Additional guidance
5.			Demonstrates no understanding 0 marks Demonstrates limited understanding 1 marks Demonstrates reasonable understanding 2 marks Demonstrates good understanding 3 marks This is an open-ended question. **1 mark:** The student has demonstrated a limited understanding of the physics involved. The student has made some statement(s) which is/are relevant to the situation, showing that at least a little of the physics within the problem is understood. **2 marks**: The student has demonstrated a reasonable understanding of the physics involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **3 marks:** The maximum available mark would be awarded to a student who has demonstrated a good understanding of the physics involved. The student shows a good comprehension of the physics of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an “excellent” answer or a “complete” one.	**3**	Open-ended question: a variety of physics arguments can be used to answer this question. Marks are awarded on the basis of whether the answer overall demonstrates “no”, “limited”, “reasonable” or “good” understanding.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Max mark</th><th>Additional guidance</th></tr>
<tr><td>6.</td><td>(a)</td><td></td><td>(electron) neutrino (1) and positron (1)</td><td>2</td><td>e^+ and ν acceptable</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Correctly marked 1
</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>(White) Dwarf 1</td><td>1</td><td>Or consistent with (b)(i)</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>$L = 4\cdot9\times10^{-4}\times3\cdot9\times10^{26}$ 1
$b=\frac{L}{4\pi r^2}$ 1
$1\cdot3\times10^{-12}=\frac{4\cdot9\times10^{-4}\times3\cdot9\times10^{26}}{4\pi r^2}$ 1
$r=1\cdot1\times10^{17}$ m 1
Accept: 1, 1·08, 1·082</td><td>4</td><td></td></tr>
<tr><td></td><td>(c)</td><td></td><td>$\frac{L}{L_0}=1\cdot5\left(\frac{M}{M_0}\right)^{3\cdot5}$
$\frac{L}{L_0}=1\cdot5\left(\frac{10\cdot3}{1}\right)^{3\cdot5}$ 1
$L=5260(L_0)$ 1
Accept: 5300, 5260·4</td><td>2</td><td></td></tr>
</table>

Question			Answer	Max mark	Additional guidance
7.	(a)		Atoms in the Nd:YAG have a shorter lifetime (in the excited state) OR Atoms in the Ar have a longer lifetime (in the excited state) 1 $\Delta f \propto \Delta E$ and $\Delta t \propto \frac{1}{\Delta E}$ or $\Delta t \propto \frac{1}{\Delta f}$ 1	**2**	
	(b)	(i)	$\Delta E \Delta t \geq \frac{h}{4\pi}$ 1 $\Delta E_{(min)} \times 5 \cdot 0 \times 10^{-6} = \frac{6 \cdot 63 \times 10^{-34}}{4\pi}$ 1 $\Delta E_{(min)} = 1 \cdot 1 \times 10^{-29}$ J 1 Accept: 1, 1·06, 1·055	**3**	
		(ii)	$(\Delta)E = h(\Delta)f$ 1 $1 \cdot 1 \times 10^{-29} = 6 \cdot 63 \times 10^{-34} \times (\Delta)f$ 1 $(\Delta)f = 1 \cdot 7 \times 10^{4}$ Hz 1 Accept: 2, 1·66, 1·659	**3**	Or consistent with (b)(i)

Question			Answer	Max mark	Additional guidance
8.	(a)		At t=0 $\sin\omega t = 0$, which would mean that y=0. This is not the case in the example here, where y=A at t=0 1	**1**	Accept assumptions that no energy is lost
	(b)	(i)	$(F =)(-)m\omega^2 y = (-)ky$ 1 $\omega^2 = \frac{ky}{my}$ $\omega = \sqrt{\frac{k}{m}}$ $\omega = 2\pi f$ 1 $2\pi f = \sqrt{\frac{k}{m}}$ $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$	**2**	
		(ii)	$f = \frac{1}{T} = \left(\frac{1}{0 \cdot 80}\right)$ 1 $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ $\frac{1}{0 \cdot 80} = \frac{1}{2\pi}\sqrt{\frac{k}{0 \cdot 50}}$ 1 $k = 31 \text{ N m}^{-1}$ 1 Accept: 30, 30·8, 30·84	**3**	
		(iii)	$T = \frac{0 \cdot 80}{\sqrt{2}}$ 1 $T = 0 \cdot 57 \text{ s}$ 1 Accept: 0·6, 0·566, 0·5657	**2**	$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ and $T=\frac{1}{f}$ $T = 2 \times \pi\sqrt{\frac{0 \cdot 50}{2 \times 31}}$ 1 $T = 0 \cdot 56 \text{ s}$ 1 Accept: 0·6, 0·564, 0·5642 Or consistent with (b)(ii)

Question			Answer	Max mark	Additional guidance
	(c)			**2**	(2) marks all three correct (1) mark for two correct

Question			Answer	Max mark	Additional guidance
9	(a)	(i)	$(\omega = 2\pi f)$ $922 = 2\pi f$ 1 $f = 147$ Hz	1	
		(ii)	$4\cdot50 = \left(\frac{2\pi}{\lambda}\right)$ 1 $v = f\lambda$ 1 $v = 147 \times \left(\frac{2\pi}{4\cdot50}\right)$ 1 $v = 205$ m s^{-1} 1 Accept:210, 205·3, 205·25	4	
		(iii)	$E = kA^2$ 1 $\frac{E}{(9\cdot50\times10^{-4})^2} = \frac{E}{8\times A^2}$ 1 $A = 3\cdot36\times10^{-4}$ m 1 Accept: 3·4, 3·359, 3·3588	3	$\frac{E_1}{A_1^2} = \frac{E_2}{A_2^2}$ acceptable
	(b)		$\mu = \frac{9\cdot0\times10^{-3}}{0\cdot69}$ 1 $v = \sqrt{\frac{T}{\mu}}$ $203 = \sqrt{\frac{T}{\left(\frac{9\cdot0\times10^{-3}}{0\cdot69}\right)}}$ 1 $T = 540$ N 1 Accept: 500, 538, 537·5	3	
	(c)	(i)	Waves <u>reflected</u> from each end <u>interfere</u> (to create maxima and minima). 1	1	
		(ii)	$f_3 = (3\times270 =)810$ Hz 1	1	

Question			Answer	Max mark	Additional guidance
10.	(a)		Pattern produced by interference. 1 Slits horizontal and vertical or at right angles 1	**2**	
	(b)		The spots are closer together. 1 The green light has a shorter wavelength and since $d\sin\theta = m\lambda$, d is fixed, $(\sin)\theta$ is smaller. 1	**2**	An argument quoting Young's slits is also acceptable. $\Delta x = \frac{\lambda D}{d}$ λ is less, D and d are fixed, so Δx is less

Question			Answer	Max mark	Additional guidance
	(c)	(i)	$\Delta x = \frac{\lambda D}{d}$ 1 $13 \cdot 0 \times 10^{-3} = \frac{\lambda \times 8 \cdot 11}{0 \cdot 41 \times 10^{-3}}$ 1 $\lambda = 6 \cdot 6 \times 10^{-7}$ m 1 Accept: 7, 6·57, 6·572	**3**	
		(ii)	% Uncertainty in fringe separation $= \left(\frac{0 \cdot 5}{13 \cdot 0}\right) \times 100$ 1 $= 3 \cdot 85\%$ % Uncertainty in slit separation $= \left(\frac{0 \cdot 01}{0 \cdot 41}\right) \times 100$ 1 $= 2 \cdot 44\%$ % Uncertainty in slit-screen separation $= \left(\frac{0 \cdot 01}{8 \cdot 11}\right) \times 100$ 1 $= 0 \cdot 123\%$ (can be ignored) % uncertainty in wavelength $= \sqrt{\left(\frac{0 \cdot 5}{13 \cdot 0}\right)^2 + \left(\frac{0 \cdot 01}{0 \cdot 41}\right)^2} \times 100\%$ 1 $= 4 \cdot 56\%$ $\Delta \lambda = \frac{4 \cdot 56}{100} \times 6 \cdot 6 \times 10^{-7}$ $\Delta \lambda = 0 \cdot 3 \times 10^{-7}$ m 1	**5**	
		(iii)	Increasing the slit-screen distance spreads out the fringes, <u>reducing the</u> (percentage) <u>uncertainty in the fringe separation</u> (which is the dominant uncertainty). 1	**1**	

Question			Answer	Max mark	Additional guidance
11	(a)		Force acting per unit positive charge (in an electric field)	**1**	
	(b)	(i)	$E=\frac{Q}{4\pi\varepsilon_0 r^2}$ 1 $E=\frac{4\cdot0\times10^{-9}}{4\pi\times8\cdot85\times10^{-12}\times0\cdot12^2}$ 1 $E_{total}=\sqrt{2\times\left[\frac{4\cdot0\times10^{-9}}{4\pi\times8\cdot85\times10^{-12}\times0\cdot12^2}\right]^2}$ 1 $E_{total}=3\cdot5\times10^3\ \text{N C}^{-1}$	**3**	If value for ε_0 not substituted, max 1 mark. third line can be done by trigonometry rather than Pythagoras. $E_{total}=2\times\left[\frac{4\cdot0\times10^{-9}}{4\pi\times8\cdot85\times10^{-12}\times0\cdot12^2}\right]\times\sin45$ 1 If the final line is not shown then maximum 2 marks can be awarded.
		(ii)	$F=QE$ 1 $F=1\cdot9\times10^{-9}\times3\cdot5\times10^3$ 1 $F=6\cdot7\times10^{-6}\ \text{N}$ 1 Accept: 7, 6·65, 6·650	**3**	$F_1=\frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$ and $F=\sqrt{F_1^2+F_2^2}$ 1 $F=\sqrt{2\times\left(\frac{4\times10^{-9}\times1\cdot9\times10^{-9}}{4\pi\times8\cdot85\times10^{-12}\times0\cdot12^2}\right)^2}$ 1 $F=6\cdot7\times10^{-6}N$ 1 Accept: 7, 6·71, 6·711 Accept: 6·718 for 9×10^9
		(iii)	Towards top of page	**1**	
		(iv)	$r=\sqrt{(0\cdot12^2+0\cdot12^2)}$ 1 $F=\frac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$ 1 $6\cdot7\times10^{-6}=\frac{1\cdot9\times10^{-9}\times Q_2}{4\pi\times8\cdot85\times10^{-12}\times\sqrt{(0\cdot12^2+0\cdot12^2)}^2}$ 1 $Q_2=1\cdot1\times10^{-8}\text{C}$ 1 Accept: 1, 1·13, 1·129	**4**	Or consistent with (b)(ii).

Question			Answer	Max mark	Additional guidance
12	(a)		Towards the top of the page.	**1**	
	(b)		$F = qvB$ 1 $4\cdot00 \times 10^{-15} = 1\cdot60 \times 10^{-19} \times v \times 115 \times 10^{-3}$ 1 $v = 2\cdot17 \times 10^{5}$ m s^{-1} 1 Accept: 2·2, 2·174, 2·1739	**3**	Starting with $v = \frac{E}{B}$ and $E = \frac{F}{Q}$ is acceptable
	(c)		(Since $F = Bqv$) At lower speeds the magnetic force is reduced. 1 Therefore unbalanced force (or acceleration) down Or The magnetic force is less than the electric force 1	**2**	Second mark dependant on the first.
	(d)		(All undeflected ions travel at) $2\cdot17 \times 10^{5}$ m s^{-1} 1 relative size of forces is independent of mass and of charge. 1	**2**	Or consistent with (b) Must justify $v = \frac{E}{B}$ as E & B remain constant v must also remain constant.

Question			Answer	Max mark	Additional guidance
13.	(a)		$t = RC$ 1 $t = 1 \cdot 0 \times 10^3 \times 1 \cdot 0$ 1 $t = 1 \cdot 0 \times 10^3 \text{s}$	**2**	
	(b)	(i)	circuit diagram showing (12V) d.c. supply, resistor and capacitor all in series. Values not required. Voltmeter or CRO connected across the capacitor.	**1**	
		(ii) (A)	(After 1 time constant or 1000 s) V= 7·6 (V) 1 $\frac{V_c}{V_s} = \frac{7 \cdot 6}{12}$ 1 $\frac{V_c}{V_s} = 63\%$	**2**	
		(ii) (B)	4·5 – 5	**1**	

Question			Answer	Max mark	Additional guidance
	(c)		Demonstrates no understanding 0 marks Demonstrates limited understanding 1 marks Demonstrates reasonable understanding 2 marks Demonstrates good understanding 3 marks This is an open-ended question. **1 mark:** The student has demonstrated a limited understanding of the physics involved. The student has made some statement(s) which is/are relevant to the situation, showing that at least a little of the physics within the problem is understood. **2 marks**: The student has demonstrated a reasonable understanding of the physics involved. The student makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **3 marks:** The maximum available mark would be awarded to a student who has demonstrated a good understanding of the physics involved. The student shows a good comprehension of the physics of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an "excellent" answer or a "complete" one.	**3**	Open-ended question: a variety of physics arguments can be used to answer this question. Marks are awarded on the basis of whether the answer overall demonstrates "no", "limited", "reasonable" or "good" understanding.

Question			Answer	Max Mark	Additional Guidance
14.	(a)	(i)	Capacitor has low reactance/impedance for high frequencies (therefore more current (and power) will be delivered to the tweeter at high frequencies). 1	**1**	
		(ii)	Inductor has low reactance/impedance for low frequencies (therefore more current (and power) will be delivered to the woofer at low frequencies). 1	**1**	
	(b)		$X_L = 2\pi fL$ 1 $8\cdot0 = 2\times\pi\times3\cdot0\times10^3\times L$ 1 $L = 4\cdot2\times10^{-4}$ H 1 Accept: 4, 4·24, 4·244	**3**	
	(c)	(i)	$\frac{dI}{dt} = 20\cdot0$ 1 $E = -L\frac{dI}{dt}$ 1 $-9\cdot0 = -L\times20\cdot0$ 1 $L = 0\cdot45$ H 1 Accept: 0·5, 0·450, 0·4500	**4**	
		(ii)	large (back) EMF.	**1**	(explanation of rapidly collapsing magnetic field) inducing high voltage Explanation in terms of energy released from inductor is acceptable.

[END OF MARKING INSTRUCTIONS]