OXFORD AQA
INTERNATIONAL QUALIFICATIONS

INTERNATIONAL A-LEVEL
PHYSICS
PH03

Unit 3 Fields and their consequences

Mark scheme

June 2026

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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question	Answers	Additional comments/Guidelines	Mark	AO
01.1	Any **one** from: ✓ • use **long** tongs to handle source • keep at least a metre away from source • **store** source in lead box **OR** keep source in lead box **when not in use** • limit exposure time	Allow description for 'tongs' and misspelling of 'tongs' Distance suggestion needs to be quantified – do not allow 'keep a safe distance' without quantification Do not allow any reference to clothing including gloves and goggles Condone 'do not point source towards people'	1	AO4

Question	Answers	Additional comments/Guidelines	Mark	AO
01.2	The proportion of (radioactive) nuclei that decay per unit time **OR** the probability of a (particular) nucleus decaying per unit time ✓	Condone per second for per unit time (also condone other per time units, eg 'per minute', 'per hour', etc) Allow ratio of activity to number of (unstable) nuclei Do not allow atom or particle for nucleus Allow answer in terms of the symbol equation $A = (-)\,\lambda N$ if symbols are defined	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
01.3	Makes one half-life determination correctly from graph ✓ Makes at least two determinations correctly from graph and averages ✓ Use of $T_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$ ✓ Answer to at least 2sf and in the range 9.6×10^{-3} to 1.1×10^{-2} (s^{-1}) ✓	Expected half-life = 1.15 minutes Allow direct read-off for 2 half-lives and then divided by 2 for mp1 and mp2 **Alternative method A for mp1, mp2 and mp3** Determination of time constant from graph eg $880e^{-1} = 324$ at 1.65 mins ✓ Two determinations of time constant and average ✓ Allow direct read off for two time constants and then divided by 2 for mp1 and mp2 Use of $\lambda = \frac{1}{\text{time constant}}$ ✓ **Alternative method B for mp1, mp2 and mp3** Use of $A = A_o e^{-\lambda t}$ to find λ ✓ Values of A and A_0 correctly read from graph ✓ Repeated with another pair of values of A and A_0 correctly read from graph and λ averaged **OR** uses $t \geq 2.2$ minutes ✓	4	1 × AO1 1 × AO2 2 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
01.4	Use of $N = N_0 e^{-\lambda t}$ **OR** recognition that $N = 1.0 \times 10^6$ ✓ 2800 (s) ✓	$t = \frac{\ln\left(\frac{N}{N_0}\right)}{-\lambda} = \frac{\ln\left(\frac{1.0 \times 10^6}{5.0 \times 10^6}\right)}{-5.7 \times 10^{-4}} = 2824 \text{ s}$ Allow use of $N = 4.0 \times 10^6$ leading to 391 s to at least 2 sf for mp1 only	2	1 × AO1 1 × AO2

Total			8

Question	Answers	Additional comments/Guidelines	Mark	AO
02.1	An arrow starting at the ball and drawn horizontally towards the centre of the circle labelled **F** ✓	Do not allow if there is a gap between arrow and ball Line must be straight	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
02.2	Idea that there must be some vertical component from the tension to support the weight of the ball ✓		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
02.3	Any **two** from: ✓✓ • $T_y = T\sin\theta$ **OR** $T_x = T\cos\theta$ • $T_y = mg$ • use of $F = m\omega^2 r$ **OR** use of $F = \frac{mv^2}{r}$ for their F and their v 1.3 (m) ✓	$\tan\theta = \frac{mg}{\text{centripetal force}}$ **OR** $r = \frac{g}{\omega^2\tan\theta}$ **OR** $r = \frac{g\cos\theta}{\omega^2\sin\theta}$ gains mp1 and mp2 Do not accept use of ω for v in third bullet $r = \frac{9.81}{4.5^2\times tan20} = 1.33$ m	3	1 × AO1 2 × AO2

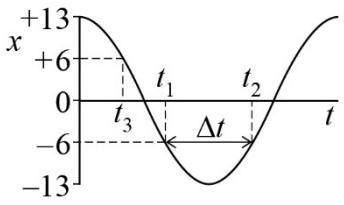
Question	Answers	Additional comments/Guidelines	Mark	AO
02.4	Idea that vertical component equals weight **OR** idea that vertical component needs to be the same as it was ✓ The angle of the string decreases ✓ Radius has increased **OR** horizontal component of tension has increased ✓ Linear speed increases **AND** reference to $\frac{mv^2}{r}$ ✓	**Allow algebraic arguments for mp1 and mp3** Allow centripetal force has increased for mp3 Allow reference to equivalent centripetal equations using v such as $v^2 = \frac{rg}{tan\theta}$	4	3 × AO2 1 × AO3

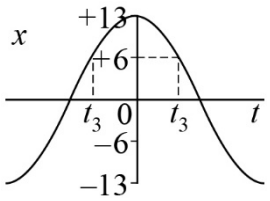
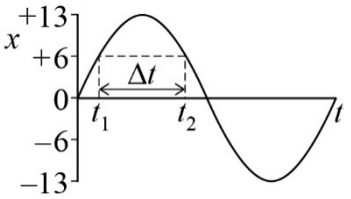
Total			**9**	

Question	Answers	Additional comments/Guidelines	Mark	AO
03.1	Use of $v = \omega\sqrt{A^2 - x^2}$ ✓ $v = 0.25$ (m s^{-1}) ✓	Condone power of ten errors in A and x $v = 22 \times \sqrt{(13 \times 10^{-3})^2 - (6 \times 10^{-3})^2} = 0.254$	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
03.2	Use of $a = \omega^2 x$ **OR** use of $F = m \times$ their a ✓ 8.1×10^{-4} (N) ✓	**Do not allow use of centripetal force equation eg $F = m\omega^2 r$ for mp1 and mp2** Ignore negative sign for acceleration or force $a = (22)^2 \times 6 \times 10^{-3} = 2.904$ $F = 2.8 \times 10^{-4} \times 2.9 = 8.13 \times 10^{-4}$ N	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
03.3	The force will be upwards **AND** idea that it will be in the opposite direction to the direction of the displacement (from the equilibrium position) ✓	Allow 'towards equilibrium position' along with an explanation that force is towards the equilibrium position in SHM Allow explanation in terms of acceleration in place of force. eg "acceleration is in opposite direction to displacement" Allow the speed is decreasing so the force must be upwards	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
03.4	Use of $x = A\cos\omega t$ ✓ $\frac{2\pi}{\omega}$ **OR** $\frac{\pi}{\omega}$ seen **OR** doubles the time from solving $x = A\cos\omega t$ ✓ 0.099 (s) ✓	Allow use of $x = A\sin\omega t$ $T = \frac{2\pi}{\omega} = \frac{2\pi}{22} = 0.2856$ s mp2 can be given if candidate correctly calculates $\frac{T}{2}$ or $\frac{T}{4}$ or if correct algebra linking ω and T is seen within working Examples of calculation from cosine: $x = A\cos\omega t$ **a)** $-6 = 13\cos 22t_1$ $\quad t_1 = 0.0932$ $t_1 - \frac{1}{4}T = 0.0218$ $t_2 = \frac{3}{4}T - 0.0218 = 0.1924$ $\Delta t = 0.1924 - 0.0932 = 0.099$ s  	3	1 × AO1 1 × AO2 1 × AO3

03.4 (cont)		**b)** $6 = 13 \cos 22t_3$ $\quad t_3 = 0.0496$ $\Delta t = 2 \times 0.0496 = 0.099$ s  Example of calculation from sine: $x = A \sin \omega t$ **c)** $6 = 13 \sin 22t_1$ $t_1 = 0.0218$ $t_2 = \frac{1}{2}T - 0.0218 = 0.121$ $\Delta t = 0.121 - 0.0218 = 0.099$ s  		

Question	Answers	Additional comments/Guidelines	Mark	AO
03.5	Idea that to be SHM the size of the force must be proportional to the displacement (from the central position) ✓ Explanation as to whether the cloth affects the force being proportional to displacement with a consistent conclusion as to whether that stops the motion being SHM, or it can still be considered to be SHM ✓	Allow explanation in terms of acceleration in place of force for mp1 Examples of creditable points for mp2: • the cloth will give a resistance to the needle (which is an additional force against the motion at that point), so it will not be SHM • the force from the cloth will be negligible and can be ignored so it will still be SHM • the motion will be driven and will continue to be SHM despite the resistance of the cloth.	2	1 × AO1 1 × AO2

Total			**10**

Question	Answers	Additional comments/Guidelines	Mark	AO
04.1	Equating $\frac{mv^2}{r}$ **OR** mw^2r with $\frac{GMm}{r^2}$ ✓ Use of $E_k = \frac{1}{2}mv^2$ ✓ 1600 (kg) ✓	$E_k = \frac{GMm}{2r}$ is awarded mp1 and mp2 $v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{6.67 \times 10^{-11} \times 1.9 \times 10^{27}}{4.5 \times 10^{8}}}$ $v = 1.68 \times 10^4$ m s^{-1} $m = \frac{E_k}{\frac{1}{2}v^2} = \frac{2.2 \times 10^{11}}{\frac{1}{2} \times (1.68 \times 10^4)^2} = 1562$ kg	3	1 × AO1 2 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
04.2	Use of $V = (-)\frac{GM}{r}$ with $\Delta W = m\Delta V$ **OR** $E_p = (-)\frac{GMm}{r}$ ✓ Calculates difference between their GPEs or use of $\Delta E_p = GMm\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ ✓ $(-)5.6 \times 10^{10}$ (J) ✓ Negative sign for answer ✓	Allow $E_p = (-)2E_k$ for mp1 Allow ecf from Question **04.1** and use of 2000 kg **Condone lack of minus sign for mp1 and mp2**	4	1 × AO1 3 × AO2

m	$\lvert GPE_{before}\rvert$	$\lvert GPE_{after}\rvert$	$\lvert \Delta GPE\rvert$
1562	4.399×10^{11}	4.949×10^{11}	5.50×10^{10}
1600	4.506×10^{11}	5.069×10^{11}	5.63×10^{10}
2000	5.632×10^{11}	6.337×10^{11}	7.04×10^{10} or 7.05×10^{10}
2Ek and 1562	4.4×10^{11}	4.949×10^{11}	5.49×10^{10}
2Ek and 1600	4.4×10^{11}	5.069×10^{11}	6.69×10^{10}
2Ek and 2000	4.4×10^{11}	6.337×10^{11}	19.4×10^{10}

Question	Answers	Additional comments/Guidelines	Mark	AO
04.3	The kinetic energy increases ✓ The total energy decreases as satellite loses more E_p than it gains E_k ✓	Allow algebraic arguments for mp1 and mp2 **Alternative for 2 marks by referring to total energy equation:** $TE = -\frac{GMm}{2r}$ ✓ As r decreases the total energy decreases (or becomes more negative) ✓	2	AO2

Total			**9**

Question	Answers	Additional comments/Guidelines	Mark	AO
05.1	Use of $E = \frac{Q}{4\pi\varepsilon_0 r^2}$ ✓ 5.0×10^5 (C) ✓	Condone the use of $\frac{kQ}{r^2}$ for mp1 but only if the value used for k rounds to 9×10^9 $Q = 110 \times 4\pi \times 8.85 \times 10^{-12} \times (6.37 \times 10^6)^2$ $= 4.96 \times 10^5$ C	2	1 × AO1 1 × AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.2	Idea that the distances moved, **relative to the distance from the centre of the Earth**, are negligible / much smaller ✓		1	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
05.3	Idea that the charge is negative because the electric field line is downwards and this is the force on a positive charge ✓	Allow answer that indicates that the force is in an opposite direction to the electric field lines Allow answer that says the Earth has negative charge and so the charge has to be negative to be repelled upwards by it	1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
05.4	Any **two** from: ✓✓ • use of $E = \frac{F}{Q}$ or 2.7×10^{-5} (N) seen **OR** use of $W = mg$ or 1.47×10^{-5} (N) seen • resultant force = $F - W$ or 1.28×10^{-5} (N) seen • use of $a = \frac{F}{m}$ 8.5 (m s^{-2}) ✓	No POT penalties for mp1 and mp2 $F = 110 \times 2.5 \times 10^{-7} = 2.75 \times 10^{-5}$ N $W = 1.5 \times 10^{-6} \times 9.81 = 1.4715 \times 10^{-5}$ N (if $g = 9.8$ then $W = 1.47 \times 10^{-5}$ N) $a = \frac{EQ-mg}{m} - g$ or $a = \frac{EQ}{m} - g$ scores mp1 and mp2 Third bullet point can be scored for resultant force or the force without the weight taken off, but not if the weight is used in the place of the force by itself $a = \frac{EQ-mg}{m} = \frac{2.75 \times 10^{-5} - 1.4715 \times 10^{-5}}{1.5 \times 10^{-6}}$ $= 8.523$ m s^{-2} (if $g = 9.8$ then a= 8.533 ms^{-2})	3	2 × AO2 1 × AO3

Total			7

Question	Answers	Additional comments/Guidelines	Mark	AO
06.1	Idea that polarised molecules or dipoles line up with the field ✓ Reduces potential difference across the plates / reduces the electric field strength across the plates (for the same charge) ✓	Allow for mp2 answers which argue that it cancels some of the net charge on the plates / reduces the charge on the plates **OR** allows more charge to be added (for the same potential difference)	2	AO1

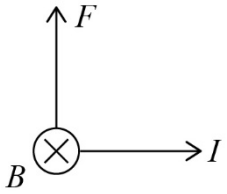
Question	Answers	Additional comments/Guidelines	Mark	AO
06.2	Use of $Q = CV$ **AND** use of $C = \frac{A\varepsilon_0\varepsilon_r}{d}$ ✓ 3.2 ✓	$\varepsilon_r = \frac{Q \times d}{V \times A \times \varepsilon_0} = \frac{1.9 \times 10^{-8} \times 1.5 \times 10^{-6}}{5 \times 2 \times 10^{-4} \times 8.85 \times 10^{-12}}$ $\varepsilon_r = 3.22$ Do not allow mp2 if units given alongside the answer	2	AO2

Question	Answers	Additional comments/Guidelines	Mark	AO
06.3	When the plate separation decreases then the capacitance will increase ✓ $Q = CV$ used to explain that increasing the capacitance will decrease the potential difference ✓	Alternative with work done: Work is done (by the field) when the front plate moves nearer to the back plate ✓ $\Delta W = Q\Delta V$ used to explain that work being done (on the capacitor) will decrease the potential difference ✓	2	1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
06.4	Any **three** from: ✓✓✓ • calculation of maximum voltage = 6.6 V **OR** minimum voltage = 3.3 V • subtraction seen of the minimum voltage from the maximum voltage to find peak-to-peak voltage • calculation seen of $T = \frac{1}{f} = 0.01$ s • correctly reads the number of divisions of one of the following: ○ peak-to-mid (amplitude) = 3.2 – 3.3 div ○ peak-to-peak = 6.4 – 6.6 div ○ period = 10 div $0.5\ V\ \text{div}^{-1}$ ✓ $1\ \text{ms div}^{-1}$ ✓	$V_{max} = \frac{1.9 \times 10^{-8}}{2.9 \times 10^{-9}} = 6.55$ V $V_{min} = \frac{1.9 \times 10^{-8}}{5.8 \times 10^{-9}} = 3.28$ V Allow $\frac{V}{\text{div}}$ or V cm^{-1} or $\frac{V}{\text{cm}}$ but not V Allow $\frac{\text{ms}}{\text{div}}$ or ms cm^{-1} or $\frac{\text{ms}}{\text{cm}}$ but not ms Only penalise lack of div^{-1} (or cm^{-1}) once in mp4 and mp5 CAO for values for mp4 and mp5 (no additional sf)	5	1 × AO2 1 × AO3 3 × AO4

Total			11

Question	Answers	Additional comments/Guidelines	Mark	AO
07.1	Idea that the force is perpendicular to the velocity of the particle ✓		1	AO1

Question	Answers	Additional comments/Guidelines	Mark	AO
07.2	(Magnetic field is acting) into the page ✓ Reference made to Fleming's left-hand rule ✓	Do not allow 'downwards' for mp1 mp2 can be given for a correct labelled diagram of Fleming's left-hand rule even if not named:  	2	AO3

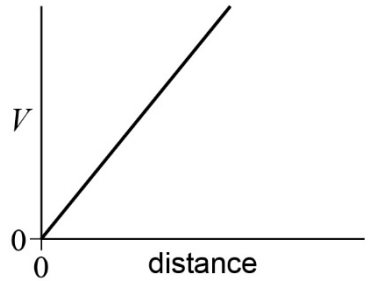
Question	Answers	Additional comments/Guidelines	Mark	AO
07.3	Ions at **P** have a smaller mass because: • radius of path to **P** is smaller than radius of path to **Q** ✓ • $r = \frac{mv}{BQ}$ in any form **OR** $BQv = \frac{mv^2}{r}$ ✓	Allow statements that explain why ions at **Q** have a larger mass. The marks are for statements which argue towards a correct conclusion Allow 'smaller diameter' for mp1 If a conclusion statement is given which is wrong then zero marks are given for this question even if either mp statement is met (eg 'ions at **P** have larger mass' or 'ions at **Q** have smaller mass' or 'ions have the same mass')	2	1 × AO1 1 × AO2

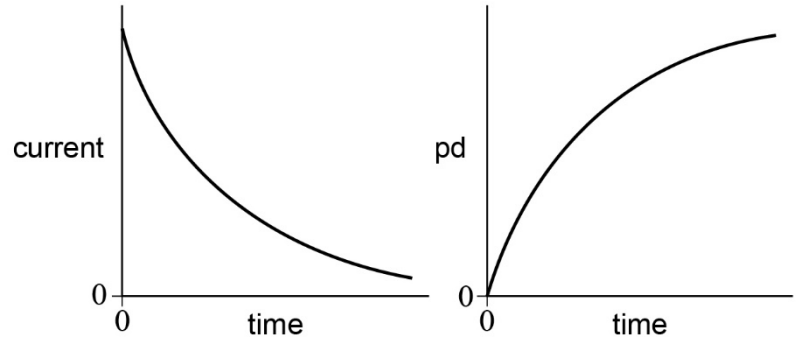
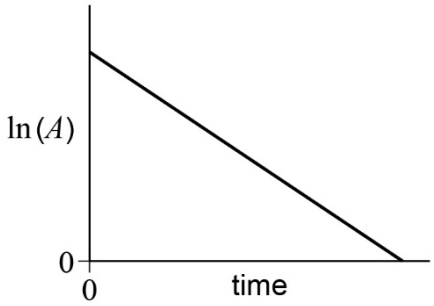
Question	Answers	Additional comments/Guidelines	Mark	AO
07.4	Any **two** from: ✓✓ • equating $\frac{mv^2}{r}$ with Bqv **OR** $r = \frac{mv}{Bq}$ • mass of ion $= \frac{7.02 \times 10^{-3}}{6.02 \times 10^{23}} = 1.17 \times 10^{-26}$ (kg) • $r = 3.5$ (cm) 0.52 (T) ✓	Allow POT errors in mp1 and mp2 Condone use of their radius and mass value in bp1 bp2 can be credited within working, and for expression or for correct value of mass being seen $B = \frac{mv}{qr} = \frac{1.17 \times 10^{-26} \times 2.5 \times 10^{5}}{1.6 \times 10^{-19} \times 3.5 \times 10^{-2}} = 0.521$ T	3	1 × AO1 1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.5	Use of $E = \frac{V}{d}$ **AND** use of $E = \frac{F}{Q}$ ✓ 3.1×10^{-15} (N) ✓	$F = \frac{QV}{d} = \frac{1.6 \times 10^{-19} \times 350}{1.8 \times 10^{-2}} = 3.11 \times 10^{-15}$ N	2	1 × AO2 1 × AO3

Question	Answers	Additional comments/Guidelines	Mark	AO
07.6	Magnetic force is equal in magnitude and opposite **in direction** to the electric force ✓	Condone stating that the resultant force is zero or the forces cancel in place of "equal in magnitude" but the opposite direction of the forces needed to be explicitly stated for the mark to be awarded	1	AO2

Total			**11**

Question	Key	Answer	AO
08	**C**	$\frac{V^2}{GM}$	AO2
09	**C**	3.62×10^8 m	AO3
10	**C**		AO3
11	**A**	$\frac{Q}{2\sqrt{2}\pi\varepsilon_0 a}$	AO3
12	**B**	7.5×10^{-5} J	AO3
13	**A**	37 μC	AO2
14	**C**	5.0 s	AO3

15	**C**		AO3
16	**C**	equal to 50%.	AO1
17	**D**		AO3
18	**B**	$\frac{\mu g}{I}$	AO2
19	**D**	120 W	AO2
20	**A**	9.0×10^{-1} Wb	AO3

21	**B**	increasing.	AO3
22	**C**	0.17 A	AO2

Total marks = 15