National
Qualifications
2016

2016 Physics

Higher

Finalised Marking Instructions

General Marking Principles for Physics Higher

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 formulae alone. When a candidate writes down several formulae 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) No marks should be awarded if a 'magic triangle' (eg ) is the only statement in a candidate's response. To gain the mark, the correct relationship must be stated eg V = IR or $R = \frac{V}{I}$, etc.

(k) In rounding to an expected number of significant figures, the mark can be awarded for answers which have up to two figures more or one figure less than the number in the data with the fewest significant figures.

(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:

- **identify**, **name**, **give**, or **state**, they need only name or present in brief form;
- **describe**, they must provide a statement or structure of characteristics and/or features;
- **explain**, they must relate cause and effect and/or make relationships between things clear;
- **determine** or **calculate**, they must determine a number from given facts, figures or information;
- **estimate**, they must determine an approximate value for something;
- **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.
- **show that**, they must use physics [and mathematics] to prove something eg a given value – *all steps, including the stated answer, must be shown*;
- **predict**, they must suggest what may happen based on available information;
- **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. $R = \frac{I}{V} = \frac{1{\cdot}5}{7{\cdot}5} = 5{\cdot}0\ \Omega$	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

Marking Instructions for each question

Section 1

Question	Answer	Max Mark
1.	B	**1**
2.	A	**1**
3.	C	**1**
4.	C	**1**
5.	C	**1**
6.	B	**1**
7.	C	**1**
8.	A	**1**
9.	E	**1**
10.	D	**1**
11.	D	**1**
12.	A	**1**
13.	C	**1**
14.	E	**1**
15.	C	**1**
16.	B	**1**
17.	D	**1**
18.	D	**1**
19.	E	**1**
20.	B	**1**

Section 2

Question			Answer	Max Mark	Additional Guidance
1.	(a)	(i)	$u_v = 9{\cdot}1 \sin 24°$ $u_v = 3{\cdot}7\ \text{m s}^{-1}$ (1)	1	Sig figs: Accept 4, 3·70, 3·701 **OR** Accept m/s
		(ii)	$u_h = 9{\cdot}1 \cos 24°$ $u_h = 8{\cdot}3\ \text{m s}^{-1}$ (1)	1	Sig figs: Accept 8, 8·31, 8·313
	(b)		$v = u + at$ (1) $0 = 3{\cdot}7 + (-9{\cdot}8)t$ $t = 0{\cdot}378$ (s) (total) $t = 0{\cdot}378 \times 2$ (1) (total) $t = 0{\cdot}76$ s **OR** $v = u + at$ (1) $-3{\cdot}7 = 3{\cdot}7 + (-9{\cdot}8) \times t$ (1) (total) $t = 0{\cdot}76$ s	2	SHOW question. Sign convention must be correct. Accept $0 = 3{\cdot}7 - 9{\cdot}8t$ If final line not shown then a maximum of 1 mark can be awarded. Guidance on alternatives $s = ut + \frac{1}{2}at^2$ (1) $0 = 3{\cdot}7t + \frac{1}{2}(-9{\cdot}8)t^2$ (1) (total) $t = 0{\cdot}76$ s
	(c)		$s = v_h \times t$ (1) $s = 8{\cdot}3 \times 0{\cdot}76$ (1) $s = 6{\cdot}3$ m (1)	3	Or consistent with (a)(ii) Sig figs: Accept 6, 6·31, 6·308 Accept $s = \frac{1}{2}(u+v)t$ Accept $s = ut + \frac{1}{2}at^2$ Accept $s = ut$ $v_h = 8{\cdot}31\ \text{m s}^{-1}$ gives s = 6·32 m is acceptable
	(d)		Smaller displacement (1) curve with decreasing gradient (1)	2	Ignore any change in time Any part of the curve drawn above the original line - award 0 marks These marks are independent.

Question			Answer	Max Mark	Additional Guidance
2.	(a)	(i)	$\bar{d} = \dfrac{1\cdot31+1\cdot40+1\cdot38+1\cdot41+1\cdot35}{5}$ $\bar{d} = 1\cdot37\text{ m}$ (1)	**1**	Sig figs: Accept 1·4, 1·370
		(ii)	$\Delta\bar{d} = \dfrac{1\cdot41-1\cdot31}{5}$ (1) $\Delta\bar{d} = 0\cdot02\text{ m}$ (1)	**2**	Sig figs: Accept 0·020 Accept $(1\cdot37 \pm 0\cdot02)\text{m}$
	(b)		$\%\Delta m = \dfrac{0\cdot01}{0\cdot20} \times 100 = 5\%$ (1) $\%\Delta h = \dfrac{0\cdot0005}{0\cdot40} \times 100 = 1\cdot3\%$ (1) $\%\Delta\bar{d} = \dfrac{0\cdot02}{1\cdot37} \times 100 = 1\cdot5\%$ (1) Mass (has largest percentage uncertainty). (1)	**4**	Or consistent with (a)(i) and (a)(ii). Each correct calculation <u>with correct substitution</u> is awarded 1 mark Each calculation is independent but must have all three calculations <u>shown</u> to access the final mark for the conclusion. Accept percentage sign missing. Wrong substitution – maximum of 2 marks. Sig figs: for $\%\Delta m$ Accept 5·0, 5·00 for $\%\Delta h$ Accept 1, 1·25, 1·250 for $\%\Delta\bar{d}$ Accept 1, 1·46, 1·460
	(c)	(i)	$E_p = mgh$ (1) $E_p = 0\cdot20 \times 9\cdot8 \times 0\cdot40$ (1) $E_p = 0\cdot78\text{ J}$ (1)	**3**	Sig figs: Accept 0·8, 0·784 Treat −9·8 as wrong substitution unless h is also negative.

Question			Answer	Max Mark	Additional Guidance
2.	(c)	(ii)	$E_w = Fd$ (1) $0{\cdot}78 = F \times 1{\cdot}37$ (1) $F = 0{\cdot}57$ N (1)	3	Or consistent with (a)(i) and (c)(i) Sig figs: Accept 0·6, 0·569, 0·5693 Candidates can arrive at this answer by alternative methods eg equating loss in E_P to gain in E_K etc. If alternative methods used, can also accept 0·572, 0·5723 1 for ALL equations 1 for ALL substitutions 1 for correct answer
		(iii)	All E_ρ converted to E_k All E_p converted to E_W Air resistance is negligible Ramp is frictionless Bearings in the wheels are frictionless The carpet is horizontal No energy/heat loss <u>on the ramp</u> etc	1	Only one correct statement required Note the ± rule applies Energy is conserved on its own **OR** No energy/ heat loss on its own – 0 marks

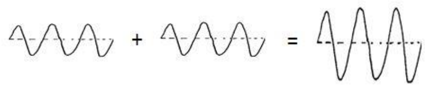
Question			Answer	Max Mark	Additional Guidance
3.	(a)		<u>Total</u> momentum before (a collision) is equal to the <u>total</u> momentum after (a collision) in the absence of external forces (1)	**1**	Not: TMB = TMA An isolated system is equivalent to the absence of external forces
	(b)		$m_1u_1 + m_2u_2 = (m_1 + u_2)v$ (1) $(0{\cdot}85 \times 0{\cdot}55) + (0{\cdot}25 \times -0{\cdot}3)$ $= (0{\cdot}25 + 0{\cdot}85)v$ (1) $v = 0{\cdot}36 \text{ m s}^{-1}$ (1)	**3**	Sign of the answer must be consistent with the substitution of + and – velocities. Sig figs: Accept 0·4, 0·357, 0·3568 If candidate then goes on to state a direction which is not consistent with their substitution then maximum two marks can be awarded. Where candidates calculate the momentum of each trolley individually both before and after, no marks are awarded unless correct addition (including sign convention) <u>and</u> equating takes place.
	(c)		$E_k = ½mv^2$ ANYWHERE (1) Before $E_k = ½m_Xv_X{}^2 + ½m_Yv_Y{}^2$ $= (½ \times 0{\cdot}85 \times 0{\cdot}55^2)$ $+ (½ \times 0{\cdot}25 \times 0{\cdot}3^2)$ $= 0{\cdot}14$ (J) (1) After $E_k = ½mv^2$ $= ½ \times 1{\cdot}1 \times 0{\cdot}36^2 = 0{\cdot}071$ (J) (1) <u>Kinetic</u> energy is lost. (Therefore inelastic.) (1)	**4**	Or consistent with (b) 1 mark for both substitutions If candidate answers 0·49 in (b), this gives 0·13 J for E_K after. $E_K before \neq E_K after$ is insufficient

Question			Answer	Max Mark	Additional Guidance
4.	(a)		$(0{\cdot}83 + 1{\cdot}20) - 1{\cdot}80$ (1) $0{\cdot}23\ \text{m s}^{-1}$ (1)	2	
	(b)	(i)	$3 \times 10^8\ \text{m s}^{-1}$ or c (1) Speed of light is the same for all observers / all (inertial) frames of reference or equivalent (1)	2	Look for this statement first - if incorrect then 0 marks. $3 \times 10^8\ \text{m s}^{-1}$ or c on its own is worth 1 mark If the numerical value for speed is given, then unit is required- otherwise 0 marks Any wrong physics in justification then maximum 1 mark for the statement
		(ii)	$l' = l\sqrt{1-\left(\frac{v}{c}\right)^2}$ (1) $l = 71\sqrt{1-0{\cdot}8^2}$ (1) $l = 43\ \text{m}$ (1)	3	Sig figs: Accept 40, 42·6, 42·60
		(iii)	Correct - from the perspective of the stationary observer there will be time dilation Incorrect - from the perspective of the students they are in the same frame of reference as the clock Not possible to say/could be both correct and incorrect - frame of reference has not been defined	1	The response must involve a statement referring to, or implying, a frame of reference
5.	(a)	(i)	$\Delta X = 0{\cdot}04\ (\text{m})$ $X = 0{\cdot}016\ (\text{m s}^{-1})$ (1) $\Delta Y = 0{\cdot}06\ (\text{m})$ $Y = 0{\cdot}024\ (\text{m s}^{-1})$ (1)	2	If values are not entered in the table, then X and Y must be identified and units required.
		(ii)	More distant galaxies are moving away at a greater velocity/ have a greater recessional velocity Or equivalent	1	The (average) speed (of the knots) is (directly) proportional to the distance (from V) Any reference to planets or stars alone - 0 marks
	(b)		$z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}}$ (1) $z = \frac{667\times10^{-9} - 656\times10^{-9}}{656\times10^{-9}}$ (1) $z = 0{\cdot}0168$ (1)	3	Sig figs: Accept 0·017, 0·01677, 0·016768 Accept $z = \frac{667-656}{656}$

Question			Answer	Max Mark	Additional Guidance
6.			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
7.	(a)		$W = QV$ (1) $= 1 \cdot 6 \times 10^{-19} \times 2000$ (1) $= 3 \cdot 2 \times 10^{-16}\,\text{J}$ (1)	**3**	Sig figs: Accept 3×10^{-16}, $3 \cdot 20 \times 10^{-16}$, $3 \cdot 200 \times 10^{-16}$, Ignore negative sign for charge.
	(b)		$Q = It$ (1) $= 0 \cdot 008 \times 60$ (1) $= 0 \cdot 48\ (C)$ (1) $number = \frac{0 \cdot 48}{1 \cdot 6 \times 10^{-19}}$ $= 3 \cdot 0 \times 10^{18}$ (1)	**4**	Sig figs: Accept 3×10^{18} If the response stops at 0·48 then a correct unit is required. Candidates can arrive at this answer by alternative methods eg P=IV and E=Pt **OR** Q=It to calculate the time for 1 electron.
	(c)		Straight lines with arrows pointing downwards.	**1**	spacing should be approximately equal (ignore end effect) Field lines must start and finish on the plates Lines at right angles to the plates

Question			Answer	Max Mark	Additional Guidance
8.	(a)		mass is converted into energy	**1**	There must be a link between mass and energy. Mass is lost on its own - 0 marks Mass defect is wrong physics - 0 marks Energy is released or equivalent is not sufficient.
	(b)		$m_{before} = 3 \cdot 3436 \times 10^{-27} + 5 \cdot 0083 \times 10^{-27}$ $= 8 \cdot 3519 \times 10^{-27}$ (kg) $m_{after} = 6 \cdot 6465 \times 10^{-27} + 1 \cdot 6749 \times 10^{-27}$ $= 8 \cdot 3214 \times 10^{-27}$ (kg) $\Delta m = 3 \cdot 0500 \times 10^{-29}$ (kg) (1) $E = mc^2$ (1) $= 3 \cdot 0500 \times 10^{-29} \times (3 \cdot 00 \times 10^8)^2$ (1) $= 2 \cdot 75 \times 10^{-12}$ J (1)	**4**	$E = mc^2$ anywhere - 1 mark. If mass before and after not used to 5 significant figures from table then stop marking - maximum 1 mark for formula Arithmetic mistake can be carried forward Truncation error in mass before and/or mass after– maximum 1 mark for formula Sig figs: 2·7, 2·745, 2·7450 If finding $E = mc^2$ for each particle, then $E = mc^2$ (1) All substitutions (1) Subtraction (1) Final answer (1)
	(c)		Plasma would cool down if it came too close to the sides (and reaction would stop)	**1**	(Reaction requires very high temperature), so plasma would melt the sides of the reactor **OR** High temperature plasma could damage/ destroy the container
	(d)		Up the page	**1**	Accept up and upwards Arrow drawn pointing up the page is acceptable If upwards arrow is drawn on the original diagram, it must be on the left hand edge The path of the particle on its own is not acceptable

Question			Answer	Max Mark	Additional Guidance
9.	(a)		The waves from the two sources have a constant phase relationship (and have the same frequency, wavelength, and velocity).	**1**	"In phase" is not sufficient
	(b)		Waves <u>meet</u> in phase OR Crest <u>meets</u> crest OR Trough <u>meets</u> trough OR Path difference = mλ	**1**	Accept peak for crest Can be shown by diagram eg  Diagram must imply addition of two waves in phase
	(c)		Path Difference = $m\lambda$ (1) $0{\cdot}282 - 0{\cdot}204 = 2 \times \lambda$ (1) $\lambda = 0{\cdot}0390$m (1) (39 mm)	**3**	Sig figs: 0·039 m 0·03900 m 0·039000 m Not: 0·04 m
	(d)		The path difference stays the same **OR** The path difference is still 2λ (1) because the wavelength has not changed (1)	**2**	Look for this statement first – if incorrect then 0 marks. The path difference stays the same **OR** The path difference is still 2λ on its own - 1 mark Any wrong physics in justification then maximum 1 mark (for the statement)

Question			Answer	Max Mark	Additional Guidance
10.	(a)		$n = \sin i / \sin r$ (1) $= \sin 36 / \sin 18$ (1) $= 1{\cdot}9$ (1)	**3**	Sig figs: Accept 2, 1·90, 1·902
	(b)		$\sin\theta_C = 1/n$ (1) $= 1/1{\cdot}9$ (1) $= 0{\cdot}5263$ $\theta_C = 32^o$ (1)	**3**	Or consistent with 10(a).
	(c)		Completed diagram, showing light emerging (approximately) parallel to the incident ray	**1**	The normal is not required

Question			Answer	Max Mark	Additional Guidance
11.			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
12.	(a)	(i)	$V = IR$ (1) $V = 1 \cdot 80\ (4 \cdot 8 + 0 \cdot 10)$ (1) V = 8·82 (V) (1) Voltmeter reading (= 12·8 − 8·82) = 4·0 V (1)	**4**	$lost\ volts = Ir$ $lost\ volts = 1 \cdot 80 \times 0 \cdot 10$ $lost\ volts = 0 \cdot 18\ \text{V}$ $V = IR$ $V = 1 \cdot 80 \times 4 \cdot 8$ $V = 8 \cdot 64\ \text{V}$ $V = 12 \cdot 8 - 0 \cdot 18 - 8 \cdot 64$ $V = 4 \cdot 0\ \text{V}$ **OR** $E = V + Ir$ $12 \cdot 8 = V + (1 \cdot 80 \times 0 \cdot 10)$ $V = 12 \cdot 62\ \text{V}$ $V = IR$ $V = 1 \cdot 80 \times 4 \cdot 8$ $V = 8 \cdot 64\ \text{V}$ $V = 12 \cdot 62 - 8 \cdot 64$ $V = 4 \cdot 0\ \text{V}$ 1 for all equations 1 for all substitutions 1 for all correct intermediate values 1 for final answer Sig figs: Accept 4, 3·98, 3·980
		(ii)	(Reading on voltmeter)/(voltage across lamp) decreases (1) (total) resistance decreases/ current increases. (1) lost volts increases/V_{tpd} decreases/p.d. across 4·8 Ω increases/<u>share</u> of p.d. across parallel branch decreases (1)	**3**	Look for this statement first - if incorrect then 0 marks. 'Reading on voltmeter decreases' on its own is worth 1 mark Any wrong physics in justification then maximum 1 mark for the statement Last 2 marks are independent of each other Can be justified by calculation (R_{lamp} is 2·2 Ω, I = 2·1 A, gives V = 2·3 V)

Question			Answer	Max Mark	Additional Guidance
12.	(b)	(i)	(Voltage applied causes) electrons to move towards conduction band of p-type/ away from n-type (towards the junction) (1) Electrons move/ drop from conduction band to valence band (1) Photon emitted (when electron drops) (1)	**3**	Look for reference to either conduction or valence band first. Otherwise 0 marks. Bands must be named correctly in first two marking point eg not valency and not conductive Any answer using recombination of holes and electrons **on its own**, with no reference to band theory, is worth 0 marks. Must be directional Any wrong physics eg holes move up (from valence band to conduction band)- 0 marks This mark is dependent upon having at least one of the first two statements
		(ii) (A)	$E = hf$ $3 \cdot 03 \times 10^{-19} = 6 \cdot 63 \times 10^{-34} \times f$ (1) $f = 4 \cdot 57 \times 10^{14}$ (Hz) $v = f\lambda$ (1) for both equations $3 \times 10^{8} = 4 \cdot 57 \times 10^{14} \times \lambda$ (1) $\lambda = 6 \cdot 56 \times 10^{-7}$ m (1)	**4**	Alternative: $E = \frac{hc}{\lambda}$ (1) Correct substitution (2) (1 for E and h; 1 for c) Final value of λ (1) Sig figs: Accept $6 \cdot 6 \times 10^{-7}$, $6 \cdot 564 \times 10^{-7}$, $6 \cdot 5644 \times 10^{-7}$
		(ii) (B)	Red (1)	**1**	or consistent with (A) If wavelength stated in this part, then colour must be consistent with this value

Question			Answer	Max Mark	Additional Guidance
13.	(a)	(i)	12 V	**1**	Accept 12·0 V
		(ii)	$E = ½ C V^2$ (1) $E = ½ \times 150 \times 10^{-3} \times 12^2$ (1) $E = 11$ J (1)	**3**	Or consistent with a(i) Sig figs: 10 J 10·8 J 10·80 J $Q = CV$ and $E = \frac{1}{2}QV$ **OR** $Q = CV$ and $E = \frac{1}{2}\frac{Q^2}{C}$ (1) Both substitutions (1) Final answer (1)
	(b)		($R_T = 56 + 19 = 75$ (Ω)) $I = \frac{V}{R}$ (1) $I = \frac{12}{75}$ (1) $I = 0{\cdot}16$ A (1)	**3**	Or consistent with a(i) Candidates can arrive at this answer by alternative methods. Sig figs: 0·2 A 0·160 A 0·1600 A
	(c)		(Lamp stays lit for a) shorter time (1) (as smaller capacitance results in) less energy stored / less charge stored (1)	**2**	Look for this first Must provide relevant justification which is not wrong physics. If wrong physics - 0 marks. E is less because $E = ½ C V^2$ is acceptable. If candidate says the current stays the same, they must identify it is the <u>initial</u> current.

Question			Answer	Max Mark	Additional Guidance
14.	(a)		$f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$ $= \frac{1}{2\times0\cdot550}\sqrt{\frac{49\cdot0}{4\cdot00\times10^{-4}}}$ (1) = 318 Hz (1)	**2**	Substitution (1) Answer (1) Sig figs: Accept 320, 318·2, 318·18
	(b)	(i)	Suitable scales with labels on axes (quantity and units) (1) [Allow for axes starting at zero or broken axes or an appropriate value] Points plotted correctly (1) Best-fit straight line (1)	**3**	If the origin is shown the scale must either be continuous or the axis must be 'broken'. Otherwise maximum 2 marks. If an invalid scale is used on either axis eg values from the table are used as the scale points - 0 marks Do not penalise if candidates plot $\sqrt{T}$ against f Graphs of T and f are incorrect for (b)(i) - 0 marks, but can still gain marks for b(ii).
		(ii)	230 Hz	**1**	Must be consistent with the candidate's graph in (b)(i) ($\sqrt{22}$ = 4·7 gives) 230 Hz Correct value of $\sqrt{T}$ must be used If f against T is drawn in b(i), then this mark can still be accessed. If values from table are used as the scale points - 0 marks

[END OF MARKING INSTRUCTIONS]