2012 Physics

Standard Grade − Credit

Finalised Marking Instructions

Part One: General Marking Principles for Physics Standard Grade – Credit

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this Paper. These principles must be read in conjunction with the specific Marking Instructions for each question.

(a) Marks for each candidate response must always be assigned in line with these general marking principles and the specific Marking Instructions for the relevant question. 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/Principal Assessor.

(b) Guidance for using marking instructions for Standard Grade Physics Credit level.

The Physics **General Marking Instructions** (GMI) provide guidance on marking issues.
http://www.sqa.org.uk/files_ccc/Physics_General_Marking_Instructions.pdf

When marking Standard Grade Physics, there are common issues which arise when considering candidates' answers.

There is often a range of acceptable answers which would sensibly answer a particular question. However, it is often difficult to anticipate all correct or partially correct responses to questions.

The Principal Assessor and Team Leaders study a large sample of candidates' scripts and use the responses to refine the Marking Instructions (MIs) to include guidance on how to interpret different responses.

The answers given in the MIs represent ideal answers.
Additional acceptable answers are also given in the MIs to offer guidance to assist interpreting candidates' answers.
Also, advice on answers which are NOT acceptable or only attract partial marks may also be given in the MIs for some questions.

Markers are reminded that marks for each candidate response must always be assigned in accordance with these general marking principles and the specific Marking Instructions for the relevant question.

Common issues with candidates' responses:

Spelling:

The incorrect spelling of technical terms should be ignored and candidates should be awarded the relevant mark. If answers can be interpreted and understood without any doubt as to the meaning, then the answer should be marked according to the MIs.
However, care should be taken to ensure that the incorrect spelling does not make the response ambiguous, leading to possible 'wrong physics'.
One notable exception is for questions requiring the responses 'reflection', 'refraction' or 'diffraction'. The spelling of these words is similar, but the words have totally different meanings. If the spelling (or handwriting) in an answer makes it difficult for you to interpret a candidate's intention, then do not award the mark.

Units:

For ***non-numerical*** answers which require a unit to be ***stated*** in an answer, the incorrect spelling of the unit is not usually penalised (if the unit can be clearly identified) eg:

'What is the correct unit for the activity of a radioactive source?' Answer: 'Becquerels'.
The answer: 'beckerels' would be acceptable.
Examples of other common misspellings: Seeverts, decibelles, Diopiters.

Also for ***non-numerical*** answers, do not penalise upper/lower casing when the abbreviated version is given eg DB, sV, hZ, bq.

However, for ***numerical answers,*** care must be taken to ensure that the unit has the correct prefix. eg for an answer t = 0·005 seconds, t = 5 ms is acceptable but NOT t = 5 Ms.

It should be noted that, in any part of a question, multiple unit errors or conversion errors / omissions should only be penalised once (deduct maximum ½ mark).

e.g. when calculating speed from distance and time , and answer required to be in m/s:

If d = 4 km
t = 2 minutes

$$v = \frac{d}{t} \quad (\tfrac{1}{2})$$
$$= \frac{400}{2} \quad (\tfrac{1}{2})$$
$$= 200 \quad (\tfrac{1}{2})$$

Although the candidate has made three unit errors (not correctly converted distance or time and has omitted the final unit) this would only attract **½ mark unit penalty.**

Some common units often attract wrong abbreviations in answers to numerical questions. When the abbreviation can be confused with a different unit then this would attract a unit penalty eg sec or secs as an abbreviation for seconds is NOT acceptable.

Common units and abbreviations:	
Acceptable unit/Abbreviation	*NOT acceptable version*
second, s	sec, secs
ampere, amp, amps, A, a	
metres per second, m/s, ms^{-1},	mps, m/s^{-1}
metres per second per second, m/s/s, m/s^2 , ms^{-2}	mpsps, m/s^{-2}

Standard form:
Candidates may fail to express an answer in standard form correctly.
For an answer t = 400 000 s, then $t = 4 \times 10^5$ s would be correct but $t = 4^5$ s would be treated as an arithmetic error (deduct (½)).

Relationship (equation) selection:

No marks should be awarded if a 'magic triangle' eg 

was the only statement in a candidate's response.

The correct relationship must be stated eg V = IR or $R = \frac{V}{I}$ etc. to gain (½) mark.

'Dotted line.' : - - - - - - - - - - - - - - -

A dotted line immediately above an answer in the MIs indicates that the answer requires use of an answer (or value) calculated or stated in a previous part of the question.
If the candidate's answer in the previous part of the question is wrong, this wrong answer may be used by the candidate in the subsequent part of the question. If the subsequent answer is correctly completed, then full marks may be awarded.
Where a question requires a Data value and the candidate has selected the wrong value, the candidate may use either the wrong value given OR the correct data value in the subsequent answer and could gain full marks if correctly completed.
Example:

(a) What is the speed of microwaves?
Candidate's answer: 340 m/s This answer would attract zero marks.

- -

(b) What distance would be travelled by these microwaves in 0.34 seconds?
Candidate may use either the value given in part (a) OR the correct value for the speed of microwaves and could gain full marks if correctly completed.

Marking from Image Issues:

When marking candidates' scripts on screen, it is important to start by checking the 'full response view' in case answers are continued elsewhere outside the answer boxes or spaces provided and to identify unreadable responses.

Also, for each candidate, the end of the script (up to very last page) should be checked for any answers completed at the end. Candidates may not indicate that an answer is continued at the end of the script.

If an answer or part of an answer is unreadable, the marker should then click the " ! " button *to raise an exception.*

This process is illustrated by :

SQA Academy, My Courses, e-marking 2012, Topic 4, Section 7 – Communications.

Or Scoris Assessor Guide , page 76-80.

Candidates are advised in the 'Your Exams ' booklet to cross out any rough work when they have made a final copy. However, crossed-out work must be marked if the candidate has not made a second attempt to answer the question. When a second attempt has been made, or started, the crossed-out marking should be ignored.

PART (c)

Part (c) below sets out how to apportion marks to answers requiring calculations.
These are the '**standard two marker**' type of questions.

Unless a numerical question specifically requires evidence of working to be shown, full marks should be given for a ***correct*** answer to a numerical question even if the steps are not shown explicitly. The individual marks shown in **part (c)** are for use when marking partially correct answers.

Markers who are new to marking Standard Grade Physics should study these issues closely, since the guidance illustrates common faults in candidates' answers to the 'standard two marker' type of question. Items 1-15 below illustrate how to apportion marks accordingly.

Experienced markers should also re-acquaint themselves with these examples before marking.

For some questions requiring numerical calculations, there may be alternative methods (eg alternative relationships) which would lead to a correct answer.

These alternative methods of reaching the answer and how to apportion marks are also included in the specific MIs for these questions.

Sometimes, a question requires a calculation which does not fit into the 'standard two marker' type of response. Full guidance on how to apportion marks will be given in the MIs for that specific question.

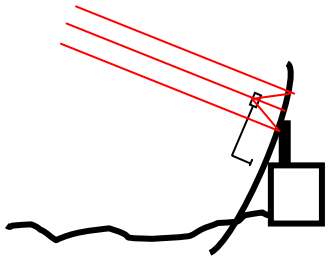
Part (c)

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.	$V=IR$ $7{\cdot}5=1{\cdot}5R$ $R=5{\cdot}0\ \Omega$	(½) (½) (1)	Ideal answer
2.	$5{\cdot}0\ \Omega$	(2) Correct answer	GMI 1
3.	$5{\cdot}0$	(1½) Unit missing	GMI 2 (a)
4.	$4{\cdot}0\ \Omega$	(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.	$V = IR\quad 7{\cdot}5 = 1{\cdot}5 \times R\quad R = 0{\cdot}2\ \Omega$	(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

Part Two: Marking Instructions for each Question

Question			Expected Answer/s	Max Mark	Additional Guidance
1	**A**		(orbits the equator with a) period of 24 hours OR Stays above the same point on the Earth's (surface) OR Orbits at 36 000 km (above the equator) OR Same period as Earth OR Same rate of rotation as Earth OR Same angular speed as Earth	**1**	• Do not accept: • 'Same speed as Earth' • '(Stays above) same point in space • 'Stationary' • 42 000 km above the Earth's surface. (unless stated above the centre of (the Earth))
1	**B**	**i**	3×10^8 m/s OR 300 000 000 m/s	**1**	(1) OR (0) must show correct unit Do not accept: "The speed of light"
1	**b**	**ii**	$v = f\lambda$ (½) $3\times10^8 = 12\times10^9 \times \lambda$ (½) $\lambda = 0\cdot025$ m (1)	**2**	Must use value for speed from (b) OR correct value for speed of microwave signals deduct (½) for wrong/missing unit If v = 340, then $\lambda = 2\cdot83 \times 10^{-8}$ m
1	**c**	**i**		**2**	(1) For passably straight parallel lines (1) For focus on receiver Direction arrows not required but if given in wrong direction then deduct 1 mark
1	**c**	**ii**	To allow as strong a signal as possible to be received/collected/gathered. Increases (amplitude of) received signal.	**1**	An indication that the received signal OR (micro)waves is increased. NOT: • To boost the signal • Reflector does not "detect" more signals. • "Picks up" • "better signal" • "More signals**"** indicated lots of different signals being collected **not** more of the same signal as the question requires.

Question			Expected Answer/s	Max Mark	Additional Guidance
2	**A**		The speed of radio waves/signals is (much) faster than the speed of sound (waves).	**1**	Accept: The speed of sound (waves) is (much) slower than the speed of radio waves/signals. NOT: • The speed of light is *different* from the speed of sound • Stating one speed only with no comparison.
2	**b**		FM waveband has short(er) wavelength (1) These radio waves do not diffract around hills (1)	**2**	First mark for describing FM as short(er) wavelength/higher frequency Second mark for indicating that short wavelength/higher frequency waves do not diffract as much. Answer can be given in the context of A and B. Do not accept: Waves "bend" These are **independent** marks. Candidates can still achieve (1) mark for correct description of long wavelengths/low frequencies diffracting. Answer can be given in the context of A and B.
2	**c**		V_{peak} = No of div x gain (½) = 3 x 10 (½) = 30 volts (1)	**2**	If wrong value for gain selected OR wrong no. of boxes in amplitude, can still get (½) for an implied equation If Vg (Gain) formula used from data book award 0 marks. Deduct (½) for wrong/missing unit

Question			Expected Answer/s	Max Mark	Additional Guidance
3	a	i	$P = IV$ (½) $36 = I \times 12$ (½) $I = 3\,A$ (1)	2	Deduct (½) for wrong/missing unit
3	a	ii	$48 = 12 + 12 + V_R$ $V_R = 24\ V$ (1)	1	Deduct (½) for wrong/missing unit
3	a	iii	$V = IR$ (½) $24 = 3 \times R$ (½) $R = 8\,\Omega$ (1)	2	Must use answers from 3 (a)(i) and (ii) or correct answers Deduct (½) for wrong/missing unit There may be a large range of possible answers depending on answers to given for a(i) and a(ii). Take care to check all answers.
3	b	i	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + ...$ (½) $\frac{1}{R_T} = \frac{1}{6} + \frac{1}{4} + \frac{1}{4}$ (½) $\frac{1}{R_T} = 0{\cdot}17 + 0{\cdot}25 + 0{\cdot}25$ $R_T = 1{\cdot}5\ \Omega$ (1)	2	If wrong equation used eg $R_T = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ then zero marks Accept *imprecise* working towards a final answer $\frac{1}{R_T} = \frac{1}{6} + \frac{1}{4} + \frac{1}{4} = 1{\cdot}5\ \Omega$ ↑ accept deduct (½) for wrong/missing unit Can be answered by applying product over sum method. If applied twice. Accept 3/2 and 1 ½ Ω as final answer.
3	b	ii A	The reading decreases/gets smaller/reduces	1	Any clear statement that the reading decreases
3	b	ii B	The resistance increases (so the current decreases)	1	NO dotted line from part (ii) A Explanation must link current decrease with increase of resistance

Question			Expected Answer/s	Max Mark	Additional Guidance
4	**a**		Phototransistor/photodiode/CCD	**1**	NOT thermometer/thermopile/ thermogram - not suitable for given context Not Infra red camera OR Infra red detector
4	**b**	**i**	to pass current to the rotating coil/commutator	**1**	Answer must **imply** that current is being passed to the commutator/rotating coil. Eg "Electrical contact" or "feed in" etc infer current being passed in. Not "charge".
4	**b**	**ii**	Reverse the magnetic field OR Change **the direction** of the current/reverse current OR Swap battery terminals	**1**	(½) each correct answer 1 mark max. If more than 2 answers given deduct (½) for each wrong answer. Accept • "Swap magnets around". • "Switch magnets around". • "Change magnets around". Not "swap magnets" or "swap battery" alone.
4	**b**	**iii A**	Commercial motor has multi-sectional commutator OR commercial motor has several/ more (rotor) coils OR Field coils OR electromagnet instead of (permanent) magnets.	**1**	Do not accept answers relating to (carbon) brushes.
4	**b**	**iii B**	Smoother operation (multi section commutator) OR Greater turning force (more coils) OR Self starting (multi section commutator) OR Ability to control speed/ magnetic field/can be turned off (field coils)		The candidates answer to 4b(iii) B must relate to their answer to 4b(iii)A Where candidates have given an incomplete answer for electromagnet in part b(iii)A, a mark can still be awarded in this question if the reason given for using electromagnets is correct eg part (A) 'it has an electromagnet' zero marks part(B) 'it can be turned off' 1 mark Do not accept answers relating to (carbon) brushes.

Question			Expected Answer/s	Max Mark	Additional Guidance
5	a		Sounds (of frequency) greater than 20 000Hz	1	Frequency/pitch above the range of human hearing Answer make must make reference to frequency/pitch. Mentioning correct units for frequency is acceptable eg "sounds above 20 000Hz" NOT "sounds above human hearing range"
5	b	i	1500 m/s	1	(1) OR (0) must show correct unit
5	b	ii	$v = \frac{d}{t}$ (½) $1500 = \frac{25}{t}$ (½) $t = 0 \cdot 0167 (s)$ (1) unit not required here unless this time is left as the final answer $\text{total time} = 2 \times 0 \cdot 0167 = 0 \cdot 0334 s$ (1) sig. fig. range (if no intermediate rounding) : $0 \cdot 03, 0 \cdot 033, 0 \cdot 0333.$	3	Must use value for speed from (b)(i) OR correct value for speed of sound waves in water Multiplication by 2 can happen at any stage (eg t = 0.017s x 2 = 0.034 s – while this is imprecise calculation it can be ignored – no penalty) Deduct (½) for wrong/missing unit in final answer *check significant figures Check calculations to see if candidate has doubled distance at start or double time at end. This could have an impact on significant figure issues. Watch intermediate rounding issues (eg pupil may round to 0.02s x 2 = 0.04s) – this is acceptable
5	b	iii A	Time interval is unchanged	1	Any indication that changing the frequency has no effect on the time
5	b	iii B	Speed (of sound in water) is same/unchanged. Frequency has no effect (on the time taken for the wave to travel the 50m)	1	
6	a		The radiation detector would detect a higher level of radiation OR count rate would be higher where there was a crack in the aircraft	1	Some indication that there would be an **increase** in the reading on the detector. A change in radiation level must be clearly indicated in the context of the chosen detector. e.g. darkening of photographic film (but not an indication that the photographic film changes colour).
6	b	i	Time taken for the (radio) **activity** (of a radioactive source) to reduce by half.	1	Do not accept: Time for radiation/count rate to half.

Question			Expected Answer/s	Max Mark	Additional Guidance
6	**b**	**ii**	Source Y (1) gamma can penetrate through the metal aircraft (½) Long half life (½).	**2**	Y only acceptable answer. Additional (½) marks can only be obtained if Y is selected. (Note:for this question, although a beta source could be used the half life of the source in the table is too short to be useful.)
6	**c**		Point away from face / people OR use tongs/ forceps OR Use <u>lead</u> (lined) aprons/gloves etc.	**1**	Accept: • Wash hands • Do not eat • Wear protective clothing • Goggles • Film badge to **monitor exposure** • Limit exposure time • Increased distance from source. • Return to container as soon as demo is finished Or any other *sensible* alternative NOT: • "Film badge" on its own-must have some explanatory statement about its monitoring function • "wear gloves" • "gloves" alone

Question			Expected Answer/s	Max Mark	Additional Guidance
6	**d**		$\frac{48}{12}$ (½) $= 4$ (half lives) (½) $128 \rightarrow 64 \rightarrow 32 \rightarrow 16 \rightarrow \underline{8}$ (MBq) (½) for showing halving process (½) for answer	**2**	Unit not required but deduct (½) if wrong unit given in final answer Halving process (½) mark is independent of the calculation of the number of half lives. So candidates who show less or more halvings can still get this (½) mark, but all halving stages must be arithmetically correctly halved.
7	**a**		$\frac{V_1}{V_2} = \frac{R_1}{R_2}$ (½) $\frac{V_1}{0.36} = \frac{48000}{2000}$ (½) $V_2 = 8 \cdot 64$ V (1) OR $\frac{V_1}{R_1} = \frac{V_2}{R_2}$ (½) $\frac{0 \cdot 36}{2000} = \frac{V_2}{48000}$ (½) $V_2 = 8 \cdot 64$ V (1)	**2**	deduct (½) for wrong/missing unit Can also use ohms law twice. Once to calculate the current, then once to find V_R ie calculate current through LDR $I = \frac{V}{R}$ (½) for both equations $= \frac{0 \cdot 36}{2000}$ (½) for all correct substitutions $= 0 \cdot 00018$ (A) then calculate V_R $V = IR$ $= 0 \cdot 00018 \times 48000$ $= 8 \cdot 64$ V (1) for final answer It is possible to use the other voltage divider equation to calculate the supply voltage then subtract the 0.36V to get the correct answer. $V_{LDR} = (\frac{R_1}{R_1 + R_2}) \times V_s$ (½) for both equations $0 \cdot 36 = (\frac{2000}{2000 + 48000}) \times V_s$ (½) for all correct substitutions $Vs = 9$ (V) $VR = V_s - V_{LDR}$ $= 9 - 0 \cdot 36$ $= 8 \cdot 64$ V (1) for final answer

<table>
<tr><th colspan="3">Question</th><th>Expected Answer/s</th><th>Max Mark</th><th>Additional Guidance</th></tr>
<tr><td>7</td><td>b</td><td>i</td><td>
<table>
<tr><th>Cash Drawer Circuit</th><th>Foot Switch</th><th>W</th><th>X</th></tr>
<tr><td>Imitation £20 Removed</td><td>Not Pressed</td><td>1</td><td>1</td></tr>
<tr><td>Imitation £20 Removed</td><td>Pressed</td><td>1</td><td>1</td></tr>
<tr><td>Imitation £20 Present</td><td>Not Pressed</td><td>0</td><td>0</td></tr>
<tr><td>Imitation £20 Present</td><td>Pressed</td><td>0</td><td>1</td></tr>
</table>
</td><td>2</td><td>1 mark per correct column of W and X

No half marks

Table <u>must</u> be completed using (logic) 1’s and (logic) 0’s.</td></tr>
<tr><td>7</td><td>b</td><td>ii</td><td>The alarm would be set off when the imitation £20 was in the drawer.</td><td>1</td><td><u>Must</u> mention the 20 pound note being in the drawer or the reverse ie if the 20 pound note is removed the alarm does not sound

Any indication that the alarm would be continually sounding when the note is in the drawer.

Accept:
• Alarm “sounds when note is in drawer”
• Alarm “goes off when note is in drawer”(‘goes off’is acceptable slang for ‘sounds’</td></tr>
<tr><td>7</td><td>b</td><td>iii</td><td>$P = \frac{V^2}{R}$ (½)
$3 = \frac{V^2}{48}$ (½)
$V^2 = 144$
$V = 12\ V$ (1)

OR
$P = I^2R$
$3 = I^2 \times 48$
$I = 0 \cdot 25\,(A)$
then
$V = IR$ OR $P = IV$
$= 0 \cdot 25 \times 48$ $3 = 0 \cdot 25 \times V$
$= 12\ V$ $V = 12\ V$</td><td>2</td><td>deduct (½) for wrong/missing unit

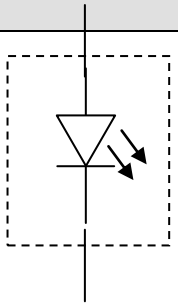
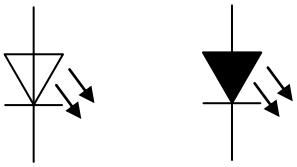
Do NOT accept $V^2 = 144 = 12V$ (max 1 mark)

For alternative version of calculation opposite:

(½) for both formulae

(½) for all substitutions correct

(1) for final answer</td></tr>
</table>

Question			Expected Answer/s	Max Mark	Additional Guidance
8	**a**	**i**		**1**	(1) or (0) accept  (1) for correct symbol <u>in correct orientation</u> - no (½) marks must have connecting wires at both ends accept: • no line through middle • arrows could be either side • accept black (fill) triangle
8	**a**	**ii**	Protect the LED OR prevent damage to the LED OR limits the current OR reduces voltage across LED	**1**	(1) for a correct answer. Not: • 'voltage through/current across LED.' • To reduce voltage alone • To stop LED 'blowing'. • To reduce charge/power to LED • To prevent LED overheating
8	**a**	**iii**	$V_R = 6\text{-}1\cdot 2 = 4\cdot 8$ V (1) $V = IR$ (½) $4\cdot 8 = 15\times 10 - 3\times R$ (½) $R = 320\ \Omega$ (1)	**3**	If error can be seen in subtraction to get V_R then can still get (2) marks **If no subtraction** and 6 V or 1·2 V used in calculation for R then (½) MAX for equation. Deduct (½) for wrong/missing unit This can also be answered using voltage divider method.
8	**b**		The explanation may start at **any** stage but each (½) should be obtained for: • Capacitor charging /discharging (½) • Voltage at X increasing /X becomes logic 1 and so Y becomes logic 0 (½) • (C discharges/is uncharged and so voltage at) X becomes logic 0 and Y becomes logic 1 (½) • Process repeats (½)	**2**	4 independent (½) marks. Candidates answer MUST refer to X and Y. Accept answers referring to High (logic 1) and Low (logic 0) Do NOT accept capacitor "filling up" or "being empty". Ignore any comments regarding the on/off status of the LED.

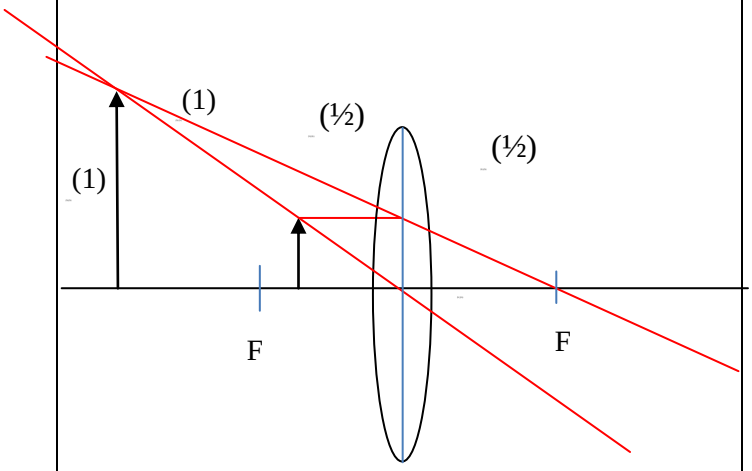
Question			Expected Answer/s	Max Mark	Additional Guidance
8	**c**		Increase the capacitance (of C) OR Increase the resistance (of R_1)	**1**	Do not accept: • Use 'bigger/larger' resistor • Use 'bigger/larger' capacitor • Increase voltage • "increase resistance of (both) resistor**s**" • "increase resistance of R_2" • "increase value of capacitor" • "increase value of resistor" Apply +/- where appropriate eg use a larger capacitor (-) which takes longer to charge (+).

Question			Expected Answer/s	Max Mark	Additional Guidance
9	a		$W = mg$ (½) $= 230 \times 10$ (½) $= 2300$ N (1)	2	deduct (½) for wrong/missing unit Accept values calculated using: g = 9·8 (2254 N) g = 9·81 (2256.3N)
9	b		2300 N	1	Unit required 1 or 0 Must use correct answer or answer from 9(a) Do not accept: "the same"
9	c		$E_P = mgh$ (½) $= 230 \times 10 \times 12$ (½) $= 27\ 600$ J (1) sig figs : {30 000, 28 000}	2	No dotted line from 9 (a) Accept values calculated using: g = 9·8 (27 048 J sf:) g = 9·81 (27 076 J sf:) deduct (½) for wrong/missing unit
9	d	i	$E_P = E_K$ (½) ½ mv^2 (½) = mgh (½) ½ x2.5 x v^2 = 2.5 x10 x 12 (½) $v = 15 \cdot 49$ m/s (1) **OR** $E_P = mgh$ (½) = 2.5 x10 x 12 = 300 (J) (½) E_k = ½ mv^2 (½) 300 = ½ x2.5 x v^2 (½) $v = 15 \cdot 49$ m/s (1) **OR** $v = \sqrt{2gh}$ (1) for implied conservation of energy and (½) for equation $= \sqrt{2 \times 10 \times 12}$ (½) $= 15 \cdot 49$ m/s (1)	3	For E_k= ½ mv^2 stated or implied award (½) For Ep= mgh stated or implied award (½) For equating Ep = E_k (or mgh to ½ mv^2) (½) (this can be implied) at any point Note: the answer for Q9 (c) **cannot** be used because it is not the E_k of the tile. ie E_k =27600J would not (½) get for **implied** conservation. s.f. 15, 15.5, 15.49

Question			Expected Answer/s	Max Mark	Additional Guidance
9	**d**	**ii**	Air resistance OR (air) friction (will slow it down)	**1**	Must be **air** resistance not resistance on its own. Accept: "Energy is lost due to friction"
10	**a**		$a = \frac{v-u}{t}$ (½) $= \frac{18-0}{15}$ (½) $= 1 \cdot 2 \text{ m/s}^2$ (1)	**2**	If wrong values extracted from graph then (½) MAX for equation deduct (½) for wrong/missing unit Do not accept a = v/t as wrong equation- stop marking and award (0) marks
10	**b**		d = area under graph (½) $= (½ \times 15 \times 18) + (50 \times 18)$ (½) $= 1035$ m (1)	**2**	If wrong substitution then (½) MAX for (implied) equation. Deduct (½) for wrong/missing unit. Any attempt to use d = vt applied to the **whole** graph is wrong physics (0) marks.
10	**c**	**i**	• (wear) tight fitting clothes • Crouch • (wear) streamlined helmet • Streamlined shoes • Solid wheels	**1**	Question refers to the cyclist in picture so answer should refer to this Not: 'Pushes forward'
10	**c**	**ii**	• Tyres • (handle) grips • Brakes • Shoes on pedals • Saddle	**1**	Not: Wheels

Question			Expected Answer/s	Max Mark	Additional Guidance
11	**a**		Increases voltage OR step-up transformer	**1**	Step-up voltage Decrease/reduce current Reduce power/energy/heat loss Apply +/- for additional incorrect responses offered (eg reduce resistance)
11	**b**		$\frac{n_s}{n_p} = \frac{V_s}{V_p}$ (½) $\frac{960}{120} = \frac{V_S}{2 \cdot 5}$ (½) $V_S = 20$ V (1)	**2**	deduct (½) for wrong/missing unit accept inverted version of formula (Vp/Vs = Np/Ns)
11	**c**		$P = I^2R$ (½) $= (200 \times 10^{-3})^2 \times 20$ (½) $= 0 \cdot 8$ W (1)	**2**	deduct (½) for wrong/missing unit watch for unit conversion errors – penalise unit error only once
12	**a**	**i**	Liquid to gas OR Liquid → gas OR Liquid - gas	**1**	1 mark for correct answer no (½) marks Must refer to states "liquid and gas" Not: • Vapourising • Evaporating/boiling
12	**a**	**ii**	Heat (energy) (needed to change state) is removed from • water or • air from the freezer section or • inside machine /freezer section	**1**	Answer should link both: • heat is being removed • the location from where the heat is removed Do not accept temperature alone based answers
12	**b**		$l_f = 3.34 \times 10^5$ (J/kg) (1) $E_H = ml$ (½) $= 1.5 \times 3.34 \times 10^5$ (½) $= 5 \cdot 01 \times 10^5$ J (1)	**3**	For any other value for l_f used from specific latent heat of fusion of materials table then (2) max - any other value for l_f then (½) max for equation deduct (½) for wrong/missing unit

Question			Expected Answer/s	Max Mark	Additional Guidance
13	**a**		$E = Pt$ (½) $= 1500 \times 35$ (½) $= 52\ 500$ J (1)	**2**	Deduct (½) for wrong/missing unit Watch for unit conversion errors – penalise unit error only once
13	**b**		$E = cm\Delta T$ (½) $52\,500 = 902 \times m \times (200 - 24)$ (½) $m = 0.33\,\text{kg}$ (1)	**2**	Must use value for Energy from 13(a) OR correct value. Must use value for c given in question otherwise (½) max for equation Deduct (½) for wrong/missing unit Sig fig range: 0.3, 0.33, 0.331, 0.3307.
13	**c**		Heat is • Lost OR • Radiated OR • escapes OR from the sole plate	**1**	Accept: • Heat is lost/radiated/ escapes to the surroundings • Some of the heat (energy) is used to heat other parts of the iron The explanation should indicate that <u>heat</u> is lost from/to... eg • power rating of iron is incorrect • inaccurate temperature readings etc.
14	**a**		Yerkes/one/an image will be: • brighter OR • more detailed OR Mills/one/an image will be: • less bright OR • less detailed	**1**	1 mark for a correct answer no (½) marks ACCEPT: • "One is brighter (and clearer)" • Brightness • "picture" instead of image NOT: • Clearer/sharper alone • Brighter alone • Larger/bigger alone • Resolution
14	**b**		$d = vt$ (½) $= 3 \times 10^8 \times (1 \times 365 \times 24 \times 60 \times 60)$ (1) + (½) $= 9 \cdot 4608 \times 10^{15}$ (m)	**2**	**This is NOT a standard 2-marker** (½) mark for initial equation (1) mark for speed of light (½) mark for correct substitution of time **No** marks for final answer (given) Unit not required but deduct (½) -if wrong Accept the number 31536000s given in place (1 x 365x 24 x60 x60)

Question			Expected Answer/s	Max Mark	Additional Guidance
14	**c**			**3**	(1) for extrapolated ray from object through centre undeviated and extrapolated back towards the image position (½) for ray from object to lens parallel to principal axis (must not extend beyond the right hand side of the lens, refraction can occur anywhere within the lens) (½) for the ray to then pass through focus and be extrapolated back towards image position. This (½) mark is dependent on a correctly drawn parallel ray. (1) for drawing in the correctly positioned and upright image (need not be labelled but if labelled incorrectly apply +/- rule and deduct 1 mark) Lines should be passably straight. Accept reasonably accurate drawing of rays.
14	**d**		Different frequencies/ wavelengths /signals require different detectors/telescopes OR Certain detectors/telescopes cannot pick up certain frequencies/wavelengths/signals OR Different signals have different frequencies/ wavelengths	**1**	1 mark for a correct answer - No (½) marks Accept: • Different telescopes detect different signals Do not accept: • 'Different types of signals'- **unless** mentioned along with different wavelengths/ frequencies/telescopes/ detectors. • "types of radiation" – ambiguous – could be α or β • Any mention of sound "types of wave" or "wave" – too vague

Question			Expected Answer/s	Max Mark	Additional Guidance
15	**a**	**i**	• Weight per unit mass OR • Force/pull per kg OR • Weight per kg	**1**	Do NOT accept: • 'gravity per kg' • 'same as 10 m/s^2' • 'newtons per kilogram'
15	**a**	**ii**	8·6 N/kg	**1**	Exact value required no tolerance from graph allowed1 or 0 Unit required for mark
15	**b**	**i**	$W = mg$ (½) $= 75 \times 8 \cdot 6$ (½) $= 645$ N (1)		Must use value given in 15(a)(ii) OR correct value deduct (½) for wrong/missing unit
15	**b**	**ii**	75 kg	**1**	1 or 0 must have unit
15	**c**	**i**	max power = number × area of panels × power per unit area (½) $= 4 \times 375 \times 87 \cdot 5$ (½) $= 131250$ W (1)	**2**	**Not standard 2 marker** first half mark may be implied by substitutions and awarded. deduct (½) for wrong/missing unit s.f. accept 131 kW, 130 kW, 131.3kW
15	**c**	**ii**	Only produces: • Voltage OR • Power OR • energy (or works) when (sun)light is **incident/shining** on them	**1**	Accept: Look for answers linking solar cells producing an output when light shines on them eg: • Only works when (sun)light shines on them • Does not work when ISS is not in (sun)light • Does not work when it is dark Do NOT accept: • Only works when sunny - (must refer to (sun)light shining on the panels) • Answers relating to cost, efficiency, installation and repair

[END OF MARKING INSTRUCTIONS]