2013 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 **Credit Marking Instructions** (GMI) provides guidance on all marking issues.
http://www.sqa.org.uk/files_ccc/Physics_Credit_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 response '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 the unit has the correct prefix.
eg for an answer <u>t = 0·005 seconds</u>, 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).

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

If d = 4 km
t = 2 minutes

$$v = \frac{d}{t} \quad (½)$$

$$= \frac{400}{2} \quad (½)$$

$$= 200 \quad (½)$$

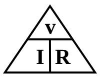
Although the candidate has made three unit errors (not correctly converted distance or time and has omitted the final unit) this would only attract **½ mark unit penalty**.

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	
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 <u>t = 400 000 s</u>, 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**		Orbit or period of 24 hours (1 day) OR Stays / orbits above the same point on the Earth('s surface) OR Stays at the same point above the Earth 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** **(KU)**	Do not accept: • 'Same speed as Earth' • '(Stays above) same point in space • 'Stationary' or implication of stationary e.g stays **at** the same point • 42 000 km above the Earth's surface. (unless stated above the centre of (the Earth))
1	**b**		Accept an unambiguous answer which indicates that the fibre is long thin/flexible strand/thread of glass. e.g. strand of glass/plastic thread of glass/plastic a long thin piece of glass/plastic flexible piece of glass	**1** **(KU)**	Do not accept: • Any answer relating to **tube** or implication thereof. • Hollow • Cable • Wire • Shred • **'Piece** of glass' alone
1	**c**		<table><tr><td>Signal</td><td>Transmission speed in m/s</td></tr><tr><td>Satellite</td><td>3×10^8</td></tr><tr><td>Optical Fibre</td><td>2×10^8</td></tr></table>	**2** **(KU)**	1 mark for each correct response Accept: 300 000 000 or 3.0×10^8 200 000 000 or 2.0×10^8 Or value in words Unit not required but do not award mark if a wrong unit is given (0 marks)

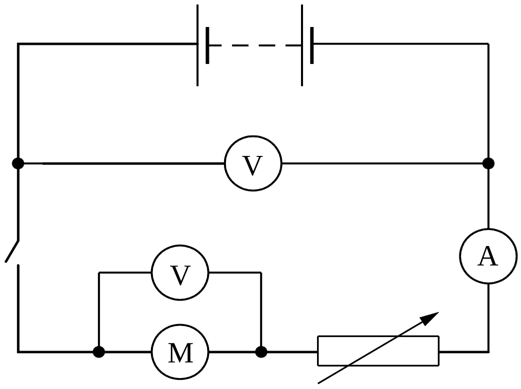
Question			Expected Answer/s	Max Mark	Additional Guidance
1	d		$t = \frac{d}{v} = \frac{50000}{2 \cdot 0 \times 10^8} = 0 \cdot 00025$ (s) (1) $t = \frac{d}{v} = \frac{73084000}{3 \cdot 0 \times 10^8} = 0 \cdot 243613$ (s) (1) time delay = 0·243613 – 0·00025 = 0·243363s = 0·243s (1)	**3** **(PS)**	Non-standard (3) mark question: (no marks allocated for stating correct equation). The first 2 marks are awarded for the calculation of the times for the signals to reach House A and House B. Accept values for transmission speed consistent with answer to Q1(c). Deduct maximum (½) mark for unit error even if more than one unit error is shown. Deduct maximum (½) mark for arithmetic error even if more than one arithmetic error is shown. Ignore units in intermediate steps. sig. fig. range: 1–3 0·2, 0·24, 0·243
2	a		Sounds (of frequency) greater than 20,000Hz.	**1** **(KU)**	Answer make must make reference to frequency/pitch. Accept: • frequency/pitch above the range of human hearing • frequencies above 20000Hz Do not accept: "sounds above human hearing range"
2	b	i	5 µs (OR 5 × 10^{-6} s, 0·000005s)	**1** **(PS)**	deduct (½) for wrong/missing unit
2	b	ii	5200 m/s	**1** **(PS)**	Unit required

Question			Expected Answer/s	Max Mark	Additional Guidance
2	**b**	**iii**	$d = v \times t$ (½) $= 5200 \times 5 \times 10^{-6}$ (½) $= 0{\cdot}026$ (m) (1) Unit required above if left as final answer. distance = $\frac{0\cdot026}{2} = 0{\cdot}013$m (1)	**3** **(PS)**	Accept value for time and speed consistent with answer to 2(b)(i) and 2(b)(ii). Final mark for halving process (this may occur at any stage in the calculation) Deduct (½) if wrong/missing unit in final answer If time used is 7µs then final distance = 0·0182 m (award 3 marks) If time used is 12 µs then final distance = 0·0312 m (award 3 marks)
2	**b**	**iv**	$\lambda = \frac{v}{f}$ (½) $= \frac{5200}{15\times10^{6}}$ (½) $= 3{\cdot}5 \times 10^{-4}$ m (1)	**2** **(KU)**	Accept value for speed consistent with answer to 2(b)(ii) sig. fig. range 1–4 3×10^{-4} m $3{\cdot}5 \times 10^{-4}$ m $3{\cdot}47 \times 10^{-4}$ m $3{\cdot}467 \times 10^{-4}$ m
3	**a**		Parallel	**1** **(KU)**	Only answer ignore spelling
3	**b**		$I = \frac{P}{V}$ (½) $= \frac{300}{230}$ (½) $= 1{\cdot}3$A (1) OR $I = \frac{P}{V}$ (½) $= \frac{900}{230}$ $= 3{\cdot}9$ Current in one mat $= \frac{3.9}{3}$ (½) $= 1.3$A (1)	**2** **(KU)**	sig. fig. range: 1–3 1A 1·3A 1·30A

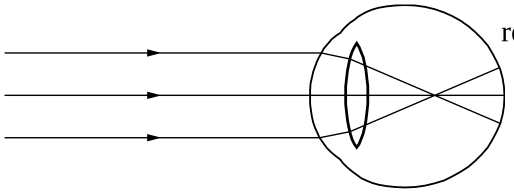
Question			Expected Answer/s	Max Mark	Additional Guidance
3	**c**		$P_{total} = 3 \times 300W = 900W$ (1) $R = \frac{V^2}{P}$ (½) sig. fig. 1–3 range: 60Ω 59Ω 58·8Ω $= \frac{230^2}{900}$ (½) 59 Ω (1) OR $I_{total} = 3 \times 1{\cdot}3 = 3{\cdot}9A$ (1) $R = \frac{P}{I^2}$ (½) sig. fig. 1–3 range: 60Ω 59Ω 59·2Ω $= \frac{900}{3{\cdot}9^2}$ (½) = 59 Ω (1)	**3**	OR consistent with using answer to Q3(b) if a valid method using current is used e.g. $R_{mat} = \frac{V}{I}$ (½) $= \frac{230}{1{\cdot}3}$ (½) $= 176.92\,\Omega$ Then to calculate R_t $R_t = \frac{176{\cdot}92}{3}$ (1) $= 59\Omega$ (1) *OR* $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ (½) $\frac{1}{176{\cdot}92} + \frac{1}{176{\cdot}92} + \frac{1}{176{\cdot}92}$ (½) $R_t = 59\,\Omega$ (1) sig. figs,: 1 - 4 60, 59, 59·0, 58·97 **OR**: $R_{mat} = \frac{P}{I^2}$ (½) $= \frac{300}{1{\cdot}3^2}$ (½) $= 177{\cdot}51(\Omega$ Then to calculate R_t $R_t = \frac{177{\cdot}51}{3}$ (1) $= 59\Omega$ (1) *OR* $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ (½) $\frac{1}{177{\cdot}51} + \frac{1}{177{\cdot}51} + \frac{1}{177{\cdot}51}$ (½) $R_T = 59\,\Omega$ (1) sig. figs,: 1 - 3 60, 59, 59·2

<table>
<tr><th colspan="3">Question</th><th>Expected Answer/s</th><th>Max Mark</th><th>Additional Guidance</th></tr>
<tr><td>3</td><td>c</td><td></td><td>cont</td><td>(PS)</td><td>OR
$I_{total} = 3 \times 1 \cdot 3$
$= 3 \cdot 9 (A)$ (1)
$R_t = \frac{V}{I_{total}}$ (½)
$= \frac{230}{3 \cdot 9}$ (½)
$= 59\,\Omega$ (1)
sig. fig. range 1 - 4
60
59
59·0
58·97</td></tr>
<tr><td>3</td><td>d</td><td></td><td>Accept explanation of:
both open and short circuit given in terms of high and low resistance readings.
open circuit in terms of high resistance reading.
e.g. The faulty mat would have a
higher resistance
(very) high resistance
infinite resistance
reading higher than 176.92Ω or 177Ω
reading higher than expected</td><td>1

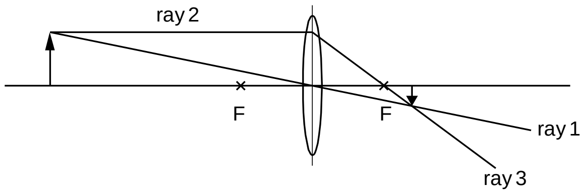
(KU)</td><td>Do not accept:
(flashing)‘1’ ohmmeter reading only
High number of ohms
answer in terms of short circuit and low resistance only.</td></tr>
</table>

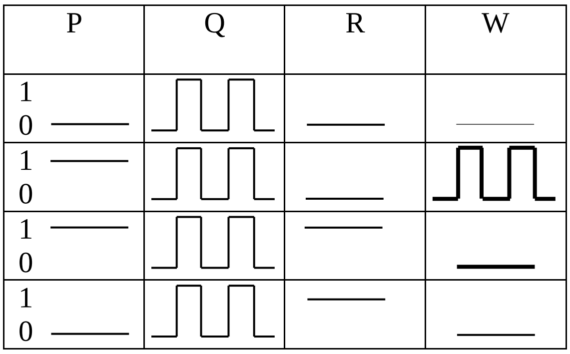
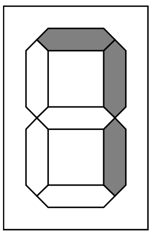
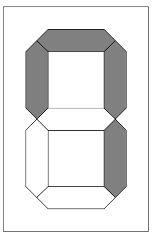
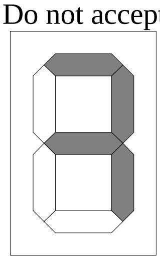
Question			Expected Answer/s	Max Mark	Additional Guidance
4	**a**			**1** **KU)**	Must have **all** labels correctly positioned . (1) or (0) only
4	**b**		$V_r = V_s - V_{motor}$ $= 24 - 18 = 6(V)$ (1) $I = \frac{V_r}{R}$ (½) $= \frac{6}{2 \cdot 1}$ (½) $= 2{\cdot}9A$ (1)	**3** **(PS)**	If arithmetic error can be seen in subtraction to get V_R then deduct (½) mark. Candidate can still get next (2) marks. **If no subtraction** and 24 V or 18 V used in calculation for V then (½) MAX for equation. Deduct (½) for wrong/missing unit $I = \frac{V}{R}$ sig. fig. range: 1–4 3A 2·9A 2·86A 2·857A
4	**c**		$Q = I \times t$ (½) $= 3{\cdot}2 \times (10 \times 60 \times 60)$ (½) $= 115200C$ (1)	**2** **(KU)**	Accept: 100000C, 120 000C, 115 000C, 115200C. If wrong or no conversion into seconds then deduct ½ mark.

Question			Expected Answer/s	Max Mark	Additional Guidance
4	d		Accept • Change the polarity of the battery • Swap over the connections to the motor • Change **the direction** of the current • Reverse current • Swap battery terminals	1 **(PS)**	Do not accept • "swap battery" alone. • Turn the battery around alone. • Swap the battery around alone. • Any answers relating to magnetic field (not relevant to this question) If more than one answer apply ± rule.
5	a		$P = \frac{1}{f}$ (½) $= \frac{1}{0 \cdot 4}$ (½) $= 2 \cdot 5\text{D}$ (1)	2 **(KU)**	deduct (½) if wrong/no conversion from 400 mm (treated as unit penalty)
5	b	i	Close objects are seen clearly / in focus **and** distant objects are blurred/out of focus. OR (Photographer) can **only** focus on / see clearly nearby objects.	1 **(KU)**	Do not accept: • answers relating to distant objects alone e.g. only distant objects are blurred • "cannot see distant objects" • Any reference to rays in the eye/ ray diagrams.

Question			Expected Answer/s	Max Mark	Additional Guidance
5	**b**	**ii**	 Passably straight lines required	**1** **(KU)**	Two independent ½ marks. (½) for showing correct refraction direction (at cornea or lens or both). (½) for showing convergence before retina and continuing to the retina. Ignore rays continued beyond retina no dotted line from 5(b)(i) must be answer relating to short sight

Question			Expected Answer/s	Max Mark	Additional Guidance
5	**b**	**iii**	concave OR diverging	**1** **(KU)**	
5	**c**		<u>Method 1</u> $t = \frac{1}{250} = 0 \cdot 004(s)$ (1) $P = \frac{E}{t}$ (½) $= \frac{60 \times 10^{-3}}{0 \cdot 004}$ (½) $= 15W$ (1) <u>Method 2</u> $E_{Total} = 250 \times 60 \times 10^{-3}$ (J) (1) $P = \frac{E}{t}$ (½) $= \frac{15}{1}$ (½) $= 15W$ (1)	**3** **(PS)**	• If correct time correctly calculated or stated award (1) mark (this may appear anywhere in the answer). • If time is stated or calculated wrongly and no calculation shown then (½) mark maximum for the power equation. • If calculation for the time / energy is shown and calculation contains an arithmetic error then deduct (½) mark (See GMI 7)

Question			Expected Answer/s	Max Mark	Additional Guidance
5	d		 • ray 1 should pass through the centre of lens (½) • ray 2 should be parallel to principal axis (½) • ray 3 should **pass through** focus F (½) • image arrowhead should be drawn upside down at position where rays 1 and 3 meet (½)	**2** **(PS)**	Passably straight lines required. Ray 2 must not extend beyond the right hand side of the lens, refraction can occur anywhere within the lens. Rays 1 and 3 need not extend beyond where they meet. Ignore extensions or extrapolations of ray 1 and ray 3.
6	a		gamma radiation can penetrate the body OR as beta radiation cannot penetrate the body	**1** **(KU)**	Accept: • Penetrate • Pass through • Body does not absorb gamma (or converse for a beta answer) Do not accept: • Answers relating to half-life only. • escapes from • 'It' can penetrate the body.
6	b		$12 \rightarrow 6 \rightarrow 3 \rightarrow 1.5$ (MBq) (½) 3 half-lives (can be implied) (½) $3 \times 13 = 39$ (hours) (½) 5pm on May 1st (or 17:00 on 1st May) (½)	**2** **(PS)**	Any halving (or doubling process $1.5 \rightarrow 3 \rightarrow 6 \rightarrow 12$) (½) mark is independent of the number of half-lives.
6	c	i	All windows shaded	**1** **(PS)**	(1) or (0)

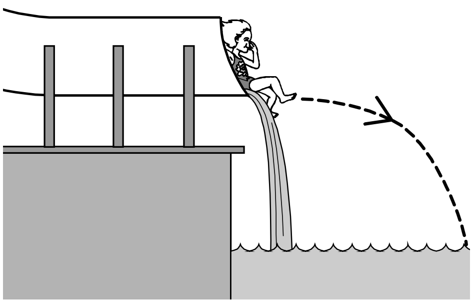
Question			Expected Answer/s	Max Mark	Additional Guidance
6	**c**	**ii**	The blacker the film (½) the more radiation they have been exposed to (½)	**1** **(KU)**	Only award Second half mark if first statement is correct. Accept: • Darker • Foggier Relating to the film Do not accept: • the film changes colour alone. • the film clouds • answers relating to film **badge** / window.
7	**a**		AND (1)	**1** **(KU)**	Accept: • and • And
7	**b**		 Answers shown 2nd and 3rd down in the W column	**2** **(PS)**	(1) for each correct entry Accept **minimum of two** pulses regardless of amplitude or position for the square wave. Ignore additional pulses if more than two are given.
7	**c**	**i**	0111 = 7	**1** **(PS)**	
7	**c**	**ii**	 or  only.	**1** **(KU)**	Or consistent with binary conversion from c(i) Do not accept: 

Question			Expected Answer/s	Max Mark	Additional Guidance
8	**a**		Voltage gain $= \frac{V_{out}}{V_{in}}$ (½) $= \frac{0\cdot5}{0\cdot02\times10^{-3}}$ (½) $= 25000$ (1)	**2** **(KU)**	deduct (½) mark if any unit given. Deduct ½ mark maximum for unit error(s). e.g. 0.5/0.02 = 25V (1 ½ marks) but 25(V) with no working award 0 marks 25000 times, ignore 'times'
8	**b**	**i**	Transistor (switch)	**1** **(KU)**	Ignore any prefix (eg bipolar, NPN, PNP)
8	**b**	**ii**	• (As temp increases,) input voltage to transistor increases (½) • (above 0·7V) switching transistor on (½) • Current in the (relay) coil (producing magnetic field). (½) • (Relay) switch closes / activates, (½) (completing the bell circuit/ operating the bell).	**2** **(PS)**	(½) for each correct stage mentioned First bullet point may refer to voltage (output) from thermocouple or amplifier increasing but do not accept 'voltage' alone. 4 independent (½) marks. Do not accept: 'transistor is saturated'
8	**c**	**i**	Power gain $= \frac{P_{out}}{P_{in}}$ (½) $4000 = \frac{P_{out}}{20\times10^{-3}}$ (½) $P_{out} = 80W$ (1)	**2** **(KU)**	Must use the power gain relationship.

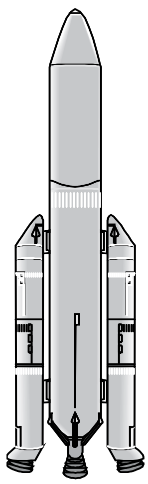
Question			Expected Answer/s	Max Mark	Additional Guidance
8	**c**	**ii**	$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2}$ (½) $= \frac{1}{16} + \frac{1}{16}$ (½) $= \frac{2}{16}$ $R_t = 8\Omega$ (1)	**2** **(PS)**	If wrong equation used eg $R_T = \frac{1}{R_1} + \frac{1}{R_2}$ then zero marks Accept *imprecise* working towards a final answer $\frac{1}{R_T} = \frac{1}{16} + \frac{1}{16} = 8\ \Omega$ accept deduct (½) for wrong/missing unit Can be answered by applying product over sum method. can be answered using 'identical value'parallel resistors method: $R = \frac{\text{value for single resistance}}{\text{total no. of resistors in parallel}}$
9	**a**		The **total** (race) **distance** divided by the (total) **time** taken.	**1** **(KU)**	Accept: Speed over a **large time** Do not accept: • the formula alone. • the mean value of the numbers in the table.

Question			Expected Answer/s	Max Mark	Additional Guidance
9	b		Must be a clear indication of runners in lanes **2, 4 and 5 only** qualifying – if no indication, stop marking award (0) marks. If runners in **lanes 2, 4 and 5 only** are identified then must have full / partial justification. For justification (2) marks : 1. Look for evidence of speed, distance, time formula given correctly: if none stop marking, award (0) marks for **entire response**. 2. If there is a correct $v=\frac{d}{t}$ calculation for minimum qualifying speed of runners (method 1) - this is full justification award (2) marks. 3. If there are correct $t=\frac{d}{v}$ calculations for some runners (but must include runners 5 and 6) (method 2), this is full justification award (2) marks. 4. If either point 2 or 3 above are not fulfilled but a correct formula involving speed, distance and time is visible award (½) mark only. <u>Method 1:</u> calculate minimum speed required $v=\frac{d}{t}$ (½) (not a standard 2 marker) $=\frac{200}{21\cdot4}$ (1) for **both** substitutions = 9·35 (m/s) (½) so runners in lanes <u>2, 4, 5</u> qualify (1) <u>Method 2:</u> $t=\frac{d}{v}$ (½) Must calculate time for runners in lanes 5 and 6 (1½) OR calculate each runner's individual time (all times must be correct) so runners in lanes <u>2, 4, 5</u> qualify (1)	3 **(PS)**	Do not accept the converse (i.e runners in lanes 1, 3 and 6 do not qualify) as this does not answer the question. <u>Method1</u> The minimum calculated speed should not be rounded to less than 2 decimal places <u>Method 2</u> The calculated times for runners in lanes 5 and 6 produce the times for the slowest qualifier and fastest non-qualifier. Lane 1: t = 21·60 (s) Lane 2: t = 21·14 (s) Lane 3: t = 21·48 (s) Lane 4: t = 21·23 (s) **Lane 5: t = 21·32 (s)** **Lane 6: t = 21·41 (s)** <u>Method 3;</u> Could work out the distance covered in the qualifying time each runner. Those covering 200m or more qualify. Unit not required here but if wrong unit for 9·35 m/s given do not award this (½) mark.

Question			Expected Answer/s	Max Mark	Additional Guidance
9	**c**	**i**	$a = \frac{(v - u)}{t}$ (½) $= \frac{(11 - 0)}{5 \cdot 8}$ (½) $= 1 \cdot 9\ m/s^2$ (1)	**2** **(KU)**	If wrong values extracted from graph then (½) MAX for equation. If t = 6 then wrong substitution award (½) mark max for (implied) equation. Deduct (½) for wrong/missing unit. Do not accept a = v/t as this is the wrong equation - stop marking and award (0)marks. sig. fig. range 1–4 1·9, 1·90, 1·897, 2
9	**c**	**ii**	distance = area under graph (½) $= \frac{1}{2}$ (11 × 5·8) + (11 × 6) (½) 31·9 + 66 = 97·9 m (1)	**2** **(PS)**	Any attempt to use d = vt applied to the graph is wrong physics (0) marks. If first time ≠ 5·8 then (½) mark max for implied equation. sig. fig. range 1–3 97·9, 98, 100
10	**a**		E_p = mgh (½) = 42 × 10 × 7·5 (½) = 3150 J (1)	**2** **(KU)**	sig. fig. 1–3 3000, 3100, 3150, 3200 Accept values calculated using: g = 9·8 (3087J sf: 3090, 3100 and 3000) g = 9·81 (3090 J sf: 3100, 3000) deduct (½) for wrong/missing unit
10	**b**		E_w = Fd (½) 1050 = 15d (½) d = 70 m (1)	**2** **(KU)**	

Question			Expected Answer/s	Max Mark	Additional Guidance
10	c		$E_k = E_p - E_h$ (½) $= 3150 - 1050$ $= 2100$(J) (½) unit not required $E_k = ½mv^2$ (½) $2100 = ½ \times 42 \times v^2$ (½) $v = 10$ m/s (1)	3 **(PS)**	or value for E_p consistent with answer to Q10(a) If arithmetic error can be seen in subtraction to get E_K then deduct (½) mark. Candidate can still get next (2) marks. **If no subtraction is attempted** and 1050 J or answer from 10(a) is used in calculation for speed then (½) MAX for kinetic energy equation. the first two (½) marks for calculating 2100 J can be implied and awarded if 2100 appears in the calculation to determine the speed.
10	d			1 **(PS)**	arrow not required line must be curved do not accept straight line Projectile path should not rise.
11	a		$\frac{N_s}{N_p} = \frac{V_s}{V_p}$ (½) $\frac{N_s}{4760} = \frac{2 \cdot 9}{230}$ (½) $N_s = 60$ (turns/ coils) (1)	2 **(KU)**	Accept the inverted version of the formula Accept 60.02 (½) mark deduction if any unit given ('turns', 'coils' acceptable) 60t or 60T wrong unit deduct (½) mark

Question			Expected Answer/s	Max Mark	Additional Guidance
11	b		Both efficiency and power equations are required for formula (½) mark (can be implied) (percentage) efficiency $= \frac{P_{out}}{P_{in}} \times 100$ (½) for both equations. $35 = \frac{4 \cdot 06}{P_{in}} \times 100$ (½) $P_{in} = 11 \cdot 6$ (W) (½) $P_{in} = I_p V_p$ $11 \cdot 6 = I_p \times 230$ (½) $I_p = 0 \cdot 05$A (1)	3 (PS)	Alternative methods possible.
11	c		Energy is lost as sound OR heat (within the transformer coils/core.)	1 (KU)	Accept: Heat is lost/radiated/ escapes to the surroundings
12	a		$E_h = cm\Delta T$ (½) $= 4320 \times 82 \times 125$ (½) = 44 280 000 J (1)	2 (KU)	Must use value for c given in question, otherwise (½) mark max for equation sig. fig. range 1–4 40 000 000 44 000 000 44 300 000 44 280 000
12	b		60% × 44280000 = 26568000(J) (1) $E_h = ml$ (½) $26568000 = m \times 3 \cdot 42 \times 10^5$ (½) m = 77·7 kg (1)	3 (PS)	or consistent with Q12(a) calculation of 60% may occur at any stage in the calculation. if no or wrong calculation using 60% is present , then award (½) mark max for latent heat equation sig. fig. range 2 - 5: 77·684, 77·68, 77·7, 78

Question			Expected Answer/s	Max Mark	Additional Guidance
12	**c**	**i**	Any appropriate renewable energy **source** Accept: Wind(power), Waves/ Tidal, Hydro(electric), Solar/ Sun(light), Biomass.	**1** **(KU)**	if more than 1 answer given then zero marks if a non-renewable source is included Do not accept: nuclear energy, Wind turbines, Solar panel(s) Water,
12	**c**	**ii**	advantage (½) disadvantage (½)	**1** **(KU)**	advantage and disadvantage must relate to the actual **source** for Q12(c)(i) (½) each correct. Disadvantage cannot simply be the converse of the first answer. E.g. constant power throughout the day, none at night. For **advantages** Accept: • 'Clean'. Do not accept : • 'cheap' only • answers relating to cost e.g. free • 'clean' when the source is biomass
13	**a**		 thrust/engine force (½) for correct label <u>and</u> direction (½) for correct label <u>and</u> direction Weight/ Force due to gravity/ Gravitational pull	**1** **(PS)**	must have correct label <u>and</u> direction for each (½) mark. Accept: • Upthrust • Upward thrust • Upwards force • Force of gravity on the rocket • Force of gravity Do not accept: • Gravity alone,

Question			Expected Answer/s	Max Mark	Additional Guidance
13	**b**	**i**	W = mg (½) = $3{\cdot}08 \times 10^5 \times 10$ (½) = $3{\cdot}08 \times 10^6$ N (1)	**2** **(KU)**	accept correct calculations using g = 9·8 or 9·81 Accept 3 080 000 N
13	**b**	**ii**	F_{un} = 3352000 – 3080000 = 272000 (N) (1) F = ma (½) a $= \frac{272000}{308000}$ (½) = 0·883 m/s^2 (1)	**3** **(PS)**	or consistent with answer in 13(b)(i) If arithmetic error can be seen in subtraction to get F_{un} then deduct (½) mark. Candidate can still get next (2) marks. **If no subtraction is attempted** and 3352000 or answer from 13(b)(i) is used in calculation for acceleration then (½) MAX for equation. sig. fig. range 2–5 0·88 0·883 0·8831 0·88312
13	**c**		It moves with constant speed in the horizontal direction (1) while accelerating due to the force of gravity in the vertical direction (1)	**2** **(KU)**	Answer should be based on the following two points: • statement relating to horizontal motion: eg 'ISS moves forward' OR curvature of the earth, OR 'surface curves away'. (1) • statement relating to vertical motion eg 'falling (towards the Earth)', or force of gravity (1) Accept: • pull of gravity NOT 'gravity' alone

Question			Expected Answer/s	Max Mark	Additional Guidance
13	**d**	**i**	The astronaut is falling (towards Earth) at the same rate as the ISS OR The astronaut is in freefall	**1** **(KU)**	Do not accept: Answers related to • little/no/zero gravity • weightlessness alone
13	**d**	**ii**	The astronaut exerts a force against the wall (½) and the wall exerts an equal and opposite force against the astronaut (½) (causing him to move)	**1** **(PS)**	Answer must refer to the astronaut. Do not accept: a straight statement of Newton III
14	**a**		Hubble will be at a lower height. OR Converse in terms of Radioastron.	**1** **(KU)**	Accept: • less/reduced/ smaller (height) • It will be lower. • Closer to the Earth
14	**b**		P = X-rays Q = Ultra violet/UV	**1** **(KU)**	(½) for each correct
14	**c**		(Black bulb) thermometer OR photodiode OR phototransistor	**1** **(KU)**	Accept: thermofilm thermistor thermopile thermocouple thermographic film heat sensitive paper IR film CCD Do not accept: skin IR camera photographic film thermogram

[END OF MARKING INSTRUCTIONS]