



**2015 Physics**

**Higher (Revised)**

**Finalised Marking Instructions**

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## Part One: General Marking Principles for Physics Higher (Revised)

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) Marking should always be positive ie, marks should be awarded for what is correct and not deducted for errors or omissions.

### GENERAL MARKING ADVICE: Physics Higher (Revised)

The marking schemes are written to assist in determining the “minimal acceptable answer” rather than listing every possible correct and incorrect answer. The following notes are offered to support Markers in making judgements on candidates’ evidence, and apply to marking both end of unit assessments and course assessments.

#### 1. General Marking Instructions

SQA published Physics General Marking Instructions in July 1999. Please refer to this publication when interpreting the detailed Marking Instructions.

#### 2. Recording of marks

The following additional advice was given to markers regarding the recording of marks on candidate scripts.

- (a) The total mark awarded for each question should be recorded in the outer margin. The inner margin should be used to record the mark for each part of a question as indicated in the detailed Marking Instructions.
- (b) The fine divisions of marks shown in the detailed Marking Instructions may be recorded within the body of the script beside the candidate’s response. Where such marks are shown they must total to the mark in the inner margin.
- (c) Numbers recorded on candidate scripts should always be the marks being awarded. Negative marks or marks to be subtracted should not be recorded on scripts.
- (d) The number out of which a mark is scored should **never** be recorded as a **denominator**.  
(½ mark will always mean one half mark and never 1 out of 2)

- (e) Where square ruled paper is enclosed inside answer books it should be clearly indicated that this item has been considered by the marker. The mark awarded should be transferred to the script booklet inner margin and marked G.
- (f) The mark awarded for each question should be transferred to the grid on the back of the script. When the marker has completed marking the candidate's response to all questions, the marks for individual questions are added to give the total script mark.
- (g) The total mark awarded for an individual question may include an odd half mark –  $\frac{1}{2}$ . If there is an odd half mark in the total script mark, this is rounded up to the next whole number when transferred to the box on the front of the script.

### 3. Other Marking Symbols which may be used

TICK	–	Correct point as detailed in scheme, includes data entry
SCORE THROUGH	–	Any part of answer which is wrong. (For a block of wrong answers indicate zero marks.)
INVERTED VEE	–	A point omitted which has led to a loss of marks.
WAVY LINE	–	Under an answer worth marks which is wrong only because a wrong answer has been carried forward from a previous part.
“G”	–	Reference to a graph on separate paper. You MUST show a mark on the graph paper and the SAME mark on the script.

### 4. Marking Symbols which may NOT be used.

“WP”	–	Marks not awarded because an apparently correct answer was due to the use of “wrong physics”.
“ARITH”	–	Candidate has made an arithmetic mistake.
“SIG FIGS” or “SF”	–	Candidate has made a mistake in the number of significant figures for a final answer.

## 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.

	<b>Answers</b>	<b>Mark +comment</b>	<b>Issue</b>
1.	$V=IR$ $7.5=1.5R$ $R=5.0\Omega$	(½) (½) (1)	Ideal Answer
2.	5.0Ω	(2) Correct Answer	GMI 1
3.	5.0	(1½) Unit missing	GMI 2(a)
4.	4.0Ω	(0) No evidence/Wrong Answer	GMI 1
5.	_____Ω	(0) No final answer	GMI 1
6.	$R = \frac{V}{I} = \frac{7.5}{1.5} = 4.0\Omega$	(1½) Arithmetic error	GMI 7
7.	$R = \frac{V}{I} = 4.0\Omega$	(½) Formula only	GMI 4 and 1
8.	$R = \frac{V}{I} = \text{_____}\Omega$	(½) Formula only	GMI 4 and 1
9.	$R = \frac{V}{I} = \frac{7.5}{1.5} = \text{_____}\Omega$	(1) Formula + subs/No final answer	GMI 4 and 1
10.	$R = \frac{V}{I} = \frac{7.5}{1.5} = 4.0$	(1) Formula + substitution	GMI 2(a) and 7
11.	$R = \frac{V}{I} = \frac{1.5}{7.5} = 5.0\Omega$	(½) Formula but wrong substitution	GMI 5
12.	$R = \frac{V}{I} = \frac{7.5}{1.5} = 5.0\Omega$	(½) Formula but wrong substitution	GMI 5
13.	$R = \frac{I}{V} = \frac{7.5}{1.5} = 5.0\Omega$	(0) Wrong formula	GMI 5
14.	$V=IR$ $7.5 = 1.5 \times R$ $R=0.2\Omega$	(1½) Arithmetic error	GMI 7
15.	$V=IR$  $R = \frac{I}{V} = \frac{1.5}{7.5} = 0.2\Omega$	(½) Formula only	GMI 20

**Part Two: Marking Instructions for each Question**

**2015 Physics Higher (Revised)**

**Section A**

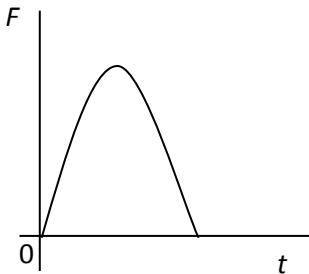
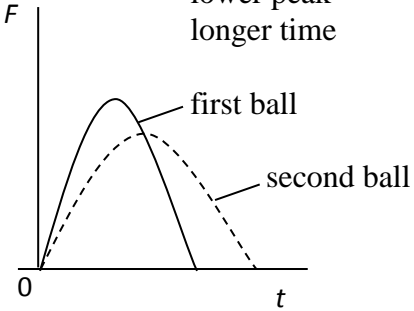
<b>Question</b>	<b>Expected Answer(s)</b>	<b>Max Mark</b>
1.	C	1
2.	B	1
3.	C	1
4.	E	1
5.	C	1
6.	E	1
7.	B	1
8.	D	1
9.	A	1
10.	D	1

<b>Question</b>	<b>Expected Answer(s)</b>	<b>Max Mark</b>
11.	A	1
12.	D	1
13.	D	1
14.	B	1
15.	A	1
16.	E	1
17.	B	1
18.	E	1
19.	E	1
20.	D	1

Section B:

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
21	a i	<b>A</b> $v = 11.6 \text{ m s}^{-1}$ (1)	Deduct (½) for wrong or missing units	1	8
		<b>B</b> $v_h = 11.6 \cos 40$ $= 8.9 \text{ m s}^{-1}$ (1) <b>(accept 8.886, 8.89, 9 not 9.0)</b>	or consistent with A	1	
		<b>C</b> $v_v = 11.6 \sin 40$ $= 7.5 \text{ m s}^{-1}$ (1) <b>(accept 7.456, 7.46, 7, not 7.0)</b>	or consistent with A	1	
21	a ii	<b>A</b> $s = ut + \frac{1}{2}at^2$ (½) $4.7 = 0 + \frac{1}{2} \times 9.8 \times t^2$ (½) $= 0.979$ (½) Total Time = $0.98 + 0.76$ $= 1.7 \text{ s}$ (½) <b>not 'secs'</b> <b>(accept 2, 1.74, 1.739)</b>	Alternative: $v^2 = u^2 + 2 a s$ $= 0 + 2 \times 9.8 \times 4.7$ $v = 9.6$ $v = u + at$ $9.6 = 0 + 9.8 t$ $t = 0.979$ Total $t = 0.98 + 0.76 = 1.7 \text{ s}$  $s$ and $a$ must have same sign  Accept 2 but not 2.0	2	
		<b>B</b> $v = \frac{d}{t}$ (½) $8.9 = \frac{d}{1.7}$ (½) $d = 15 \text{ m}$ (1) <b>(accept 15.1, 15.13)</b>	Or consistent with (a)(ii)(A) <b>and</b> (a)(i)(B)  1.74 is ok for $t$ , giving $d = 15, 15.5$ or $15.49$	2	
	b	<ul style="list-style-type: none"> <li>(total energy remains the same)</li> <li>the greater the angle the more energy used to lift the put to a greater height before release (½)</li> <li>less energy available to convert to <math>E_k</math> (½)</li> </ul>	<ul style="list-style-type: none"> <li>Kinetic energy is less (½)  <u>This statement is required before any marks awarded.</u></li> <li>(The release) speed is less (½)</li> </ul>	1 (1A)	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin	
22	a	$v^2 = u^2 + 2as$ $0 = 90^2 + 2 \times a \times 1980$ $a = -2.04545 (\text{ms}^{-2})$  $F = ma$ $= 3520 \times (-)2.04545$ $= (-)7200 (\text{N})$  $w = mg$ $= 3520 \times 1.25$ $= 4400 (\text{N})$  Force exerted by engines = $4400 + 7200$ $= 11600 \text{ N } (1/2)$	(1/2) (1/2)  (1/2) (1/2)  (1/2)	<u>Independent calculations</u> If 2000 for s, max (2) <i>u</i> and <i>s</i> must have the same sign  Negative sign missing subtract (1/2)  If drop negative sign from line 2 to line 3 subtract (1/2)  If final answer is 11500 N then student used <i>s</i> = 2000, max (2)	3 (3A)	5
	b	(Constant speed $\Rightarrow$ ) upward force = weight (1/2) $3 T \cos 20 = 1380$ (1 1/2)  $T = 490 (\text{N})$		Or "forces are balanced"  If "T = 490 (N)" not shown, then max (1 1/2)	2 (2A)	

Question		Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
23	a i	$Ft = mv - mu$ (½) $F \times 0.020 = 0.16 \times 39 - 0$ (½) $= 310 \text{ N}$ (1) (accept 312 N)		Or $v = u + at$ $39 = 0 + a \times 0.020$ $a = 1950$ $F = ma$ $= 0.16 \times 1950$ <b>Both formulae</b> (½) <b>Both substitutions</b> (½) $F = 312 \text{ N}$ (1)  Wrong or missing unit in final answer, deduct (½)	2	5
	a ii			At least one labelled axis is required, otherwise (0) Then, correct shape of graph (1)  If peak labelled as 310 N, deduct (½). If peak labelled as occurring at 0.02 s, deduct (½)  If no label on origin, subtract (½)	1	
	b		lower peak (1) longer time (1)	Graphs not identified (0)  Ignore areas being different.	2 (2A)	



Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
24	<p>Demonstrates no understanding (0)</p> <p>Limited understanding (1)</p> <p>Reasonable understanding (2)</p> <p>Good understanding (3)</p> <p>This is an open-ended question.</p> <p><b>1 mark:</b> 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.</p> <p><b>2 marks:</b> 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.</p> <p><b>3 marks:</b> 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.</p>	<p>Open ended question – a variety of Physics arguments can be used to answer this question.</p> <p>Marks are awarded on the basis of whether the answer, overall, demonstrates ‘no’, ‘limited’, ‘reasonable’ or ‘good’ understanding.</p>	3 (1A)	3

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
25	a	photons of particular/some/certain energies/frequencies are absorbed (½)  in the Sun's (upper/outer) atmosphere (½)	Or, particular/certain frequencies/wavelengths of light are absorbed  "the atmosphere" is too vague	1	7
	b i	Light is redshifted/shifted <u>towards</u> red (½)  (as) the galaxies are <u>moving away</u> (from the Sun) (½)	Or, the wavelength has increased Not: 'blueshift'/'becomes red'/'shifted to red' – these are wrong physics, award 0 marks.  Or distant galaxy has greater <u>recessional</u> velocity	1	
	b ii	$z = (\lambda_o - \lambda_r) / \lambda_r$ (½) $= (450 \times 10^{-9} - 410 \times 10^{-9}) / 410 \times 10^{-9}$ (½) $= 0.098$	Must start with the appropriate relationship  Award a maximum of (½) mark if final answer is not 0.098	1	
	b iii	$v = zc$ (½) $= 0.098 \times 3 \times 10^8$ (½) $= 2.94 \times 10^7 \text{ m s}^{-1}$  $d = v/H_o$ (½) $= (2.94 \times 10^7) / (2.3 \times 10^{-18})$ (½) $= 1.3 \times 10^{25} \text{ m}$ (1)  (= $1.4 \times 10^9 \text{ ly}$ )	This (½) mark anywhere If $z$ is not 0.098, then incorrect substitution.  This (½) mark anywhere  (accept $1.28 \times 10^{25}$ , $1.278 \times 10^{25}$ )  There is no need to convert to light years but if done, it must be correct, otherwise max (2) marks	3 (3A)	
	c	The redshift is greater for the distant galaxy, meaning that the distant galaxy is moving away faster than the nearby galaxy (1)		1	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
26	a	Photon (1)		1	4
	b i	$126 \text{ GeV} = 126 \times 10^9 \times (1.60 \times 10^{-19})$ (1) $= 2.02 \times 10^{-8} \text{ (J)}$  $m = E/c^2$ (½) $= 2.02 \times 10^{-8} / (3.00 \times 10^8)^2$ (½) $(= 2.24 \times 10^{-25})$ $= 2.2 \times 10^{-25} \text{ (kg)}$	This conversion must be clearly shown somewhere in the answer This (½) mark anywhere  Deduct (½) if $2.2 \times 10^{-25}$ not shown as the final line	2	
	b ii	$(2.2 \times 10^{-25} / 1.673 \times 10^{-27} =) 134$ (½)  (Higgs boson is) <u>2</u> orders of magnitude <u>bigger</u> (½)	(approx.) 100 (½)  If mass of neutron ( $1.675 \times 10^{-27}$ ) is used, treat as wrong physics – award zero marks.  134 times bigger, (½) only	1 (1A)	
27	a i	(some) <u>mass is converted</u> into energy (1)	“mass is lost” on its own gets (½)  “mass is changed” is insufficient	1	5
	a ii	The thorium nucleus will have some of the (kinetic) energy (1)	or $\gamma$ is also emitted  “lost as heat/sound energy” is wrong physics, award zero marks	1 (1A)	
	b i	scandium (1)	or ‘Sc’	1	
	b ii	(an extra particle) the (anti)neutrino would have (some kinetic) energy (1) (1)	“another particle also emitted” gets (½)	2	

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
28	<p>Demonstrates no understanding (0)</p> <p>Limited understanding (1)</p> <p>Reasonable understanding (2)</p> <p>Good understanding (3)</p> <p>This is an open-ended question.</p> <p><b>1 mark:</b> 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.</p> <p><b>2 marks:</b> 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.</p> <p><b>3 marks:</b> 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.</p>	<p>Open ended question – a variety of Physics arguments can be used to answer this question.</p> <p>Marks are awarded on the basis of whether the answer, overall, demonstrates ‘no’, ‘limited’, ‘reasonable’ or ‘good’ understanding.</p>	3 (1A)	3

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
29	a i	<ul style="list-style-type: none"> <li>Different frequencies / colours are <u>refracted</u> through different angles (1)</li> </ul> <p style="text-align: center;"><b>OR</b></p> <ul style="list-style-type: none"> <li>different frequencies / colours have different <u>refractive indices</u> (1)</li> </ul>	<p>Not wavelength on its own but ignore if reference made to frequency.</p> <p>Do NOT accept “bending” on its own but ignore it if follows ‘refraction’</p> <p>A correct answer followed by ‘diffract’ or ‘defract’, <b>0 marks</b></p>	1	8
	a ii	$n = \frac{v_1}{v_2} \quad (1/2)$ $1.54 = \frac{3 \times 10^8}{v_2} \quad (1/2)$ $v_2 = 1.95 \times 10^8 \text{ ms}^{-1} \quad (1)$	(accept 1.9, 1.948, 1.9481)	2	
	b i	$v = f\lambda \quad (1/2)$ $3.0 \times 10^8 = 4.57 \times 10^{14} \times \lambda \quad (1/2)$ $\lambda = 656 \times 10^9$ $m\lambda = d \sin\theta \quad (1/2)$ $2 \times 656 \times 10^9 = d \times \sin 19 \quad (1/2)$ $d = 4.03 \times 10^{-6} \text{ m} \quad (1)$		3 (2A)	
	b ii	<ul style="list-style-type: none"> <li>different colours have different <math>\lambda</math> (1/2)</li> <li><math>m\lambda = d \sin\theta</math> (1/2)</li> <li><math>m</math> and <math>d</math> are the same (1/2)</li> <li><math>\theta</math> is different for different <math>\lambda</math> (1/2)</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>different colours have different <math>\lambda</math> (1/2)</li> <li>Path difference = <math>m\lambda</math> (1/2)</li> <li>for the same <math>m</math> (1/2)</li> <li>PD is different for different <math>\lambda</math> (1/2)</li> </ul>	Any answer using different colours/ wavelengths diffract different amounts as the explanation is wrong physics – award 0 marks	2 (2A)	

Question		Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
30	a i	$R_{\text{total}} = V / I$ $= 4.5 / 0.30$ $= 15 \Omega$ $R_{\text{lamp}} = R_{\text{total}} - (2.5 + 0.5)$ $= 12 (\Omega)$	(1/2) (1/2) (1/2) (1/2)	<b>OR</b> $E = IR + Ir$ $4.5 = 0.3 \times R + 0.3 \times 0.5$ $R = 14.5$ $R_{\text{lamp}} = 14.5 - 2.5 = 12 \Omega$ Lose (1/2) if last line not shown	2	9
	a ii	$P = I^2 R$ $= 0.30^2 \times 12$ $= 1.1 \text{ W}$ (accept 1.08 W)	(1/2) (1/2) (1)	<b>OR,</b> $V = IR = 0.3 \times 12$ $(= 3.6)$ Need the above before any marks can be awarded for the next line $P = IV$ (1/2) $= 0.3 \times 3.6$ (1/2) $= 1.1 \text{ W}$ (1)	2	
	b i	3.5 V	(1)	Deduct (1/2) for a wrong or missing unit.	1	
	b ii	$E = V + Ir$ $4.5 = V + 0.2 \times 0.5$ $V = 4.4 \text{ (V)}$ $V_{Rv} = 4.4 - 3.5 = 0.9 \text{ V}$	(1/2) (1/2) (1/2) (1/2)	Or consistent with (b)(i)	2	
	c	(when a) current passes through a p-n junction photons are emitted	(1/2) (1/2) (1)	or electrons move  light emitted (1/2)	2	

Question		Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
31	a	$Q = CV$ $= 32 \times 10^{-6} \times 5000$ $= 0.16C$	 (½)  (½)	Must start with the relationship  deduct (½) if Q = 0.16 (C) not shown	1	5
	b	$E = \frac{1}{2} QV$ $= \frac{1}{2} \times 0.16 \times 5000$ $= 400J$ <b>OR</b> $E = \frac{1}{2} CV^2$ $= \frac{1}{2} \times 32 \times 10^{-6} \times 5000$ $= 400J$	 (½)  (½)  (1)  (½)  (½)  (1)	must be 0.16, cannot carry a wrong answer from (a)  <b>OR</b> $E = \frac{1}{2} Q^2/C$ (½) $= \frac{1}{2} \times 0.16^2 / 32 \times 10^{-6}$ (½) $= 400 J$ (1)	2	
	c	$I = V/R$ $= 5000 / 40$ $= 125 A$	 (½)  (½)  (1)		2 (2A)	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
32	a	(vertically) into the page	not “down(wards)”, but “down into the page” is ok	1	8
	b i	Correct drawing of axes, plotting of points and drawing a smooth curve (2)  A non-linear scale on either axis is wrong Physics and prevents access to any marks	Any quantity or unit missing from labels, (½) off per axis, but the labelling of the origin is not required in this answer. Penalise here if power of 10 is missing.	2	
	b ii	$\text{gradient} = (y_2 - y_1) / (x_2 - x_1)$ $= (9 \times 10^{-3} - 0) / (450 - 0) \quad (½)$ $= 2.0 \times 10^{-5} \text{ (m T)} \quad (½)$ <p style="text-align: center;"><b>or (T m)</b></p>	points must be on graph line  Unit not required, but if wrong unit – max (½)	1	
	b iii	$\frac{mv}{Q} = \text{gradient}$ $v = \text{gradient} \times Q/m$ $= 2.0 \times 10^{-5} \times 1.60 \times 10^{-19} / 9.11 \times 10^{-31} \text{ (1)}$ $= 3.5 \times 10^6 \text{ m s}^{-1} \text{ (1)}$		2 (2A)	
	c	Set/measure speed $v$ (of electron) (½) measure radius $r$ (½) keep $B$ constant (½) repeat for different $v$ (½)		2	

[END OF MARKING INSTRUCTIONS]