2012 Physics

Higher

Finalised Marking Instructions

Scottish Qualifications Authority

Marking Instructions − Higher Physics

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 − ½. 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 <u>NOT</u> 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.

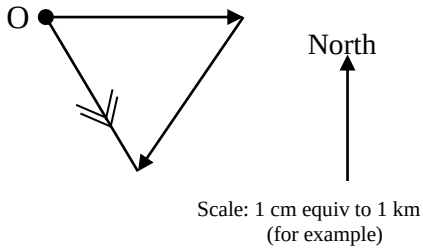
	Answers	**Mark +comment**	**Issue**
1.	$V=IR$ $7{\cdot}5=1{\cdot}5R$ $R=5{\cdot}0\,\Omega$	(½) (½) (1)	Ideal Answer
2.	$5{\cdot}0\,\Omega$	(2) Correct Answer	GMI 1
3.	5·0	(1½) Unit missing	GMI 2(a)
4.	$4{\cdot}0\,\Omega$	(0) No evidence/Wrong Answer	GMI 1
5.	_____ Ω	(0) No final answer	GMI 1
6.	$R=\frac{V}{I}=\frac{7{\cdot}5}{1{\cdot}5}=4{\cdot}0\,\Omega$	(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

2012 Physics Higher

Marking scheme

Section A

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

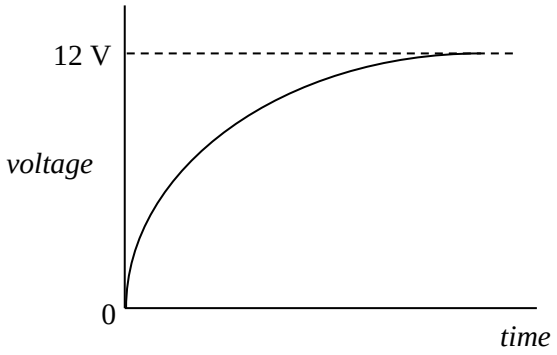
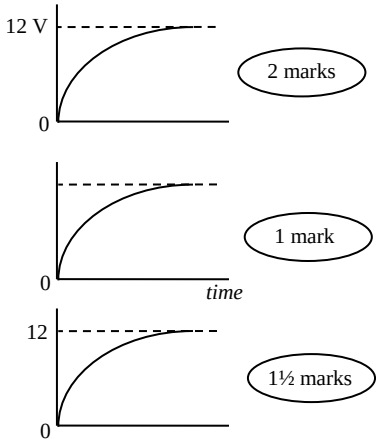
Sample Answer and Mark Allocation	**Notes**	Inner Margin	Outer Margin
21. (a) (i)  Scale: 1 cm equiv to 1 km (for example) By scale diagram (½) for correct diagram to scale, length and angle (½) for adding correctly showing resultant direction (arrow needed) displacement = 15·7 ± 0·3 km (½) bearing = 154 ± 2 (26° E of S) (64° S of W) (½) (tolerances are for scale diagrams only)	If East & West 'swapped', zero. Alternative method: $a^2 = b^2 + c^2 - 2bc\cos A$ $= 12^2 + 15^2 - 2 \times 12 \times 15 \cos 70°$ (½) = 15·7 km (15·68) (½) $\frac{a}{sinA} = \frac{b}{sinB}$ $\frac{15\cdot7}{sin70°} = \frac{15}{sin\theta}$ (½) (θ = 64°) bearing = 154 (½)	2	8
(ii) $v = \frac{s}{t}$ $= \frac{15\cdot7}{1\cdot25}$ (½) = 12·6 km h^{-1} (1) at 154 (½)	or consistent with displacement from (a) (i) Deduct (½) for wrong/missing unit Alternative: 15·7 km gives 3·49 m s^{-1}	2	
(b) (i) 15·7 km (½) on a bearing of 154 (½)	or consistent with (a) (i) Must be numbers, not "same as (a) (i)"	1•	
(ii) $t = \frac{d}{v}$ $= \frac{33}{22}$ (½) = 1·5 (hours) (½) $v = \frac{s}{t}$ $= \frac{15\cdot7}{1\cdot5}$ (½) = 10·5 km h^{-1} (1) on a bearing of 154 (½)	Alternative: 2·9 m s^{-1} on a bearing of 154	3+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
22. (a) (i) $d = vt$ $= 20 \times 3{\cdot}06$ $= 61{\cdot}2$ m (1)	Alternative: distance = area under first graph Deduct (½) for wrong/missing units. Deduct (½) for a <u>clear</u> arithmetic error eg $d = 20 \times 3{\cdot}06 = 57$ m	1●	5
(ii) $v^2 = u^2 + 2as$ (½) $0 = 15^2 + 2 \times -9{\cdot}8 \times s$ (½) $s = 11{\cdot}5$ m (1) (11·48 m)	Alternatives: $s = ut + ½at^2$ (½) $= 15 \times 1{\cdot}53 + ½ \times -9{\cdot}8 \times (1{\cdot}53)^2$ (½) $= 11{\cdot}5$ m (1) or $d =$ area under v-t graph (½) $= ½ \times 1{\cdot}53 \times 15$ (½) $= 11{\cdot}5$ m (1) Deduct (½) for $g = 10$ or 9·81	2●	
(b) More likely (1) horizontal velocity will decrease (½) range will decrease time in air will decrease height reached will decrease max height is reached earlier	Look for this first. OR "velocity/vertical velocity decreases <u>more than before</u>" Can also be answered using energy conservation ie 1. There is now work done against/ by friction. 2. The E_k of the ball (gradually) reduces compared to before. 3. The max E_p of the ball is less (than before). 4. The max height is therefore less. 5. The ball is more likely to hit the tree.	2+	

Sample Answer and Mark Allocation	**Notes**	Inner Margin	Outer Margin
23. (a) (i) $E_w = QV$ (½) $= 1{\cdot}6 \times 10^{-19} \times 1220$ (½) $= 1{\cdot}95 \times 10^{-16}$ (J)	Must start with equation as this is a 'show' question. Deduct ½ if final line not shown	1	7
(ii) QV/work done = ½ mv^2 (½) $1{\cdot}95 \times 10^{-16} = ½ \times 2{\cdot}18 \times 10^{-25} \times v^2$ (½) $v = 4{\cdot}23 \times 10^4$ m s^{-1} (1)	If wrong substitution here, stop marking	2•	
(b) $Ft = \Delta mv$ (½) $0{\cdot}07 \times 60 = 750 \times \Delta v$ (½) $\Delta v = 5{\cdot}6 \times 10^{-3}$ m s^{-1} (1)	if $Ft = mv - mu$ $0{\cdot}07 \times 60 = 750 \times v - 750 \times 0$ $v = 5{\cdot}6 \times 10^{-3}$ m s^{-1}	2	
(c) Force from Xenon engine greater (1) Change in momentum of the Xenon ions would be greater (than Krypton ions) (½) Impulse from Xenon ions would be greater (½)	Must have force from Xenon engine greater or zero marks Must name the engine, ie not "the first engine". Alternative: force from Xenon ion engine greater (1) E_k of xenon ions greater (than krypton ions) (½) more work done ($E_w = Fd$) (½)	2+	

Sample Answer and Mark Allocation		Notes	Inner Margin	Outer Margin
24. (a)	<table><tr><td>*P/T*</td><td>347</td><td>347</td><td>346</td><td>348</td><td>348</td></tr></table> (1) for all data Pressure and temperature are directly proportional when T is in Kelvin. OR P/T = 347 or "constant" (1)		2+	5
(b)	As temperature increases, E_k of gas molecules/particles increases (½) (or molecules travel faster) and hit/collide with the walls of the container more often/frequently (½) with greater force (½) pressure increases (½)	Must be E_k, not just "energy". Must have <u>atoms/molecules/particles colliding with the (container) walls</u> somewhere in the answer before any of these (½) marks can be awarded	2	
(c)	To ensure all the gas in the flask is heated evenly or all the gas is at the same temperature (1)		1•	

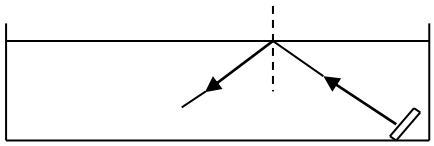
Sample Answer and Mark Allocation	**Notes**	Inner Margin	Outer Margin
25. (a) (i) $I = \dfrac{E}{(R+r)}$ (½) $= \dfrac{12}{(6+2)}$ (½) $=$ **1·5 A** (1)	$I = V/R$ $(E = V + Ir)$ } not enough on own	2	7
(ii) $V = Ir$ $= 1{\cdot}5 \times 2$ (½) $=$ **3·0 V** (½)	or consistent with (a) (i) $V = E - IR$ $= 12 - (1{\cdot}5 \times 6)$ (½) $=$ **3·0 V** (½) or $V_1 = \left(\dfrac{R_1}{R_1 + R_2}\right) \times V_S$ $= \left(\dfrac{2}{2+6}\right) \times 12$ (½) $=$ **3·0 V** (½) (½) off if no/wrong unit	1	
(iii) $P = I^2R$ (½) $= (1{\cdot}5)^2 \times 6$ (½) $=$ **13·5 W** (14 W) (1) or $P = V^2/R$ (½) $= 9^2/6$ (½) $=$ **13·5 W** (14 W) (1) or $P = IV$ (½) $= 1{\cdot}5 \times 9$ (½) $=$ **13·5 W** (14 W) (1)		2•	
(b) $P = I^2R$ (½) (Circuit) current increases (½) Total or circuit resistance decreases (½) Internal resistance less (½) or $P = V^2/R$ (½) Voltage across lamp increases (½) Lost volts decreases (½) Internal resistance less (½)	Look first for "**internal resistance less**" (½) Then the other two (½) marks are dependent on the formula used for the justification. Could be attempted by calculation	2+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
26. (a)  shape levelling off (1) at 12 V (1)	 Must have at least one identifying label on axes to get any marks. Origin missing - (½) off	2	7
(b) $R = V/I$ (½) $= \frac{12}{2\times10^{-3}}$ (½) = **6000 Ω** (1) (6·0 k Ω)	Accept $6{\cdot}0 \times 10^3\ \Omega$ $6{\cdot}00 \times 10^3\ \Omega$ $6{\cdot}000 \times 10^3\ \Omega$	2●	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
26. (c) (i) Initial current only depends on the values of the e.m.f. of the supply and resistor R which do not change. (1)	Both e.m.f. and resistance are required If miss out "which do not change" – zero marks	1●	
(ii) Smaller (1) Capacitor takes less time to discharge (1)	Must attempt an explanation Correct conclusion 1 mark, so long as not followed by wrong physics. "Graph falls faster than before" not precise enough for second mark. If answer only says it is a "smaller capacitor" – this gets zero (as this means the physical size of the capacitor)	2+	

Sample Answer and Mark Allocation				Notes	Inner Margin	Outer Margin
27.	(a)	Resistance of fabric = 40 Ω	(1)		2	9
		$\frac{R_1}{R_2} = \frac{R_3}{R_4}$	(½)			
		$\frac{R_V}{40} = \frac{240}{80}$	(½)			
		R_V = **120 Ω**		(½) off if last line missing (½) off if wrong unit		
27.	(b) (i)	Differential (Mode)	(1)	Zero marks for "difference mode" or "deferential mode".	1	
	(ii)	Gain = $\frac{R_f}{R_1}$			1	
		= $\frac{560}{100}$	(½)			
		= **5·6**	(½)	5·6 V, (½) off Gain = -5·6, zero marks		

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
27. (b) (iii) (A) Gain = $\frac{V_{out}}{V_{in}}$ (½) $5{\cdot}6 = \frac{10{\cdot}8}{V_{in}}$ (½) V_{in} = **1·93 V** 1	or $V_o = \frac{R_f}{R_1}(V_2 - V_1)$ (½) $10{\cdot}8 = 5{\cdot}6 \times (V_2 - V_1)$ (½) $(V_2 - V_1)$ = **1·93 V** (1) Accept 1·9286, 1·929, 1·93, 1·9 V	2•	
(B) Potential at X = 2·25 + 1·93 = 4·18 V (½) $\frac{R_1}{R_2} = \frac{V_1}{V_2}$ (½) $\frac{R_1}{120} = \frac{4{\cdot}18}{(9 - 4{\cdot}18)}$ (½) R_1 = 104 Ω (½) Length of fabric = **66 mm** (1)	or consistent with (b) (iii) (A) or $V_1 = \left(\frac{R_1}{R_1 + R_2}\right)V_s$ (½) (½) $4{\cdot}18 = \left(\frac{R_1}{R_1 + 120}\right) \times 9$ (½) R_1 = 104 Ω (½) Length of fabric = 66 mm (1) **66 mm** on its own → 3 marks **66** on its own → 2½ marks	3+	

Sample Answer and Mark Allocation		Notes	Inner Margin	Outer Margin
28. (a) $n = \frac{\sin\theta_1}{\sin\theta_2}$ (½) $1{\cdot}33 = \frac{\sin X}{\sin 36}$ (½) X = **51°** (1)		Accept 51·42, 51·4, 51 and 50° but 51·0° - (½) off Degree symbol missing - (½) off	2	6
(b) (i) Angle of <u>refraction</u> is 90° or <u>Refracted</u> ray makes an angle of 90° with normal or <u>Refracted</u> ray is along surface of water 1		"There is no refracted ray" – zero marks "Total internal reflection is about to take place" – zero marks	1•	
(ii) $\sin\theta_C = 1/n$ (½) $= 1/1{\cdot}33$ (½) $\theta_C = \mathbf{49°}$ (1)		Accept 48·753, 48·75, 48·8 and 49° but 49·0, 48·7 and 50° - (½) off	2	
(c)  Totally internally reflected ray shown (1) If the angle of reflection in the diagram is given a value, it must be 49°.		If angles of incidence and reflection look significantly different – zero marks (use professional judgement). If answer goes on to show wrong physics (reflection or refraction angles), then zero marks.	1+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
29. (a) $d\sin\theta = n\lambda$ (½) $d \times \sin 35{\cdot}3 = 3 \times 633 \times 10^{-9}$ (½) $d =$ **$3{\cdot}29 \times 10^{-6}$ m** (1)	Accept: $3{\cdot}2863 \times 10^{-6}$ $3{\cdot}286 \times 10^{-6}$ $3{\cdot}29 \times 10^{-6}$ $3{\cdot}3 \times 10^{-6}$	2	5
(b) Number of lines per metre $= \frac{1}{3{\cdot}29 \times 10^{-6}}$ (½) $=$ **$3{\cdot}04 \times 10^{5}$** (½)	Accept: $3{\cdot}0395 \times 10^{5}$ $3{\cdot}040 \times 10^{5}$ $3{\cdot}04 \times 10^{5}$ $3{\cdot}0 \times 10^{5}$ but 3×10^{5} - (½) off	1•	
(c) Difference $= (3{\cdot}04 - 3{\cdot}00) \times 10^{5}$ $= 0{\cdot}04 \times 10^{5}$ (½) Percentage difference $= \frac{0{\cdot}04 \times 10^{5}}{3{\cdot}00 \times 10^{5}} \times 100$ (½) $= 1{\cdot}33\%$ (½) **Technician's value <u>does</u> agree** (½)	The substitution here must be to at least 3 significant figures. If answer to (b) is wrong, but answer to (c) is consistent – full marks Must show a calculation for the justification, otherwise zero marks. Could answer question by calculating 2% of $3{\cdot}00 \times 10^{5}$ and comparing Arithmetic mistake - (½) off	2+	

Sample Answer and Mark Allocation				Notes	Inner Margin	Outer Margin
30. (a)		Decreases	(1)		1	6
(b)	(i)	Photoconductive mode	(1)		1	
	(ii)	Current increases	(½)	Any wrong physics in the explanation → max (½) (for 'current increases')	2	
		more photons of light arrive at the junction	(½)			
		more free charge carriers produced	(½)			
		per second (could be linked to either photons or charge carriers)	(½)			
(c)		$I_1 d_1^2 = I_2 d_2^2$	(½)	Irradiance is directly proportional to current so ok to use this formula.	2•	
		$3{\cdot}0 \times 10^{-6} \times 1{\cdot}2^2 = I_2 \times 0{\cdot}8^2$	(½)	Must show squaring in second line, otherwise stop marking.		
		$I_2 = 6{\cdot}75$ µA	(1)	6·8 µA is ok.		
				6·7 µA loses (½) (wrong rounding)		

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
31. (a) $D = \frac{E}{m}$ (½) $500 \times 10^{-6} = \frac{E}{0{\cdot}04}$ (½) $E = 2{\cdot}0 \times 10^{-5}$ J (1)		2	5
(b) $\dot{H} = \frac{H}{t}$ $5{\cdot}0 \times 10^{-3} = \frac{H}{2}$ (½) $H = 0{\cdot}01$ (*Sv*) (½) $H = Dw_R$ $0{\cdot}01 = 500 \times 10^{-6} \times w_R$ (½) $w_R = 20$ (½) alpha radiation (1)		3+	

[END OF MARKING INSTRUCTIONS]