2011 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

2011 Physics Higher

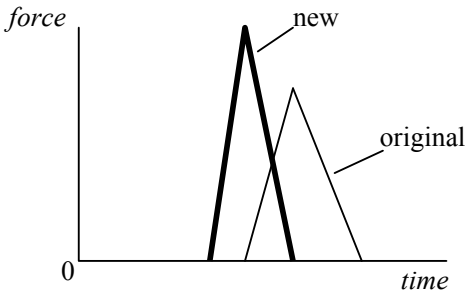
Marking scheme

Section A

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

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
21. (a) (i) $v^2 = u^2 + 2as$ ½ $0 = 7^2 + 2 \times (-9{\cdot}8) \times s$ ½ s = **2·5** m 1	OR $v = u + at$ $0 = 7 + (-9{\cdot}8)\, t$ } two equations ½ t = 0·71 s $s = ut + ½\, a\, t^2$ $= 7 \times 0{\cdot}71 +$ $½\, (-9{\cdot}8)\, (0{\cdot}71)^2$ } two substitutions ½ $=$ **2·5 m** } final answer **1** If take g = 10 or 9·81 then deduct ½ per question	2	6
(ii) $v = u + at$ ½ $0 = 7 + (-9{\cdot}8) \times t$ ½ t = **0·71** s	OR $s = \left(\frac{u+v}{2}\right) t$ ½ $2{\cdot}5 = \left(\frac{7+0}{2}\right) \times t$ ½ t = **0·71** s Deduct ½ if last line is missing Deduct ½ if missing or wrong unit 'secs' is a unit error and loses ½ As this is a 'show' question, answer must quote a formula	1	

Sample Answer and Mark Allocation					Notes	Inner Margin	Outer Margin
21.	(b)	(i)	**1·5** m s^{-1} to the **right**	1	If miss out direction – deduct ½ Missing units – deduct ½	1•	
		(ii)	Statement Z	1	If no attempt at justification or wrong Physics in justification } **zero**	2+	
			Horizontal speed of ball remains constant and equal to (horizontal) speed of trolley or **Horizontal** speed of the ball remains constant at 1·5 m s^{-1}	1	**Horizontal** is required		

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
22. (a) (i) *Impulse* = *Area under F-t graph* ½ = ½ × 6·4 × 0·25 ½ = **0·80** kg m s^{-1} 1	OR N s but N s^{-1} is a unit error – deduct ½ **Accept 0·8 kg m s^{-1}**	2	7
(ii) **0·80** kg m s^{-1} ½ in the negative direction OR to the left ½ OR negative sign	OR N s but N s^{-1} is a unit error – deduct ½ OR consistent with (a) (i)	1	
(iii) *(Impulse = Change in momentum)* $F \times t$ = $mv - mu$ ½ -0·80 = m (-0·45 – 0·48) ½ m = **0·86** kg 1	If signs incorrect give only formula ½ OR consistent with (a) (ii)	2+	
(b)  Height of graph larger 1 Base of graph shorter 1	Relative position of new graph on axis not important Labels on axes missing / Origin missing } No penalty as long as original shown	2•	

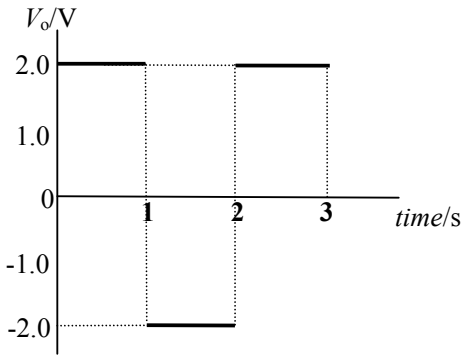
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
23. (a) (i) $m = 111{\cdot}49 - 111{\cdot}26$ $= 0{\cdot}23$ g ½ $\rho = m/V$ ½ $= 0{\cdot}23 \times 10^{-3}/2{\cdot}0 \times 10^{-4}$ ½ $=$ **1·15** kg m^{-3} ½	If calculate two densities and subtract – no penalty **½** off for each unit error	2	7
(ii) Not all the air will be evacuated from jar OR It is impossible to get a (perfect) vacuum OR Some air has leaked back in 1		1•	
(b) (i) $P_1V_1 = P_2V_2$ ½ $1{\cdot}01 \times 10^5 \times 200 = P_2 \times 250$ ½ $P_2 =$ **8·1** × **10^4** Pa 1	Accept: P_2 = 8, 8·1, 8·08, 8·080 × 10^4 Pa OR 80 000, 81 000, 80 800 Pa	2•	
(ii) Particles collide with walls of jar ½ Number of collisions on walls of jar is less frequent/less often ½ Average force (on walls) decreases ½ Pressure on walls of jar decreases ½	**Look for this description first - it is needed before any other marks can be given** **For 'particles' accept 'molecules'** **Must be frequency, not just "less collisions"** Any mention of E_k or speed of particles changing – **max** ½ mark	2	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
24. (a) (i) 10 joules of energy are given to each coulomb (of charge) passing through the supply OR It is the t.p.d. on open circuit OR It is the reading on voltmeter (across cell) on open circuit 1	Any mention of voltage 'flowing', 'travelling' or 'moving' is wrong Physics and gets zero	1	7
(ii) $I = \frac{E}{(R+r)}$ ½ $1{\cdot}25 = \frac{10}{(6+r)}$ ½ r = **2·0 Ω**	OR $r = \frac{lost\ volts}{I}$ ½ $= \frac{10-7{\cdot}5}{1{\cdot}25}$ ½ = **2·0 Ω** Deduct ½ if last line is missing Deduct ½ if wrong unit $\frac{R_1}{R_2} = \frac{V_1}{V_2}$ ½ $\frac{r}{6{\cdot}0} = \frac{2{\cdot}5}{7{\cdot}5}$ ½ r = **2·0 Ω** 1	1	
(b) (i) (Total) resistance decreases ½ (circuit) current increases ½ lost volts increases 1	All independent marks The use of up and down arrows is not accepted	2•	
(ii) Parallel resistance = R = V/I ½ = 6·0/2·0 ½ = 3·0 Ω $1/R_T = 1/R_1 + 1/R_2$ ½ $1/3 = 1/6 + 1/R$ ½ R = **6·0 Ω** 1	OR Total resistance = E/I ½ = 10/2·0 = 5·0 Ω Resistance of parallel network = 5 – 2 ½ = 3 Ω OR $R_T = \frac{Product}{Sum}$ ½ $3 = \frac{6\times R}{6+R}$ ½ R = **6·0 Ω** 1 Note – potential divider ratio could be used to get R_p = 3·0 **Ω**	3+	

Sample Answer and Mark Allocation				Notes	Inner Margin	Outer Margin
25.	(a)	200 μC of charge increases voltage across plates by 1 volt OR 200 μC per volt OR One volt across the plates of the capacitor causes 200 μC of charge to be stored	1		1	10
	(b)	(i) $I = E/R$ $= 12/1400$ $=$ **0·0086** A (**8·6 mA**)	½ ½ 1		2	
		(ii) $E = ½ CV^2$ initial stored energy $= ½ \times (200 \times 10^{-6}) \times 12^2$ $= 0·0144$ J final stored energy $= ½ \times (200 \times 10^{-6}) \times 4^2$ $= 0·0016$ J Difference = 0·0144 - 0·0016 decrease in stored energy $=$ **0·0128** J	½ ½ ½ ½ 1	 If this number is rounded off (eg to 0·014) – deduct ½ Deduct ½ if missing or wrong unit	3•	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(c) (i) 0·30 s	Deduct ½ if missing or wrong unit	1•	
(ii) $s = ut + ½ a t^2$ ½ $0·80 = 1·5 \times 0·3 + ½ \times a \times (0·3)^2$ ½ $a =$ **7·8** m s^{-2} 1	OR consistent with 25(c) (i)	2+	
(iii) Percentage (fractional) uncertainty in (measuring) <u>distance</u> will be smaller or Percentage (fractional) uncertainty in (measuring) <u>time</u> will be smaller	Must be ***percentage*** or ***fractional*** uncertainty ie "uncertainty in time is less" is insufficient	1+	

Sample Answer and Mark Allocation					Notes	Inner Margin	Outer Margin
26.	(a)	(i)	Inverting	1	Do not accept "inverted" or "inverse"	1	7
		(ii)	$V_o = -\frac{R_f}{R_1} \times V_1$	½	Formula is wrong if negative sign is missing	2	
			$12 = \frac{-80}{10} \times V_1$	½	or using any other correct points from graph		
			$V_1 =$ **-1·5** V	1	Accuracy of calculation determined from ± ½ scale division reading from graph		
		(iii)	Output cannot be greater than (approx 85% of) the supply voltage OR Saturation <u>of the amplifier</u> has been reached	1	*"Output voltage saturates"* **- no** *"It saturates"* **- no** *"Op amp saturates"* **- yes**	1	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(b) 		3+	
(0 – 1s) constant positive voltage ½	Either or both labels missing **½ off**		
(1 – 2s) constant negative voltage ½	Either or both units on axes is missing **½ off**		
(2 – 3s) constant positive voltage ½			
Correct values of these constant voltages 3 × ½			

Sample Answer and Mark Allocation		Notes	Inner Margin	Outer Margin
27. (a) (i)	$n = \frac{\sin\ \theta_1}{\sin\ \theta_2}$ ½ $1{\cdot}66 = \frac{\sin\ 40}{\sin\ \theta}$ ½ θ = **22·8°** 1	Degrees symbol missing – ½ off	2	7
(ii)	(A) $\sin\theta_C = 1/n$ ½ $= 1/1{\cdot}66$ ½ $\theta_C = 37{\cdot}0°$ 1	Degrees symbol missing – ½ off	2	
	(B) **74°** 1	or consistent with 27(a)(ii)(A) Degrees symbol missing – ½ off	1+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(b) No OR "it is totally internally reflected" ½ *n* depends on frequency OR $n_{blue} > n_{red}$ OR blue refracts more than red ½ (critical angle) $_{blue}$ < (critical angle) $_{red}$ OR the angle of incidence has increased ½ angle of incidence of blue light on face PQ is greater than the critical angle ½	Look for "**No**" first before progressing Must be totally internally reflected, not just internally reflected	2+	

Sample Answer and Mark Allocation				Notes	Inner Margin	Outer Margin
28.	(a)	Light travels as waves OR Energy in light is carried as a wave OR Light is a wave	1	"Light carries waves" - NO	1	5
	(b) (i)	$d\sin\theta = n\lambda$	½	If use 22° then only ½ for formula	2	
		$5 \times 10^{-6} \times \sin 11 = 2 \times \lambda$	½	**Must be 11° and n = 2**		
		λ = **480** nm	1			
	(ii)	Spacing of maxima increases	½	Look for first statement before progressing	2+	
		λ in liquid increases (as n decreases)	½			
		$\sin\theta = n\lambda/d$	½	No justification – zero		
		θ increases	½	**Wrong Physics in justification gets zero, eg any mention of the 'n' in this formula being the refractive index**		

2011 Physics − Higher			
Sample Answer and Mark Allocation	**Notes**	Inner Margin	Outer Margin
29. (a) (i) $f = \frac{c}{\lambda}$ ½ $= \frac{3\cdot00\times10^{8}}{525\times10^{-9}}$ ½ $= 5\cdot71 \times 10^{14}$ Hz $E = hf$ ½ $= 6\cdot63 \times 10^{-34} \times 5\cdot71 \times 10^{14}$ ½ $= \mathbf{3\cdot79 \times 10^{-19}}$ J	Last line needed – if not **½ off** No or wrong unit **½ off**	2•	6
(ii) $E_k = hf - hf_o$ $= 3\cdot79 \times 10^{-19} - 2\cdot24 \times 10^{-19}$ $= \mathbf{1\cdot55 \times 10^{-19}}$ J 1	Must use $3\cdot79 \times 10^{-19}$ A negative answer gets zero	1	
(b) (i) Photons with frequency below f_o do not have enough energy to release electrons OR Photons with frequency below f_o have energy smaller than work function 1	"because f_o is threshold frequency" – **No** **Must be an answer in terms of photon energy**	1	
(ii) Work function $= hf_o$ (or $E = hf_o$) ½ $2\cdot24 \times 10^{-19} = (6\cdot63 \times 10^{-34}) \times f_o$ ½ $f_o = \mathbf{3\cdot38 \times 10^{14}}$ Hz 1		2•	

2011 Physics − Higher Sample Answer and Mark Allocation				Notes	Inner Margin	Outer Margin
30.	(a)	(i)	(Nuclear) Fusion 1	*"Fussion"* gets **0 marks**	1	8
		(ii)	Total mass before = $3{\cdot}342 \times 10^{-27} + 5{\cdot}005 \times 10^{-27}$ = $8{\cdot}347 \times 10^{-27}$ (kg) ½ Total mass after = $6{\cdot}642 \times 10^{-27} + 1{\cdot}675 \times 10^{-27}$ = $8{\cdot}317 \times 10^{-27}$ (kg) ½ Loss in mass = $0{\cdot}030 \times 10^{-27}$(kg) Energy released = mc^2 ½ = $0{\cdot}030 \times 10^{-27} \times (3{\cdot}00 \times 10^{8})^2$ ½ = **$2{\cdot}7 \times 10^{-12}$** J 1	If one mass is rounded, max 1 If both rounded, max ½ (formula)	3•	
	(b)	(i)	Energy absorbed ½ = $-1{\cdot}360 \times 10^{-19} - (-5{\cdot}424 \times 10^{-19})$ = $4{\cdot}064 \times 10^{-19}$(J) $E = hf$ ½ $4{\cdot}064 \times 10^{-19} = 6{\cdot}63 \times 10^{-34} \times f$ ½ $f = 6{\cdot}13 \times 10^{14}$ (Hz) $\lambda = \frac{c}{f}$ ½ $= \frac{3{\cdot}00 \times 10^{8}}{6{\cdot}13 \times 10^{14}}$ ½ = **489** nm ½	If subtraction results in a negative energy **– only formulae marks**	3+	
		(ii)	"Blue" OR "blue-green" NOT "green"	*or* consistent with (b)(i) as long as in the visible spectrum	1•	

[END OF MARKING INSTRUCTIONS]