2008 Physics

Higher

Finalised Marking Instructions

Scottish Qualifications Authority

Detailed 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 7·5=1·5R R=5·0Ω	(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.	$R=\frac{V}{I}=\frac{7{\cdot}5}{1{\cdot}5}=4{\cdot}0\Omega$	(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 7·5 = 1·5 × R R=0·2Ω	(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

2008 Physics Higher

Marking scheme

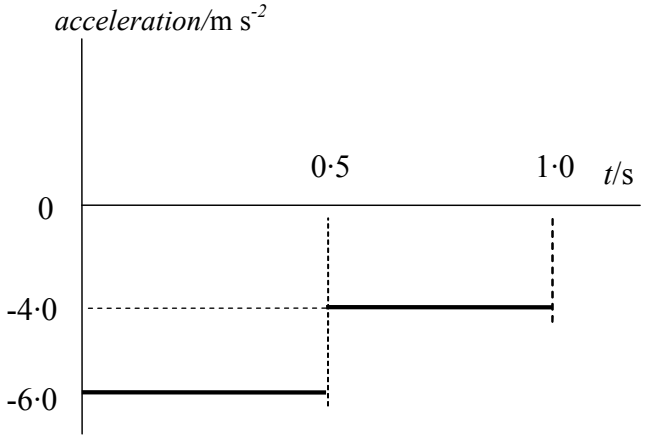
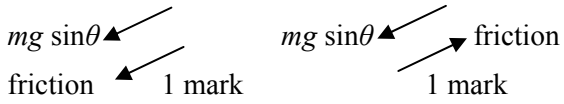
Section A

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

Sample Answer and Mark Allocation			Notes	Inner Margin	Outer Margin
21. (a)	$v^2 = u^2 + 2as$	½	watch for u, v correct way round	2	**8**
	$12^2 = 30^2 + (2 \times -9 \times s)$	½	watch for ***a*** (must be negative) otherwise max ½ for formula		
	$\boldsymbol{s = 42}$ **m**	1			
	OR				
	$t = \frac{v-u}{a}$				
	$= \frac{12-30}{-9} = 2\,(s)$		If $\frac{12-30}{-9} = -2$ s and then substitute +2 treat as arith – ½		
	$s = ut + ½\, at^2$				
	$= (30 \times 2) + (½ \times -9 \times 2^2)$	½			
	$= 42$ m	1			
		½ for both equations			
	OR				
	$t = \frac{v-u}{a} = 2(s)$				
	$s = \text{av. speed} \times \text{time}$				
		½ both equations	Must be average speed, otherwise 0		
	$= 21 \times 2$	½			
	$= 42$ m	1			
(b)	Speed at Q is greater/faster	½	Must have 1st statement or 0 marks	2+	
	Mass of car is greater/bigger	½			
	Deceleration/acc^n is less	½			
	Since $a = F/m$ (and F is constant)	½	Deduct ½ for weight/heavier in place of mass		
	Can gain full marks by calculation		Don't accept acc^n/dec^n 'SLOWER'		

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(c) (i) electrons and holes recombine at/in the junction (and energy is released) 1/0 do <u>not</u> accept 'depletion layer' for 'junction'	Not meet/come together/travel to Can say +ve <u>and</u> –ve charge carriers but not just charge carriers	1	
(ii) $V_r = 12 - 5 = \mathbf{7}$ V ½ $I = \frac{P}{V}$ $= \frac{2 \cdot 2}{5} = 0 \cdot 44\,(\text{A})$ ½ $R = \frac{V}{I}$ ½ both equations $= \frac{7}{0 \cdot 44}$ ½ $= \mathbf{16\ \Omega}$ 1 $(15 \cdot 9\ \Omega)$ **OR** $R = V^2/P = 5^2/2.2 = 11.4\,\Omega$ → 0, on its own $I = P/V = 2.2/5 = 0.44$ (A) ½ $R = V/I = 12/0.44 = 27.3\,\Omega$ ½ $R = 27.3 - 11.4$ (½) $= 15.9\,\Omega$ 1 ½ for all 3 equations	anywhere	3+	

Sample Answer and Mark Allocation					Notes	Inner Margin	Outer Margin
22.	(a)	(i)	$F = mg \sin\theta$	½		2	**9**
			$= 40 \times 9{\cdot}8 \times \sin 30$	½	-½ if g = 10		
			= **196 N**	1			
		(ii)	Balanced forces **OR** $F = mg\sin\theta$ + Frictional force	½	or consistent with (a)(i)	2•	
			$240 = 196 + F_f$	½			
			F_f = **44 N**	1			
	(b)	(i)	Constant ½ deceleration ½		ie ½ for deceleration/-ve acc^n then ½ for constant/uniform steadily	1•	
			Or give value of a = - 6 m s^{-2}	1			
			Constant deceleration	1			
			Constant acceleration	½			
			Constant negative acceleration	1			
			Constant acc^n down the slope	1			
			Acceleration down the slope	½			
			Velocity decreasing	½			
			Slowing down/speed decreasing	0			
			Slowing down/speed decreasing uniformly	½			
			Deceleration of - 6 m s^{-2}	½	-½ for wrong or missing unit		
			Acceleration of - 6 m s^{-2}	1			
			Deceleration of 6 m s^{-2}	1			
			Velocity decreasing uniformly	1			
			Acceleration of 6 m s^{-2}	½			

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(ii)  Each horizontal line drawn below axis ½ + ½ Each correct value ½ + ½	Deduct ½ if time values missing Accept -3.8 If lines not horizontal 0 marks	2+	
(iii) moving up slope *mg*sinθ/comp of weight and friction are in the same direction 1 moving back down slope forces are in opposite directions or friction has changed direction 1 **OR** by diagram:  	Can show by calculation Use weight in place of component of *W* (eg weight down slope) – max 1 mark	2+	

Sample Answer and Mark Allocation				Notes	Inner Margin	Outer Margin
23. (a)	(i)	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$	½		2	**8**
		$\frac{2 \cdot 82 \times 10^6}{(19 + 273)} = \frac{P_2}{(5 + 273)}$	½			
		$P_2 = \mathbf{2 \cdot 68 \times 10^6\ Pa}$	1			
	(ii)	No change	½	Need 1st statement or 0 marks, then independent marks	2•	
		both mass and volume remain constant	1			
		and density = mass/volume OR $\rho = m/V$	½			
		Possible alternative:				
		(small) increase in density	½			
		since volume less and mass constant	1			
		and density = mass/volume	½			
		BUT MUST SAY 'CYLINDER CONTRACTS'				
(b)	(i)	$m = \rho V$	½		2	
		$m = 37 \cdot 6 \times 0 \cdot 03$	½			
		$m = \mathbf{1 \cdot 13\ kg}$	1			
	(ii)	Fewer molecules/atoms/particles inside canister so fewer collisions/hits **with walls** per second	1	Need to mention rate/time eg 'less often'	1+	
		(must say fewer molecules – not just fewer collisions only)		Less force per collision 0 marks but smaller average force is fine		
		any mention of slower movement etc – 0				
	(iii)	(gas stops escaping when) pressure inside = pressure outside		Pressures inside/outside balance	1•	
		OR				
		gas has reached atmospheric pressure	1	No pressure difference inside/ outside		
		OR				
		because 1.01×10^5 Pa = atmospheric pressure				

Sample Answer and Mark Allocation			Notes	Inner Margin	Outer Margin
24. (a) (i)	**4 Ω**	1	Deduct ½ for missing or wrong unit	1	**7**
(ii)	$I = \frac{E}{R_{(T)}}$ or $\frac{V}{R}$	½	Or consistent with (a)(i)	2	
	$= \frac{2 \times 1 \cdot 5}{4}$	½			
	$= \mathbf{0 \cdot 75\ A}$	1			
(iii)	$P = I^2\ R$	½	Or consistent with (a)(i) & (ii)	2•	
	$= 0 \cdot 75^2 \times 3 \cdot 6$	½			
	$= \mathbf{2 \cdot 0\ W}$	1			
OR	$V = I\ R$				
	$= 0 \cdot 75 \times 3 \cdot 6$				
	$= 2 \cdot 7\ \text{V}$				
		½ both equations			
then	$P = I\ V$				
	$= 0 \cdot 75 \times 2 \cdot 7$	½			
	$= 2 \cdot 0\ \text{W}$	1			
OR	$P = V^2 / R = 2 \cdot 7^2 / 3 \cdot 6$	½			
	$= 2 \cdot 0\ \text{W}$	1			
(b)	Power output is less	½		2+	
	Current is less	½			
	$P = I^2\ R$	½			
	R (load) is constant	½			
	OR				
	Power output is less	½			
	t.p.d./V is less	½			
	$P = \frac{V^2}{R}$	½			
	R (load) is constant	½			
	OR				
	Power is less	½			
	Current is less	½			
	$P = I\ V$	½			
	t.p.d./V is also less	½			

Sample Answer and Mark Allocation				Notes	Inner Margin	Outer Margin
25.	(a)		Quantity of charge stored per volt 1		1	**9**
		OR	Coulombs per volt	'1 Coulomb per Volt' gets 0		
		OR	ratio of charge to p.d/voltage			
			If say $C = \frac{Q}{V}$, must define Q and V to get mark			

Sample Answer and Mark Allocation			Notes	Inner Margin	Outer Margin
(b) (i)	$12 - 8 \cdot 6 = \mathbf{3 \cdot 4\ V}$	1	Deduct ½ for missing or wrong unit	1•	
(ii)	$R = V/I$	½	Or consistent with (b)(i)	2	
	$= 3 \cdot 4 / 0 \cdot 0016$	½			
	$= \mathbf{2125\ \Omega}$	1			
(iii)	$V = 12$ V from diagram	1	anywhere	3+	
	$E = ½\, C\, V^2$	½	anywhere		
	$10 \cdot 8 \times 10^{-3} = ½ \times C \times 12^2$	½			
	$C = \mathbf{0 \cdot 00015\ F}$ (150 μF)	1			
	OR				
	$E = ½\, Q\, V$				
	$10 \cdot 8 \times 10^{-3} = ½ \times Q \times 12$	1			
	$Q = \mathbf{0 \cdot 0018}\,(C)$				
	$E = ½ \dfrac{Q^2}{C}$	½ for both equations			
	$10 \cdot 8 \times 10^{-3} = ½ \times \dfrac{0 \cdot 0018^2}{C}$	½ substitution			
	$C = \mathbf{0 \cdot 00015\ F}$	1			
(c)	Time is less	½	MUST say time/it is less or 0 marks eg 'capacitor charges faster' 0 marks	2•	
	Circuit resistance is less Current/rate of flow of charge is greater	1 ½	independent		
	Deduct ½ for current/voltage 'through' capacitor				

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Sample Answer and Mark Allocation		**Notes**	Inner Margin	Outer Margin
26. (a) $\frac{R_1}{R_2} = \frac{R_3}{R_4}$	½		3•	**8**
$\frac{R(\text{ldr})}{1.2} = \frac{6}{4}$	½			
If WP (eg subst. wrong), stop marking				
$R(\text{ldr}) = 1.8\ (\text{k}\Omega)$	1	If stop here need unit for R If no equation/substitution and $R = 1.8\,\text{k}\Omega$, max 2 marks		
From graph irradiance = **0·48 W m^{-2}** +/- 0·02	1	Range 0.46-0.50 If bare 0.48 W m^{-2} then 1 mark only		

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
(b) (i) $\frac{2\cdot0}{2\cdot0+1\cdot2}\times12$ ½ eqn, ½ sub $=\mathbf{7\cdot5\ V}$ **OR** $I=\frac{V}{R_t}$ $=\frac{12}{(1200+2000)}=0\cdot00375$ (A) ½ $V = I\ R_{ldr}$ $=0\cdot00375\times2000$ ½ $=7\cdot5$ V **OR** $\frac{V_1}{V_2}=\frac{R_1}{R_2}$ and $\frac{7.5}{4.5}=\frac{2}{1.2}$ ½, = 1.67 ½	Need final line or lose ½ For formula used twice For substitution Deduct ½ if no final line	1	
(ii) $V_O=(V_2-V_1)\frac{R_f}{R_1}$ ½ $=(7\cdot2-7\cdot5)\times\frac{140}{20}$ ½ $=\mathbf{-2\cdot1\ V}$ 1	Watch for V_2 and V_1 substituted correctly	2	
(iii) Yellow LED is lit 1 Because it is **forward biased** 1 Need first statement – otherwise 0	MUST be consistent with (ii) ie if +2.1 V in (ii) then must state blue LED lit	2•	

Sample Answer and Mark Allocation				Notes	Inner Margin	Outer Margin
27. (a)	(i)	$\frac{\sin\theta_a}{\sin\theta_g} = n$ or $n = \frac{\sin\theta_1}{\sin\theta_2}$	½	**OR** $\frac{\sin\theta_a}{\sin\theta_g} = \frac{n_g}{n_a}$	2	**6**
		$\frac{\sin 28}{\sin\theta_g} = 1\cdot 61$	½			
		$\boldsymbol{\theta_g = 17^\circ}$ deduct ½ if no units	1			
	(ii)	$\lambda_{(air)} = \frac{v_{(air)}}{f}$	½		3+	
		$= \frac{3\times 10^8}{4\cdot 8\times 10^{14}}$	½			
		$\left(= 6\cdot 25\times 10^{-7}\,(\text{m})\right)$		If stop here, max 1 mark		
		$\lambda_g = \frac{\lambda_{air}}{n}$ (anywhere)	½	Each formula ½		
		$= \frac{6\cdot 25\times 10^{-7}}{1\cdot 61}$	½	If use value of red light from data sheet, max ½ for second formula ie 633, 644, 656 nm		
		$= \mathbf{3\cdot 88\times 10^{-7}\,m}$	1			
		OR				
		$v_g = \frac{v_a}{n}$	½			
		$= \frac{3\times 10^8}{1\cdot 61}$	½	If use $2\times 10^8\ \text{m s}^{-1}$, max ½ for second formula		
		$\left(= 1\cdot 86\times 10^{-8}\left(\text{m s}^{-1}\right)\right)$				
		$\lambda_g = \frac{v_g}{f}$ anywhere	½			
		$= \frac{1\cdot 86\times 10^8}{4\cdot 8\times 10^{14}}$	½			
		$= 3\cdot 88\times 10^{-7}\,\text{m}\ (3.875)$	1			
	(b)	Ray will pass through point X	½	No justification, 0 marks WP in justification, 0 marks irrelevant justification ½ (eg speed/frequency change) not 'bends' for justification	1•	
		Refractive index for blue light > refractive index for red	½			
		OR				
		Blue refracted more				

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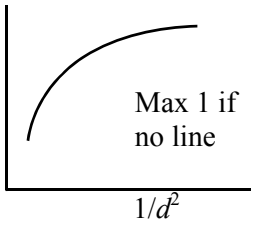
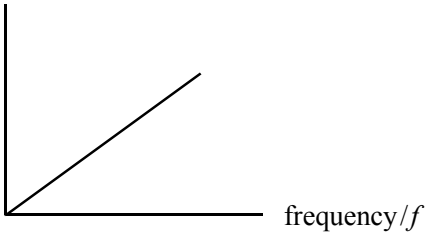
Sample Answer and Mark Allocation		**Notes**	Inner Margin	Outer Margin
28. (a)	Power = 40/20 = 2 mW 1 $P = I \times A$ ½ $2 \times 10^{-3} = I \times 8 \times 10^{-5}$ ½ I = **25** W m^{-2} 1	Formula ½ anywhere Deduct ½ for prefix error To access last 2 marks, the only mistake allowed to be carried forward is a prefix/arith error eg P = 20/40 = 0.5 Max ½ for 'I' formula	3	**5**
(b)	For point source $I_1 d_1^2 = I_2 d_2^2$ **OR** $I d^2$ = constant } Anywhere – can be implied by calculations ½ $I_1 d_1^2 = 1{\cdot}1 \times 0{\cdot}5^2$ = **0·28** $I_2 d_2^2 = 0{\cdot}8 \times 0{\cdot}7^2$ = **0·39** $I_3 d_3^2 = 0{\cdot}6 \times 0{\cdot}9^2$ = **0·49** **max 1 mark if only 2 values calculated** (1 for all 3 values) (Values not equal) – not a point source ½ Wrong conclusion, max 1½ **Note:** Values of $I d$ = 0·55, 0·56, 0·54	**OR** Plot graph of I against $1/d^2$ I  ½ for labelled axes Values $1/d^2$ 4 2 1·2 ½ Use all points to plot graph. Not a straight line (through origin) ½ statement ($I d^2$ is not constant) Not a point source ½ **OR** I not proportional to $1/d^2$	2+	

Sample Answer and Mark Allocation			Notes	Inner Margin	Outer Margin
29. (a)	energy/E/hf  		Deduct ½ if origin not labelled No labels on axes, 0 marks Both axes must be labelled Line should be straight and through the origin	1	**5**
(b)	$E = hf$ anywhere	½		3+	
	$= 6.63 \times 10^{-34} \times 6.1 \times 10^{14}$	½			
	$\left(= 4.044 \times 10^{-19}\right)$				
	Photon energy = WF + E_k	½	anywhere		
	WF = $4.044 \times 10^{-19} - 6 \times 10^{-20}$	½			
	$= 3.44 \times 10^{-19}$ J	1			
	Accept 3×10^{-19} 3.4×10^{-19} 3.444×10^{-19}				
	3.0×10^{-19} deduct ½				
(c)	Each photon still has same amount of energy	1	1 or 0 BUT, if followed by WP, 0 marks	1•	

Sample Answer and Mark Allocation					Notes	Inner Margin	Outer Margin
30.	(a)	(i)	**12000** decays per second	1	Alternatives to 'decay':	1	**5**
			12 decays per second 0 marks		12000 nucleii disintegrating/ breaking down per second - must be nucleii - not atoms/particles		
			12000 decays per minute 0 marks				
			12000 gamma rays/photons per s 0 marks				
			Number of decays per second 0 marks				
			1200 counts per second 0 marks				
		(ii)	aluminium – 2 half values	½		2+	
			lead – 3 half values	½			
			800 -- 400 -- 200 -- 100 -- 50 -- 25		This alone is 1 mark		
			count rate = 25 counts per second	1			
			If use 12000 (from part a) then		Units counts/s can be given here		
			12000 -- 6000 -- 3000 -- 1500 -- 75 -- 37.5				
			award 1 mark				

Sample Answer and Mark Allocation			Notes	Inner Margin	Outer Margin
(b) (i)	**0·03 μSv**	1	0·03 μGy 0 marks	1	
(ii)	$\frac{60}{0 \cdot 03} = \mathbf{2000}$	1	OR consistent with (b)(i) -½ if any unit given	1	

[END OF MARKING INSTRUCTIONS]