2009 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.	$V=IR$ $7{\cdot}5=1{\cdot}5R$ $R=5{\cdot}0\,\Omega$	(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.	$V=IR$ $7{\cdot}5 = 1{\cdot}5 \times R$ $R=0{\cdot}2\,\Omega$	(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

2009 Physics Higher

Marking scheme

Section A

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

2009 Physics − Higher **Sample Answer and Mark Allocation**				**Notes**	Inner Margin	Outer Margin
21.	(a)	(i)	$u_h = 6{\cdot}5 \cos 50° = 4{\cdot}2 \text{ m s}^{-1}$ 1		1	7
		(ii)	$u_v = 6{\cdot}5 \sin 50° = 5{\cdot}0 \text{ m s}^{-1}$ 1		1	
	(b)	t	$= \frac{s}{v}$ $= \frac{2{\cdot}9}{4{\cdot}2}$ ½ $= 0{\cdot}69$ (s) ½		1	
	(c)	s	$= ut + ½\, at^2$ ½ $= 5 \times 0{\cdot}69 + ½ \times -9{\cdot}8 \times (0{\cdot}69)^2$ ½ $= 1{\cdot}1$ (m) ½ so height $\boldsymbol{h} = 2{\cdot}3 + 1{\cdot}1 = 3{\cdot}4$ m ½	"u" and "a" must have opposite signs, otherwise max ½ for formula	2+	
	(d)		Ball would **not** land in basket ½ (initial) vertical speed would increase 1 So ball is higher than the basket when it has travelled 2·9 m horizontally or So ball has travelled further horizontally when it is at the same height as the basket ½		2+	

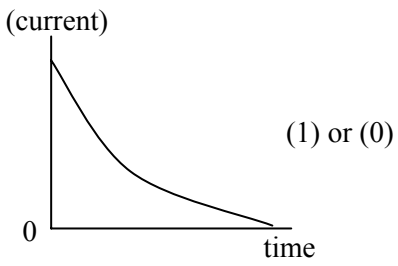
Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
22. (a) (i) (A) mean = $\frac{248+259+251+263+254}{5}$ = 255 μs 1		1 •	7
(B) uncertainty = $\frac{263-248}{5}$ = (±) 3 μs 1	lose last mark if go on to calculate % uncertainty (1·18%)	1 •	
(ii) (mean contact time = 255 ± 3 μs) max value = 258 μs ½ club does **not** meet standard ½	must attempt explanation but WP in explanation gets zero for question	1+	
(b) (i) $F = \frac{mv-mu}{t}$ ½ $= \frac{4\cdot5\times10^{-2}\times(50-0)}{450\times10^{-6}}$ ½ = 5000 N 1		2	
(ii) Impulse on the ball is greater or 1 Δmv is greater Speed increased 1		2 •	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
23. (a) (i) $P \times V =$ 2000 1995 2002 2001 (all 4 values) 1 $P \times V =$ constant 1 or $P \times V = 2000$ or $P_1V_1 = P_2V_2$ or $P = k/V$		2	10
(ii) Gas molecules collide with walls of container (½) more often (½) so (average) force increases (½) pressure increases (½) Any mention of energy or speed of molecules increasing or 'harder collisions' is WP so gets zero	first ½ mark needed first 'pressure constant' or 'decreases' gets (0)	2	
(b) (i) pressure due to water $P = \rho gh$ ½ $= 1020 \times 9{\cdot}8 \times 12$ ½ $= 120000$ (Pa) ½ *Total pressure* = $120000 + 1{\cdot}01 \times 10^5$ ½ $= 2{\cdot}21 \times 10^5$ (Pa)	deduct ½ if final answer not given	2	
(ii) $P_1V_1 = P_2V_2$ ½ $1{\cdot}01 \times 10^5 \times 1{\cdot}50 \times 10^{-3} = 2{\cdot}21 \times 10^5 \times V_2$ ½ $V_2 = 6{\cdot}86 \times 10^{-4}$ m^3 1		2	
(c) (As diver ascends) pressure decreases ½ as P = ρgh ½ volume of air in lungs will increase (or pressure difference increases) ½ so lungs may become damaged ½	dependent on having at least one of the explanations above.	2+	

Sample Answer and Mark Allocation		Notes	Inner Margin	Outer Margin
24. (a) (i) $V_{tpd} = IR$				6
$= 1{\cdot}5 \times 3$	½			
$= 4{\cdot}5$ (V)	½	if stop at 4·5 V, get (1) '4·5' gets ½		
lost volts $= E - V_{tpd}$	½	independent		
$= 6{\cdot}0 - 4{\cdot}5$				
$= 1{\cdot}5$ V	½		2 •	
(ii) $r = \frac{\text{lost volts}}{I}$	½			
$= \frac{1{\cdot}5}{3{\cdot}0}$	½	or consistent with (a) (i)		
$= 0{\cdot}5\ \Omega$	1			
Alts				
$r = \frac{E}{I}$ — short circuit current	½			
$= \frac{6{\cdot}0}{12}$	½			
$= 0{\cdot}5\ \Omega$	1			
$E = IR + Ir$	½			
$6{\cdot}0 = (3 \times 1{\cdot}5) + (3 \times r)$	½			
$r = 0{\cdot}5\ \Omega$	1		2 •	
(b) current decreases	1	must attempt explanation - answer on own gets zero		
so lost volts ($V = Ir$) decreases	1		2+	

Sample Answer and Mark Allocation		Notes	Inner Margin	Outer Margin
25. (a) (i) $V_P = 3 \times 0{\cdot}5 = 1{\cdot}5$ mV	1	if go further ie work out V_{rms} – zero	1	9
(ii) (Period = 4 ms)				
$f = \frac{1}{T}$	½			
$= \frac{1}{4\times10^{-3}}$	½			
= 250 Hz	1		2	

Sample Answer and Mark Allocation			Notes	Inner Margin	Outer Margin
(b) (i)	inverting (mode)	1		1	
(ii)	$V_{rms} = \frac{V_{peak}}{\sqrt{2}}$	½	Can use gain formula first gives $V_O = -12{\cdot}4$ V etc		
	$= \frac{6{\cdot}2\times10^{-3}}{\sqrt{2}}$	½			
	$= 4{\cdot}38 \times 10^{-3}$ (V)	½			
	$\frac{V_O}{V_i} = -\frac{R_f}{R_1}$	½			
	$\frac{V_O}{4{\cdot}38\times10^{-3}} = -\frac{10\times10^{6}}{5\times10^{3}}$	½		3+	
	$V_O =$ (–) 8·8 V	½			
(iii)	trace will be "clipped"/flattened at (+/- 9 V) or <u>almost</u> square wave (1)	1			
	max output voltage will be +/- 9 V/V_s or op-amp saturates or saturation occurs	1		2+	

Sample Answer and Mark Allocation	Notes	Inner Margin	Outer Margin
26. (a) 	no origin label – deduct ½	1 •	8
(b) $V_R = I R$ ½ $= 5 \times 10^{-3} \times 500$ ½ $= 2{\cdot}5$ (V) ½ $V_C = 12 - 2{\cdot}5$ ½ $= 9{\cdot}5$ V 1		3+	
(c) $E = \frac{1}{2}CV^2$ ½ $= 0{\cdot}5 \times 47 \times 10^{-6} \times 12^2$ ½ $= 3{\cdot}4 \times 10^{-3}$ J 1	Must use 12 V – otherwise max ½ for correct formula. Alternative: Q = CV $= 47 \times 10^{-6} \times 12$ $= 5{\cdot}64 \times 10^{-4}$ (C) E = ½ QV $= ½ \times 5{\cdot}64 \times 10^{-4} \times 12$ $= 3{\cdot}4 \times 10^{-3}$ J 1 ½ for both formulae ½ for both substitutions	2	
(d) Max energy the same/'no effect' 1 Values of "C" and "V" are same as before 1		2+	

2009 Physics − Higher Sample Answer and Mark Allocation			Notes	Inner Margin	Outer Margin
27.	(a)	waves meet out of phase or crest meets trough or path difference = $(n + ½)\ \lambda$	1	must have waves meeting/ combining		4
	(b)	λ blue light is shorter (than λ red light) and $n\lambda = d \sin\theta$ or $\sin\theta = n\lambda / d$	½ ½		1 •	
	(c)	$n\lambda = d \sin\theta$ $2 \times 4{\cdot}73 \times 10^{-7} = 2{\cdot}00 \times 10^{-6} \sin\theta$ $\theta = 28{\cdot}2°$	½ ½ 1		2+	

2009 Physics − Higher **Sample Answer and Mark Allocation**			**Notes**	Inner Margin	Outer Margin
28. (a) (i)	$E_3 \rightarrow E_0$	1	$E_0 \rightarrow E_3$ – zero between E_0 and E_3 – zero between E_3 and E_0 – ok		7
	$(\Delta)E \propto f$ or $E = hf$ or in words	½			
	$f \propto \frac{1}{\lambda}$ or $v = f\lambda$ or in words	½	wrong transition – no marks can be shown by calculation	2 •	
(ii)	$(\Delta)E = hf$ or $W_2 - W_1 = hf$	½			
	$-5\cdot2\times10^{-19} - \left(-9\cdot0\times10^{-19}\right) = 6\cdot63\times10^{-34} \times f$	½			
	$f = 5\cdot7 \times 10^{14}$ Hz	1		2	
(b)	$\lambda_a = \left(\frac{v}{f}\right) = \frac{3\times10^8}{4\cdot6\times10^{14}}$ (substitution)	½	can be got anywhere for 1 mark		
	$= 6\cdot5 \times 10^{-7}$ (m)	½			
	$\frac{\lambda_a}{\lambda_g} = \frac{\sin\theta_a}{\sin\theta_g}$	½			
	$\frac{6\cdot5\times10^{-7}}{\lambda_g} = \frac{\sin53°}{\sin30°}$	½			
	$\lambda_g = 4\cdot1 \times 10^{-7}$ m	1		3+	

Sample Answer and Mark Allocation		Notes	Inner Margin	Outer Margin
29. (a) (i) $E_k = hf - hf_0$ $= 5{\cdot}23 \times 10^{-19} - 2{\cdot}56 \times 10^{-19}$ $= 2{\cdot}67 \times 10^{-19}$ J	1		1	5
(ii) $E_k = \frac{1}{2}mv^2$	½			
$2{\cdot}67\times10^{-19} = \frac{1}{2}\times 9{\cdot}11\times10^{-31} \times v^2$	½			
$v = 7{\cdot}66\times10^{5}$ m s^{-1}	1		2 •	
(b) No change (to maximum speed)/no effect	1			
Energy/frequency of photons does not change or Energy an electron receives is the same	1		2+	

Sample Answer and Mark Allocation				Notes	Inner Margin	Outer Margin
30. (a) (i)		$r = 95$	½			7
		$s = 7$	½		1	
	(ii)	Total mass of reactants				
		> total mass of products or loss of mass	½	needs to be directional ie mass before > mass after		
		("missing" mass is converted into energy) according to $E = mc^2$	½		1	
	(iii)	Total mass before				
		= $390{\cdot}173 \times 10^{-27} + 1{\cdot}675 \times 10^{-27}$				
		= $3{\cdot}91848 \times 10^{-25}$ (kg)	½	if mass rounding off then max 1½		
		Total mass after				
		= $230{\cdot}584 \times 10^{-27} + 157{\cdot}544 \times 10^{-27} + (2 \times 1{\cdot}675 \times 10^{-27})$				
		= $3{\cdot}91478 \times 10^{-25}$ (kg)	½			
		Δm = $3{\cdot}91848 \times 10^{-25} - 3{\cdot}91478 \times 10^{-25}$				
		= $3{\cdot}7 \times 10^{-28}$ (kg)				
		E = mc^2	½			
		= $3{\cdot}7 \times 10^{-28} \times (3 \times 10^8)^2$	½			
		= $3{\cdot}3 \times 10^{-11}$ J	1		3	

Sample Answer and Mark Allocation				Notes	Inner Margin	Outer Margin
(b)	(i)	12 mm	1		1	
	(ii)	200 → 100 → 50				
		2 half-value thicknesses	½			
		= 2 × 12 = 24 mm	½		1	

[END OF MARKING INSTRUCTIONS]