2013 Physics

Higher

Finalised Marking Instructions

Part One: General Marking Principles for Physics Higher

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.

(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

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.

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

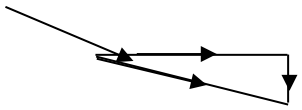
Part Two: Marking Instructions for each Question

Section A

Question			Acceptable Answer/s
1			**E**
2			**B**
3			**B**
4			**A**
5			**C**
6			**A**
7			**C**
8			**E**
9			**D**
10			**E**

Question			Acceptable Answer/s
11			**D**
12			**B**
13			**E**
14			**A**
15			**B**
16			**D**
17			**B**
18			**C**
19			**D**
20			**D**

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
21. (a)	**Must start with a formula or (0)** $v = u + at$ ½ $20 = 0 + 4a$ ½ $a = 5{\cdot}0$ m s^{-2} Deduct ½ if this line not shown	missing/wrong units, deduct ½ u and v wrong way round, ½ **max for formula** Gradient method is okay: $a = \Delta v/t = 20/4 = 5$ m s^{-2} ***a=v/t* not acceptable**	**1**	**6**
(b)	car: $d = v \times t$; $d = 15 \times 4$; $d = 60$ ½ motorcycle: $s = ut + ½ at^2$; $s = ½ \times 5 \times 16$; $s = 40$ ½ Extra distance = 60 – 40 = 20 m **1** ***Can also use $v^2 = u^2 + 2as$*** ***$20^2 = 0 + 2 \times 5 \times s$ for motorcycle***	or, by area under graph; car: $A = l \times b$; $A = 15 \times 4$; $A = 60$m ½ motorcycle: $A = ½ b \times h$; $A = ½ \times 4 \times 20$; $A = 40$m ½	**2•**	
(c)(i)	$F_{(resultant)}$ = ma $F_{(resultant)}$ = 290 × 5 ½ $F_{(resultant)}$ = 1450 (N) ½ Frictional force = 1450 - 1800 = (-)350 N **1**		**2•**	
(c)(ii)	The *faster it goes*, the greater the *air resistance*. ½ **or** ***frictional forces / friction / drag*** ***then*** $F_{(drive)}$ constant, the *unbalanced* force would decrease **or** increasing $F_{(drive)}$ keeps the *unbalanced* force constant **or** ***overall/net force* - must have** ½	**Must have first (½) to access second (½)** **Must be force**	**1•**	

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
22. (a)	$s = ut + ½\ at^2$ ½ $s = 0 + ½ \times -9{\cdot}8 \times \mathbf{0{\cdot}50^2}$ ½ $s = -1{\cdot}225$ m height above ground = 2·5 – 1·225 = 1·275 m **1** **(accept 1·28 m, 1·3 m)**	**If use a = 9·81 or 10 m s^{-2}** ***deduct ½ mark once in question***	**2**	**7**
(b)	At impact, vertical velocity: $v^2 = u^2 + 2as$ $v^2 = 0 + 2 \times -9{\cdot}8 \times -2{\cdot}5$ ½ $v = 7$ **(**m s^{-1}**)** ½ horiz velocity: $v = 24$ **(**m s^{-1}**)** ½ resultant velocity: $v^2 = 49 + 576$ ½ $v = 25$ m s^{-1} ½ tan $\theta = 7/24$ $\theta = 16{\cdot}26°$ = 16 ° ½  **either show angle clearly on a diagram or state 16^o to horizontal / ground or 74^o to vertical**	**Alternative formulas possible, but always *a* and *s* must have the same sign.** **For solution by scale drawing only:** ***Resultant velocity = 25·0 ± 0·5* m s^{-1}*** ***angle = 16 ± 2°*** **Any mention of a bearing loses angle ½ *mark***	**3+**	
(c)	(As the temperature increases,) the E_k/v of the molecules increases/greater ½ **Must be <u>kinetic</u> energy, not just 'energy'** More collisions <u>per second</u> with the walls ½ **more often/more frequent** Collide with a greater force/**harder/more violently** ½ Pressure increases ½	**Must have 'molecules colliding with the walls' before any marks can be awarded.** **Must conclude that <u>pressure increases</u> before any marks can be awarded.**	**2**	

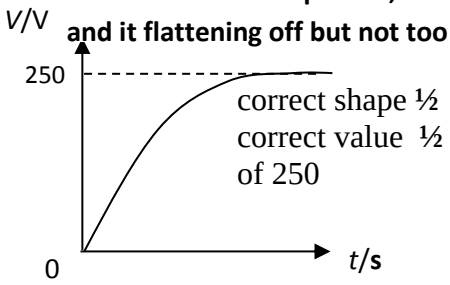
Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
23. (a)	total momentum before a collision is equal to total momentum after collision, ½ in the absence of external forces ½	**Must have total and collision or interaction** first ½ needed first "for an isolated/**closed** system"	**1**	**6**
(b)	$\Delta mv = mv - mu$ ½ **Values in line 2 must be final - initial** $\Delta mv = 1200 \times 0 - 1200 \times 13{\cdot}4$ ½ $\Delta mv = -16080$ kg m s^{-1} $\Delta mv = -1{\cdot}6 \times 10^4$ kg m s^{-1} **1**	**i.e.** if u and v wrong way round, formula ½ only **must have change in momentum i.e. '*mv*' or '*p*' = 16080 kg m s^{-1} gets *0 marks***	**2•**	
(c)	$v^2 = u^2 + 2as$ $0 = 13{\cdot}4^2 + 2 \times a \times 0{\cdot}48$ $a = -187{\cdot}04$ m s^{-2} **1** $F = ma$ ½ $F = 75 \times$ **(-)**187·04 ½ $F =$**(-)**14 028 N **if stop here sig fig error deduct** ½ $F = 1{\cdot}4 \times 10^4$ N **1**	**OR,** $E_k = ½ mv^2$ $= ½ \times 75 \times 13{\cdot}4^2$ $= 6733{\cdot}5$ (J) **1** $E_w = F \times d$ ½ $6733.5 = F \times 0{\cdot}48$ ½ $\Rightarrow F = 1{\cdot}4 \times 10^4$ N **1** **OR** **s = (u + v)t/2** **0·48 = (13·4 + 0)t/2** **t = 0·072** **1** **F t = m(v – u)** ½ **F × 0·072 = 75(0–13·4)** ½ **F = 1·4 × 10^4N** **1**	**3+**	

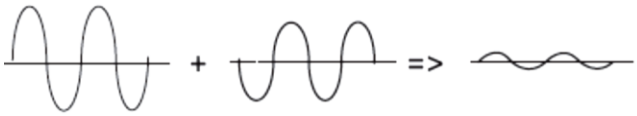
Question	Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
24. (a)	$P = F/A$	½			**9**
	$1{\cdot}01 \times 10^5 = 262/A$	½		**2**	
	$A = 2{\cdot}59 \times 10^{-3}$ m^2	**1**			
(b)(i)	$\Delta P = 513\,000 - 1{\cdot}01 \times 10^5$		**if no subtraction, ½ max. (for $P = \rho gh$)**		
	$\Delta P = 412\,000$ Pa	**1**			
	$(\Delta)P = \rho gh$	½			
	$412\,000 = 1{\cdot}02 \times 10^3 \times 9{\cdot}8 \times h$	½		**3•**	
	Depth $h = 41{\cdot}2$ m	**1**			
(b)(ii)	Volume increases/**expands/gets bigger**	½	Look for this first		
	P decreases P ∝ 1/ V PV = const.	½		**1•**	
(c)	Voltage at inverting input is 12 V		***V_1* = 12V ½ mark** ***V_2* = 6V ½ mark** **but <u>must</u> specifically identify V_1 and V_2.**		
	$V_o = (V_2 - V_1) \times \frac{R_f}{R_i}$	½			
	$V_o = (6 - 12) \times \frac{150 \times 10^3}{50 \times 10^3}$	½			
	$= -18$ (V)				
	(Op-amp saturates at a maximum) V_o of −15V	**1**	**But if states "<u>voltage</u> saturates" *deduct last 1 mark***	**3+**	
	Accept V_o in range –12V to –15V		***V_o* = ± 12 to 15 V *deduct last 1 mark as negative not chosen***		

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
25. (a)(i)	0·22 V **1**	**Missing or wrong unit deduct ½ mark**	**1**	**6**
(a)(ii)	$E = V + Ir$ ½ $0{\cdot}22 = 0{\cdot}10 + 3r$ ½ $r = 0{\cdot}04\Omega$ **1** **Alternative methods** **use r = - gradient of graph** $r = -\left(\frac{V_2 - V_1}{I_2 - I_1}\right)$ } ½ **= - (0·1 – 0·2)/ (3·00 – 0·5)** ½ ***r* = 0·04Ω** **1** **use *V = I(R + r)*** **0·2 = 0·5 (0·4 + r)** **1** ***r* = 0·04Ω** **1** **use short circuit current** $r = \frac{e.m.f.}{I_{short\ circuit}}$ $r = \frac{0{\cdot}22}{5{\cdot}5}$ } ← **1** **= 0·04Ω** **1**	Other possible subs.: ***V*** | ***I*** | ***R*** 0·20 | 0·5 | **0·40** 0·18 | 1·0 | **0·18** 0·16 | 1·5 | **0·107** 0·14 | 2·0 | **0·07** 0·12 | 2·5 | **0·048** 0·10 | 3·0 | **0·033** **OR,** **$r = V_{(lost)}/I$** **= (0.22 – 0.2)/0.5** **1** **[or other appropriate substitutions]** **= 0.04 Ω** **1**	**2**	

Question	Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
25. (b)	$E = I(R + r)$	½	**Look for conclusion first.** **If no conclusion, no marks at all.**	**3+**	
	$0{\cdot}88 = I(0{\cdot}12 + 0{\cdot}15)$	½			
	$I = 3{\cdot}26$ A	**1**			
	Yes/**valve open**	**1**			
	Last mark depends on an appropriate calculation shown.		**If only, "Yes because the current is greater than 2·5A",** ***0 marks as no calculation given to back up statement.***		

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
26. (a)	tot. time = no. of divs x time base setting = 10 × 0·01 = 0·1 (s) ½ f = number of waves / tot. time = 2·5 / 0·1 ½ = 25 Hz **1**	OR, [period = 4 × 0·01 = 0·04 s] f = 1/T ½ = 1/0·04 ½ = 25 Hz **1**	**2•**	**5**
(b)	$V_p = \sqrt{2}\ V_{rms}$ ½ = **√2 × 2·30** ½ = 3·25 V **1**		**2**	
(c)	Stays constant/**no change/nothing happens** ½ Current is independent of supply frequency ½	**First ½ mark independent**	**1**	

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
27. **(a)(i)**	$V = IR$ ½ $250 = I \times 15\,000$ ½ $I = 17$ mA **1**	Sig figs: Other acceptable answers 20, 16·7, 16·67 16·667 or more deduct ½	**2**	**7**
(a)(ii)	**look for correct shape first, i.e. correct curve and it flattening off but not too abruptly.** 	labels or units missing, deduct ½ no origin labelled, deduct ½ **lose ½ if curve not clearly through origin.**	**1**	
(a)(iii)	**must start with a formula** $E = ½ CV^2$ ½ $= ½ \times 470 \times 10^{-6} \times 250^2$ ½ $= 14{\cdot}7$ **J** **wrong unit, *deduct ½ mark***	**or Q = CV & E = ½ QV** exact answer is 14·6875, **but this needs to be rounded to 14·7.** deduct ½ if last line missing	**1**	
(b)	$P = \frac{E}{t}$ ½ $= \frac{14{\cdot}7}{200 \times 10^{-6}}$ ½ $= 73\,500$ W **1**	Using E =14·6875J, $P = 73\,400$ W	**2•**	
(c)	Reduce the value of the resistor. **1** **smaller resistance** **smaller value of resistance**	**smaller resistor *0 marks*** **lower resistor *0 marks*** **any wrong physics negates marks eg** **change supply voltage *0 marks*** **change capacitance *0 marks***	**1•**	

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
28. (a)(i)	waves <u>meet</u> out of phase **OR** crests <u>meet</u> troughs **1** **superpose, overlap (must convey meeting of the waves)** **Can be shown by a diagram, e.g.** 		**1**	**6**
(a)(ii)	Path diff = $n\lambda$ p.d. = $3 \times 28 \times 10^{-3}$ ½ p.d. = 84 (mm) ½ distance from S_2 to P = 620 + 84 S_2 to P = 704 mm **1**	**Can still get 1 mark for p.d. = 84 even when it is wrongly subtracted from 620.**	**2**	
(b)	$n\lambda = d\sin\theta$ ½ $n \times 420 \times 10^{-9} = 3{\cdot}27 \times 10^{-6} \times \sin 40$ ½ $n = 5$ **1** total no. of maxima = 5 above + 5 below + central = 11 **1**	<u>Watch sub. of sin 40. sin 80 substituted gives $n = 7{\cdot}7$</u> **If any 'units' given, *deduct ½ mark***	**3+**	

Question	Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
29. (a)	$n = \sin\theta_1 / \sin\theta_2$	½			**5**
	$1{\cdot}49 = \sin\theta_{air} / \sin 19$	½			
	$\theta_{air} = 29°$	**1**	**deduct ½ if ^{o} missing**	**2**	
(b)	$n = 1/\sin\theta_c$	½			
	$1{\cdot}49 = 1/\sin\theta_c$	½			
	$\theta_c = 42°$	**1**		**2+**	
(c)	Different frequencies/colours are <u>refracted</u> through different angles **OR** The <u>refractive index</u> is different for different frequencies/colours	**1**	**Do not accept:-** **"bending" on its own, but ignore it if follows 'refraction'.** **a correct answer followed by 'diffract' or 'defract', *0 marks.***	**1**	

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
30. (a)	$I_1d_1^2 = I_2d_2^2$ **or** $\mathbf{Id^2 = k}$ $242 \times 0{\cdot}10^2 = 242 \times \mathbf{10^{-2}}$ $106 \times 0{\cdot}15^2 = 239 \times \mathbf{10^{-2}}$ $60 \times 0{\cdot}20^2 = 240 \times \mathbf{10^{-2}}$ $39 \times 0{\cdot}25^2 = 244 \times \mathbf{10^{-2}}$ **1** All values of Id^2 are about the same ½ So it <u>is</u> a point source ½	<u>This line, if it is all that is written down, gets ½.</u> For <u>all</u> calculations shown Last line need for final ½.	**2•**	**7**
(b)(i)	laser beam does not diverge/**spread out** OR laser is not a point source (of light) **1** OR reading is high because laser light is concentrated on a small area	***1 mark* OR *0 marks*** **any correct statement of comparative characteristics, *1 mark***	**1**	
(b)(ii)	$v = f\lambda$ ½ $3{\cdot}0 \times 10^8 = f \times 633 \times 10^{-9}$ ½ <u>$f = 4{\cdot}74 \times 10^{14}$</u> $E=hf$ ½ $=6{\cdot}63 \times 10^{-34} \times 4{\cdot}74 \times 10^{14}$ ½ <u>$= 3{\cdot}142 \times 10^{-19}$</u> $N_{photons} = \frac{\text{total energy}}{\text{photon energy}}$ $= \frac{1{\cdot}00 \times 10^{-4}}{3{\cdot}142 \times 10^{-19}}$ <u>$= 3{\cdot}18 \times 10^{14}$</u> **1**		**3+**	
(b)(iii)	for laser light: photons have same frequency**, energy, wavelength (or λ)** ½ all photons are in phase ½ **OR** for <u>filament</u> lamp: photons have a range of frequencies ½ photons are not in phase ½	**'all photons travel in the same direction'** ½ **Any 2 from 3** **'photons travel in all directions'** **Must be clear which source is being referred to.**	**1**	

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
31. (a)(i)	Lithium or Li (ignore correct values of A) **1**	Incorrect Z but correct corresponding element, deduct ½ "Li" with incorrect Z gets **0**	**1**	**6**
(a)(ii)	$E = mc^2$ ½ $2{\cdot}97 \times 10^{-12} = m \times (3 \times 10^8)^2$ ½ $m = 0{\cdot}033 \times 10^{-27}$ (kg) ½ $\mathbf{X} + 3{\cdot}342 \times 10^{-27} =$ $(2 \times 6{\cdot}642 + 1{\cdot}675 + 0{\cdot}033) \times 10^{-27}$ ½ $\mathbf{X} = 11{\cdot}650 \times 10^{-27}$ kg **1**		**3•**	
(b)	$\dot{H} = D\dot{w}_R$ ½ $= (2 \times 1) + (1{\cdot}25 \times 2) + (0{\cdot}2 \times 10)$ $\dot{H} = 6{\cdot}5$ μSv h^{-1} so, $H = 12 \times 6{\cdot}5$ ½ **= 78 μSv** **1**	**Can start with another dosimetry formula, but must correctly substitute all the way through chosen formula(s).**	**2•**	

[END OF MARKING INSTRUCTIONS]