2013 Physics (Revised)

Higher

Finalised Marking Instructions

Part One: General Marking Principles for Physics Higher (Revised)

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 (Revised)

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.

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			**A**
2			**B**
3			**B**
4			**A**
5			**E**
6			**A**
7			**B**
8			**A**
9			**C**
10			**C**

Question			Acceptable Answer/s
11			**E**
12			**D**
13			**B**
14			**C**
15			**B**
16			**D**
17			**B**
18			**E**
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**	**7**
(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)	$F_{(resultant)} = ma$ $F_{(resultant)} = 290 \times 5$ 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•**	
(d)	graph curves **(gradually, away from velocity axis)** after 5 seconds **1** **(values are needed on the time axis for this to be established)**	"sudden" change **in gradient** is wrong physics.	**1**	

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
22. (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**	**8**
(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 $F = 75 \times$ **(-)**$187{\cdot}04$ 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^{4}N 1**	**3+**	
(d)	Time **(**of collision**)** increased ½ **change in momentum is the same** ½ **(**Average**)** force **(**acting on dummy/passenger**)** is decreased/**reduced/smaller** **1**	**Look for "smaller force" first. Zero marks if this is not there.** **Do not accept arrows for "increases" or "decreases".**	**2 (1A)**	

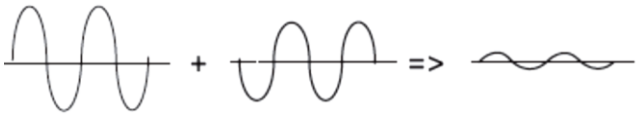
Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
23.	estimate of masses (20 kg < student mass < 200 kg) ½ estimate of distance (0·1 m< distance < 2 m) ½ $F = G\frac{m_1 m_2}{r^2}$ ½ Correct substitution ½ Final answer and unit **1**	**both estimates must be within the given tolerances in order to access the final 1·5 marks.**	**3 (1A)**	**3**

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
24. (a)	The <u>decrease in length</u> (in the direction of motion) of an <u>object moving</u> relative to an <u>observer</u>. **N.B. it must be clear that the observer is in a different frame of reference.**	<u>on its own zero marks</u>. <u>Formulae with all symbols defined 1 mark</u>	**1 (1A)**	**5**
(b)	$\gamma = \frac{1}{\sqrt{1-\left(v/c\right)^2}}$ $\gamma = \frac{1}{\sqrt{1-(0\cdot8)^2}}$ **½** $\gamma = 1\cdot7$ **½**	If units given deduct ½ **Accept:** **2 (but not 2·0)** **1·7** **1·67** **1·667**	**1**	
(c)	$l' = l/\gamma$ or $l = \gamma\, l'$ **1** **Or** $\gamma = l/l'$	**1 or 0**	**1**	
(d)	Lorentz factor is (approximately) unity/equal to one **1** negligible change in length/time/mass observed **1**	**Look for this first.**	**2**	

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
25. (a)	Description of what Big Bang theory is **1** [e.g. The Universe was initially in a hot and very dense state and then rapidly expanded. The universe started from a point/singularity and rapidly expanded.] One supporting factor **1** [e.g. abundance of hydrogen/helium CMB/present temperature of Universe Darkness of the sky] **Redshift of <u>galaxies</u>** **Olber's paradox** **All three of C, M and B required**	**These terms or equivalent descriptions.**	**2**	**5**
(b)	Demonstrates no understanding **0** Limited understanding **1** Reasonable understanding **2** Good understanding **3**	Open ended question – **a variety of Physics arguments can be used to answer this question. Marks are awarded on the basis of whether the answer, overall, demonstrates 'no', 'limited', 'reasonable' or 'good' understanding**.	**3 (1A)**	

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
26. **(a)(i)**	$E_w = Q\,V$ ½ $= 1{\cdot}6 \times 10^{-19} \times 55\,000$ ½ $= 8{\cdot}8 \times 10^{-15}$ J	**This is a** 'Show' question, so must state formula deduct ½ if last line not shown	**1**	**6**
(a)(ii)	$E_k = ½\,mv^2$ ½ $8{\cdot}8 \times 10^{-15} = ½ \times 1{\cdot}673 \times 10^{-27} \times v^2$ ½ $v = 3{\cdot}2 \times 10^6$ m s^{-1} **1**	**Must use 8·8 x 10^{-15}** accept 3·243, 3·24 and 3, but not 3·0	**2**	
(b)	Into the page or down/**downwards** **1** **but not "down the page"**		**1**	
(c)	a.c. voltage used to change the direction of the **force on protons/polarity of the dees/**electric field across the gap. **1** (Electric field must change direction to accelerate the protons because) the direction the protons cross the gap changes **keeps <u>changing</u>**. **1**	<u>Any order</u>	**2 (1A)**	

Question	Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
27.	Demonstrates no understanding Limited understanding Reasonable understanding Good understanding	**0** **1** **2** **3**	Open ended question **– a variety of Physics arguments can be used to answer this question. Marks are awarded on the basis of whether the answer, overall, demonstrates 'no', 'limited', 'reasonable' or 'good' understanding.**	**3 (1A)**	**3**

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**	**8**
(a)(ii)	Path diff = $m\lambda$ 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)(i)	$m\lambda = d\sin\theta$ ½ m x $420 \times 10^{-9} = 3{\cdot}27 \times 10^{-6} \times \sin 40$ ½ $m = 5$ **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+**	
(b)(ii)	greater λ/wavelength ½ when λ increases ($\sin\theta$ and) θ increase**s** ½ the number of visible maxima will decrease **1**	No marks for a statement with no justification.	**2 (1A)**	

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**	

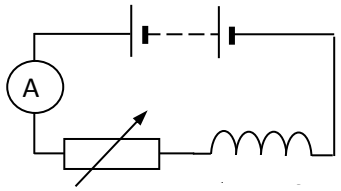
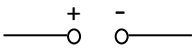
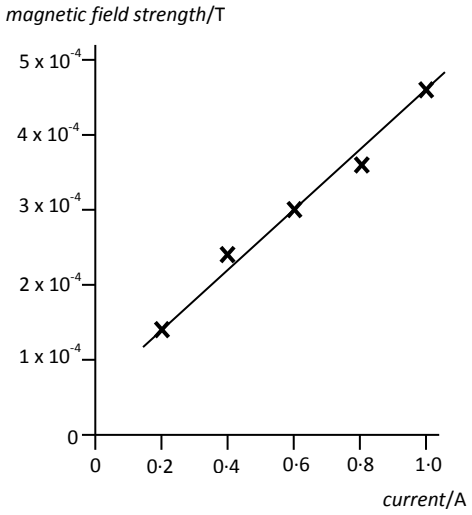
Question	Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
30. (a)(i)	0·22 V	**1**	**Missing or wrong unit deduct ½ mark**	**1**	**6**
(a)(ii)	$E = V + Ir$	½	Other possible subs.:	**2**	
	$0{\cdot}22 = 0{\cdot}10 + 3r$	½			
	$r = 0{\cdot}04\Omega$	**1**			
	Alternative methods				
	use r = - gradient of graph				
	$r = -\left(\frac{V_2 - V_1}{I_2 - I_1}\right)$	½			
	$= -(0{\cdot}1 - 0{\cdot}2)/(3{\cdot}00 - 0{\cdot}5)$	½			
	$r = 0{\cdot}04\Omega$	**1**			
	use $V = I(R + r)$				
	$0{\cdot}2 = 0{\cdot}5\,(0{\cdot}4 + r)$	**1**			
	$r = 0{\cdot}04\Omega$	**1**			
	use short circuit current $r = \frac{e.m.f.}{I_{short\ circuit}}$				
	$r = \frac{0{\cdot}22}{5{\cdot}5}$	**1**			
	$= 0{\cdot}04\Omega$	**1**			

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]
$= 0.04\ \Omega$ **1**

Question	Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
30. (b)	$E = I(R + r)$	½	**Look for conclusion first.**		
	$0{\cdot}88 = I(0{\cdot}12 + 0{\cdot}15)$	½	**If no conclusion, no marks at all.**		
	$I = 3{\cdot}26$ A	**1**			
	Yes/**valve open**	**1**		**3+**	
	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
31. (a)	**most**/majority of electrons in valance band ½ **or "fewer electrons in conduction band"** band gap is small ½ electrons are excited to conduction band ½ charge can flow when electrons are in conduction band ½	**Independent ½ s** any order labelled diagram on its own (1)	**2**	**6**
(b)	value greater than 2·1 V but less than 2·8 V **(inclusive)** **1**	must have unit **must be a value, not a range.**	**1 (1A)**	
(c)	$v = f\lambda$ ½ $3 \times 10^{8} = f \times 850 \times 10^{-9}$ ½ $f = 3{\cdot}53 \times 10^{14}$ (Hz) $E = hf$ ½ $= 6{\cdot}63 \times 10^{-34} \times 3{\cdot}53 \times 10^{14}$ ½ $= 2{\cdot}34 \times 10^{-19}$ J **1**	$v = f\lambda$ $E = hf$ **(½) each** for both formulas anywhere	**3 (3A)**	

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
32. (a)	Suitable components selected and circuit symbols correct **1** suitable circuit (i.e. it would work) e.g. **1**  **resistor must be variable (unless variable supply used).**	Values not required Accept  or  	**2**	**8**
(b)	 	**2 marks for a fully correct graph.** **Axes labels must have both the name of the quantity and its unit.** **Each point must be plotted to within ± a half scale division.** **There must be a single, straight, best-fit line through the points.** **A non-linear scale on either axis is wrong and prevents access to any marks.**	**2**	
(c)	(the graph is a straight line that) does not pass through origin **OR** **1** the magnetic field strength is not zero when the current is zero		**1 (1A)**	

Question	Sample Answers and Mark Allocation		Notes	Inner Margin	Outer Margin
32. (d)	gradient of graph = $3{\cdot}8 \times 10^{-4}$ (TA^{-1})	**1**	accept $3{\cdot}6 \times 10^{-4}$ to $4{\cdot}0 \times 10^{-4}$	**3 (3A)**	
	gradient = $6{\cdot}3 \times 10^{-7} \frac{N}{r}$	½	**If <u>values</u> of B and I (from the table or the graph line) are used in the formula, zero marks.**		
	$3{\cdot}8 \times 10^{-4} = 6{\cdot}3 \times 10^{-7} \frac{30}{r}$	½			
	r = *0·05 m*	**1**	<u>0·0497; 0·04974</u>		

[END OF MARKING INSTRUCTIONS]