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. If a specific candidate response does not seem to be covered by either the principles or detailed Marking Instructions, and you are uncertain how to assess it, you must seek guidance from your Team Leader/Principal Assessor.

(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.	$5{\cdot}0$	(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

2015 Physics Higher

Section A

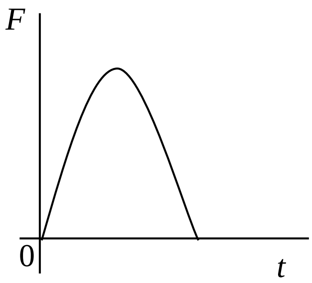
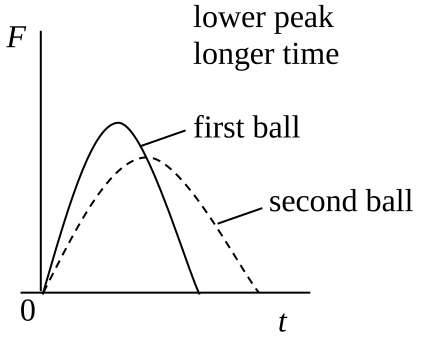
Question	Expected Answer(s)	Max Mark
1.	E	**1**
2.	C	**1**
3.	B	**1**
4.	C	**1**
5.	B	**1**
6.	B	**1**
7.	C	**1**
8.	D	**1**
9.	B	**1**
10.	E	**1**

Question	Expected Answer(s)	Max Mark
11.	E	**1**
12.	A	**1**
13.	A	**1**
14.	A	**1**
15.	D	**1**
16.	D	**1**
17.	A	**1**
18.	E	**1**
19.	D	**1**
20.	B	**1**

Section B:

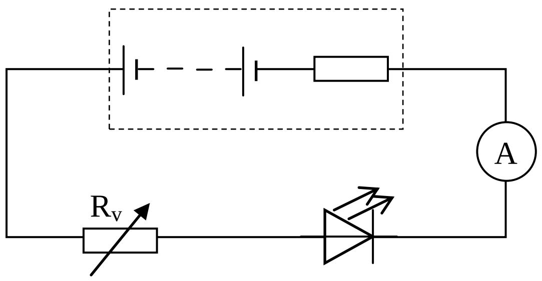
Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
21	a	i	**A** $v = 11{\cdot}6\ \text{m s}^{-1}$ **(1)**	Deduct **(½)** for wrong/missing unit	1●	8
			B $v_h = 11{\cdot}6 \cos 40$ $= 8{\cdot}9\ \text{m s}^{-1}$ **(1)** **(accept 8·886, 8·89, 9 <u>not</u> 9·0)**	or consistent with A	1	
			C $v_v = 11{\cdot}6 \sin 40$ $= 7{\cdot}5\ \text{m s}^{-1}$ **(1)** **(accept 7·456, 7·46,7, <u>not</u> 7·0)**	or consistent with A	1	
21	a	ii	**A** $s = ut + \frac{1}{2}at^2$ **(½)** $4{\cdot}7 = 0 + ½ \times 9{\cdot}8 \times t^2$ **(½)** $= 0{\cdot}979$ **(½)** Total Time = $0{\cdot}98 + 0{\cdot}76$ $= 1{\cdot}7$ s **(½)** **not 'sec'** **(accept 2, 1·74, 1·739)**	Alternative: $v^2 = u^2 + 2as$ $= 0 + 2 \times 9{\cdot}8 \times 4{\cdot}7$ $v = 9{\cdot}6$ $v = u + at$ $9{\cdot}6 = 0 + 9{\cdot}8\,t$ $t = 0{\cdot}979$ Total $t = 0{\cdot}98 + 0{\cdot}76 = 1{\cdot}7$ s *s* and *a* must have same sign **Accept 2 but not 2·0**	2●	
			B $v = \frac{d}{t}$ **(½)** $8{\cdot}9 = \frac{d}{1{\cdot}7}$ **(½)** $d = 15$ m **(1)** **(accept 15·5, 15·49)**	Or consistent with (a)(ii)(A) **<u>and</u>** (a)(i)(B) 1·74 is ok for *t*, giving *d* = 15, 15·5 **or** 15·49	2	
	b		• (total energy remains the same) • the greater the angle the more energy used to lift the put to a greater height before release **(½)** • less energy available to convert to E_k **(½)**	• Kinetic energy is less **(½)** <u>This statement is required before any marks awarded.</u> • (The release) speed is less **(½)**	1+	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
22	**a**	$v^2 = u^2 + 2as$ **(½)** $0 = 90^2 + 2 \times a \times 1980$ **(½)** $a = -2 \cdot 04545 \left(\text{ms}^{-2}\right)$ $F = ma$ **(½)** $= 3520 \times (-) 2 \cdot 04545$ **(½)** $= (-) 7200 (\text{N})$ $w = mg$ $= 3520 \times 1 \cdot 25$ $= 4400 (\text{N})$ **(½)** Force exerted by engines = 4400 + 7200 = 11 600 N **(½)**	<u>Independent calculations</u> If 2000 for s, max **(2)** Negative sign missing subtract **(½)** *u* and *s* must have the same sign Drop negative sign from line 2 to line 3 subtract **(½)** If final answer is 11500 N then student used *s* = 2000, max **(2)**	**3+**	**5**
	b	(constant speed $\Rightarrow$) upward force = weight **(½)** 3 Tcos20 = 1380 **(1½)** T = 490(N)	Or 'Forces are balanced' – anywhere in answer If "T = 490 (N)" not shown, then max **(1½)**	**2●**	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
23	**a**	**i**	$\Delta mv = mv - mu$ $= 0{\cdot}16 \times 39$ $= 6{\cdot}24\left(\text{kg m s}^{-1}\right)$ **Both formulae (½)** **Both substitutions (½)** $Ft = mv - mu$ $F \times 0{\cdot}020 = 6{\cdot}24$ $= 310\ \text{N}$ (**accept 312 N**)	$Ft = mv - mu$ **(½)** $F \times 0{\cdot}020 = 0{\cdot}16 \times 39 - 0$ **(½)** $= 312$ N **(1)** **Or** $v = u + at$ $39 = 0 + a \times 0{\cdot}020$ $a = 1950$ **Both formulae (½)** $F = ma$ **Both substitutions (½)** $= 0{\cdot}16 \times 1950$ $= 312$ N **(1)** **Wrong or missing unit deduct (½)**	**2**	**5**
	a	**ii**	At least one labelled axis is required, otherwise **(0)** Then, shape of graph **(1)**  	No origin subtract **(½)** If peak labelled as 310 N, deduct **(½)**	**1●**	
	b		lower peak **(1)** longer time **(1)**  	Graphs not identified **(0)** Ignore areas being different.	**2+**	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
24	**a**	Line does not pass through the origin. **(1)**	**OR** use values from graph to show $\frac{P}{T} \neq$ a constant	**1+**	**5**
	b	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ **(½)** $\frac{P_2}{(273+170)} = \frac{101}{273}$ **(½)** $P_2 = 164\,\text{kPa}$ **(1)**	Can use any corresponding values from table/graph Allow up to 5 significant figures If temperature is not in kelvin, then max **(½)** for formula	**2●**	
	c	• as temperature decreases the particles slow down/lose E_k **(½)** • strike the sides of the container less often **(½)** • each collision less forceful/hard **(½)** • pressure decreases **(½)** Reference must be clearly about the force of the <u>individual particle collisions</u> eg "the particles move more slowly and so strike the walls less often, meaning the force is less and so the pressure is less" gets **(1½)**	Answer <u>must have both</u> of: ○ Pressure decreases <u>and</u> ○ Particle collisions <u>with walls/container</u> before any marks can be awarded. Do not accept arrows to mean 'decreases', unless a key is given	**2**	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
25	**a**	**i**	$V_1 = V_{supply} \times R_1 / (R_1 + R_2)$ **(½)** $= 9 \cdot 0 \times 1000 / 1800$ **(½)** $= 5 \cdot 0 (\mathrm{V})$ Alternative: $I = V_{tot} / R_{tot}$ $= 9 \cdot 0 / 1800 = 5 \cdot 0 \times 10^{-3} (\mathrm{A})$ $V_{XY} = I \times R_{XY}$ **(½)** $= 5 \cdot 0 \times 10^{-3} \times 1000$ **(½)** $= 5 \cdot 0 (\mathrm{V})$	Must start with an appropriate relationship. Final line must be shown, otherwise lose second **(½)**.	**1**	**5**
	a	**ii**	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ **(½)** $= 2 / 1000$ $R_T = 500\,\Omega$ **(½)** $V_1 = V_s \times R_1 / (R_1 + R_2)$ $= 9 \cdot 0 \times 500 / 1300$ $= 3 \cdot 5 (\mathrm{V})$ **(1)** accept 3·46 V		**2●**	
	b		Student **A**'s design is better. **(1)** For student **B**'s design, the addition of 1000 Ω in parallel with 10 000 Ω produces a greater proportional decrease in the parallel resistance (than for **A**'s design). **(½)** This causes a greater proportional decrease in the p.d. across the output terminals **(½)**	To get the first mark, there must be an attempt at a justification (without any wrong physics) Can be done using a complete recalculation as in (a)(ii). $(\mathrm{R_p} = 909\Omega, \mathrm{V_o} = 0 \cdot 92\mathrm{V})$ **OR** argument the other way round.	**2+**	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
26	a	i	$R_{\text{total}} = V / I$ **(½)** $= 4\cdot5 / 0\cdot30$ **(½)** $= 15(\Omega)$ **(½)** $R_{\text{lamp}} = R_{\text{total}} - (2\cdot5 + 0\cdot5)$ **(½)** $= 12(\Omega)$	**OR** $E = IR + Ir$ $4\cdot5 = 0\cdot3 \times R + 0\cdot3 \times 0\cdot5$ $R = 14\cdot5$ $R_{lamp} = 14\cdot5 - 2\cdot5 = 12\Omega$ **Lose ½ if last line not shown**	2	9
	a	ii	$P = I^2R$ **(½)** $= 0\cdot30^2 \times 12$ **(½)** $= 1\cdot1\text{W}$ **(1)** **accept 1·08 W**	**OR** V = IR = 0·3 × 12 (= 3·6) P = IV **(½)** = 0·3 × 3·6 **(½)** = 1·1 W **(1)**	2	
	b	i		LED symbol **(½)** Polarity **(½)**	1	
	b	ii	A: 3·5 V **(1)**	No tolerance in value Deduct ½ for wrong/missing unit.	1●	
			$\text{B}: E = V + Ir$ **(½)** $4\cdot5 = \text{V} + 0\cdot2 \times 0\cdot5$ **(½)** $V = 4\cdot4(\text{V})$ **(½)** $V_{Rv} = 4\cdot4 - 3\cdot5 = 0\cdot9\text{V}$ **(½)** **Or consistent with (b)(ii)(A)**	V_{lost} = Ir **(½)** = 0·2 × 0·5 = 0·1 V **(½)** V = 4·5 − 0·1 = 4·4 V **(½)** V_{Rv} = 4·4 – 3·5 = 0·9 V **(½)**	2●	
	b	iii	(When the LED is forward biased) holes and electrons (re)combine (at the junction) (of the LED) and photons (of light) are produced/emitted.	If say 'electron hole pairs are created', this is wrong physics **(0)**	1	

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
27	a	$Q = CV$ **(½)** $= 32\times10^{-6}\times5000$ **(½)** $= 0\cdot16(\mathrm{C})$	Must start with formula deduct **(½)** if Q = 0·16(C) not shown	1	5
	b	$E = \frac{1}{2}QV$ **(½)** $= \frac{1}{2}\times0\cdot16\times5000$ **(½)** $= 400\,\mathrm{J}$ **(1)** **OR** $E = \frac{1}{2}CV^2$ **(½)** $= \frac{1}{2}\times32\times10^{-6}\times5000^2$ **(½)** $= 400\,\mathrm{J}$ **(1)**	must be 0·16, cannot carry a wrong answer from (a)	2	
	c	I = V/R **(½)** $= 5000 / 40$ **(½)** $= 125\,\mathrm{A}$ **(1)** **OR** E = ½ Q^2/C **(½)** = ½ × $0\cdot16^2/32\times10^{-6}$ **(½)** = 400 J **(1)**		2●	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
28	a	i	Impurity atoms are 'added' (to a pure semiconductor.) **(1)**		1	6
	a	ii	(A semiconductor which has been doped so that the) majority charge carriers are negative/electrons **(1)**		1	
	b	i	Photovoltaic **(1)**		1	
	b	ii	$V_2 = V_o = -V_1 \times R_f / R_i$ **(½)** $= -0 \cdot 6 \times 45/5$ **(½)** $= -5 \cdot 4\text{V}$ **(1)**	If –ve is missing from the formula, then 0 marks	2	
	b	iii	−12V **(1)** (to −10 V, ie approx. 85% of −12) If a statement is also provided and it contains wrong physics then 0 marks {even if −12 V given}, eg 'because the (output) voltage saturates'.	Answer must be negative	1●	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
29	a	i	(The work function is the) minimum energy needed to eject an electron (from the surface) **(1)**		1	8
	a	ii	$E_k = hc/\lambda -$ work function **(½)** $= 6\cdot63\times10^{-34}\times3\times10^{8}/425\times10^{-9} - 3\cdot2\times10^{-19}$ **(½)** $= 1\cdot48\times10^{-19}\,\text{J}$ **(1)** **OR** $E = hf$ $f = v/\lambda$ **(½) for <u>both</u> formula** $= 6\cdot63\times10^{-34}\times7\cdot058823\times10^{14}$ $= 3\times10^{8}/425\times10^{-9}$ $= 4\cdot68\times10^{-19}\,\text{J}$ $= 7\cdot058823\times10^{14}\,(\text{Hz})$ $E_k = E -$ work function $= 4\cdot68\times10^{-19} - 3\cdot2\times10^{-19}$ **(½) for subtracting work function** $= 1\cdot48\times10^{-19}\,\text{J}$ **(1)** **OR** $E_k = hf - hf_0$ $f = v/\lambda$ **(½) for <u>both</u> formula** $= 6\cdot63\times10^{-34}\times7\cdot058823\times10^{14} - 3\cdot2\times10^{-19}$ **(½)** $= 1\cdot48\times10^{-19}\,\text{J}$ **(1)**		2	

Question			Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
29	b	i	E_k gained = QV **½ anywhere** **Or** W **or** E_w **(½)** $= 1 \cdot 6 \times 10^{-19} \times 120$ $= 1 \cdot 92 \times 10^{-17}$ J Total $E_k = 1 \cdot 36 \times 10^{-19} + 1 \cdot 92 \times 10^{-17}$ $= 1 \cdot 9336 \times 10^{-17}$ J **(½)** $E_k = \frac{1}{2} mv^2$ **½ anywhere** $v^2 = 1 \cdot 9336 \times 10^{-17} / 0 \cdot 5 \times 9 \cdot 11 \times 10^{-31}$ $v = 6 \cdot 52 \times 10^6 \text{ m s}^{-1}$ **(1)**	Stop marking if E_k gained is –ve in total E_k line If original E_k not added then max 1½ marks for two formulas and QV subst^n ½ off if original E_k not added.	**3+**	
	b	ii	Not correct **(1)** At each stage the kinetic energy has doubled but the speed increases by the square root (as E_k = ½ mv^2) **(1)** **OR** NO, **(1)** as initial E_k must be included. **(1)**	Must attempt to justify (and no wrong physics) to get first mark	**2+**	

<table>
<tr><th colspan="3">Question</th><th>Sample Answers and Mark Allocation</th><th>Notes</th><th>Inner Margin</th><th>Outer Margin</th></tr>
<tr><td rowspan="4">30</td><td>a</td><td>i</td><td>• Different frequencies / colours are <u>refracted</u> through different angles (1)
OR
• different frequencies / colours have different <u>refractive indices</u> (1)</td><td>Not wavelength on its own but ignore if reference made to frequency.
Do NOT accept “bending” on its own but ignore it if follows ‘refraction’
A correct answer followed by ‘diffract’ or ‘defract’, 0 marks</td><td>1</td><td rowspan="4">8</td></tr>
<tr><td>a</td><td>ii</td><td>$n = \frac{v_1}{v_2}$ (½)
$1{\cdot}54 = \frac{3\times10^8}{v_2}$ (½)
$v_2 = 1{\cdot}95\times10^8\,\mathrm{m\,s^{-1}}$ (1)</td><td></td><td>2</td></tr>
<tr><td>b</td><td>i</td><td>$v = f\lambda$ (½)
$3{\cdot}0\times10^8 = 4{\cdot}57\times10^{14}\times\lambda$ (½)
$\lambda = 656\times10^{-9}$
$n\lambda = d\sin\theta$ (½)
$2\times656\times10^{-9} = d\times\sin19$ (½)
$d = 4{\cdot}03\times10^{-6}\,\mathrm{m}$ (1)</td><td></td><td>3+</td></tr>
<tr><td>b</td><td>ii</td><td>• different colours have different λ (½)
• nλ = dsinθ (½)
• n and d are the same (½)
• θ is different for different λ (½)
OR
• different colours have different λ (½)
• Path difference = nλ (½)
• for the same n (½)
• PD is different for different λ (½)</td><td>Any answer saying it is due to the different diffraction of red and blue light is wrong physics and gets (0)</td><td>2+</td></tr>
</table>

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
31	a	$E = mc^2$ **(½)** $7\cdot96662\times10^{-13} = m\times\left(3\times10^8\right)^2$ **(½)** $m = 8\cdot85180\times10^{-30}\ (\text{kg})$ **(1)** Mass of nitrogen nucleus $= (20\cdot1031\times10^{-27} + 6\cdot69944\times10^{-27} + 8\cdot85180\times10^{-30}) - 1\cdot68706\times10^{-27}$ $= 2\cdot51243\times10^{-26}\ \text{kg}$ **(1)**	kg needed if this is final answer If data not used to six figures from table, then stop marking → max **(2)** marks eg any rounding here, stop marking	**3+**	**6**
	b **i**	$\dot{H} = H/t$ **(½)** $= 95\times10^{-3}/180\times24$ **(½)** $= 22\ \mu\text{Sv h}^{-1}$	Must show formula, not just numbers deduct (½) if = 22 (μSv h^{-1}) not shown	**1**	
	b **ii**	$\dot{H} = \dot{D}w_R$ **OR** $H/t = D/t\times w_R$ **(½)** $22 = 11\times w_R$ **(½)** $w_R = 2$ **(1)**		**2**	

[END OF MARKING INSTRUCTIONS]