AQA

A-LEVEL
Physics

Investigative and Practical Skills in AS Physics - PHY3T/Q15
Final Marking Guidelines

Specification 2450/2455
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Version/Stage: Final Marking Guidelines

Guidance for teachers marking Physics ISAs

The marking guidelines have been devised by a team of experienced examiners. They have tried to anticipate all possible responses worthy of credit. In order to establish consistency it is essential that all centres mark exactly to this scheme.

For ease of use the mark scheme has been presented in tabular form. Concise answers are given in the left-hand column. More detailed explanatory notes for some questions are included in the right-hand column.

Marking of Stage 1 of the ISA – student data and graph – should ideally be completed before the ISA written test to ensure that candidates do not change any data. (Alternatively, centres should take other steps to ensure that candidates do not change any information on their data script/graph). The marking of this section should be annotated with a red tick at the point where the mark has been awarded together with the letter referring to this mark scheme, eg '✓b'. **No other comments or feedback should be written on the candidates' scripts**. The total mark for this section should be written at the top of the paper. This will be transferred to the grid on the front page of the ISA test booklet.

Marking of the ISA test should be done using a red tick to represent each mark awarded. Further annotated comments **can** be added where necessary as an explanation as to why a particular point has been awarded which will greatly aid the moderation process. The total mark for each question should be entered on the grid on the front cover of the ISA booklet and the total mark calculated. Assessment Advisers are allocated to each centre and they can advise on the marking process. You should receive the contact details for the Assessment Advisor through the post. If you have not received them, please contact the AQA subject team.

Stage 1		Mark	Additional guidance notes
(a)	Circuit set up correctly, including correct polarity of the ammeter ✓	1	If the circuit is not correct the supervisor should make a note on the candidate's script. The supervisor can help the candidate to set up the circuit correctly, but this mark cannot be awarded if any help was given. Candidates should not be penalised for help given where the problem is due to faulty components etc.
(b)	Table with column headings showing all recorded results, derived quantities and correct units for <u>all</u> columns in the table. Table must include data for all eight resistors provided. ✓	1	Column headings can be either in words or standard symbols. Units can be in words or the correct abbreviation. e.g. current/amperes, I/A. Alternative acceptable labelling includes I(A), I in A etc. (N.B. 'amp' is not an acceptable abbreviation for the unit of current) The unit of $1/I$ should be correctly quoted as A^{-1} Do not award if any units are in the body of the table.
(c)	Precision of ammeter correctly quoted **AND** Significant figures correct for all readings ✓	1	Resistor values quoted exactly to same sf as labelled. Current quoted to decimal places/sf compatible with instrument precision. No penalty for significant figures of derived quantities.
(d)	Correct computation of $1/I$ The mark is awarded if the 1st and 3rd data lines are correct. ✓	1	Where students have taken repeat current values this marking point requires **both** correct value of $1/I$ **and** correct mean current values. No sf penalty on these values.
(e)	Graph scale on *R* axis must include 'zero' (as stated in task sheet) and suitably large graph scale (do not award if scale on axis, including zero, could have been doubled) but take account of requirement for the *R* axis to include zero Scale must be sensible divisions which can be easily read, e.g. scales in multiples of 3, 6, 7, 9 etc are unsatisfactory. **AND** Axes correctly labelled with units **AND** $1/I$ plotted on y-axis (as stated in Task Sheet) ✓	1	From zero to the furthest point on the *R* axis should occupy at least half of the axis. A scale division in 4's might sometimes be acceptable. Alternative labelling of axes as given in (a) above. Ecf for unit errors/omissions already penalised in (a), although a different error on either axis will incur a penalty.

Stage 1		Mark	Additional guidance notes
(f)	Points accurately plotted to within 1 mm. Check 1st and 3rd points from the *y*-axis, which must both be correctly plotted to award the mark ✓	1	This mark is independent of mark (e), i.e. if candidates have used an unsuitable scale they can still achieve marks for accurately plotting the points.
(g)	Straight line of best fit drawn ✓	1	The line of best fit should have an approximately equal distribution of points on either side of the line.
	Total	**7**	

Section A

Question		Mark	Additional guidance notes
1(a)	Current/ I allow $1/I$ ✓	1	
1(b)(i)	Rearranging emf equation in form $\frac{1}{I} = \frac{R}{\varepsilon} + \frac{r}{\varepsilon}$ ✓ Pointing out $y = mx + c$ where $c = \frac{r}{\varepsilon}$ ✓	2	Accept $\frac{1}{I} = \frac{r}{\varepsilon}$ when $R = 0$ as an alternative for first mark
1(b)(ii)	Correctly reading intercept on y axis of their graph ✓ Correct value of r (calculated from 1.5 x intercept) with unit Ω ✓	2	Unit for intercept not required
1(c)(i)	Correctly states value of $\frac{1}{I}$ which has largest % uncertainty. ✓	1	The smallest value of I would usually give the largest % uncertainty. It might, however, occur at another value of I, and this alternative value is acceptable provided it does give the larger % uncertainty.
1(c)(ii)	Correctly calculates value of % uncertainty of $1/I$ ✓	1	Calculated from ammeter precision for the single current reading. If repeat readings have been taken, value should be calculated from 0.5 x range or ammeter precision (if no variation in repeat current readings), and converted to a % value Allow ecf from 1(c)(i) if incorrect value chosen No sf penalty

Question		Mark	Additional guidance notes
1(d)	Changes in ε or r due to cell 'running down'/chemical changes in cell **OR** Heating effects might cause increase in R **OR** Heating effects causing safety issues re: 'hot' components ✓	1	Needs a reason with a brief explanation
1(e)(i)	Evidence of calculation of current shown in workings. Correct current value = 0.43A ✓ Power = 0.28 W ✓	2	Allow evidence of calculation of current from $I = \varepsilon/(R + r)$, even if actual value not computed. No sf penalty Allow 'working mark' for alternative calculation using 'potential divider'. Correct final answer with no 'workings' achieves only one mark.
1(e)(ii)	0.5W and 1.0W **both** circled✓	1	Allow answer consistent with ecf from 1(e)(i).
	Total	**11**	

Section B

Question		Mark	Additional guidance notes
2(a)	5.1 and 7.1 ✓	1	Exact answers only.
2(b)	Both plotted points to nearest mm✓ Best line of fit to points✓	2	The line should be a straight line with approximately an equal number of points on either side of the line.
2(c)	Large triangle drawn at least 8 cm x 8 cm ✓ Correct values read from graph✓ Gradient value in range 0.190 to 0.210 to 2 or 3 sf ✓	3	
2(d)	$\left(R = \frac{1}{\text{gradient}}\right) = 5.0\ \Omega$ Must have unit ✓	1	Allow ecf from gradient value **No sf penalty**
	Total	**7**	

Question		Mark	Additional guidance notes
3(a)(i)	5.04 (Ω) or 5.0 (Ω) ✓ (Allow also 5.06 Ω or 5.1 Ω , obtained by intermediate rounding up of 3.50^2)	1	From $R=\frac{V^2}{P}$
3(a)(ii)	(Uncertainty in *V* = 0.29%) Uncertainty in V^2 = 0.57%, 0.58% or 0.6% ✓ Uncertainty in *P* = 2.1% ✓ Uncertainty in *R* =2.6%, 2.7% or 3% Answer to 1 or 2 sf only ✓	3	From uncertainty in *V* = 0.01/3.50 x 100% From uncertainty in *P* = 0.05/2.43 x 100% = 2.1% 2.1 % + uncty in V^2 (0.6%) = 2.7% Allow ecf from incorrect uncertainty for V^2 or *P*
3(a)(iii)	(Absolute) uncertainty in *R* is (±) 0.14 or just 0.1 Ω (using 2.6%) (or 0.15 or 0.2 Ω using 3%) ✓	1	Must have unit (Ω) Must be to 1 or 2 sf and must be consistent with sf used from 3(a)(ii) No penalty for omitting ± sign
3(a)(iv)	Works out possible range of values of *R* based on uncertainty in 3(a)(iii), eg *R* is in range 5.0 to 5.2 Ω using uncertainty of ± 0.1 Ω ✓ Value from 2(d) is within the calculated range (or not depending on figures, allowing ecf) ✓	2	No credit for statement to effect that the values are or are not consistent, without any reference to uncertainty Allow ecf from 3(a)(iii) Allow ecf from 2(d)
	Total	**7**	

Question		Mark	Additional guidance notes
4(a)(i)	Voltmeter across terminals with nothing else connected to battery / no additional load. ✓	1	
4(a)(ii)	This will give zero/virtually no current ✓	1	
4(b)(i)	$\frac{VI}{\varepsilon I}$ Answer must clearly show power: εI and VI, with I cancelling out to give formula stated in the question. ✓	1	
4(b)(ii)	Voltmeter connected across cell terminals ✓ Switch open, voltmeter records ε Switch closed, voltmeter records V Both statements required for mark ✓	2	Candidates who put the voltmeter in the wrong place can still achieve the second mark providing they give a detailed description which makes it clear that: To measure emf, the voltmeter should be placed across the cell with the external resistor disconnected <u>And</u> To measure V, the voltmeter should be connected across the external resistor when a current is being supplied by the cell
4(c)	Vary external resistor and measure new value of V, for at least 7 different values of external resistor ✓ Precautions - switch off between readings/take repeat readings (to check that emf or internal resistance not changed significantly). ✓	2	

Question		Mark	Additional guidance notes
4(d)	Efficiency increases as external resistance increases ✓ Explanation Efficiency = Power in R / total power generated $I^2R / I^2(R + r) = R / (R + r)$ So as *R* increases the ratio becomes larger or ratio of power in load to power in internal resistance increases.✓	2	Explanation in terms of *V* and ε is acceptable.
	Total	**9**	
	ISA Total	**41**	