



**General Certificate of Education (A-level)
June 2012**

Physics

Investigative Skills Assignment (ISA P)

PHY3T/P12/mark

Written Test

Final

Marking Guidelines

Marking Guidelines Explanatory Notes

The marking guidelines should be considered a working document. A version of the marking guidelines will be placed on the Secure Key Materials Website in September. This is to allow centres to undertake ISA practical's as soon as they wish. Centres can use this version of the marking guidelines to mark candidates work. However this version of the marking guidelines may be subject to amendments. An updated version of the marking guidelines to be used during the present academic year will be placed on the Secure Key Materials Website by **31st October**. Examinations Officers must ensure that Teachers receive the final version of the marking guidelines. **Centres should ensure that their marking is in line with the updated version of the marking guidelines.**

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.

Further guidance and information about the marking guidelines will be given at the teacher support meetings which will be held in the later half of autumn 2011. Assessment Advisers are also allocated to each centre and they can also advise on the marking process.

ISA (P) Resistors in parallel

Stage 1		Mark	Additional guidance notes
(a)	Correctly setting up the circuit as given in the diagram ✓	1	This mark cannot be awarded if any help has been given in setting up the circuit but: <ul style="list-style-type: none"> Ignore help due to faulty equipment and safety checks. Do not penalise for incorrect connection of 3 terminal rheostat/potential divider.
(b)	Single table with column headings showing all recorded results for V , I and R , with additional column for $1/R$ ✓	1	Column headings can either be in words or standard symbols. Do not penalise here for not taking repeat readings (see (e) below). Allow V recorded once on a separate line rather than on every line in table.
(c)	All units for V , I , R and $1/R$ correct, and only in column headings ✓	1	Units can be in words or the correct abbreviation, eg current/amperes, //A. Allow also units in brackets, eg I (A), current (amperes), current in A, current in amperes etc. For $1/R$ the correct unit is Ω^{-1} . For current allow 'amps'.
(d)	Decimal places correct for all current readings, compatible with precision of ammeter. Resistor values should be to same sig figs (ie 2 sf) as stated on labels eg 2.2, 4.7, 22, 100 Ω etc ✓	1	No mark if a student incorrectly copies resistor values, eg quotes 22.0 rather than 22Ω , ie if student has added additional sig figs to the values labelled by centres. (Centre labelling should be appropriate for the tolerance of resistor used).
(e)	At least one repeat reading of current for each resistor value. Shown in table with column for mean value. Correct computation of mean value of current and $1/R$ values for the first and last line of the tabulated results ✓ No sf penalty for these results.	1	
(f)	Axes labelled with quantity and unit: //A on the vertical axis and $1/R/\Omega^{-1}$ on horizontal axis ✓	1	Alternative method of labelling axes as in (b) and (c) above for table headings and units. Allow ecf where same unit penalty has already been applied in (c). Do not award mark if axes wrong way around. Do not penalise if current axis is labelled just I , rather than I_{mean} provided the mean current values have been plotted.

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(g)	Suitably large graph scale (do not award if scale on either axis could have been doubled). Scale must be 'sensible' divisions which can be easily read , eg scales in multiples of 3, 4, 6, 7, 9, etc are unsatisfactory ✓	1	The plotted points should occupy at least half of each axis, with the scale(s) starting at non zero values if necessary.
(h)	Points accurately plotted to within 1 mm ✓ Checking the first and last points. Both points must be correctly plotted to award the mark.	1	This mark is independent of mark (g), ie if candidates have used an unsuitable scale they can still achieve marks for accurately plotting the points.
(i)	Best fit straight line drawn ✓	1	To award the mark the line should be a straight line with approximately an equal number of points on either side of the line. Points which are obviously anomalous should not unduly influence the line.
Total		9	

Section A		Mark	Additional guidance notes
1(a)	Resistance or R ✓ (but not resistor)	1	Do not allow $1/R$.
1(b)	Correct value of % uncertainty quoted ✓ from: uncertainty = $(\pm) 0.5 \times$ spread of repeats Where repeat current readings are identical the % uncertainty should be based on the instrument precision.	1	No penalty for omitting \pm . No sig fig penalty. Candidates who did not take repeat readings do not have access to this mark.
1(c)	Correctly stated maximum and minimum value for largest value of R based on 5% tolerance. Unit is required for both values quoted. eg if largest resistor used was $100\ \Omega$, maximum value is $105\ \Omega$, and smallest value is $95\ \Omega$ ✓	1	

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1(d)(i)	Reduced/lower current ✓	1	
1(d)(ii)	Either of the two types of error (random or systematic) with the correct explanation ✓	1	Either Random error because each time contact is made quality/resistance of contact will not be same/will differ. Or Systematic error because each time contact is made the resistance is same/changes results by same increment every time.
1(e)	Graph is a straight line indicating a linear relationship between I and $1/R$ Or Quantities plotted increase in proportion/change in one is proportional to change in the other ✓ Reference to line not passing through origin so not directly proportional ✓	2	Where either or both axes do not start at zero it is not possible to determine by observation if there is direct proportionality or not between the plotted quantities. Access to both marks is still possible where a student acknowledges this point – ie refers to straight line and possibility/not knowing if line goes through origin as to whether relationship is just linear or direct proportionality. (Both marks may also be awarded where a student states that the relationship is of the form $y = mx + c$ and indicates what each term represents in the context of the question).
1(f)	Statement as to whether experiment is reliable or not together with: either Reference to closeness or not of repeat readings or Reference to closeness or not of graph points to line of best fit ✓	1	
	Total	8	

ISA (P) Resistors in parallel

Section B		Mark	Additional guidance notes
2(a)	3.80, 3.91, 4.09 ✓ Exact values only.	1	
2(b)	3 points correctly plotted to within $\pm 1\text{mm}$ ✓ straight line of best fit drawn ✓	2	Same criteria for the straight line as in stage 1 (i).
2(c)	Triangle drawn with smallest side at least 8 cm ✓ correct values read from graph ✓ Gradient in the range 0.0150 to 0.0170 must be to 2 or 3 sf ✓ ($\Omega^\circ\text{C}^{-1}$)	3	Gradient must lie within limits stated. No ecf from incorrectly read values unless it falls within stated limits. No unit penalty.
2(d)(i)	Suggests a straight line ✓ With a positive intercept on R axis/does not go through the origin ✓	2	Answers referring the relationship to being similar to $y = mx + c$ are also acceptable.
2(d)(ii)	$k = \text{gradient} = 0.0160\Omega^\circ\text{C}^{-1}$ ✓ Must have unit. To 2 or 3 sf.	1	Allow ΩK^{-1} as alternative unit. Allow ecf from gradient value in 2(c).
2(d)(iii)	R_0 in the range 2.95 to 3.05 Ω ✓ Must have unit, must be to 3 sf.	1	NB Large tolerance allowed so that students with a poor line of best fit can still access this mark.
2(e)	Resistance values change/go up or down by same amount ✓ No effect on k ✓ Value of R_0 (from intercept) would be higher or lower/would change ✓	3	
	Total	13	

ISA (P) Resistors in parallel

Question 3		Mark	Additional guidance notes
3(a)(i)	% uncertainty in current = $(\pm) 5\%$ ✓	1	No penalty for omission of \pm sign. No sf penalty.
3(a)(ii)	% uncertainty in pd = $(\pm) 3\%$ (or 3.2%) ✓	1	No penalty for omission of \pm sign. No sf penalty.
3(a)(iii)	% uncertainty in resistance = $(\pm) 8\%$ (or 8.2%) ✓ Must be quoted to 1 or 2 sf only. Calculated from 3(a)(i) + 3(a)(ii)	1	No penalty for omission of \pm sign.
3(b)	Resistance values only differ by about 5% over a 10°C temp change ✓ Meters could not measure accurately enough to distinguish small change in resistance ✓	2	Some reference to % difference in resistance values over 10°C temperature change for first mark. Explanation of implications ie 8% uncertainty - not sufficiently accurate to measure a small resistance change for 2 nd mark. Allow ecf from 3(a)(iii) and explanation consistent with it.
	Total	5	

ISA (P) Resistors in parallel

Question 4		Mark	Additional guidance notes
4(a)	<p>(a) Correct circuit diagram with 2 cells, ammeter and voltmeter, $3 \times 20\Omega$ resistors in parallel.</p> <p>(b) Explains how to calculate total resistance of parallel combinations from meter readings, using $R = V/I$.</p> <p>(c) Suggests plotting R_T against $1/n$.</p> <p>(d) Straight line through origin indicates total resistance (directly) proportional to $1/n$ or inversely proportional to n.</p> <p>(e) Suggestion to reduce error, eg minimising contact resistance/reducing heating effect by disconnecting in between readings etc.</p> <p style="text-align: right;">✓✓✓✓ 5 max 4</p>	max 4	<p>For mark (a) circuit diagram must be exactly as specified (2 cells, no additional resistors etc).</p> <p>No penalty if a switch has been correctly included in the circuit.</p> <p>Any 4 of 5 marking points indicated. Markers should indicate the appropriate letter to which the mark refers (eg ✓ a).</p>
4(b)	<p>Calculation Correct calculation of maximum current for six 20Ω resistors in parallel with 3V battery ✓ (ie Total resistance = $20/6 = 3.33\Omega$) Hence max current (= V/R) = $3/3.33 = 0.9\text{A}$)</p> <p>Decision Correct box ticked Range 0 – 1.0 A precision $\pm 0.01\text{A}$ ✓</p>	2	<p>Must give some brief details of the calculation.</p>
	Total	6	