ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics

Investigative Skills Assignment (ISA) P

PHY3T/P09/mark
Written Test

Marking Guidelines

2009 examination – June series

Mark Guidelines Explanatory Notes

The mark 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.

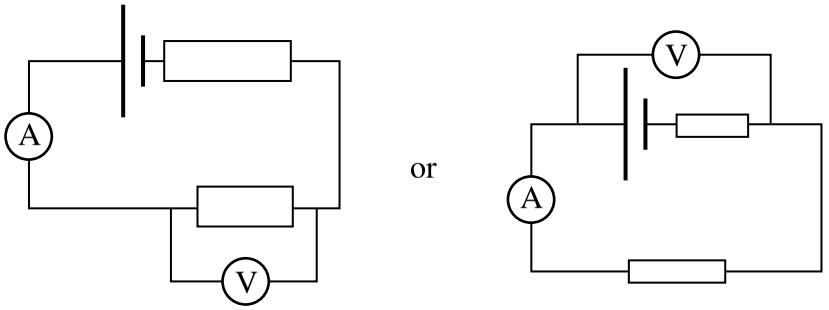
For ease of use the mark guidelines has been presented in tabular form. Concise answers are given in the left-hand column. More detailed explanatory notes for some questions are included in the right-hand column.

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 would have to take other steps to ensure that candidates did 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 from the mark scheme, e.g. '✓b'. **No other comments or feedback should be written on the candidates' script.** 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 marks for each question should be entered on the grid on the front cover of the ISA booklet and the total mark calculated.

There will be 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 2009. Assessment advisors are also allocated to each centre and they can also advise on the marking process.

ISA (P) EMF and Internal Resistance Investigation

Stage 1		Mark	Additional guidance notes
(a)	Circuit diagram fully correct, either with or without switch. Allow mark if internal resistance of cell is not shown	**1**	Correct symbols are adequate without labels. 
(b)	Table, with correct column headings showing recorded results for current and terminal pd	**1**	Column headings can be either words or standard symbols. Accept 'voltage' for 'terminal pd'.
(c)	Resistance column with correct resistance values and unit	**1**	Candidates were specifically instructed to include a column for resistance. Column headings can be **resistance** or **R**. (see note on units in (d) below).
(d)	Correct units for pd and current in column headings	**1**	Units can be in words or correct abbreviation. E.g. curent/A, *I*/A or current (amp). Also accept units written in format current (A) or *I* /(A). If candidates have achieved a mark for column labelled resistance, (c) above, then this must also have the correct unit. If candidates have already been penalised for omitting resistance column, allow unit mark for correct units for current and terminal pd.

Stage 1		Mark	Additional guidance notes
(e)	Decimal places correct in all readings (compatible with precision of ammeter and voltmeter used)	**1**	E.g. For a voltmeter with precision 0.01 V, acceptable readings would include 0.07, 0.20, 5.00 V etc. Readings of 0.2, 5 or 5.0 V are incompatible with the instrument precision and are therefore unacceptable.
(f)	8 different voltage and current readings	**1**	No penalty if candidates have had access to additional resistors (in perhaps a resistance box), and have done more than the required 8 readings.
(g)	Suitable 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 e.g., not in multiples of 2, 7 etc.)	**1**	The plotted points should occupy at least half of each axis. Candidates may need to start either axis from a non-zero value to ensure the points occupy a suitably large area of the graph.
(h)	Correctly labelled axes with units	**1**	Both axes labelled with quantity and unit. Words or symbols may be used for physical quantities and units, e.g. Current/A. Also allow units in brackets e.g. Current (A)
(i)	Points accurately plotted to within 1 mm (no more than **one** point > ± 1 mm)	**1**	This mark is independent of mark (g), i.e. if candidates have used an unsuitable scale they can still achieve marks for accurately plotting the points.
(j)	Line of best fit drawn	**1**	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. If the plotted points suggest a curve line, the mark can be awarded for a suitable smooth curve.
	Total	**10**	

Section A			
Question 1			
(a)	Correctly stated precision for **both** instruments	**1**	
(b)	Correctly stated % uncertainty for both smallest current ✓ and smallest terminal pd ✓ calculated from % uncertainty = $\frac{\text{instrument precision}}{\text{smallest pd (or current)}} \times 100$	**2**	
(c)	Correct statement of whichever quantity gives largest uncertainty with justification that this quantity has largest percentage uncertainty. Allow e.c.f. from (b).	**1**	
(d)	Large resistor will give very small current ✓ Percentage uncertainty in current is too high ✓	**2**	
(e)	Emf changes/internal resistance changes/ cell running down	**1**	Accept also sensible alternatives including reference to polarisation, effect of cell getting hot, chemicals depleting.
(f)	Appropriate comment re: points on graph No mark for just YES or NO.	**1**	A statement explaining that the readings are/are not reliable because all points are close/ not close to the line of best fit is adequate. Although repeat results were not required, where a candidate did do repeat readings, an appropriate statement re: repeat readings is also acceptable.

Section A			
Question 1			
(g) (i) (ii)	Emf of cell or battery ✓ Internal resistance of cell or battery. Allow with or without negative sign since question refers to 'physical quantity' ✓	**2**	Allow symbols (i) ε for emf(not E) (ii) r for internal resistance (not R).
	Total	**10**	

Section B			
Question 2			
(a) (i)	Triangle drawn with horizontal side at least 7 cm ✓ Correct values read from graph ✓ Correct answer for gradient. Allow –5.2 ± 0.2, quoted to 2 or 3 significant figures ✓✓ (ii) Gradient represents internal resistance of cell A + internal resistance of cell B ./(r_A + r_B) ✓	**5**	**Deduct** 1 mark for omission of negative sign. No penalty for omission of/or incorrect unit.
(b)	All 3 points plotted correctly to nearest mm ✓✓ **or** any 2 points correctly plotted to nearest mm 1 mark Line of best fit drawn through points ✓	**3**	
(c)	Gradient should be the same as other graph because cells connected in this way would have **same** total internal resistance	**1**	
(d) (i)	emf $\varepsilon_{(A-B)}$ = 7.5 V (allow 7.4 – 7.6 V) Answer quoted to 2 or 3 significant figures ✓ (ii) emf ε_A = 9.0 V (allow 8.9 – 9.1 V) Answer quoted to 2 or 3 significant figures ✓ correct explanation or method ✓	**3**	Allow 1 mark for ε_A if candidate explains that it is midpoint between two intercepts on y axis but incorrectly states or computes value. Candidates who solve by algebraic methods can also be awarded full marks for a correct answer and 1 mark for a correct method with an incorrect answer.
	Total	**12**	

Section B			
Question 3			
(a)	18.9 Ω ✓	**1**	
(b)	Value of *R* does not need to be known, since resistors are only used to vary current pd/ value of resistance does not come into formula $\varepsilon = V - Ir$	**1**	Accept explanation that resistors are used to give a range of current and pd values, which are the measured quantities on which emf depends.
(c) (i)	Systematic error/zero error ✓	**3**	Allow mark if student explains that actual value of emf should be lower than shown by results from graph, without stating 0.22 V lower.
(ii)	The value of the emfs will be 0.22 V too high/ emfs should be 0.22 V lower /✓		
(iii)	Gradient not affected/no difference ✓		
	Total	**5**	

Section B			
Question 4			
	Any 4 of the following points • set up circuit with cell, resistor R, ammeter in series & voltmeter across resistor • values of R varied **above and below** known value of r • details of how to measure power, e.g. by V, I • readings/ $P = VI$ • switch off after every reading to avoid cell 'running down', (or polarisation etc) • suggestion to plot power versus resistance of R • suggestion that graph will have a maximum power at $R = r$ ✓ ✓ ✓ ✓ 4 marks max	**4**	Accept a correct circuit diagram.
	Total	**4**	
	Total	**31**	