General Certificate of Education

Physics

Investigative Skills Assignment (ISA) Q

PHY6T/Q11/mark
Written Test

Final Marking Guidelines

2011 examination – June series

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**. Examination 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, e.g. '✓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 2010. Assessment Advisers are also allocated to each centre and they can also advise on the marking process.

Changes from the previous version are side-barred on the appropriate side of the marking grid.

ISA (Q) Capacitor Discharge

Stage 1		Mark	Additional guidance notes
(a)	Candidate sets up correct working circuit without help ✓	**1**	Ignore help due to faulty equipment and safety checks (to the polarity of the capacitor and to the supply).
(b)	Single table with column headings showing all recorded pd readings (V_0 and V_{10}) together with column for resistor values given. **All units** for raw data and resistor values correct **only** in column headings. ✓	**1**	Column headings can be either in words or standard symbols. Units can be in words or the correct abbreviation, e.g. potential difference/volts, V_{10}/V. Alternative acceptable labelling includes pd or voltage etc. Do not penalise here for not taking repeat readings (see (d) below).
(c)	Decimal places correct for all pd readings, compatible with precision of voltmeter. Resistor values should be to same sig figs (ie 2 sf) as stated e.g. 15, 22, 33, 47 kΩ etc. ✓	**1**	**No** mark if a student incorrectly copies resistor values eg quotes 15.0 rather than 15 kΩ 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.) Although a minimum of 7 readings is the normal requirement it was felt there was easily enought results for 8 resistor valves.
(d)	Evidence of at least 2 repeat readings for pd at each resistor value, (ie 3 readings altogether) ✓ No penalty if candidate has not retaken V_0 for repeat pd readings at each resistor value	**1**	It is likely that V_0 will remain constant at least whilst taking a repeat reading of V_{10}. Hence candidates can simply quote repeat values of V_{10} for the same resistor. Over the full experiment V_0 may decrease slightly and hence needs to be recorded for each diffierent resistor value.
(e)	Tabulated data showing mean value of V_{10}. Sig figs must be the comparable with the voltmeter precision. eg if voltmeter reads 0.01 V, all mean values should be quoted to 2 decimal places. Alternatively mean value of $\frac{V_0}{V_{10}}$ is acceptable ✓ (where candidates have a slightly different value of V_0 for every repeat value of V_{10}).	**1**	Ecf from (d) no penalty here if only 1 repeat reading. Check the 2nd and last mean values in the table.
(f)	Tabulated values of $\frac{1}{R}$ and $\ln\left(\frac{V_0}{V_{10}}\right)$ included in table ✓ with correct unit for $\frac{1}{R}$ and no unit for $\ln\left(\frac{V_0}{V_{10}}\right)$	**1**	No sig fig penalty on these values. At least two values checked, focussing on any suspect data, and the checked data indicated. Check 2nd and last values for computation of $\frac{1}{R}$ and $\ln\left(\frac{V_0}{V_{10}}\right)$

(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 ✓ Axes must be labelled with quantity and unit – In $\left(\frac{V_0}{V_{10}}\right)$ on the vertical axis (with no unit) and $\frac{1}{R}$ / kΩ^{-1} on horizontal axis	**1**	The plotted points should occupy at least half of each axis. Alternative method of labelling axes as in (a) above for table headings and units, eg time (seconds) etc. Do not award mark if axes wrong way around. Do not penalise same error for unit if already penalised in 1(f).
(h)	Most points accurately plotted to within 1 mm (no more than one point > ± 1 mm) and straight line of best fit drawn ✓ Points accurately plotted to within 1mm and line of best fit drawn ✓ Plotting points assessed by checking the 2nd and 3rd points from the origin.	**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. The line should be a straight line to award the mark. Do not allow ecf on plotting points/line of best fit if $\frac{1}{R}$ values were treated as categoric values.
	Total	**8**	

ISA (Q) Computer Discharge

Section A		Mark	Additional guidance notes
1(a)	Time ✓	**1**	Accept *C* (capacitance). V_0 is **not** acceptable. No other acceptable alternative answers.
1(b)	Correct % uncertainty based on spread of repeat readings of V_{10}. ✓ (from: uncertainty = ± 0.5 × spread of repeats, then converted to percentage uncertainty) For candidates who had computed the mean value of $\frac{V_0}{V_{10}}$ instead of V_{10} can be awarded the mark if they have correctly computed the % uncertainty in $\frac{V_0}{V_{10}}$ based on spread of repeats.	**1**	No penalty for omitting ±. No sig fig penalty Candidates who did not take repeat readings do not have access to this mark.
1(c)	1st mark is for stating difficulty and 2nd mark for discussing/explaining that particular difficulty. (Cannot acheive second mark without the first). (A) Reaction time ✓ because of effect on measurement of *V* at exactly 10 s / effect on starting discharge at exactly $t = 0$ ✓ (B) Difficulty in reading two meters at the same time ✓ need to look at 1st meter and then refocus on 2nd meter ✓ **4 marks max**	**4**	Alternative 'difficulties' with accompanying discussion/explanation, as alternatives to answers stated. Markers must indicate the marking points (A, B, C, D, E or F) for which the mark has been awarded. (C) Difficulty in starting discharge & clock at same time ✓ difficulty in knowing precise 'contact time' ✓ (D) Recognition that smaller resistors affect accuracy of V_{10} less than larger resistors ✓ because capacitor has discharged quicker meaning that voltage will not be varying as much after 10 s. ✓ (E) sample time of digital meter ✓ meter with low sample rate might mean meter has not 'refreshed' at exactly 10 s ✓ (F) Reference to precision of voltmeter ✓ Discussion of zero error and how to deal with it on an analogue instrument ✓ (simply stating requirement of a voltmeter with 'small' precision is only worth 1 mark in total.)

1(d)	Data logger: (A) Automatically takes voltage and time <u>simultaneously</u> (B) Updates much quicker / higher sample rate (C) Eliminates reaction time errors (D) Do not need to measure V_0 at the instant you switch on ✓✓ **2 marks max**	**2**	Underlined word or equivalent phrase must be included in the answer. 1 mark for each point. Maximum 2 marks Markers must indicate the marking points (A, B, C or D) for which the mark has been awarded.
1(e)(i)	Evidence of intermediate step: $V_{10} = V_0 e^{-10/RC}$ (or $\ln V = \ln V_0 - t/RC$) ✓ $\frac{V_0}{V_{10}} = e^{\frac{10}{RC}}$	**1**	
1(e)(ii)	Gradient of graph = t/C (where $t = 10$ s) **or** C = 10 seconds/gradient (no penalty for omitting seconds) ✓	**1**	
	Total	**10**	

ISA (Q) Capacitor Discharge

Section B		Mark	Additional Guidance Notes
Question 2			
2(a)	Background radiation ✓ Background count = 20 count/minute unit required ✓	**2**	Ignore any –ve sign for background count Must be written to 2 sf
2(b)	R = 99, 86 R_C = 79, 66 all to 2 sf ✓ $\ln(R_C / \text{minute}^{-1})$ = 4.37, 4.19 all to 3 sf ✓	**2**	
2(c)	Both plotted points correctly plotted to within ± 1 mm or less from exact position ✓ Correct line of best fit ✓	**2**	The line must be a straight line (as instructed), with approximately an equal number of points on either side of the line.
2(d)	Triangle drawn with smallest side at least 8 cm ✓ (or 8 grid squares) correct values read from graph ✓ gradient = –0.00698 (± 0.00030) min^{-1} ✓ must have –ve sign and must be to 2 or 3 sf ✓	**3**	Gradient must lie within limits stated. No ecf from incorrectly read values unless it falls within stated limits. No unit penalty.
2(e)	Recognises gradient = (–) λ **or** Uses gradient for value of λ = 7.0 (± 0.30) × 10^{-3} minute^{-1} ✓ $T_{1/2}$ = 99 minutes to 2 or 3 sf ✓	**2**	For 1st mark accept evidence that value of gradient has been substituted into correct formula for half life. No penalty for missing –ve sign. Allow ect from incorrect gradient value. Unit penalty if half life has been calculated in different unit (to minutes stated in question)
	Total	**11**	

ISA (Q) Capacitor Discharge

Section B		Mark	Additional Guidance Notes
Question 3			
3(a)	Random ✓	**1**	
3(b)(i)	Uncertainty = (± √429) = ± 21 No sf penalty ✓	**1**	Details of calculation not required. Marks can be awarded for correct numerical answers. Also no penalty for quoting uncertainty or % uncertainty without '±'.
3(b)(ii)	% uncertainty = ± 4.9 % ✓ No sf penalty. (Note that % uncertainty in total count is same as % uncertainty in corresponding count rate.)	**1**	Accept also 4.8 % (number achieved keeping all sig figs in calculator) No penalty for omitting % or '±'. No sf penalty
3(b)(iii)	% uncertainty for 84 counts is ± 10.9 % ✓ Taking data over larger time period / larger total count will have smaller percentage uncertainty. ✓	**2**	Accept ±11% No penalty for omission of ± sign. No sf penalty for estimated % uncertainties.
	Total	**5**	

ISA (Q) Capacitor Discharge

Question 4		Mark	Additional Guidance Notes
4(a)(i)	Absorption and 'spreading out'/(inverse square law effect) of radiation ✓ leads to Smaller counts/count rate at each time interval ✓ Less accurate because larger uncertainty due to smaller total counts at each time interval ✓ background counts has a great effect. ✓	**3**	
4(a)(ii)	Same gradient ✓ Intercept on vertical axis lower ✓ Larger scatter of points ✓	**3**	(because same value of decay constant) Explanations **not** required for each mark (because of greater uncertainty in each reading) Explanations **not** required for each work.
4(b)	Handle with tongs / hold at arm's length / sources stored in lead shielding / warning signs on lab / any other sensible precaution etc. **Any 2 of above points for 1 mark**	**1**	
	Total	**7**	