Version 1.1

General Certificate of Education (A-level)
June 2013

Physics

Investigative Skills Assignment (ISA P)

PHY6T/P13/mark

Written Test

Final Marking Guidelines

Set and published by the Assessment and Qualifications Alliance.

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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 centre's to undertake ISA practicals 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.

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.

ISA (P) Gas Laws

Stage 1		Mark	Additional guidance notes
(a)	Table with column headings and units ✓ Must include columns for *M, L, F*, $\log_{10}(F/\text{N})$ and $\log_{10}(L/\text{m})$.	**1**	(Also allow *L* and log(*L)* in cm or mm, but logs must be written in the correct form given in the task sheet ie $\log_{10}(L/\text{cm})$). Allow log instead of $\log_{10}$. Column headings can either be in words or standard symbols.
(b)	Correct sf on all raw distance measurements taken ✓	**1**	Should be to nearest mm.
(c)	At least one repeat reading for each length measurement and correct computation for mean length and $\log_{10}(L)$. Check 2nd and 4th data line ✓	**1**	The mark is awarded if 2nd and 4th data lines are correct. No sf penalty.
(d)	Correct computation of *F* and $\log_{10}(F/\text{N})$ ✓ Check 2nd and 4th data lines	**1**	No sig fig penalty on these values. (Eg typical values of *F* in range 20 to 9 N, and $\log_{10}(F)$ 1.30 to 0.95).
(e)	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, 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.
(f)	Axes labelled with quantity and unit Must be $\log_{10}(F/\text{N})$ for y axis and $\log_{10}(L/\text{m})$ for x axis ✓	**1**	Allow log instead of $\log_{10}$. Do not award mark if axes wrong way around. (Also allow *L*/cm or *L*/mm). Ecf for incorrectly written log value already penalised in (a) column headings.
(g)	Points accurately plotted to within 1 mm Check the 1st and 5th point which must both be correctly plotted to award the mark Straight line of best fit drawn ✓	**1**	The line of best fit should be a straight line with an approximately even distribution of points on either side of the line. This mark is independent of mark (f), ie if candidates have used an unsuitable scale they can still achieve a mark for accurately plotting the points and drawing the line of best fit.
	Total	**7**	

ISA (P) Gas Laws

Section A		Mark	Additional guidance notes
1(a)	Temperature and mass ✓	**1**	Allow 'number of moles' or 'quantity' instead of mass.
1(b)	Internal diameter of syringe/diameter of piston/bore diameter ✓ Vernier callipers/callipers ✓	**2**	Or measured external tube diameter and thickness of tube ✓ With callipers ✓ Only allow micrometer as instrument where student has specifically stated measuring the diameter of the piston.
1(c)(i)	From spread of mean using uncertainty = 0.5 × range And converted to a %✓	**1**	No sf penalty no penalty for omitting ± or % sign. If no spread of readings uncertainty is instrument precision, ±1mm
1(c)(ii)	Uncertainty in diameter = 0.8% Uncertainty in area = 1.6% ✓ Allow 1 or 2 sf. Uncertainty in volume = 1.6% + uncertainty in length (3.6%) = 5% (or 5.2%) ✓ Volume 6.4 ± 0.3 ✓ (for both volume and uncertainty value) (cm^3) Appropriate unit and volume given to 2 sf ✓	**4**	Allow ecf from uncertainty in diameter. Allow ecf from total % uncertainty. Volume in alternative unit acceptable. (NB 3 sf would be inappropriate – uncertainty in value dictates only 1 or 2 sf).
1(c)(iii)	Volume of air in pipe at end of syringe / shape of piston✓ Systematic error ✓	**2**	Allow zero error.
1(d)	$\log_{10}F = \log_{10}K - \log_{10}L$ ✓ Gradient should be –1 ✓✓ (one mark for negative sign, one mark for 1) (Just a reference to measuring gradient without specifying it should be –1 should be awarded 1 of the 2 marks above for gradient).	**3**	Accept log instead of $\log_{10}$.

ISA (P) Gas Laws

1(e)	Discussion points: ● Decrease in the area will give a greater uncertainty in the area measurement ● Greater lengths hence length measurement more precise/less uncertainty in length measurement. ● Smaller area allows greater pressure difference with smaller masses Any 2 of above discussion points ✓✓ 2 marks max	**2**	
1(f)(i)	Either explanation Turn syringe upside down and add masses pressing downwards on piston. Or Diagram showing the arrangement ✓	**1**	Any other workable alternative.
1(f)(ii)	$p = p_0 + Mg/A$ ✓	**1**	Do not allow expression with weight instead of mass.
	Total	**17**	

ISA (P) Gas Laws

Section B		Mark	Additional guidance notes

2(a)	Mean length: 139,145
	Volume :153,160 ✓
		1	Candidates would have to have deduced × sect area to compute volume.
			
			Where candidates have kept a 'full quota' of significant figures in their calculations for both area and volume this can lead to different results. Consequently the following combinations are acceptable:
			• Temperature 86 degrees C
			  ○ Mean length 139 Volume 152/153/154
			• Temperature 98 degrees C
			  ○ Mean length 145 Volume 159/160/161
			
			For the 86 degrees C line of data, if a candidate has decided to treat the length of 136 mm as anomalous, the following values are also acceptable:
			• Mean Length 141 Volume 155/156

2(b)	2 points correctly plotted to within ± 1mm or less from exact position ✓ straight line of best fit drawn✓	**2**	Same criteria for the straight line as in stage 1 (j).
2(c)	Triangle drawn with smallest side at least 8 cm And correct values read from graph ✓ Gradient value in range 0.40 to 0.46 (0.395 to 0.464)✓ 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(d)	Appropriate method of calc (eg using similar triangles, or $y = mx + c$) ✓ Temperature = -275°C (must be a negative value) ✓ Allow ecf from gradient value.	**2**	Unit required for mark. NB no marks for student just quoting a value for the temperature without any supporting calculation.
2(e)	Linear relationship/of form $y=mx + c$/increase in Volume proportional to increase in Temperature ✓	**1**	**Not** Volume proportional or directly proportional to Temperature.

2(f)	Gradient lower ✓ Intercept on y axis lower ✓ 3rd mark is for stating gradient halved and intercept on y axis halved (if the 3rd mark is awarded, this automatically achieves 1st and 2nd marks) ✓	**3**	Full marks can be achieved if candidates have stated their gradient and y- intercept values and halved them.
	Total	**12**	

ISA (P) Gas Laws

Question 3		Mark	Additional guidance notes
3	(a) Volume to be kept constant/ using suitably large volume of gas initially. (b) When temperature changed, adjusting number of weights on piston until volume brought back to same value. (c) Suitable method for providing different temperatures eg water bath. (d) Suggest range of temperatures appropriate for road conditions eg –15 to 90°C (e) Suggest range of weights to use to produce increase in pressure of a few atmospheres (this would require a calculation based on cross sectional area quoted). (f) Suggested method for measuring pressure e.g. monometer, bowden gauge, pressure sensor (g) Method for reducing error eg allowing enough time for temperature of gas to reach temperature of water, repeating both increasing and decreasing temperature. (h) Plot *p* – *T* graph. ✓✓✓✓✓ 5 marks max	**5**	**Indicate letter corresponding to marking point awarded (e.g. ✓a).**
	Total	**5**	