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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5451

Specification A

PHA3/P Practical Examination

Mark Scheme

2009 examination - January series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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Dr Michael Cresswell Director General

GCE Physics, Specification A, PHA3/P, Practical Examination

Question 1	AO3a: planning	
	measurements: (to measure the angle between the hacksaw blades and the surface of the table) use a protractor ✓ [marking for trig methods: use a ruler to measure s, the distance A advances up hacksaw, calculate angle using $\alpha = \sin^{-1}\left(\frac{\Delta h}{s}\right)$; use a ruler to measure x, the horizontal displacement of A, calculate angle $\alpha = \tan^{-1}\left(\frac{\Delta h}{x}\right)$] (to measure Δh, the (change in) vertical **height** of A or B or C above the table), use a ruler [millimetre scale] (allow vernier scale or travelling microscope) ✓	**2**
	strategy: explains method of measuring Δh, e.g. by measuring from A to bench **before** and **after** movement of the strip [Δh = s sin α earns $_1$S but does not earn P marks when *α* is measured with a protractor; $\Delta h = \sqrt{s^2 - x^2}$ earns $_1$S and P marks] ✓ measures Δh for different *α* and checks for quantitative link by plotting a graph of Δh [m × g × Δh] against α (allow $_2$S if $_1$S = 0) ✓ for a fixed heating time ✓ checked by using a stopwatch ✓ ($_4$S = 0 if $_3$S = 0)	**4**
	control: (constant rate of heat transfer by) keeping same relative positions of source and B ✓ ensured by measuring distance between source and B with a ruler ✓ (reject clamp source) constant **room** temperature (no explanation required) ✓	**2**
	difficulties: (*difficulty + how to overcome = 2*) any **two** of the following: reduce uncertainty in Δh ✓ by allowing time for the strip to cool to room temperature before repeating and/or by checking that the ruler is vertical (suitable test/sketch must be given) ✓ and/or by avoiding parallax when reading ruler (suitable procedure/sketch must be given) ✓ and/or by measuring Δh at A and then at C and average results ✓ and/or by **repeating experiment** (for same α) and **average** the results [reject anomalies] ✓ and/or by finding Δh using $\Delta h = \sqrt{s^2 - x^2}$ and/or by using a set square or plumb line to establish x ✓ and/or by using fine-toothed hacksaw blades (to improve precision) ✓ and/or by using longer hacksaw blades [longer heating time] to maximise Δh ✓ reduce uncertainty in α ✓ by using a large protractor ✓ and/or by establishing α using correct trigonometry ✓ and/or by using a set square or a plumb line to reduce uncertainty in any vertical or horizontal linear measurement associated with the determination of α ✓ reduce uncertainty in heating time, t ✓ by heating for a long time ✓	**max 4**
	Total	**max 8**

Question 2		AO3b: implementing		
(a)	(i) & (ii)	initial observations:	y_0 to the nearest mm, value sensible, and h_0 to the nearest mm, h_0 in range 175 mm to 225 mm ✓	**1**
(b)		tabulation:	y /mm x /mm ✓	
		results:	5 sets of x and y, negative correlation or 0/2 ✓✓ deduct 1 mark if x range < 200 mm (allow y = 0 set)	**4**
		significant figures:	all x and all y to mm ✓	
(c)		tabulation:	$(y_0 - y)$ x^2 ✓	
		significant figures:	all x^2 data sets 4 s.f. (accept some 3 s.f. for mixed orders of magnitude) or all to 3 s.f. (accept 2 s.f. etc) ✓	
		quality:	4 of 5 points to ± 2 mm of straight line of positive gradient (providing suitably-scaled graph drawn) ✓	
		AO3c: applying evidence and drawing conclusions		**8**
		axes:	marked $(y_0 - y)$/m and x^2/m^2 ✓✓ deduct ½ for each missing, rounding down	
		scales:	suitable (e.g. 8 × 8) ✓✓ [5 × 5, 2 × 8, 8 × 2 ✓]	
		points:	5 points plotted correctly (check at least one) ✓ with straight best-fit line of positive gradient drawn	
(d)	(i)	G from suitable Δ (e.g. 8 × 8) ✓		
	(ii)	Gh_0, no unit, in range 0.325 or 0.33, 0.34, 0.35, 0.36 or 0.37 ✓✓ [0.300 to 0.400 or 0.31, 0.32, 0.38 or 0.39 ✓]		**3**
		AO3d: evaluating evidence and procedures		
(e)	(i)	use the plumb line [ruler previously made vertical using a setsquare] to locate (mark) [place the end of the other ruler] the position on the floor directly below the point of projection ✓		
		using same/similar technique, locate the position on the floor below the pointer; measure x (along the floor) using the additional metre ruler ✓ (accept reverse, i.e. establish position below the pointer then locate (and mark) the position below the point of projection, etc)		**2**
		[placing the setsquare in contact with the vertical ruler and using the additional ruler to measure the horizontal distance to the pointer so the additional metre ruler is not in contact with the floor is worth **1 max**]; give credit for detail given in suitable diagram		
	(ii)	idea that h_0 is kept constant (reject bland 'h0'); allow 'released at the same [at same place, at same height]', 'released at the top [end] of the tube' ✓		
		same '**position** of the tube' (reject 'same slope' or constant angle') ✓		**max 2**
		ball bearing released **from rest** (reject 'not pushed', 'same ball bearing') ✓		
	(iii)	y_0 is smaller [$(y_0 - y)$ values are smaller] ✓		
		by the same amount (reject 'proportionally smaller') ✓		**max 2**
		graph is displaced downwards [displaced rightwards, y intercept is lower] ✓ (reject 'G the same'; no e.c.f. carried forward for y_0 is larger)		
			Total	**22**