Version 1.0: 0708

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Physics 5451

Specification A

PHA3/P Practical Examination

Mark Scheme

2008 examination - June series

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

Question 1	AO3a: planning	
	measurements: (to measure the depth, d, of the liquid) use a metre ruler [millimetre scale] ✓ (to measure the vertical displacement, h, of the container) use of a vernier scale [travelling microscope or vernier callipers] (reject 'micrometer') ✓ (to measure the mass of the sugar added to the water) uses a balance [scales] (reject 'a scale') ✓	**3**
	strategy: explains valid procedure to determine mass of water [solution], e.g. mass of filled and empty container or tares the balance before adding liquid to container [mass of water (not of solution) by volumetric method based on $\rho \times V$ requires use of measuring cylinder/calibrated container] ✓ calculates percentage sugar concentration, by mass, using (idea of) $\frac{\text{mass of sugar}}{\text{mass of sugar} + \text{mass of water}} \times 100$ (allow $_2$S if $_1$S = 0) ✓ read [measure] the position [height], h_0, [when h = 0] of the container as in Figure 1 ✓ (note that this position cannot be achieved with any liquid in the container) add solution then adjust vertical position to that shown in Figure 3; read [measure] new position [height], h_1; determine h from $h_0 - h_1$ ✓ [if h is pre-set and concentration is varied until the light is re transmitted through the mask, $_{34}$S = 1 max] (no credit for $_4$S if $_3$S = 0; $_{34}$S = 0) determine h and measure d (reject 'd = 250 mm') for different concentrations (hence calculate n); plot graph of n against concentration ✓ (allow $_5$S even if $_{1234}$S = 0; don't penalise if d is not re-measured when concentration is changed)	**max 3**
	control: use same source [laser] (accept 'use same frequency', 'same laser beam') ✓ conduct experiment (with liquid) at the same temperature ✓ maintain same angle of incidence [direction of incident light] ✓ (allow 'clamp laser' but reject 'same position' or 'fixed')	**max 2**

	difficulties: *(difficulty + how overcome = 2)* any **two** of the following: reduce uncertainty in d [n] ✓ do not place ruler in liquid when measuring depth and/or ✓ ensure ruler is vertical using suitable test and/or ✓ view ruler at eye level or use plane mirror to avoid parallax error and/or ✓ use large depth (allow 'volume', assuming shape of container is fixed) ✓ reduce uncertainty in h ✓ use large depth (allow 'volume' but don't credit this twice, i.e. for d [n] and for h) and/or ✓ wait until surface of liquid is at rest before making measurement and/or ✓ use small pinion/rack with small [fine] pitch ✓ (no credit for checking zero error, procedures involving ruler or using small hole in mask) reduce uncertainty in concentration of solution [masses of sugar and/or water] ✓ use large masses (of sugar and/or water) [large volume of water] and/or ✓ increase temperature of solution (to increase range of available concentrations) ✓ ensure that all the sugar is dissolved [concentration is uniform] ✓ stir [agitate] solution (reject 'mix') ✓ ensure that laser pointer is used safely ✓ any reasonable measure, e.g. switch off when not in use or do not view the beam directly; any sensible procedure to avoid direct viewing gets credit, e.g. goggles (not 'safety glasses') ✓ (ignore ideas about use of blackout, 'avoiding spillage of water')	**max 4**
	Total	**max 8**

Question 2			
(a)		**AO3b implementing** *initial observations:* h_0 and h_1 recorded to the nearest mm, $(h_0 - h_1)$ in range 100 mm to 200 mm ✓	**1**
(b)/(c)		*tabulation:* h/mm x/mm ✓ *results:* six sets of h and x ✓ x range at least 500 mm ✓ initial [smallest tabulated] x in range 75 mm to 125 mm ✓ (if candidate measures h_0, h_1, h and x to 0.1 mm, penalise in (a) but allow in (b)/(c)) *significant figures:* all h to nearest mm ✓ all x to nearest mm ✓	**6**
(d)	(i)	quality: at least 5 points to ± 2 mm of best fit line ✓ (providing suitably-scaled graph drawn) **AO3c applying evidence and drawing conclusions** *axes:* marked h/mm and x/mm ✓✓ deduct ½ for each error or omission, rounding down *scales:* suitable (e.g. 8 × 8) ✓✓, [5 × 5, 2 × 8, 8 × 2 ✓] *points:* six points plotted correctly (check at least one) ✓ with best-fit line drawn of positive gradient	**9**
	(ii)	G from suitable Δs (e.g. 8 × 8) ✓	
	(iii)	$\frac{h_0 - h_1}{G}$, in mm, in range 338 to 374, or 35, 36 or 37 cm ✓✓ [320 to 392 mm or 33, 34 or 38 cm ✓]	
(e)	(i)	**AO3d evaluating evidence and procedures** reading of h_1 contains the greater uncertainty (or 0/2) ✓ because $h_1 < h_0$ ✓ (accept 'h_1 is smaller'; correct error calculations can supplant explanation)	**6**
	(ii)	for same x, 2 springs extend less than 3 springs ✓ for the same change in x, the change in h is less ✓ h range is reduced (reject 'h smaller') ✓ } max 1 uncertainty [error] in G is increased (reject G reduced) ✓	
	(iii)	must position spirit level directly above pivot (or 0/2) ✓ so spirit level produces no (net) turning moment ✓ [so (line of action of) weight of spirit level acts through pivot] (reject 'same force on each side of pivot')	
		Total	**22**