New Specification

Rewarding Learning

ADVANCED
General Certificate of Education
2018

Physics

Assessment Unit A2 3A

assessing

Practical Techniques and Data Analysis

[APH31]

WEDNESDAY 9 MAY, MORNING

MARK SCHEME

Subject-specific Instructions

In numerical problems, the marks for the intermediate steps shown in the mark scheme are for the benefit of candidates who do not obtain the final correct answer. A correct answer and unit, if obtained from a valid starting-point, gets full credit, even if all the intermediate steps are not shown. It is not necessary to quote correct units for intermediate numerical quantities.

Note that this "correct answer" rule does not apply for formal proofs and derivations, which must be valid in all stages to obtain full credit.

Do not reward wrong physics. No credit is given for consistent substitution of numerical data, or subsequent arithmetic, **in a physically incorrect equation**. However, answers to subsequent stages of questions that are consistent with an earlier incorrect numerical answer, and are based on physically correct equation, must gain full credit. Designate this by writing **ECF** (Error Carried Forward) by your text marks.

The normal penalty for an arithmetical and/or unit error is to lose the mark(s) for the answer/unit line. Substitution errors lose both the substitution and answer marks, but 10^n errors (e.g. writing 550 nm as 550×10^{-6} m) count only as arithmetical slips and lose the answer mark.

In marking graphs you will have to exercise some professional judgement, but other features must be marked strictly according to the scheme. In labelling the axes, candidates should give the label/unit. The mark for "Scales" is normally awarded only if the plotted points occupy at least half of the printed graph along each axis. In addition, the scale must be to an easily manageable factor, such as 1:2, 1:4, 1:5, 1:10, 1:20. A factor of, for example 10 mm to represent 30 cm does not score because of the difficulty of accurately plotting or reading off values.

The credit for plotting the points is, following the normal tariff, 2 marks for plotting 5 points correctly and 1 mark for plotting 4. "Correctly" means to within ± one small square (± 2 mm) on the printed grid in either x- or y- direction. The marker's professional judgement comes in here. One tick is to be awarded for drawing the best straight line through the points. Do not agonise over scoring (or not) this mark, your professional judgement will allow you to come to a decision very quickly.

In measuring the gradient, one mark is reserved for a "large triangle". This means that either rise or run (or both) must be at least 5 cm on the printed graph/grid. Some candidates do not draw their triangle, but use points read off from the line. Provided the rise and/or run in this virtual triangle meet the 5 cm criterion, the mark is scored. Beware of candidates who read off their gradient points directly from a table. The marker must check that the points used actually **lie on the line** and meet the 5 cm test.

				AVAILABLE MARKS
1	**(a)**	chosen values of D between 14 cm and approx. 38 cm (36–40) to nearest mm	[1]	
		more than one set of values – Heading correct with unit /s	[1]	
		multiple oscillations (all times > 5 s)	[1]	
		5 correct values of T	[1]	
		([–1] if any t value not to 2 d.p.)		
	(b)	**(i)** log T = b log D + log k	[1]	
		mapping to y = mx + c, both axes correct	[1]	
		(ii) b = gradient	[1]	
	(c)	log (T/s) and log (D/cm)	[1]	
		log D values correct	[1]	
		log T values correct	[1]	
		values to 2 d.p.	[1]	
		(penalty [–1] if ln used)		
	(d)	x scale	[1]	
		y scale	[1]	
		points plotted, [–1] each error	[2]	
		best fit straight line	[1]	
		([–1] if labels missing)		
	(e)	large triangle + correct values from best fit line	[1]	
		consistent value	[1]	
		b = –1 quality 0.9–1.1	[1]	
		–ve value on answer line	[1]	20
		(if **(b)(ii)** = intercept max [2]) (e.c.f.)		

				AVAILABLE MARKS
2	**(a)**	5 y values to nearest mm	[1]	
		spread in y values, final value 800 ± 20 mm	[1]	
		2 different lens positions recorded to nearest mm	[1]	
		x values calculated to nearest mm	[1]	
		(apply mm penalty once only, values in cm [–1] once only)		
	(b) **(i)**	$y = \frac{x^2}{y} + 4f$	[1]	
		mapped to y = mx + c correctly	[1]	
	(ii)	f is intercept/4	[1]	
		(e.c.f. from mapping in **(i)**)		
	(iii)	x^2/y/mm	[1]	
		values correct	[1]	
	(c) **(i)**	scale and label on x-axis, correct quantity plotted	[1]	
		points plotted, [–1] each error	[3]	
		best fit straight line	[1]	
	(ii)	their intercept	[1]	
		quality 600 ± 40	[1]	
		f = 150 mm (e.c.f. their intercept)	[1]	
		(use of point of line, [2]/[3])		
	(iii)	extreme fit line drawn	[1]	
		value (of intercepts) subtracted	[1]	
		% uncertainly calculated correctly	[1]	20
			Total	**40**