Rewarding Learning

ADVANCED
General Certificate of Education
2016

Physics

Assessment Unit A2 3
Practical Techniques

Session 2

[AY232]

FRIDAY 6 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.

Section A

						AVAILABLE MARKS
1	**(a)**		5 values of l_1 and $l_2 \geqslant$ 20 cm	[1]		
			5 values of l_2 and l_1 to 1 d.p.	[1]		
			5 angles (integers)	[1]		
			l values increasing with m	[1]		
			θ values decreasing	[1]	[5]	
	(b)	**(i)**	L calculated correctly (consistent with **(a)** or correct going from 4 s.f. to 3 s.f.)		[1]	
		(ii)	Values correct	[1]		
			Units g	[1]		
			3 sig. fig. correct	[1]	[3]	
		(iii)	Scales (major grid line separation for $\frac{1}{2}$ axis)	[1]		
			Labels and units on axis correct/consistent with table	[1]		
			Points plotted correctly ([–1] each incorrect or omitted)	[2]		
			Best fit line	[1]	[5]	
	(c)	**(i)**	Values correct from a large triangle	[1]		
			Gradient calculated correctly (don't accept fractions)	[1]		
			Unit cm g^{-1} ecf from **(b)(ii)**	[1]	[3]	
		(ii)	Puts gradient = 1/k	[1]		
			Correctly calculates k	[1]	[2]	
		(iii)	The (original average) length when $m = 0$ (consistency in d.p. must be observed) alternative: unstretched		[1]	20
2	**(a)**		5 readings recorded in *mA* (accept correct amendments to heading)		[3]	
			[–1] if readings not decreasing			
	(b)	**(i)**	$\ln I = \ln I_0 - PN$ (allow missed negative)	[1]		
			Correct mapping to y = mx + c	[1]	[2]	
		(ii)	Values correct down table to 2 d.p.	[1]		
			Label $\ln(I/\text{mA})$	[1]	[2]	
		(iii)	Scale	[1]		
			Label and unit on axis correct	[1]		
			Points plotted correctly ([–1] each incorrect or omitted)	[2]		
			Best fit line	[1]	[5]	
			Penalty [–1] for re-scaling N axis			

						AVAILABLE MARKS
	(c)	**(i)**	Correct positive value	[2]	[2]	
			Correct negative value	[1]		
		(ii)	Reads intercept correctly	[1]		
			Calculates I_0 correctly from their intercept	[1]		
			Draw extreme fit line	[1]		
			New intercept	[1]		
			I_0 difference	[1]	[5]	
			Alternative for no intercept on **Fig. 2.2**			
			Calculates I_0 using: a point on BFL	[1]		
			the gradient of BFL	[1]		
			Draw an EFL	[1]		
			Calculate new I_0 from EFL	[1]		
			Difference in I_0 values	[1]		
		(iii)	Gradient the same (as BFL), below BFL		[1]	20
3	**(a)**	**(i)**	Subs correct or correct algebra making g the subject	[1]		
			9.95 or 9.9	[1]	[2]	
		(ii)	Uncertainty = 0.11	[1]		
			1.4%	[1]	[2]	
		(iii)	% uncertainty in T = 7.6% (or 0.076)	[1]		
			Either doubles % uncertainty in T or			
			halves % uncertainty in (R – r) and doubles % uncertainty in g	[1]		
			16.6% or 0.166 (ecf from **(ii)**)	[1]		
			Calculates absolute uncertainty in g from their % uncertainty			
			1.65 (ecf from wrong % uncertainty, wrong **(i)** or wrong **(ii)**)	[1]	[4]	
	(b)	**(i)**	Squares both sides of equation $T^2 = 4\pi^2 \left[\frac{7(R-r)}{5g}\right]$	[1]		
			k = 55.3/g or 5.63	[1]		
			Units = $s^2\ m^{-1}$	[1]	[3]	
		(ii)	Measure T using stopclock for ⩾ 5 oscillations	[1]		
			Measure d, divide by 2 to get r	[1]		
			Using caliper or micrometer	[1]		
			Repeat and average time	[1]		
			Divide time by number of oscillations to get T	[1]		
			Use a range of ⩾ 5 r values	[1]		
			Repeat and average each d value	[1]		
			Graph of T^2 against r	[1]		
			R = intercept/k	[1]	[9]	20
					Total	**60**