



**ADVANCED**  
General Certificate of Education  
2016

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## **Physics**

**Assessment Unit A2 3**  
**Practical Techniques**

**Session 1**

**[AY231]**

**THURSDAY 5 MAY, MORNING**

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## **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  $550 \times 10^{-6}$  m) count only as arithmetical slips and lose the answer mark.

## Section A

		AVAILABLE MARKS
1	(a) 5 values of $l_1$ and $l_2 \geq 20$ cm 5 values of $l_2$ and $l_1$ to 1 d.p. 5 angles (integers only) $l$ values increasing with m $\theta$ values decreasing	[1] [1] [1] [1] [1] [5]
	(b) (i) L calculated correctly (consistent with (a), or correct from 4 s.f. to 3 s.f.)	[1]
	(ii) Values correct Units g 3 sig. fig. correct	[1] [1] [1] [3]
	(iii) Scales (major grid line separation for $\frac{1}{2}$ axis) Labels and units on axis correct/consistent with table Points plotted correctly ([−1] each incorrect or omitted) Best fit line	[1] [1] [2] [1] [5]
	(c) (i) Values correct from a large triangle Gradient calculated correctly (don't accept fractions) Unit $\text{cm g}^{-1}$ ecf from (b)(ii)	[1] [1] [1] [3]
	(ii) Puts gradient = $1/(2k)$ Correctly calculates k	[1] [1] [2]
	(iii) The (original average) length when $m = 0$ alternative: unstretched	[1] 20
2	(a) 5 readings recorded in mA (consistency in d.p. must be observed) (accept correct amendments to heading) [−1] if readings not decreasing	[3]
	(b) (i) $\ln I = \ln I_0 - PN$ (allow missed negative) Correct mapping to $y = mx + c$	[1] [1] [2]
	(ii) Values correct down table to 2 d.p. Label $\ln(I/\text{mA})$	[1] [1] [2]
	(iii) Scale Label and unit on axis consistent with <b>Table 2.1</b> Points plotted correctly ([−1] each incorrect or omitted) Best fit line Penalty [−1] for re-scaling N axis	[1] [1] [2] [1] [5]

				AVAILABLE MARKS
(c) (i)	Correct positive value Correct negative value	[2]	[2]	
(ii)	Reads intercept correctly Calculates $I_0$ correctly from their intercept Draw extreme fit line New intercept $I_0$ difference	[1]	[1]	[1]
(iii)	Gradient the same (as BFL), above BFL	[1]		20
3	(a) (i)	Subs correct or correct algebra making g the subject 9.95 or 9.9	[1]	[2]
(ii)	Uncertainty = 0.11 1.4%	[1]	[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 $T^2 = 4\pi^2 \left[ \frac{7(R-r)}{5g} \right]$ k = 55.3/g or 5.63	[1]	[1]	
	Units = $s^2 m^{-1}$	[1]	[3]	
(ii)	Measure T using stopwatch for $\geq 5$ 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 $\geq 5$ 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	