Rewarding Learning

ADVANCED
General Certificate of Education
2014

Physics

Assessment Unit A2 3
Practical Techniques

Session 1

[AY231]

FRIDAY 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 later stages 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 judgment 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 judgment 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)	(i)	Heading to include number of oscillations counted and unit (using the solidus)	[1]		
			5 sets of readings for 5 or more oscillations at each length	[3]		
			Repetition for each length and average (may not be shown)	[1]		
			Period *T* to 2 d.p.	[1]	[6]	
			Penalty [–1] if values of *T* not decreasing as *D* decreases			
		(ii)	10, 15, 20, 25, 30		[1]	
	(b)	(i)	Rearrange to $T^2d - Ad^2 - B = 0$	[1]		
			Rearrange to $T^2d = Ad^2 + B$ and mapping to $y = mx + c$	[1]	[2]	
			S. E. $T^2d - Ad^2 - B$ and mapped [1]/[2]			
		(ii)	Values for T^2d Values for d^2		[1]	
		(iii)	**Suitable** labelled scales (points occupy ⩾ half axis)	[1]		
			4 or more points correctly plotted	[2]		
			Best fit line of their plotted points	[1]	[4]	
		(iv)	Large triangle	[1]		
			Gradient A calculated correctly (0.3 – guide)	[1]		
			Unit s^2cm^{-1}	[1]		
			B = intercept on *y*-axis when $d^2 = 0$/or by calculation	[1]		
			Their values	[1]		
			Unit s^2cm	[1]	[6]	20
2	(a)	(i)	Five values of pairs of voltage and current, [1] each pair Penalties: [–1] for voltage not to 2 d.p. (once only) [–1] for current not to 2 d.p. (once only)		[5]	
		(ii)	Values of power dissipated by the bulb	[1]		
			unit W (allow VA etc)	[1]	[2]	
	(b)	(i)	$\lg_{10} P = n \lg_{10} V + \lg_{10} B$ any form	[1]		
			Mapping	[1]	[2]	
		(ii)	Values for $\lg_{10}(P/W)$ Values for $\lg_{10}(V/V)$		[2]	
		(iii)	5 points correctly plotted Penalty [–1] for each mistake to zero	[2]		
			Best fit line of their plotted points	[1]	[3]	
		(iv)	Large triangle	[1]		
			Gradient n calculated correctly	[1]		
			Quality n in range 1.20–1.60 (1 or 2 d.p.) from correct calculation	[1]	[3]	
		(v)	Drawing a good extreme-fit line	[1]		
			Determining gradient of extreme-fit line	[1]		
			$\%n = \frac{\Delta n}{n_{BFL}} \times \frac{100}{1}$	[1]	[3]	20

					AVAILABLE MARKS
3	**(a)**	**(i)**	Release from same point	[1]	
			Start from rest	[1]	
			And . . .		
			Length of slope using a metre rule to ±1 mm	[1]	
			Time using a stopclock or electronic gate circuit ±0.01 s	[1]	
			Diameter using vernier callipers ±0.1 mm	[1]	
			To find velocity divide the distance travelled by the time taken (to roll down the slope)	[1]	
			The mass = density × volume (= density × π $(d/2)^2$ × length)	[1]	
			Reliability improved by repetition **and averaging** (time or diameter)	[1] [8]	
		(ii)	Mass = $7850 \times \pi \times \left(\frac{0.0620}{2}\right)^2 \times 0.0420$		
			= **0.995 kg**	[1]	
			% uncertainty in $d^2 = 2 \times 100 \times \frac{0.1}{62} = 0.32\%$	[1]	
			% uncertainty in L = $100 \times \frac{0.1}{42} = 0.24\%$	[1]	
			Total % uncertainty = 0.5(6)%, sum of their % uncertainties	[1]	
			So uncertainty = 0.995 × 0.56% = ±0.0056 kg (±0.006 kg) ecf % U	[1] [5]	
	(b)	**(i)**	Measure slope length *x* and vertical height *y*	[1]	
			Sin $\theta = y/x$ (any trig' method)	[1]	
			or		
			Protractor	[1]	
			Description of method	[1] [2]	
		(ii)	Friction (on the slope)	[1]	
	(c)		$\overline{v} = \frac{u + v}{2}$	[1]	
			a = average velocity × 2/time to roll down the slope	[1]	
			or		
			$s = ut + \frac{1}{2}at^2$ and u = 0	[1]	
			$a = \frac{2s}{t^2}$	[1] [2]	
	(d)	**(i)**	$(KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 1.60 \times (1.42)^2)$		
			= **1.61 J**	[1]	
		(ii)	h = 0.15 m	[1]	20
				Total	**60**