

Physics B (Advancing Physics)

Advanced Subsidiary GCE

Unit **G492**: Understanding Processes/Experimentation and Data Handling

Mark Scheme for June 2011

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All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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Qn	Expected Answers	Marks	Additional guidance										
1 (a) (b)	kg m s ⁻² (1); N m and W s (1)	2											
2 (a) (b)	10 ⁻⁶ (1) 10 ³ (1)	2											
3		2	Three equal-length arrows (by eye) joined tip-to-tail (1) Forming a (closed equilateral) triangle (1)										
4	<table border="1"> <tr> <td>increasing amplitude</td> <td></td> </tr> <tr> <td>increasing frequency</td> <td>✓</td> </tr> <tr> <td>increasing intensity</td> <td></td> </tr> <tr> <td>increasing wavelength</td> <td></td> </tr> <tr> <td>increasing width</td> <td>✓</td> </tr> </table>	increasing amplitude		increasing frequency	✓	increasing intensity		increasing wavelength		increasing width	✓	2	Deduct one mark for each extra tick.
increasing amplitude													
increasing frequency	✓												
increasing intensity													
increasing wavelength													
increasing width	✓												
5 (a) (b)	$d = 1 \times 10^{-3} \text{ m} / 400 = 2.5 \times 10^{-6} \text{ m}$ (1) $n\lambda = d \sin \theta \Rightarrow \sin \theta = n\lambda / d$ $\sin \theta = 2 \times 5.0 \times 10^{-7} \text{ m} / 1.6 \times 10^{-6} \text{ m} = 0.625$ $\Rightarrow \theta = 39^\circ$ (1)m (1)e	1 2	No marks for first order If you see 38.7°, it must be right = (2) Allow (1) m for using the value of d from (a)										
6 (a) (b)	$F = 850 \text{ kg} \times (27 \text{ m s}^{-1} / 15 \text{ s}) = 1530 \text{ N} \approx 1500 \text{ N}$ (1)m (1)e $P = Fv = 1100 \text{ N} \times 27 \text{ m s}^{-1} = 29700 \text{ W} = 30000 \text{ W}$ (1)	2 1											
7	$ \text{displacement} = \sqrt{\{(15-3)^2 + 7^2\}} = \sqrt{193} = 13.9/14$ paces (1) bearing = $360^\circ \arctan(7/(15-3)) = 360^\circ - \arctan(0.583)$ $= 360^\circ - 30.3^\circ = 330^\circ$ 1 st mark is for calculation of the angle and the 2 nd is for correctly reporting it.	1 2	Allow any clear indication of direction, e.g. N 30.3° W, including diagram with correct angle labelled. For scale drawing, allow 13 – 15 paces at 28° – 32° Allow 30.3°W of N or 59.7° N of W or either angle labelled on the diagram.										
8 (a) (b)	'loop' = $\frac{1}{2}\lambda$ and $0.5 \times 20 \text{ cm} = 50 \text{ cm} / 5$ (1) Appropriate test proposed: can be assumed if an appropriate test is carried out correctly (1) proposed test carried out correctly on all 3 data sets(1) conclusion (yes, to precision of data given) (1)	1 3	Allow alternative valid approach, e.g. 5 half-wavelengths = 50 cm so $\lambda = 50 \text{ cm} / (5 \times 0.5) = 20 \text{ cm}$ Should calculate, for all 3 data pairs, either f^2/T (14.4, 14.5, 14.7) or f/\sqrt{T} (3.79, 3.80, 3.83) or their inverses (0.0694, 0.0692, 0.0680) and (0.264, 0.263, 0.261). Allow conclusion 'No' only if candidate indicates that calculated 'constant' shows a distinct trend. Max 1 mark for answers involving graphs.										
Section A total:		21											

Qn		Expected Answers	Marks	Additional guidance
9 (a)	(i)	$v = 0$ initially (1)	1	'flat' is not enough without reference to 0
	(ii)	$W > T$ (and then $W = T$) and then $T > W$ (1) Because W is decreasing/it is ejecting gas (1)	2	Do not penalise for statements or idea of T increasing.
(b)	(i)	tangent drawn at $t = 6.0$ s with $\Delta t \geq 1$ (1) Uses $\Delta v/\Delta t$ (1) Answer in range 9 to 11 m s ⁻² (1)	3	1 st mark is independent of the others e.g. gradient – allow rounding (this is a <i>show that</i> question)
	(ii)	$F_{\text{res}} = ma = 6.9 \text{ kg} \times 10 \text{ m s}^{-2} = 69 \text{ N}$ or $W = 6.9 \text{ kg} \times 9.8 \text{ N kg}^{-1} = 68 \text{ N} \approx 69 \text{ N}$ (1) so $T = F_{\text{res}} + W$ must be about double W (1)	2	Use own acceleration or 10 m s^{-2} Allow algebraic approach $ma = T - mg \Rightarrow T = ma + mg$ And $a \approx g$ so $T = 2mg$
(c)		Starts curving up sooner (1) Curves diverge continually (1)	2	Allow curve starting at zero. Judge by eye
Total:			10	
10 (a)		Energy needed to liberate electrons (1); Higher frequency/lower wavelength means higher energy photons (1); light provides energy in 'packets' (1); violet photons are energetic enough to liberate electrons, while red are not (1); greater intensity = more photons (1); one photon liberates one electron (1); more photons \Rightarrow more electrons produced (1); in wave model, red light will emit if you wait long enough but this does not happen (so wave model is wrong) (1)	4	One mark for each point. QWC is organise information clearly. The 4 th mark would not be awarded for a confused answer which does not link quantum behaviour with red and violet light.
(b)		$E = hf = 6.6 \times 10^{-34} \text{ J s} \times 5.6 \times 10^{14} \text{ Hz} = 3.7 \times 10^{-19} \text{ J}$ (1); comparison of calculated value with given threshold (1)	2	ORA: calculate $f_{\text{min}} = 3.7 \times 10^{-19} \text{ J} / 6.6 \times 10^{-34} \text{ J s} = 5.6 \times 10^{14} \text{ Hz}$ (1);
(c)		No electrons produced below $3.7 (\times 10^{-19} \text{ J})$ (1); Above this, (extra) energy supplied goes to electron (1)	2	Reject reference to direct proportion.
(d)		Any reasonable application/use involving detection of light or measurement of its intensity (1); limitation e.g. limited range of wavelengths detectable (not red end of spectrum), need for clean potassium surface (1)	2	E.g. solar panel, measuring light level, automatic switch.
Total:			10	

Qn		Expected Answers	Marks	Additional guidance
11 (a)	(i)	$(70^\circ/360^\circ) \times 365 \text{ days} = 70.97(1)e (\approx 71 \text{ days})$	2	71.0 implies evaluation. Allow rounding of intermediate calculation.
	(ii)	period = $71 \times 24 \times 60 / 40 = 2556 \text{ minutes} (1)m (1)e$	2	70.97 days \Rightarrow 2555 minutes. Accept 2600 minutes for 2 marks
(b)	(i)	half d = opposite side of right-angled triangle with vertex $35^\circ (1)$ $0.5 \times d/R = \sin(35^\circ) \Rightarrow d = 2R \sin(35^\circ) (1)$	2	Working may be on a labelled drawing, possibly on Fig. 11.1. 1 st mark for recognising the triangle, second for the algebra.
	(ii)	$d = 2 \times 1.4 \times 10^{11} \text{ m} \times \sin(35^\circ) = 1.6 \times 10^{11} \text{ m}$ $c = 1.6 \times 10^{11} \text{ m} / (11 \times 60 \text{ s}) = 2.4 \times 10^8 \text{ m s}^{-1} (1)m (1)e$	2	
	(iii)	suggestion (1); explanation (1)	2	Suggestion: estimate for R <u>too low</u> (1) this makes d too low which lowers the value for c (1) Suggestion time <u>too large</u> (1) because it's hard to measure/only an estimate(1)
Total:			10	
12 (a)		horiz: $u \cos \theta$ vert: $u \sin \theta (1)$	1	both needed.
(b)	(i)	Using $s = ut + \frac{1}{2}at^2 (1)$; $s = 0 (1)$; $u =$ vert component of $u = u \sin \theta (1)$; $a = -g (1)$	3	Any three points Allow alternative valid approaches, with choice of equation (1); $a = -g (1)$; other conditions with respect to. $u, v, s, t (2)$;
	(ii)	$0 = (u \sin \theta)t - \frac{1}{2}gt^2 \Rightarrow u \sin \theta = \frac{1}{2}gt (1)$ $t = 2u \sin \theta / g$ $= 2 \times 8.0 \text{ m s}^{-1} \times \sin(50^\circ) / 9.8 \text{ m s}^{-2} = 1.25 \text{ s} (1)s (1)e$	3	Use of invalid equation = zero marks Allow other methods: choice of valid equation and rearrangement as necessary(1); substitution (1); evaluation (1) 1.25 s or 1.3 s gets 3 marks automatically
(c)		Throw at smaller angle $\theta (1)$; collisions with sides of buckets (1)	2	Allow any feasible strategy for (1); second mark needs a possible physical explanation. Allow e.g lower $u (1)$ so less energy to dissipate (1)
Total:			9	
Section B total:			39	

Qn	Expected Answers	Marks	Additional guidance			
13 (a)	distance travelled better defined / using similar visual stimulus to start and stop timing / student A's method requires doing more than one thing at a time – higher chance of error/ larger distance travelled, so time longer and therefore less uncertain.	1	Any plausible reason. Allow reading of text to imply B makes repeated measurements of a single pass up the tank.			
(b)	suggestion(1); correction (1)	2	e.g. starting stop watch when wave generated, not at end (1); allow to reach end before starting timing (1); or measuring depth with ruler with 0 not at end (1); correction by subtraction, etc. (1)			
(c)	(i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>2.43/2.434</td></tr> <tr><td>2.92/2.924</td></tr> </table>	2.43/2.434	2.92/2.924	1	Both correct for the mark. Allow 3 or 4 s.f. only.
	2.43/2.434					
	2.92/2.924					
	(ii)	Each correct point (1) best fit line (1)	3	Vertically above minor division gridline and not above half-way between minor divisions. Allow e.c.f. from (i). Judge best fit line by eye.		
(iii)	$v = \sqrt{gd} \Rightarrow v^2 = gd$ (so v^2 against d has gradient g)	1	Rearranged equation is enough for the mark.			
(iv)	Gradient from graph calculated (1)m (1) e	2	Accept values from 9.3 to 10.3 m s ⁻²			
(d)	(i)	3% (1)	1	Allow 3.3% or any number of sf		
	(ii)	percentage/fractional uncertainty in t is significantly greater than in L or d (1)	1			
	(iii)	$v = 2 \times 0.62 \text{ m} / (0.7 + 0.2) \text{ s} = 1.38 \text{ m s}^{-1}$ (1) $g = v^2/d = (1.38 \text{ m s}^{-1})^2 / 0.30 \text{ m} = 6.3 \text{ m s}^{-2}$ (1) % uncertainty = $(10.5 \text{ m s}^{-2} - 6.3 \text{ m s}^{-2}) \times 100 / 10.5 \text{ m s}^{-2} = 40\%$ (1)	3	Independent marking point. Allow ecf from v to calculate g . e.g. only considering a single journey (omission of the 2) gives $g = 1.582 \text{ m s}^{-2}$, leading to an uncertainty of 85% Must use 0.30 m in calculation of g . 1 or 2 s.f. only (correct % uncertainty = 40% to 1 or 2 s.f.)		
Total:		15				

Qn		Expected Answers	Marks	Additional guidance
14 (a)		Many uncontrolled variables owtte (1)	1	Can quote e.g. 'may have different size/widths'
(b)	(i)	test for tyre 2 of type A (1)	1	Accept either way round 2 A or A 2 e.g. pressed harder onto rollers(1) so friction increased (1) e.g. fault in inflation pressure meter (1) causing it to read too low (1) / systematic error in time taken to stop the wheel (1) giving time values too short (1)
	(ii)	All values (significantly) > other two tests	1	
	(iii)	Allow any reasoned suggestion; one mark for possible cause, one for explanation giving right direction	2	
(c)	(i)	variation is in 3 rd s.f./uncertainty is about 0.01 N (1); 2 s.f. would lose significant information/4 s.f. not justified as you should round to the size of the uncertainty (1)	2	1 st mark for appreciation that the variation in a test is in the last figure quoted; 2 nd mark for justifying this. Can credit the idea of it being an outlier with reference to the other values horizontally (1) and vertically (1)
	(ii)	(significantly)> test 1 or test 2 (1); does not fit data trend down the column (1)	2	
(d)		Type B at 80Ncm ⁻² (high pressure) (1) because the (rolling) friction is lower (1)	2	
Total:			11	

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