OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE

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

Mark Scheme for June 2011

Oxford Cambridge and RSA Examinations

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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		increasing amplitude: ; increasing frequency: ✓; increasing intensity: ; increasing wavelength: ; increasing width: ✓	2	Deduct one mark for each extra tick.
5 (a)		$d = 1\times10^{-3}$ m/400 = 2.5 × 10^{-6} m (1)	1	
(b)		$n\lambda = d \sin\theta \Rightarrow \sin\theta = n\lambda/d$ $\sin\theta = 2\times5.0 \times 10^{-7}$ m/1.6 × 10^{-6} m = 0.625 $\Rightarrow \theta$ = 39° (1)m (1)e	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)		F = 850 kg × (27 m s^{-1}/15 s)= 1530 N ≈1500 N(1)m (1)e	2	
(b)		$P = Fv$ = 1100 N × 27 m s^{-1} = 29 700 W = 30 000 W(1)	1	
7		|displacement| = $\sqrt{\{(15-3)^2 + 7^2\}} = \sqrt{193}$ = 13.9/14 paces (1) bearing = 360° arctan(7/(15-3)) = 360° - arctan(0.583) = 360° - 30.3° = 330° 1st mark is for calculation of the angle and the 2nd 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)		'loop' = ½λ and 0.5 × 20 cm = 50 cm / 5 (1)	1	Allow alternative valid approach, e.g. 5 half-wavelengths = 50 cm so λ = 50 cm/(5 × 0.5) = 20 cm
(b)		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)	3	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	1st mark is independent of the others e.g. gradient – allow rounding (this is a *show that* question)
	(ii)	$F_{res} = ma$ = 6.9 kg × 10 m s^{-2} = 69 N or W = 6.9 kg × 9.8 N kg^{-1} = 68N ≈ 69 N (1) so $T = F_{res} + W$ 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 ⇒ 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 4th 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 × 10^{-34} J s × 5.6×10^{14} Hz = 3.7 × 10^{-19}J (1); comparison of calculated value with given threshold (1)	2	ORA: calculate f_{min} = 3.7×10^{-19}J/6.6 × 10^{-34}J s=5.6×10^{14}Hz(1);
(c)		No electrons produced below 3.7 (× 10^{-19}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°/360°)×365 days(1)m; = 70.97(1)e (≈71 days)	2	71.0 implies evaluation. Allow rounding of intermediate calculation.
	(ii)	period = 71×24×60/40 = 2556 minutes (1)m (1)e	2	70.97 days ⇒2555 minutes. Accept 2600 minutes for 2 marks
(b)	(i)	half d = opposite side of right-angled triangle with vertex 35° (1) 0.5×d/R = sin(35°) ⇒ $d = 2R \sin(35°)$ (1)	2	Working may be on a labelled drawing, possibly on Fig. 11.1. 1st mark for recognising the triangle, second for the algebra.
	(ii)	$d = 2\times1.4\times10^{11}$ m × sin (35°) = 1.6×10^{11} m $c = 1.6 \times 10^{11}$ m/(11× 60s) = 2.4×10^{8} 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 $s = ut + ½at^2$ (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)	$0 = (u \sin\theta)t - ½gt^2 \Rightarrow u \sin\theta = ½gt$ (1) $t = 2u \sin\theta/g$ = 2×8.0 m s^{-1}× sin(50°)/9.8 m s^{-2} =1.25 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 θ (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)	2.43/2.434 2.92/2.924	1	Both correct for the mark. Allow 3 or 4 s.f. only.
	(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 =** 2×0.62 m/(0.7+ 0.2) s = 1.38 m s^{-1}(1) $g = v^2/d$ = (1.38 m s^{-1})^2/0.30 m = 6.3 m s^{-2} (1) % uncertainty = (10.5 m s^{-2}-6.3 m s^{-2})×100/10.5 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 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
	(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	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)
(c)	(i)	variation is in 3rd 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	1st mark for appreciation that the variation in a test is in the last figure quoted; 2nd mark for justifying this.
	(ii)	(significantly)> test 1 or test 2 (1); does not fit data trend down the column (1)	2	Can credit the idea of it being an outlier with reference to the other values horizontally (1) and vertically (1)
(d)		Type B at 80Ncm^{-2}(high pressure) (1) because the (rolling) friction is lower (1)	2	
		Total:	**11**	

Qn		Expected Answers	Marks	Additional guidance
15 (a)		Assumption that the Sun's rays are parallel (1); Knew angle was 0° at Syene (1); deduced 7° latitude difference between Syene & Alexandria owtte (1); knew time to travel at known speed from S to A (1); deduced distance from speed or time of travel (1); use of 700 stadia per degree/realised distance was 7/360 of circumference of Earth (1); calculation 4900 ×360/7 = 252 000 stadia (1)	4	Any four points. Or Sun directly overhead QWC is 'select and use a form and style of writing appropriate to purpose and to complex subject matter'; 4th mark would not be awarded if the story is not clearly conveyed. Allow bulleted lists.
(b)		Any reasonable disadvantage related to lack of repeatability/consistency (1)	1	E.g. differences in terrain or weather conditions or day length will affect speed of caravan.
(c)	**(i)**	160 m (1) 180 m (1)	2	Penalise one mark for > 2sf. Penalise one mark for max and min values in wrong place
	(ii)	max = 4900×170 m× (360°/6°) = 50 000 000 m (49 980 000 m) (1) min = 4900×170 m× (360°/8°) = 37 500 000 m (37 485 000 m)(1) Comparison with 40 010 000 m. (1)	3	Third mark is independent of first two marks.
	(iii)	(angle) 1° in 7° = 14%/ (stadion) 5% is 1 in 20 (1) angle is a far greater source of uncertainty (1)	2	1st mark for comparing uncertainties in angle and stadion; 2nd for conclusion
(d)		True distance is **less** than the one he used (1); so the final circumference is too big (1) (ecf); Estimate uncertainty from the diagram 5-8% (1) Uncertainty in much **less** than uncertainty in angle, so will have less effect on the calculated value (1)	2	Accept either approach
		Total:	**14**	
		Section C total:	**40**	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
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