

# **Physics B (Advancing Physics)**

Advanced Subsidiary GCE

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

## **Mark Scheme for June 2011**

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Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.


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Qn	Expected Answers	Marks	Additional guidance										
1 (a)	kg m s <sup>-2</sup> (1);	2											
(b)	N m and W s (1)												
2 (a)	10 <sup>-6</sup> (1)	2											
(b)	10 <sup>3</sup> (1)												
3		2	Three equal-length arrows (by eye) joined tip-to-tail (1) Forming a (closed equilateral) triangle (1) Deduct one mark for each extra tick.										
4	<table border="1" data-bbox="411 1433 587 1859"> <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	
increasing amplitude													
increasing frequency	✓												
increasing intensity													
increasing wavelength													
increasing width	✓												
5 (a)	$d = 1 \times 10^{-3} \text{ m} / 400 = 2.5 \times 10^{-6} \text{ m}$ (1)	1											
(b)	$n\lambda = d \sin \theta \Rightarrow \sin \theta = n\lambda / d$ $\sin \theta = 2 \times 5.0 \times 10^{-7} \text{ m} / 1.6 \times 10^{-6} \text{ m} = 0.625$ $\Rightarrow \theta = 39^\circ$ (1)m (1)e	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)	$F = 850 \text{ kg} \times (27 \text{ m s}^{-1} / 15 \text{ s}) = 1530 \text{ N} \approx 1500 \text{ N}$ (1)m (1)e	2											
(b)	$P = Fv = 1100 \text{ N} \times 27 \text{ m s}^{-1} = 29700 \text{ W} = 30000 \text{ W}$ (1)	1											
7	$ \text{displacement}  = \sqrt{\{(15-3)^2 + 7^2\}} = \sqrt{193} = 13.9/14$ paces (1)	1	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°										
	bearing = $360^\circ - \arctan(7/(15-3)) = 360^\circ - \arctan(0.583) = 360^\circ - 30.3^\circ = 330^\circ$ 1 <sup>st</sup> mark is for calculation of the angle and the 2 <sup>nd</sup> is for correctly reporting it.	2	Allow 30.3°W of N or 59.7° N of W or either angle labelled on the diagram.										
8 (a)	'loop' = $\frac{1}{2}\lambda$ and $0.5 \times 20 \text{ cm} = 50 \text{ cm} / 5$ (1)	1	Allow alternative valid approach, e.g. 5 half-wavelengths = 50 cm so $\lambda = 50 \text{ cm} / (5 \times 0.5) = 20 \text{ cm}$										
(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.										
		<b>21</b>	<b>Section A total:</b>										

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) tangent drawn at $t = 6.0$ s with $\Delta t \geq 1$ (1)	2	Do not penalise for statements or idea of $T$ increasing. 1 <sup>st</sup> mark is independent of the others e.g. gradient – allow rounding (this is a <i>show that</i> question)
	(i) Uses $\Delta v/\Delta t$ (1) Answer in range 9 to 11 m s <sup>-2</sup> (1)	3	
(b)	(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) Starts curving up sooner (1) Curves diverge continually (1)	2	Use own acceleration or 10 m s <sup>-2</sup> 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
	<b>Total:</b>	<b>10</b>	
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 <sup>th</sup> mark would not be awarded for a confused answer which does not link quantum behaviour with red and violet light.
	$E = hf = 6.6 \times 10^{-34} \text{ J s} \times 5.6 \times 10^{14} \text{ Hz} = 3.7 \times 10^{-19} \text{ J}$ (1); comparison of calculated value with given threshold (1)		
	No electrons produced below $3.7 \times 10^{-19} \text{ J}$ (1); Above this, (extra) energy supplied goes to electron (1)		
	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)		
	<b>Total:</b>	<b>10</b>	
(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.
	<b>Total:</b>	<b>10</b>	

Qn	Expected Answers	Marks	Additional guidance
11 (a)	(i)	2	71.0 implies evaluation. Allow rounding of intermediate calculation.
	(ii)	2	70.97 days $\Rightarrow$ 2555 minutes. Accept 2600 minutes for 2 marks
	(i)	2	Working may be on a labelled drawing, possibly on Fig. 11.1. 1 <sup>st</sup> mark for recognising the triangle, second for the algebra.
	(ii)	2	
	(iii)	2	Suggestion: estimate for $R$ <u>too low</u> (1) this <b>makes <math>d</math> too low</b> which lowers the value for $c$ (1) Suggestion time <u>too large</u> (1) because it's hard to measure/only an estimate(1)
<b>Total:</b>		<b>10</b>	
12 (a)	horiz: $u \cos \theta$ vert: $u \sin \theta$ (1)	1	both needed.
	(i)	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)	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)
<b>Total:</b>		<b>9</b>	
<b>Section B total:</b>		<b>39</b>	

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 style="text-align: center;">2.43/2.434</td> </tr> <tr> <td style="text-align: center;">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					
(d)	(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 <sup>-2</sup>		
	(i) 3% (1)	1	Allow 3.3% or any number of sf		
	(ii) <b>percentage/fractional</b> uncertainty in $t$ is <b>significantly</b> greater than in $L$ or $d$ (1)	1	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.)		
	(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			
	<b>Total:</b>	<b>15</b>			

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) (ii) All values (significantly) > other two tests (iii) Allow any reasoned suggestion; one mark for possible cause, one for explanation giving right direction	1 1 2	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)
(c)	(i) variation is in 3 <sup>rd</sup> 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) (ii) (significantly)> test 1 or test 2 (1); does not fit data trend down the column (1)	2 2	1 <sup>st</sup> mark for appreciation that the variation in a test is in the last figure quoted; 2 <sup>nd</sup> mark for justifying this.  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 <sup>-2</sup> (high pressure) (1) because the (rolling) friction is lower (1)	2	
<b>Total:</b>		<b>11</b>	

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 (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 $4900 \times 360/7 = 252\,000$ stadia (1) Any reasonable disadvantage related to lack of repeatability/consistency (1)	4	Any four points. Or Sun directly overhead
(b)		1	QWC is 'select and use a form and style of writing appropriate to purpose and to complex subject matter'; 4 <sup>th</sup> mark would not be awarded if the story is not clearly conveyed. Allow bulleted lists. E.g. differences in terrain or weather conditions or day length will affect speed of caravan.
(c)	(i) 160 m (1) 180 m (1) (ii) $\max = 4900 \times 170 \text{ m} \times (360^\circ/6^\circ) = 50\,000\,000 \text{ m}$ (49 980 000 m) (1) $\min = 4900 \times 170 \text{ m} \times (360^\circ/8^\circ) = 37\,500\,000 \text{ m}$ (37 485 000 m)(1) Comparison with 40 010 000 m. (1)	2	Penalise one mark for > 2sf. Penalise one mark for max and min values in wrong place
(d)	(iii) (angle) 1° in 7° = 14%/ (stadion) 5% is 1 in 20 (1) angle is a far greater source of uncertainty (1) True distance is <b>less</b> 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 <b>less</b> than uncertainty in angle, so will have less effect on the calculated value (1)	2	Third mark is independent of first two marks. 1 <sup>st</sup> mark for comparing uncertainties in angle and stadion; 2 <sup>nd</sup> for conclusion Accept either approach
	<b>Total:</b>	<b>14</b>	
	<b>Section C total:</b>	<b>40</b>	



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