RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE

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

Mark Scheme for January 2011

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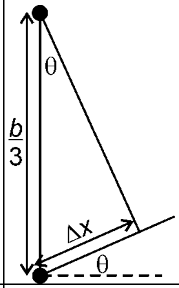
Qn	Expected Answers	Marks	Additional guidance
1	(a) W (1); (b) F <u>and</u> s (1)	1 1	Accept any obvious references
2	(a) A (1); (b) B (1); (c) A (1)	3	
3	third box (added as vectors) (1); sixth box ($p \propto A^2$) (1)	2	2 correct boxes and 4 blanks = 2 marks; one correct box and at least four blanks = 1 mark 2 correct boxes, 1 incorrect and 3 blanks = 1 mark No other combinations score any marks.
4	(a) $E=hf = 6.6\times10^{-34}$ J s$\times4.8\times10^{14}$ Hz = 3.2×10^{-19} J (1); (b) In 1 s, $N = 50\times10^{-3}$J/3.2×10^{-19} J = 1.6×10^{17} (1)m (1)e	1 2	If rounded, E must be correctly rounded to get the mark in (a) Allow ecf from incorrectly rounded E in (a) but not if wildly wrong
5	(a) $\lambda = c/f = 3 \times 10^{8}$ m s^{-1}/909 $\times 10^{3}$ Hz = 330 m (1)m (1)e (b) waves from two transmitters interfere destructively(1); inter-nodal distance = ½λ so spacing = 165 m (1)	2 2	 owtte e.g. cancel allow 150 m from λ = ½ 300m Accept standing wave argument
6	(Speed very high therefore) very short times to be measured/distance in lab too small (1); Δt likely to be large fraction of t owtte(1)	2	2nd mark for relating time measurement to its uncertainty, e.g. ref. to large %age uncertainty in t or to small time resolution of timer
7	(a) $v^2 = u^2 + 2as$ = (12 m s^{-1})^2 + 2(-9.8 m s^{-2})(3.0m)(1) = 85.2 m^{2}s^{-2} so v = $\sqrt{85.2}$ m^{2}s^{-2} = 9.2 m s^{-1}(1)m (1)e (b) gets there on way up and on way back down (1)	 3 1	a & s need opposite signs for 1st mark
	Section A total:	**20**	

Qn	Expected Answers	Marks	Additional guidance
	Section B		
8 (a)	(i) regular vertical movements/changes in water level (1); some parts don't move at all (1); No movement along surface (1)	2	Any two points.
	(ii) A at ends and N in centre(1); so length = ½λ (1)	2	
	(iii) ½T = 48 s from Fig. 8.1⇒T = 96 s (1); f = 1/96 Hz = 0.010 Hz (1); $v = f\lambda$ = 0.010 Hz × 1600 m = 17 m s^{-1} (1)m (1)e	4	Or ¼ T = 24 s or $v=\lambda/T$ (1); = 1600 m/96s (1)s = 17 m s^{-1} (1)e correct rounding needed for evaluation mark
(b)	different wind speed may produce different standing wave pattern (1); T↓2× to 48s⇒f↑2×(1); ⇒ λ ↓2× to 800 m(1); will fit as standing wave (with 2 half-wavelengths) (1);	3	Any three points. e.g. stronger wind ⇒ higher frequency Spotting that f doubles gets this a mark or$T$ ↓2× to 48s⇒ λ ↓2× from $v=\lambda/T$ above (2); **QWC**: Last marking point here is 'logical steps' point; do not give 3 marks if there are any errors of physics in the argument i.e. CON implied
(c)	(Very much) longer/bigger <u>so</u> waves take longer to go up and back or T↑ ⇒ f↓⇒ λ↑ (assuming v unchanged) ⇒ A-N-A distance↑ so lake is longer (1)	1	accept different in depth (shallower), so waves travel slower
	Total:	**12**	

Qn	Expected Answers	Marks	Additional guidance
9 (a)	(i) $t = v/a$ = 12.0 m s^{-1}/9.8 m s^{-2} = 1.22 s (1) /ora from 1s gives 9.8 m s^{-1} so 12.0 m s^{-1} takes a bit longer. (1) (ii) s=½ $(u+v)t$ = ½ (0+12 m s^{-1}) × 1.22s = 7.3m (1)m (1)e (iii) for free fall t = 1.22 s for steady speed t = (150 m – 7.3 m)/6 m s^{-1} = 23.8 s (1) total time = 23.8 s+ 1.22 s = 25.0 s (1)	1 2 2	ORA $v=\sqrt{(2as)}$ = $\sqrt{(2×9.8 \text{ m s}^{-2} ×7 \text{ m})}$ =11.7 m s^{-1} ≈ 12 m s^{-1} (1)m (1)e last mark requires the two times to be added
(b)	curve starts out on line and gradient drops gradually (1); decelerates as curve from v ≤ 12 m s^{-1} (1); asymptotic with 6 m s^{-1} (1); decelerating phase parallel but sooner (1)	2	Any two points; if second part is worth 2, do not penalise for poor beginning First part should be convex curve second part concave curve; do not give if it starts too high areas under graphs are equal.
(c)	(i) longer time = smaller acceleration <u>so</u> smaller force/ extends distance over which landing force is exerted on lander <u>so</u> same work done by smaller force (1) (ii) a = 6.0 m s^{-1}/0.25 s = 24 m s^{-2} (1) $F = ma$ = 53 kg × 24 m s^{-2} = 1270 N ≈1300 N (1)	1 2	Or momentum changes over shorter time so smaller force Or Δp = 318 N s (1); so F = 318 N s/0.25 s = 1270 N (1) Allow also $ma + mg$ = 1790 N
	Total:	**10**	

Qn	Expected Answers	Marks	Additional guidance
10(a)	(i) all in phase/facing same direction owtte (ii) 3A	1 1	
(b)	(i) One phasor rotation corresponds to λ (1); 120° = 1/3 rotation for the extra $\lambda/3$ (1) (ii) Arrows correctly drawn in circles in Fig. 10.4 (1); Three arrows tip-to-tail in triangle with directions consistent with Fig. 10.4(1) (iii) $\sin\theta = \Delta x/(b/3)$ (1); $=(\lambda/3)/(b/3) = \lambda/b$ so $\lambda = b \sin \theta$ (1)	2 2 2	Must explicitly link λ to 1 rotation for this mark. Judge by eye ('20 to' and '20 past' in clock terms) Allow other valid vector addition methods, e.g. parallelogram (judge by eye).  this diagram identifying θ and $b/3$ is enough for first mark and second mark is for substituting $\Delta x = \lambda/3$ and rearranging. Do not give this with ecf from incorrect diagram.
(c)	$\sin\theta = \lambda/b = 2.4$ cm/6.0 cm= 0.40 $\Rightarrow \theta = 23.6° \approx 24°$ (1)m (1)e	2	
	Total:	**10**	
11(a)	(i) system in equilibrium/ (horizontal) forces balance (1); *F* is (equally) shared between two horizontal components of tension (1) (ii) $\frac{1}{2}F = 70$ N $= T\cos(36°) \Rightarrow T = 70$ N/0.81 = 86.5 N ≈ 90 N (1)m(1)e	2 2	NOT $F = 2T$ but $F = 2T\cos\theta$ is OK, as is vector addition diagram. 2nd mark must be correct physics referring to horizontal components. Calculation giving double the correct answer, then divided by two with no justification = (0); vector triangle involving 140 N is probably wrong.
(b)	(i) KE gain = work done = Fs = 85 N×0.80 m = 68 J (1) (ii) energy loss/resistive force due to friction etc. (1); tension in string/bow drops (as it returns to vertical) (1); angle θ becomes greater (1); so horizontal component becomes less (1)	1 3	Allow max 1 mark for arguments based on energy loss/resistive forces. Last mark is consequent upon identifying increase in angle **QWC** is organise info. clearly & coherently
	Total:	**8**	
	Section B total:	**40**	

Qn	Expected Answers	Marks	Additional guidance
12 (a)	Calculating at least two values of v^2 (1); Identify Max v^2 and Min v^2 or Max v and Min v (1) Direct reference to range bar — 6.4 to 7.4 m^2 s^{-2} (1)	3	Max v^2 = (2.72 m s^{-1})^2 = 7.4 m^2 s^{-2}/Min v^2 = (2.52 m s^{-1})^2 = 6.4 m^2 s^{-2} Accept 'all the values lie within the range' for second mark. Allow an ecf for third marking point
(b)	Δh is too small to plot on any sensible scale (1) (percentage) uncertainty in h small (1) (percentage) uncertainty in $v(^2)$ much greater(1)	2	Any two from three
(c)	Assumption: reading for h 0.6 m is an outlier and should be ignored (in the first instance) (1) Best fit line within bounds (template on Scoris) (1) Correct method using at least 0.1m from x-axis (1)m gradient (19.4 m s^{-2}) (1)e	4	Assumption needs to be clear – either written or outlier circled/identified Best fit line does not go through origin ecf from own line
(d)	(i) Energy losses would result in E_k being too small(1) E_k is too large so not a possible explanation (1) (ii) recognises source of systematic error (1); explains positive intercept in terms of v being too big (1)	4	h measured from bottom instead of centre of card (1); h values all <u>smaller</u> than true distance fallen so v^2 values all bigger than expected owtte(1)
	Total:	**13**	
13 (a)	0.01/1.0 = 0.01 θ = arctan(0.01) = 0.0099997 = 0.5729° sin θ = 0.0099995 which is very close to 0.01 (1) / sin θ = $x/\sqrt{(x^2 + L^2)}$ (1)m(1)e	2	
(b)	(i) 3.8 (1) ± 0.3 (1) (ii) Percentage/fractional uncertainties for Δx is 8% (1) while Δd is 4% (1) so x contributes most (1) (iii) $\Delta L/L$/0.6%/percentage uncertainty is very much smaller (than (b ii)) (1) (iv) λ_{min}=(0.25-0.01)×10^{-3}m×(3.8-0.3)×10^{-3}m (1)/1.72m =4.88×10^{-7}m (1)m(1)e (v) $\Delta\lambda$= 5.60 ×10^{-7}m - 4.87×10^{-7}m = 7×10^{-8}m	2 3 1 3 1	 allow ecf from (b) (i) Third mark is dependent on calculations – allow ecf from own calculations 1st mark is taking smallest d & x If answer is not = 4.88×10^{-7}m then check for ecf from (b) (i) Allow 2 s.f.(7.2×10^{-8}m)
(c)	% uncertainty in x doubles/increases (to 16%) (1) % uncertainty in d halves/decreases (to 2%) (1); Δx was already the major contributor (1) so $\Delta\lambda$ increases (1)	3	Three from four marking points Can plug in values and recalculate
	Total:	**15**	

Qn	Expected Answers	Marks	Additional guidance
14 (a)	360° = 2π×2.0 m = 12.6 m(1); (1/6)°= 12.6m/(360×6)= 0.0058 m ≈ 6 mm (1)	2	
(b)	(i) 40° + 10'+ 6' = (40+ 16/60)° = 40.27° (1)m(1)e (1) 4sf (ii) percentage uncertainty = 100×(1/60)/40.27 = 0.04% (1)m(1)e	3 2	One mark for reading scale correctly (40° 16') One mark for correct conversion to decimal degrees s.f mark should be consistent with candidate's answer Allow uncertainty of ±½' giving answer 0.02% Watch e.c.f. from (i)
(c)	allows identification/elimination of outliers(1); mean value is a better estimate than any individual reading (1); reduces uncertainty (in mean) (1); identifies range of/uncertainty in data (1); gives more confidence in mean value. (1)	3	Any 3 points Do not accept 'can calculate mean' unless qualified 'Makes answer more accurate' by itself is not enough for marking points 3 or 4 Accept 'reliable' / 'repeatable' as 'more confidence in mean value'.
(d)	Stars have known/consistent/predictable positions (1); Planetary positions can be compared with fixed stars (1); allowed him to check accuracy of his quadrant(s) (1); and to compare his different instruments (1)	2	Any two points Idea of reference points (for planetary movement). 'Fixed stars' without any more is just repeating the question. 'calibrate his equipment' (from article) gains this mark.
	Total:	**12**	
	Section C total:	**40**	

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