OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE **G492**

Understanding Processes/Experimentation and Data Handing

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

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Qn	Expected Answers	Marks	Additional guidance
1	(a) J s^{-1} (1); (b) N kg^{-1} (1)	2	
2	(a) A (1); (b) C (1); (c) B (1)	3	
3	$f = c/\lambda = 3.0 \times 10^8$ m $s^{-1}/1.8 \times 10^{-10}$ m $= 1.67 \times 10^{18}$ Hz (1); $E=hf = 6.6 \times 10^{-34}$ J s $\times 1.67 \times 10^{18}$ Hz $= 1.1 \times 10^{-15}$ J (1)s (1)e	3	Can use $E = hc/\lambda$; quoting equation (1); & then (1)s (1) e If equation wrong (e.g. $E = h\lambda/c$) then no marks for Q3. No e.c.f allowed from incorrect frequency;
4	second box (phasors line up) (1); third box (slits closer together) (1)	2	One for each correct tick. Cancel one mark for each extra tick.
5	(a) any antinode indicated (1) (b) λ = 1.2 m(1); f = 1/0.4 s = 2.5 Hz (1)	1 2	
6	(a) $t = (v - u)/a = 27$ m $s^{-1}/(0.86 \times 9.8$ m $s^{-2})$ = 3.2 s (1)m (1)e (b) $a = (v^2-u^2)/2s$ =(- [27 m $s^{-1}]^2$)/(2 × 35 m =10.4 m s^{-2} $F=ma$=1600 kg ×10.4 m s^{-2}= 16 700 N= 17 000 N (1)m (1)e	2 2	As u is not specified, allow any calculation based on candidate's own value. Sign unimportant. Can calc $\Delta E_k/s$= 583 kJ/35m = 17 kN
7	(a) $W = Fs$=(110 kg×9.8 m s^{-2}) ×1.2 m = 1290 J ≈ 1300 J (1)m (1)e (b) s = 30 cm – 6 cm = 24 cm (1) $F = W/s$ = 1300 J/(24 × 10^{-2} m) = 5420 N = 5400 N (1)	2 2	Must have evidence of calculation 1st mark is for 24 cm / 0.24m / 24 × 10^{-2} m. Accept 24 without units. Second mark is for correct final answer Or via *suvat* (u= 4.85 m s^{-1}, a = 49 m s^{-2}) & $F=ma$. Allow answer which includes the weight of the barrel→ 6500 N.
	Section A total:	**21**	

Qn	Expected Answers	Marks	Additional guidance
8 (a)	W and AR downwards and U upwards	1	Must be vertical: ignore lengths of arrows or points of application
(b)	(i) Needs to be moving (relative to air) (for there be be air resistance)(1)	1	'Balloon is at rest' is enough irrespective of any qualification.
	(ii) F = (0.0060 kg×9.8 m s^{-2}) - (0.0035 kg×9.8 m s^{-2}) (1) = 0.0245 N (≈ 0.02 N) (1)	2	Allow 0.024 N or 0.025 N (not just 0.02 N) as evidence of evaluation
(c)	(i) identifying streamlining/ appropriate change in shape or size of balloon (1) Relating change to reduction in F_{AR} (at constant v) (1)	2	**QWC**: maximum 1 mark if terms not correctly used or spelled.
	(ii) Gradient dropping: resultant force drops (producing smaller acceleration) due to increased air resistance (1); Horizontal line: $F_{AR} = U - W$ (1)	2	Answer must explain in terms of the forces involved; 'air resistance increases' is enough 'Resultant force = 0' owtte is enough here. Reference to 'terminal velocity' is neutral.
	(iii) kv = 0.016 N s m^{-1} × 1.5 m s^{-1}= 0.024 N (1) Comparison with answer to (b)(ii) (1)	2	If reverse argument is used, needs to start with F from (b)(ii) (second marking point), and then calculate k close to 0.016 N s m^{-1} for the first marking point.
	Total:	**10**	

Qn	Expected Answers	Marks	Additional guidance
9 (a)	(i) $\sin(\theta)=n\lambda/d$ = 1 × 700×10^{-9} m/1.3×10 $^{-6}$ m = 0.54 θ = 33° (1)m (1)e	2	ora: d sin(30°) = 650 nm ≈ 700 nm (1)m (1)e
	(ii) smaller θ (1) $\lambda = d \sin\theta$, so (for the same λ) $d \uparrow (\Rightarrow \sin\theta\downarrow) \Rightarrow \theta\downarrow$ (1)	2	(1) for smaller θ (1) for explanation linked to equation which may be implied.
(b)	(i) 2 $\lambda = d \sin(90°)$=1.3×10 $^{-6}$ m × 1 $\Rightarrow\lambda$ = 6.50 × 10 $^{-7}$m (1)m (1)e;	2	Zero marks if n=2 not used
	(ii) 700 nm > value calculated in (i) (1) Would result in θ > 90°, which is not possible (1)	2	Calculating sin θ = 1.09 (1) So no solution for θ possible (1) Accept well-reasoned approach based on path differences
(c)	destructive interference occurs in this region (1); for all visible wavelengths (1)/ λ in this region must be either infrared (first order) or ultraviolet (second order)(1); neither is visible/present in the incident light (1)	2	'no visible wavelengths give solutions to n$\lambda = d \sin(\theta)$ in that region' gets both marks
	Total:	**10**	

Qn	Expected Answers	Marks	Additional guidance
10 (a)	Transverse: oscillations/vibrations in direction perpendicular to direction of movement of wave (1); Longitudinal: oscillations/vibrations in direction parallel to direction of movement of wave (1)	2	(1) for linking transverse to oscillations perpendicular (to direction of wave motion), (1) for linking longitudinal to oscillations parallel (to direction of wave motion) Marks can be given for clear diagrams
(b)	(i) time of travel of P-waves is $t_P = D \div v_P$ / that of S-waves is $t_S = D \div v_S$ (1); $\Delta t = t_s - t_p = \frac{D}{v_s} - \frac{D}{v_p}\left(= D\left(\frac{1}{v_s} - \frac{1}{v_p}\right)\right)$ (1) (ii) Δt = 50 s (1); $D = \Delta t /(1/v_S - 1/v_P)$ = 50 s/(1/3500 m s^{-1} -1/8000 m s^{-1}) = 50 s/(1.6 × 10^{-4} s m^{-1}) = 310 000 m (1) s (1)e	2 3	First mark is for a correct application of $v/D/t$ to either wave ± 2 s; 48 s ⇒ 299 000 m, 52 s ⇒ 325 000 m For e.c.f.,D = $\Delta t/(1.6 \times 10^{-4}$ s m$^{-1})$ Correct substitution of v_s and v_p gets the (1)s This can be inferred from e.g. (1.6 × 10^{-4} s m^{-1})
(c)	Correct amplitudes identified (1) ratio of amplitudes = 285/105 ≈ 2.67 2.67^2 = 7.11 ≈ 7 (1)	2	Allow amplitudes of 250 – 300 and 80 – 120 mm Allow peak-to-peak values instead of amplitudes Accept ratio in format 13:2 etc. ecf incorrect amplitudes and rounding before squaring Give the first mark if you can see the two amplitudes or peak-to-peak values. Ignore units in final answer.
(d)	log scale allows great range of values owtte to be registered in a smaller range of numbers (1)	1	
	Total:	**10**	

Qn	Expected Answers	Marks	Additional guidance
11(a)	Scale drawing: right-angled triangle with angle 30° (1); hypotenuse 1000 N (1); adjacent side 900 N (1) Calculation: $F_H = T\cos(\theta)$ (1); = 1000 N × cos(30°) (1) = 870 N ≈ 900 N (1)	3	Remember that correct answer with no working gets full marks, so 866 N = 3 marks
(b)	(i) Vertical component of tension = 1000 N sin(30°) = 500 N (1) Minimum mass of kitesurfer = 500 N/ 9.8 N = 51 kg (1)	2	Can be done by scale drawing, possibly from (a). If 'mass' and 'weight' are not properly distinguished, this mark is not awarded. Can be implicit in calculation.
	(ii) Suggesting a factor with relationship to kite size (wind speed or speed/skill/activity of surfer) (1) Stating the direction of the effect **and** explaining the relationship (1)	2	Need not specify direction of effect, e.g. 'You need different sized kites in different wind speeds' or 'You need a different kite for speed surfing from that for acrobatics' is OK E.g. 'In faster winds, you will need a smaller kite or you will go too fast/be lifted off the water'
(c)	Horizontal (component of) force from kite = (horizontal) force from water on board (1); and in opposite direction (1)	2	Ignore reference to vertical components. Ignore attribution of horizontal force from water to e.g. resistance, friction, component of normal reaction '**horizontal** forces in equilibrium' will gain this mark, 'forces in equilibrium' will not.
	Total:	**9**	
	Section B total:	**39**	

Qn	Expected Answers	Marks	Additional guidance
12 (a)	(i) Any two points from: Correct reference to spread/range of data excluding potential outlier (1); Visible gap between outlier and rest of data (1) Attempt to quantify separation of outlier from mean/minimum of remaining data in terms of spread (1) (ii) Suggestion should make it clear that wire has been damaged in some way, e.g. narrowed by twisting (1)	2 1	accept reference to standard deviation or interquartile range, etc e.g. 'is very much lower than the others' 'greater than twice the spread from the mean' gets both marks. 'weakened' is enough
(b)	Uncertainty = 1 N (1) Rounding force to ± 1 N = 9 N (1)	2	Must be 1 s.f. 9.1 ± 1 N would get the first marking point but not the second
(c)	(i) %age uncertainty = 0.005mm × 100/0.38mm = 1.3 % = 1% (1)m (1)e (ii) %age uncertainty in *d* « %age uncertainty in *F*	2 1	Expect 1 s.f. allow 2; for > 2 s.f. maximum mark = 1 Must compare *d* with *F* (may use fractional uncertainties)
(d)	mean stress = 9 N/1.1×10^{-7} m^2 = 8.2 × 10^7 Pa (1) m (1) e repeat with uncertainty = 1 N/1.1×10^{-7} m^2 = 1.0 × 10^7 Pa (1) e.c.f for both calculations from part (b)	3	Need to use candidate's values from (b) here. Can do via: Max stress = (9+1)N/1.1×10^{-7} m^2 = 9.1 × 10^7 Pa and/or Min stress = (9-1)N/1.1×10^{-7} m^2 = 7.3 × 10^7 Pa To obtain e.g uncertainty = (max – mean) = 1 × 10^7 Pa (1) Can be found from e.g. 1/9 or 11% of mean ignore s.f. errors in both mean and uncertainty.
	Total:	**11**	

Qn	Expected Answers	Marks	Additional guidance
13 (a)	(i) Curve + interpolation to give *h* between 28 & 29 m (1)	1	Consistent with candidate's curve.
	(ii) Use of gradient at start or data points for 0 & 0.5 s (1) gradient ≈ 15 m/0.5 s = 30 m s^{-1}/ data points give 25 m s^{-1} (1)	2	Gradient triangle must have base of at least≥ 0.2 s. Consistent with candidate's own tangent Accept use of $v^2 = u^2 + 2as$ with s = answer to (a)(i) and a = -9.8 m s^{-2} to give u about 23.4 m s^{-1}
	(iii) gradient decreasing (continually) during ascent (1); negative gradient increasing during descent (1)	2	Must refer to both ascent and descent: can refer to both parts as a single motion if clear, e.g. 'gradient decreases from positive to zero to negative'
(b)	(i) $v^2 = u^2 + 2as$ with v = 0 (1) $0 = 25^2 + 2 \times (-9.8) \times s \Rightarrow s$ = 625/19.6 = 32 m (1)s (1)e Ignore errors in allocating – sign to *g* or *u* & *s* in the use of this equation: just look for 31.9 m	3	Or $v=u+at \Rightarrow t$ = 2.55 s (1) followed by $s=ut+½at^2$ (1)m (1)e If t = 2.75 s taken from graph, first mark is not given but can then get the remaining two marks. Reverse argument from s = 30 m to calculate u is OK.
	(ii) Air resistance/drag (1); provided decelerating force/reduced velocity//dissipated energy (1)	2	any mention of air resistance is enough for this first mark. Second mark needs a clear and correct explanation.
(c)	(i) Force from wind is horizontal (1); need vertical force from wind to affect height reached (1) horizontal and vertical motion are independent (1)	2	Any two points.
	(ii) Time of flight = 2×time to highest point= 2× 2.75 s (1); speed of wind = 37 m/5.5 s = 6.7 m s^{-1} (1)	2	check with 13(a)(i) if different from 2.75 s If time not doubled give zero marks unless total time of flight = 4.0 s from graph (e.g. landed on a roof). 37 m/4.0 s = 9.25 m s^{-1}
	Total:	**14**	

Qn	Expected Answers	Marks	Additional guidance
14 (a)	(i) Best-fit curve (1); stopping p.d. from graph (1)	2	Not straight line; should be through/close to points. Curve must reach the p.d. axis for second mark and be consistent with candidate's graph. Expect values about 1.32 V.
	(ii) correct plotting (2); best-fit line (1); gradient: $3.5\,V/8.5\times10^{14}$ Hz (1)m = 4.1×10^{-15} V Hz^{-1} (1)e	5	All 3 points in tolerance = (2); 2 correct = (1) (overlay on scoris). If point in blue overlay box is incorrect, check candidate's value in(a)(i). Point on edge of overlay tolerance box is in. Line in tolerance by eye e.c.f. own line; can use any data points for calculation as all are close to line. Max 1 mark for gradient calculation if 10^{14} not included correctly **OR** 4×10^{14} on x-axis read as 0. No marks awarded if both errors made.
	(iii) $h = e \times$ gradient$=1.6\times10^{-19}\times4.1\times10^{-15} = 6.6\times10^{-34}$ J s (1)	1	e.c.f. own gradient. Must show evidence of working for answer of 6.6×10^{-34}. Watch for incorrect gradient giving correct *h* by fiddling = 0 marks.
(b)	(i) uncertainty in h = (0.5/100) × 6.57×10^{-34} J s $= 3\times10^{-36}$ J s (1) $h_{max} = 6.57\times10^{-34} + 3\times10^{-36}$ J s $= 6.60\times10^{-34}$ J s (1)	2	Or 6.57×10^{-34} J s × 1.005 $= 6.60\times10^{-34}$ J s (1)m (1)e
	(ii) Millikan's (maximum) value < (minimum) accepted value/ ranges do not overlap owtte (1) suggested incorrect variable (i.e. *V*, *f* or *e*) (1); suggested reason for error (can be generic, e.g. incorrect calibration of instrument involved) (1).	3	**QWC** is third mark, for 'organise information clearly and coherently'.
(c)	Established theories had worked well (1); idea was too different from accepted theory(1); insufficient experimental support for new theory (1)	2	Any two points.
	Total:	**15**	
	Section C total:	**40**	

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