OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE

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

Mark Scheme for January 2012

Oxford Cambridge and RSA Examinations

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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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Annotations

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Follow through
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response
	Arithmetic error
	Wrong physics or equation

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Calculated answers are frequently shown to 3 significant figures for the convenience of markers. Candidates are expected to express answers to an appropriate number of significant figures, often 2.

Incorrect rounding is an evaluation error

Sig fig errors should be penalised only where indicated

SECTION A

Question			Answer	Marks	Guidance
1	(a)		speed and velocity	1	either order
	(b)		force and velocity	1	either order
	(c)		power = energy (/time)	1	
2			A B A C	1 1 1 1	
3			ticks in 2nd box ($\lambda\uparrow$) & 5th box ($D\uparrow$)	2	Completely correct (two appropriate ticks and 3 empty or cancelled boxes) = 2 marks; One error only(one appropriate tick and no more than one other tick) = 1 mark
4	(a)		0.5kg × 9.8 m s^{-2} × 8.0 m = 39.2 J = 39 J (1)	1	
	(b)		½0.5kg(15 m s^{-1})^2 - 39 J (1)m = 17J (1)s v=√(2×17J/0.5kg) = 8.3 m s^{-1} (1)e	3	Method mark for initial KE - PE Can use $v^2=u^2+2as$ 1(m) 1(e) and (1) for as negative If as is positive then the (e) mark is awarded only if a comment is made on the unreasonable value of v (19.5 m s^{-1})
5			$a = F/m$ = (25 N - 18 N)/2.6 kg = (-)2.7 m s^{-2}(1)m (1)e	2	Method mark for force difference/mass 6.9 m s^{-2}/9.6 m s^{-2}/16.5 m s^{-2} for (1)

Question			Answer	Marks	Guidance
6	(a)		$f = c/\lambda = 3.0 \times 10^{8}$ m s^{-1} / 5.89×10^{-7}m (1)m $= 5.09 \times 10^{14}$ Hz (1)e $E = hf = 3.36 \times 10^{-19}$ J (1) $\approx 3 \times 10^{-19}$ J	3	Allow use of $F = hc/\lambda$: recall of equation (1) followed by (1) m (1) e
	(b)		N = 100 W/3.36×10^{-19} J = 2.97/2.98 $\times 10^{20}$ (1) $\approx$ 3.0×10^{20} all energy becomes light owtte (1)	2	Allow own value from 6a, but do not award first mark if rounding is incorrect. Use of 3.0 x 10^{-19}J photon $^{-1} \Rightarrow$ 3.33 x 10^{20} photons s^{-1} If candidate makes assumption about efficiency in calculation, award the second mark at that point.
7			Correct method (1) Candidate's chosen method correctly followed through to give a result (1) answer between 0.20 and 0.22 m (1)	3	Demonstration that distance = area under the graph gets the first mark. This should be close to the whole correct area, more than just a triangle joining (0,0) to (0.03,11). Consistent application of own method. This also applies if the candidate draws a straight line from (0,0) to (0.03,11) and then uses area of the triangle, which is also true if $s = \frac{1}{2}(u+v)t$ is used: this gives 0.165 m. Use of $s = vt$ is 0 marks.
			Section A Total	**23**	

SECTION B

Question			Answer	Marks	Guidance
8	(a)		node-node distance = ½λ (1)	1	allow 'each loop is ½λ' owtte or any clear indication that the length of the string is ½λ
	(b)		$c = f\lambda$ = 82 Hz ×1.3 m = 106.6 m s^{-1} ≈ 100 m s^{-1} (1) m (1) e	2	Watch for $c = \lambda/T$ used incorrectly.
	(c)	(i)	$T = \mu v^2$ = 8.4×10^{-3} kg ×(106.6 m s^{-1})^2 = 95.45 / 95.5 / 95 N (1)m (1)e	2	100 m s^{-1} gives 84 N, 107 m s^{-1} gives 96 N.
		(ii)	(same T and) smaller $\mu \Rightarrow$ greater v and greater $v \Rightarrow$ greater f (for same λ) (1)	1	Accept use of formula

	(d)		waves in both directions (1);
			reflected/returned/bounces back at end (1);
			idea of superposition / interference (of these 2 waves) (1);
			node = zero amplitude/no oscillation (1);
			antinode = maximum amplitude/oscillation (1);
			node at each end (1);
			antinodes midway between nodes or vice versa (1)
				3	Any 3 points
					
					QWC: correct use and spelling of e.g. superposition, interference, node, antinode, frequency, wavelength
					If QWC is not adequate (i.e. misuse of technical terms) then do not award more than 2/3

			Total	**9**	

Question			Answer	Marks	Guidance
9	(a)	(i)	a = 27 m s^{-1}/10.9 s = 2.48 m s^{-2}(1) $F = ma$ = 860 kg x 2.48 m s^{-2} (1) m $\Rightarrow F$ = 2130 N (1)	3	2.5 m s^{-2} gives 2150 N/ ecf from own acceleration
		(ii)	mass increases (1) a smaller $\therefore$ longer time (to reach 60 mph) (1)	2	
	(b)	(i)	No/zero resultant force (1)	1	**OR** 'forces are balanced', 'forces in equilibrium'
		(ii)	$F = P/v$ = 15 000W /20 m s^{-1} (1) = 750 N (1)	2	0.75 N worth (1) of the two
		(iii)	time to burn 1 litre = 18 km/20 ms^{-1} = 900 s(1) E per s = 33 x 10^6 J/900 s = 3.7 x 10^4 W (1)	2	**OR** Fuel used = 20/18000 litre = 1.1×10^{-3} litre (1) E = 33×10^6 ×1.1×10^{-3} J = 3.7×10^4 J (1)
		(iv)	power/energy losses AND mechanism either produced by friction (e.g. in transmission system, rolling friction or air resistance) or location (e.g. heat losses in exhaust)(1)	1	
			Total	**11**	
10	(a)		$\lambda = b\sin\theta \Rightarrow b$=7.0 × 10^{-11}m/sin(1°) = 4. 0 × 10^{-9} m	1	
	(b)	(i)	$v = h/\lambda m$ = 1.0(4) × 10^7 m s^{-1} (1)m & s (1)e	2	
		(ii)	$E\uparrow \Rightarrow v\uparrow$ (1); $v\uparrow \Rightarrow \lambda\downarrow$ (1); $\lambda\downarrow \Rightarrow \theta\downarrow$/fringes closer together (1)	3	Can get one of the first two marks for $E\uparrow \Rightarrow \lambda\downarrow$ QWC is clear, ordered answer; for each step award (1)
	(c)		Must add phasors for all paths (1); at points marked 0, the phasors curl up/have very small resultant phasor (1); low resultant phasor amplitude $\Rightarrow$ low probability of electron arriving there (1)	2	Any two points Treat reference to photons instead of electrons as neutral in this part.
	(d)		Wavelength ≤ gap spacing for diffraction (1); Electron wavelength (much) smaller wavelength than light (1); small interatomic distance needs wavelength about 0.1 nm/ light wavelength is 600 ÷ 0.1 times too big (1)	2	Any two points Allow also: calculates λ/b = 6000 (1); arcsin (λ/b) is not possible (as λ/b > 1)(1) third marking point for use of data provided
			Total	**10**	

Question			Answer	Marks	Guidance
11	(a)	(i)	v_x= 5 m s^{-1} cos(40°) = 3.8(3) m s^{-1} (1) v_y= 5 m s^{-1} sin(40°) = 3.2(1) m s^{-1} (1)	2	Just look for the calculated answers: a bald 3.8 and 3.2 by themselves are enough for both marks, as the attribution is obvious.
		(ii)	a_x= (3.83 m s^{-1} - 5 m s^{-1})/2 s (1)m; = -0.58(5) m s^{-2} (1)e	2	Use candidate's own value of v_x; allow 4 m s^{-1} 3.8 m s^{-1} ⇒ -0.6 m s^{-2} 4 m s^{-1} ⇒ -0.5 m s^{-2} If sign wrong (a_x= 0.58(5) m s^{-2}) then award 1 mark
	(b)		components drawn in correct directions and labelled (1); sensible scale chosen and components correctly plotted (1); magnitude = 1.7 m s^{-2} (1); angle = 340°/20° 'west of north' (relative to x-y directions) (1)	4	Allow ecf from own value of a_x in (a)(ii) Angle labelled on diagram is enough for direction. 20° with no indicated direction does not get the mark. 340° is bearing and does not need added direction information Allow measurement of angle from diagram with tolerance 18° to 23° / 337° to 342° Allow angle from diagram but direction of resultant must be correct.
	(c)		work = F × distance moved in direction of force (1); component of F in this direction is zero (so no work done) (1)	2	First mark is for realising that s must be / have component in direction of F in calculation of work; Second mark is for appreciating that this component is zero
			Total	**10**	
			Section B Total	**40**	

SECTION C

Question			Answer	Marks	Guidance
12	(a)	(i)	mean = 1.1(1) s (1) spread = 0.2(0) s (1)	2	allow 2 s.f. for spread but no more
		(ii)	1.6 s > 2× 0.2 s from 1.1 s (1)	1	ecf from own mean and spread. Must have appropriate decision as to whether it is an outlier.
		(iii)	v = 2 × 165 m / 1.1 s = 300 m s^{-1} (1)	1	Allow ecf from (a) (i) use of 1.11 s gives 297 m s^{-1}
	(b)		Any reasonable suggestion (1) explanation either of the source of the uncertainty/ or of the effect on the measurement(1)	2	
	(c)		Improvement (1) explanation (1)	2	eg electronic timing/recording of sound, greater distance to reflecting wall; explanation related to suggested improvement. Improved technique leading to increased reliability/accuracy.
			Total	**8**	

Question			Answer	Marks	Guidance
13	(a)	(i)	0.22(1), 0.26(0), 0.30(2) or 0.30(3)	2	all correct = 2, 2 correct = 1
		(ii)	plotting (2) line (1)	3	all correct = 2, 2 correct = 1 (ecf) tolerance on each point = ± 0.5 small scale division by eye: NOT through origin
	(b)	(i)	considering when t = 0 (1) s should = 0 (1)	2	
		(ii)	triangle base/ Δt must be at least 0.05 s (1) expected gradient = 4.7 to 5.0 (1)	2	Must have appropriate triangle or pair of data points. ecf own line
		(iii)	g = double gradient (9.6 to 10.0) (1) unit: m s^{-2} (1)	2	ecf allow N kg^{-1}
	(c)	(i)	t is too big/s too small (1) plausible suggestion for why (1)	2	Owtte e.g t should be smaller or s should be bigger
		(ii)	With respect to s gradient **does not** change (1) idea of ALL values shifted equally(1) **OR** With respect to t the gradient **does** change (1) constant error in t affects values of t^2 by different amounts (1)	2	
			Total	**15**	

Question			Answer	Marks	Guidance
14	(a)	(i)	0.1 mm ×100/0.5 mm = 20% (1)m (1)e	2	
		(ii)	(5 ×100/100) = 5% is less than 20% /(i) (1) diameter of oil droplet gives greater uncertainty(1)	2	
	(b)		Volume of oil V = tA (1) equating with $(4/3)\pi r^3$ with $\pi R^2 t$ (1) appropriate algebraic manipulation (1)	3	Substituting for π is a valid alternative approach but V = tA must be evident to gain 3 marks.
	(c)	(i)	percentage /fractional error is unchanged owtte (1)	1	Allow dividing both by two.
		(ii)	$t = (4\times0.25\times10^{-3}\text{ m})^3/(3\times(0.05\text{m})^2)$ $= 8.33 \times 10^{-9}$ m (1)m (1)e $x = t/12 = 6.9 \times10^{-10}$ m / 7×10^{-10} m (1)	3	may have r and R both in mm or both in m or equivalent in μm or nm using 8×10^{-9} m gives 6.7×10^{-10} m using 8.3×10^{-9} m gives 6.9×10^{-10} m allow ecf for $t/12$ for final answer
		(iii)	Using max or min value of r = 0.30 or 0.20 mm (1) $x_{max} = 1.2 \times 10^{-9}$ m or $x_{min} = 3.6 \times 10^{-10}$ m Δx using $x_{max} = 5.1 \times 10^{-10}$ m or using $x_{min} = 3.3 \times 10^{-10}$ m (1); %age uncertainty = $(5.1 \times 10^{-10}\text{ m}/6.9 \times 10^{-10}\text{ m}) \times 100\%$ = 74 (70)% using x_{max} or 48 (50)% using x_{min} (1)	3	Can use min r and mean, max r and mean or min r and max r Allow full credit for %age uncertainty in x = 3 × %age uncertainty in r (2) = 3 × 20% = 60% (1) Treat any use of $\Delta R/R$ as neutral Penalise > 2sf
			Total	**14**	
			Section C Total	**37**	

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