OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE

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

Mark Scheme for June 2012

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

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.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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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 or repeated error
	Error in number of significant figures
	Correct response
	Arithmetic error
	Wrong physics or equation

The Abbreviations, annotations and conventions used in the detailed mark scheme are:

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

Subject Specific Marking Instructions

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text:

8 (c)

10 (b)

11 (c)(ii)

13 (a)

14 (b)

SECTION A

Question			Answer	Marks	Guidance
1	(a)		0.1	1	
	(b)		100	1	
2	(a)		J & Nm	1	Both needed
	(b)		kg m s^{-2}	1	
	(c)		N kg^{-1}	1	
3	(a)		B	1	
	(b)		C	1	
	(c)		D	1	
4	(a)		$F = ma$ = 1200 kg × 1.8 m s^{-2} = 2160 N = 2200 N	1	Ignore confusion with signs.
	(b)		$v^2 = u^2 + 2as$ (1); $\Rightarrow s = (v^2 – u^2)/2a$ = (169 $m^2 s^{-2}$ – 900 $m^2 s^{-2}$)/(2×-1.8 m s^{-2}) = -731 $m^2 s^{-2}$/-3.6 m s^{-2} = 203 m = 200 m(1)	2	First mark for selection of correct equation Allow use of v = u + at followed by s = ut + 1/2 at^2 for this mark Second mark for evaluation. Allow rounding between stages where done. Ignore confusion with signs if magnitude of answer is correct.
5			$n\lambda = d \sin(\theta) \Rightarrow \lambda$ = 1.4 × 10^{-6} m × sin(19°) (1) = 4.56 × 10^{-7} m = 4.6 × 10^{-7} m (1)	2	First mark for correct choice of equation and substitution. Penalise incorrect rounding e.g. to 4.55 × 10^{-7} m
6	(a)		wavefronts spread out (1); 4 wavefronts on right, each one wavelength apart (1)	2	Can be up to 180° Judge by eye Ignore region of +/- λ each side of the aperture
	(b)		wavefronts with greater λ (1); Greater angular spread than in (a) (1)	2	Judge by eye; can look on either side of the aperture Ignore curvatures
7	(a)	(i)		1	Two in phase: labelling unnecessary; need not be put together to give resultant but must be parallel and same direction. Arrows needed. May be drawn within circles.
		(ii)		1	90° phase difference (by eye); need not be touching or tip-to-tail to get the mark. Arrows needed.
	(b)		amplitude^2 (1) is (directly) proportional to probability (1) Allow $p \propto A^2$ for (2).	2	If 'probability =amplitude^2' is written, then max (1) irrespective of what else is written.. Allow 'resultant' or 'magnitude' for amplitude.
			Total	**21**	

Question			Answer	Marks	Guidance
8	(a)		incident and reflected waves (1); interfere destructively/are out of phase (1)	2	1st mark for two waves meeting but must imply the reflected and incident waves 2nd mark is for the idea of cancellation; may refer to path difference that's not being λ, or detector being at a node,
	(b)	(i)	reflected wave path length changes (while incident is unchanged) (1); so phase difference changes from out of phase to in phase to out of phase etc. (1)	2	**reject** any reference to standing waves/nodes and antinodes in this question part
		(ii)	reading from the graph to deduce distance moved between maxima/minima = 14 ± 0.1 mm (1); wavelength = twice that distance = 28 mm (1)	2	
	(c)		Unchanged: Feature: same number of peaks and troughs/ separation of peaks and troughs (1); Explanation: because wavelength has not changed (1); Changed: Feature: peak/average signals will increase (1); Explanation: because greater intensity/amplitude from transmitter reaches both detector and reflector (1)	4	QWC requires the correct use of terms (expect wavelength, interference/superposition, path length, amplitude/intensity) with not more than one mis-spelling Allow other valid features. Could refer to signal with no reflector **accept** reference to loss of signal but **reject** 'closer to transmitter' (as it is in the stem) without further qualification
			Total	**10**	

Question			Answer	Marks	Guidance
9	(a)		$15 \times 80 \times 10^{-3}$ W = 1.2 W ≈ 1 J in the 1 s (1)	1	accept calculation of power
	(b)	(i)	$f = E/h = 3.7 \times 10^{-19}$ J/ 6.6×10^{-34} J s = 5.6×10^{14} Hz (1) $\lambda = c/f = 3 \times 10^{8}$ m s^{-1}/5.6×10^{14} Hz = 5.35×10^{-7} m (1)	2	or via $E = hc/\lambda$ (1)m (1) e
		(ii)	$N = 15 \times 80 \times 10^{-3}$ W/3.7×10^{-19} J = 1.2 W/3.7×10^{-19} J = 3.2×10^{18} (s^{-1}) (1)m (1) e	2	1 W from (a) gives 2.7×10^{18}
	(c)	(i)	1.4×10^{3} W $m^{-2} \times 0.18$ m × 0.09 m = 22.68 W = 23W	1	
		(ii)	absorbed by clouds/air/ atmospheric pollution or panel not perpendicular to solar radiation	1	Allow extra distance/ further from Sun
		(iii)	lamp is needed in dark/er conditions/lamp needs a constant energy source (1); solar panel does not work in low light intensity (night) /produces insufficient power in low light intensity/is variable (1)	2	e.g. lamp is used at night, no solar energy available, or light intensity from Sun varies with weather
			Total	**9**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>10</td><td>(a)</td><td>(i)</td><td>distance = 3.0 m × π = 9.4 m
so t = 9.4 m / 5.0 s = 1.9 s ≈ 2s</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><td></td><td>v_A / m s $^{-1}$</td><td>v_B / m s $^{-1}$</td><td>v_C / m s $^{-1}$</td></tr><tr><td>x-component</td><td>0</td><td>5.0</td><td>0</td></tr><tr><td>y-component</td><td>5.0</td><td>0</td><td>-5.0</td></tr></table></td><td>2</td><td>Mark by column.

two correct columns = (1), all correct = 2</td></tr>
<tr><td></td><td></td><td>(iii)</td><td><table><tr><td></td><td>d_{AB}/ m</td><td>d_{AC} / m</td></tr><tr><td>x-component</td><td>3.0</td><td>6.0</td></tr><tr><td>y-component</td><td>3.0</td><td>0</td></tr></table></td><td>2</td><td>Mark by column.

each correct column = (1)</td></tr>
<tr><td></td><td>(b)</td><td></td><td>horizontal component:
u = 12 m s $^{-1}$, v = 12 cos(40°) m s $^{-1}$
Δv = 12 cos(40°) m s $^{-1}$ - 12 m s $^{-1}$ (1)
= (9.2 - 12) m s $^{-1}$ = -2.8 m s $^{-1}$
a =-2.8 m s $^{-1}$ /1.6 s = -1.8 m s $^{-2}$ (1)

vertical component:
(u = 0 m s $^{-1}$) v = - 12 sin(40°) m s $^{-1}$ (1) = - 7.7 m s $^{-1}$
Δv = - 7.7 m s $^{-1}$
a = -7.7 m s $^{-1}$/1.6 s =-4.8 m s $^{-2}$ (1)</td><td>4</td><td>For the x-component, omission of u = 12 m s $^{-1}$ from calculation is a gross error of physics and so can have no marks for this part.

Only penalise incorrect/missing minus sign once: a correct numerical answer with incorrect sign would get 1 out of 2 for either component if it is the first manifestation of a sign error; the second such error is not penalised so bald answers 1.8 m s $^{-2}$ and 4.8 m s $^{-2}$ would get 3 marks</td></tr>
<tr><td colspan="3"></td><td>Total</td><td>9</td><td></td></tr>
</table>

Question			Answer	Marks	Guidance
11	(a)		$E = mgh$ = 2100 kg × 9.8 m s $^{-2}$ × 1.2 m = 24 700 J ≈25 000J (1)	1	Evaluation must be clear. This may be implied by quoting gpe to 3 (or more) s.f.
	(b)	(i)	height = (1.2 + 0.85) m (1); = 2.05 m E = 2100 kg × 9.8 m s^{-2} × 2.05 m = 42 200 J ≈ 40 kJ (1)	2	Or Δh = 0.85 m ⇒ ΔE =17500J (1);⇒ E =24700 J+17500J = 42000 J ≈ 40 kJ (1)
		(ii)	F= 42 000 J / 0.85 m = 49 400 N ≈ 50 000 N	1	47 000 N if 40 kJ used
		(iii)	greater mass is being moved ⇒ greater ΔE ⇒ greater F	1	**accept** (increased mass results in) increased weight
	(c)	(i)	needs greater force to penetrate (1); because earth gets compacted/ground is getting denser (1) OR greater friction as pile goes deeper (1); because sides of pile rubbing on ground (1)	2	First mark for factor and second for linking to reduced penetration. 'Resistance' only acceptable if nature of force is clear
		(ii)	Any test not giving a calculated set of values for example, 'draw a graph' or 'do an experiment' is automatically 0/4 Correct Test (1); Can be inferred from a <u>complete</u> set of <u>correct</u> <u>calculations</u> Calculation (2); Must involve use of d and N to gain credit Conclusions (1)	4	Any incorrect test followed through to conclusion = maximum 2 marks. either calculate k for one data pair and check for the other three or see if $d\sqrt{N}$ or d^2N is constant for all four k = 0.85 m for N = 1 and predictions for N = 2, 3, 4 are 0.6, 0.49 and 0.43 $d\sqrt{N}$ = 0.85, 0.89, 0.83, 0.72 d^2N = 0.72, 0.79, 0.69, 0.52 2 or 3 appropriate calculations for (1), all 4 appropriate for (2) Accept conclusion which shows sensible use of own results, e.g. 'probably not because values vary a lot', or 'yes, to 1 s.f.', or 'Not sure, need to get more results'. This mark cannot be awarded unless all the data has been tested and must be consistent with proposed test.
			Total	**11**	

Question			Answer	Marks	Guidance
12	(a)		smallest <u>difference</u> that can be detected	1	Sensible definition of resolution
	(b)	(i)	digital: 0.01 A (1); smallest current difference that can be read (1) analogue: = ± 2 A (1) to the nearest division (1)	4	Accept 0.005 A (1); rounding to nearest smallest reading (1), smallest digit on the scale. Accept 1 A – rounding to nearest half division.
		(ii)	0.01 A × 100%/ 3 A = 0.3% (1)m (1)e	2	Allow for value from (i). Ignore s.f. error here. Uncertainty must be consistent with (i)
	(c)	(i)	<u>All</u> readings will be <u>smaller</u> than the correct value (by the same amount) (1)	1	Accept wording such as consistent
		(ii)	adjusting the needle position (to zero) / noting the zero error and adding it to each reading (1)	1	recalibrate is not enough on its own and needs some idea of re-setting (needle) to zero
	(d)		23° x (50 A/90°) = (12.8) 13 A (1)	1	Sig fig penalty to 4 or more sig figs.
	(e)		Easier to see sudden movement of needle than changes in digits/ digital meter samples/has time lag (1)	1	Accept analogue meter has a quicker response time
	(f)		one of: Idea of not affecting the measurement (1); Meter will overheat and could be damaged (1); smaller p.d. drop across the resistor (1)	1	For 1st marking point, should make it clear that a high resistance ammeter will reduce the current from the current with no meter present
			Total	**12**	

Question			Answer	Marks	Guidance
13	(a)	(i)	Plotted points (2); best fit line(1) gradient -clear working from readings taken from line (1)m (1)e	5	4 correct = (2); 3 correct = (1); <3 correct = (0) (within half a square) penalise gradients based on $\Delta V < 0.2V$ allow ecf for gradient of own line but expect values within the range (3.9 - 4.3) × 10^{-15} V Hz^{-1}
		(ii)	[gradient] =V Hz^{-1}=V s (1) ([*h*/*e*] =)J s /C = V s (1)	2	Other approaches possible. Award a mark for recognising Hz = s^{-1} or V=JC^{-1}
		(iii)	4.1 × 10^{-15} V Hz^{-1} = *h*/1.6 × 10^{-19} C *h* =4.1×10^{-15} V Hz^{-1}×1.6×10^{-19} C = 6.6×10^{-34} J s (1)m (1)e	2	4×10^{-15} V Hz^{-1}×1.6×10^{-19} C = 6.4×10^{-34} J
	(b)	(i)	Data does not fit the line or the trend in the table (1) Recognition that the value is too high/point plotted above the line (1); Practical reason for the value being too high/cannot see the LED even though it is emitting owtte (1)	3	Looking for quality of answer – may involve calculation and workings on graph. e.g. comparing *f* = 5.57×10^{14} Hz at *V* = 2.60 V with appropriate datum from line Need to see the link between too high a value for V_s and problems in observation. Allow visibility difficulty, including colour blindness
		(ii)	% error in V_s for maximum value of 3.02 V is 6.6 % (this represents a minimum error) (1); and is still significantly more than the 0.5% tolerance on the LED (1)	2	A correct % calculation and comparison on other data points – maximum 1 mark.
			Total	**14**	

Question			Answer	Marks	Guidance
14	(a)	(i)	thicker/shorter/higher Young's Modulus	1	Do not accept 'stiffer' or denser but accept different material
		(ii)	to confirm that procedure works/to reveal any problems in experimentation/to improve the experiment (1); to give a rough answer to compare with expected value (1); to give an idea of the spread of results he might expect (1)	2	Any two points.
		(iii)	Mean = 5310 kg m^{-3} (1); range = 730 kg m^{-3} so spread = 365 kg m^{-3} (1); 5310 kg m^{-3} + 365 kg m^{-3} > 5480 kg m^{-3} (1)	3	Accept % calculations for second mark. Third mark can only be awarded if 3% is compared to spread (%range)
	(b)		sealed room viewed from outside (1); to avoid draughts or any other disturbance (which would cause the masses on the rod to swing) (1) Use of telescope (1) to not introduce additional gravitational forces (1) temperature (1); convection currents act as draughts or expansion moves the masses out of place (1) magnetic forces (1) may introduce forces between masses (not due to gravity) (1)	4	factor (1) and justification (1) × 2 QWC requires two factors each with some justification
	(c)	(i)	Difference between minimum / maximum value and mean = (5850 - 5480 kg m^{-3}) = 370/375/380 kg m^{-3} (1); comparison with 5480 kg m^{-3}/14 = 391 kg m^{-3} (1)	2	Accept reverse argument. 375/5480=0.068< 1/14 (0.071) May have |extreme-mean| or half (max – min) Minimum = 5100 kg m^{-3}, maximum = 5850 kg m^{-3}
		(ii)	Difference between Cavendish's value and the modern value (± 40 kg m^{-3} or ± 0.7%) (1); Explicit comparison of this with the equivalent factor for Cavendish's stated uncertainty (±370/375/380 kg m^{-3} or ±1/14 or ± 7%) (1)	2	Modern value can be implied (in question stem) but Cavendish values must be quoted/ used. Can also use ± 391 kg m^{-3} Allow clear comparison between modern value and the range of values of Cavendish's data for both marks
			Total	**14**	

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