OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced Subsidiary GCE

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

Mark Scheme for January 2013

Oxford Cambridge and RSA Examinations

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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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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

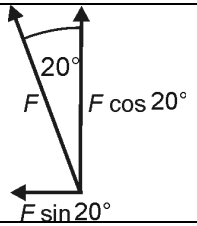
Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

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

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

Question			Answer	Marks	Guidance
1	(a)		kg m ^{2} s $^{-2}$	1	
	(b)		kg m s $^{-2}$	1	
2	(a)		**B**	1	
	(b)		**C**	1	
	(c)		**A**	1	
	(d)		**D**	1	
3	(a)		½ × 5 s × 10 m s $^{-1}$ + 3 s × 10 m s $^{-1}$ = 25 m + 30 m = 55 (m) (1)m (1)e	2	Method mark for a clear valid procedure, i.e. finding area under graph (even if not the first 8 s) Need to see 55 for the 2nd mark
	(b)		Use of tangent (1); Calculation of gradient value (1)	2	Any not drawing tangent touching curve at 9 s get 0 for (b) Expect values between 2.0 & 4.0 m s $^{-2}$ Ignore sign. minimum Δt of 1 s must be used for 2nd mark
	(c)		**B**	1	
4	(a)		0.6 (m)	1	
	(b)		3.0 (m s $^{-1}$)	1	ecf from (a)
5			decreasing *d* and increasing λ(1st box)	1	No extra ticks allowed.
6			2nd & 3rd boxes and no others	2	One mark each. If both correct plus one extra tick, 1 mark only. No other combinations of three or more ticks gain credit.
7	(a)		0.75 cm = 7.5 × 10 $^{-3}$ / 0.0075 (m)	1	Accept between 7 and 8 mm
	(b)		θ = arctan(0.0075/1.5) = 0.286° (1)m; (1)(e)	2	Allow ecf from (a) if answer to (a) is of right order of magnitude, i.e. > 1 mm and < 1 cm. If *x* is outside this range, allow 1 mark for correctly calculating from their value.
	(c)		λ = 0.1 × 10^{-3} m × sin(0.3°) = 5.2 × 10^{-7} m (1)m; (1)e	2	or via $x/L = \lambda/d$ = 5.0 × 10^{-7} m use of unrounded 0.286° gives 5.0 x 10^{-7}m ecf only if (b) has 2/2 No marks if *x* used instead of *d*. Do not give 2nd mark if answer expressed to > 3 s.f.
			Section A Total	**21**	

Question			Answer	Marks	Guidance
8	(a)	(i)	$s=\frac{1}{2}gt^2 \Rightarrow t=\sqrt{(2s/g)} = \sqrt{(100\text{ m}/9.8\text{ m s}^{-2})} = 3.2$ s (1)m; (1)e	2	Ora from t = 3 s: use of $s=\frac{1}{2}gt^2$ with correct substitution (1)m, answer = 44 m (1)e
		(ii)	Package is moving horizontally (with v of plane) (1); horizontal component is constant / no horizontal force/acceleration (1); horizontal component is unaffected by gravity / horizontal and vertical components are independent (1)	2	Any two points
		(iii)	d = 120 m s^{-1} × 3.2 s = 384 m	1	or 120 m s^{-1} × 3 s = 360 m. ecf using t from (a)(i) use of unrounded answer from (i) gives 383 m
	(b)		*Suggested fragile supply:* medicines/electronic goods/water containers/weapons (1); *Consequence of dropping fragile goods from greater height:* longer time in air (1); greater drift (1); wind will affect motion of package (1); wind will vary with time/height (1); reduce drift by dropping from as close to 200 m as possible (1); recognition of air resistance (1)	1 3	Any sensible specified fragile supply; NOT food, people or animals Any three consequences of flying higher. Further development of any point may warrant a second mark, as in last two examples given. QWC requires at least two factors to be considered.
			Total	**9**	
9	(a)	(i)	Work done on each push = 5000 N × 3 m (1); = 15 000 J four pushes per cycle ⇒ work done = 4 × 15 000 J = 60 000 J(1)	2	
		(ii)	f = 4 m s^{-1} / 10 m = 0.4 Hz (1); $t = 1/f$ = 1/0.4 Hz = 2.5 s (1)	2	Or via $T = \lambda/v$ or via $t = d/v$ where $d = \lambda$(1)m; (1)e
		(iii)	$P = E/t$ = 60 000 J/2.5 s = 24 000 W (1) m; (1) e	2	ecf from (i) and/or (ii)
	(b)		Number of units needed = 1 GW/50 kW = 20 000 (1); length of coastline needed = 20 000 × 5 m = 100 km (1) 50 kW is a maximum so mean power output will be lower due to typical waves being smaller /different locations (1); Discussion of capital cost of units/ connection to grid (1); Discussion of environmental issues (1);	4	Any four points. Ecf own number of units needed. QWC requires a relevant calculation.
			Total	**10**	

Question			Answer	Marks	Guidance
10	(a)	(i)	d = 1 × 10^{-3} m/650 = 1.54 ×10^{-6} m (1)m; (1)e	2	Evaluation mark needs evidence of actual calculation
		(ii)	λ = 1.54 ×10^{-6} m × sin(18.4°) = 4.86 ×10^{-7} m (1)m; (1)e	2	1.5 ×10^{-6} m gives 4.73 ×10^{-7} m
	(b)	(i)	$f = E/h$ =16.3 ×10^{-19} J/6.63 × 10^{-34} J s = 2.46 × 10^{15} Hz (1)m; (1)e	2	Evaluation mark needs evidence of actual calculation
		(ii)	$f = c/\lambda$ = 3.00 × 10^{8} m s^{-1}/400×10^{-9} m = 7.50 × 10^{14} Hz (1); $E = hf$ = 6.63 × 10^{-34} J s × 7.50 × 10^{14} Hz = 4.97 × 10^{-19} J (1)	2	If 400 nm not chosen, no marks for (b)(ii) or scale from (700/400) × 2.84 × 10^{-19} J (1)m; (1)e or recall of $E = \underline{h}/\lambda$ (1); = 4.97 × 10^{-19} J (1)
		(iii)	1 between either of the top two levels and the 2nd level (1); 2 between the top two levels (1) OR New levels, identified and labelled with energies, giving appropriate transitions to 0 get (1) each	2	Labelling should be unambiguous if V & IR not used. Accept extra labelled levels implying transition to 0.
			Total	**10**	
11	(a)		9500 kg × 9.8 m s^{-2} = 93 000 N	1	
	(b)	(i)		3	correct diagram (1); horizontal component labelled Fsin(20°) /Fcos(70°) (1); vertical component labelled Fsin(70°) /Fcos(20°) (1) if diagram is incorrect but components are consistent with the diagram, then both components together get (1)
		(ii)	F cos(20°) = mg ⇒ F = 93 000 N/0.94 = 99 000 N(1)m; (1)e	2	Ecf from (a) and (b)(i) F = 90 000 N gives 95800 N
		(iii)	F sin(20°) = 99 000 N × 0.34 = 33 660 N = 34 000 N (1); a=F/m = 34 000 N/ 9500 kg = 3.6 m s^{-2} (1)	2	ecf above Using unrounded force from above gives 3.5 m s^{-2}
	(c)		magnitude = √{(9 m s^{-1})^2 + (24 m s^{-1})^2} = 25.6 m s^{-1} (1); direction = N arctan(9 m s^{-1}/24 m s^{-1}) E = N 20.6 ° E (1)m; (1)e	3	Or bearing = 20.6 ° or any correct, clearly labelled angle
			Total	**11**	

Question			Answer	Marks	Guidance
12	(a)	(i)	(0.5×10^{-3} m/5 m) x100% = 0.01% (1)m; (1)e	2	Allow also 0.5 mm at each end ⇒ 0.02 %
		(ii)	same uncertainty divided by shorter length results in increased percentage uncertainty (1)	1	repeat calculation (0.5×10^{-3} m/2×10^{-3} m) x100% = 25% gains the mark (or, using two end errors, 50 %)
	(b)	(i)	20.8 mm /8 = 2.6 mm (1) 3.2 mm → 2.0 mm = (range of) 1.2 mm (1) spread = 0.6 mm (1)	3	(bald answer of 0.6mm gains 2 marks)
		(ii)	Applies test of 1.8 being within twice the value of the spread from the mean (using their values from b(i)) (1) ; conclusion consistent with (correct) test (1).	2	
	(c)	(i)	0.01 mm	1	Allow 0.005 mm
		(ii)	Wire diameter may vary across its length (1); Repeated values are taken and an average taken (1)	2	First mark is physical variation; Second mark is statistical improvement
		(iii)	0.61 (mm)	1	allow 0.611 (mm) as average of several readings reduces uncertainly.
	(d)		suggestion of change, both variable and direction (1); justification for change (1); some effect on another variable (1)	3	• thinner wire (1) extension ↑ so much reduced %uncertainty in extension (1) other variables constant but must ensure strain <1% (1) • thicker wire (1) reduced % uncertainty in *d*/*A* (1) but need to increase *F* to produce similar extension (or greater extension but strain <1%) (1) • greater tension (1) extension ↑ so much reduced %uncertainty in extension (1) other variables constant but must ensure strain <1% (1) • longer wire (1) extension ↑ so much reduced %uncertainty in extension (1) keep *F* & *A* constant (1) **but** longer wire, so reduced %uncertainty in length gets the first mark only as justification is incorrect **reject** 'greater extension' without statement of how it is to be obtained. Reject answers which suggest more accurate equipment
			Total	**15**	

Question			Answer	Marks	Guidance
13	(a)		Understanding that the turbines have different design briefs for different conditions Sensible suggestions such as Different heights/size of blade/angle of tilt/	2	Identifying factor (1); explaining reason for difference (1) or two factors stated for (1) each
	(b)	(i)	B – because it has the highest power output at this range of wind speeds (1)	1	
		(ii)	A – because it has the highest output at 10 m s^{-1} (1); assumption is that the trend is still rising (1)	2	credit answers of B on grounds that advantage of A on windy days is outweighed by poorer performance on other days
	(c)	(i)	table values 729 and 1000 (1) both points plotted correctly (within ½ a square) (1) correct line of best fit drawn (1)	3	credit curve or straight line through origin treating points before turbine starts turning as anomalous
		(ii)	Conclusion consistent with line drawn linear relationship/directly proportional (1) identification of the points below 100 m^3 s^{-3} which do not fit the line/relationship(1);	2	Must be clearly $P \propto v^3$, not $P \propto v$
	(d)		Proposed test to find k (1) Carried out on all 3 data pairs (1) Valid conclusion consistent with test (1)	3	eg constant ratio P/A, or $P \propto d^2 \Rightarrow$ doubling d quadruples P
			Total	**13**	

Question			Answer	Marks	Guidance
14	(a)	(i)	$2\pi r$ = 40087 km (1) /360 = 111.4 (km) (1)	2	Accept sin or tan 1^o = x/R approach
		(ii)	0.25 of $1^o \Rightarrow$ 0.25 x 111.4 km = 28 (km)	1	or 0.25 x 100 km = 25 (km) Accept bald answers without working
	(b)	(i)	360^o /24 h = 15^o h^{-1}	1	ora (15°/360°) x 24h = 1h
		(ii)	16:56 -12:00 =4 h 56 min = 4.93 h (1); 4.93 h × 15^o h^{-1} = 74^o (1)	2	No ecf own wrong time Using 4.56 h gives 68.4^o and gets no marks
		(iii)	1^o of longitude corresponds to smaller and smaller distances as you move from the Equator (1); Use of (a)(i) only applies to two places on the equator (1)	2	Accept answers that recognise the difference in latitude between Greenwich and NY for 1 mark.
	(c)	(i)	Rolling/yawing/pitching will interfere with correct movement of pendulum	1	
		(ii)	In case one failed (1); others will confirm which is faulty (1); could happen more than once on a long journey (1); to compare performance of different chronometers (1)	2	Reject ideas about 'taking an average' or 'making more reliable'. Any two points
			Total	**11**	

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