OCR
RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced Subsidiary GCE

Unit **G481:** Mechanics

Mark Scheme for January 2012

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.

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Annotations available in scoris

Annotation	Meaning
	correct response
	incorrect response
	benefit of the doubt (where professional judgement has been used)
	benefit of the doubt **not** given
	error carried forward
	information omitted
	contradiction (in cases where candidates contradict themselves in the same response)
	follow through
	error in number of significant figures
	error in the power of 10 in calculation
	arithmetic or calculation error
	not answered question
	wrong physics
	reading error

Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
allow	=	answers that can be accepted
not	=	answers which are not worthy of credit
reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant
( )	=	words which are not essential to gain credit
__	=	underlined word (or the equivalent) must be present in answer to score a mark
ecf	=	error carried forward
AW	=	alternative wording
ora	=	or reverse argument

CATEGORISATION OF MARKS

The marking schemes categorise marks on the MACB scheme.

B marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.

M marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.

C marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.

A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

If the data given in a question is to 2 sf, then allow answers to 2 or more significant figures.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Additional Guidance.
(Significant figures are rigorously assessed in the practical skills.)

Question			Answers	Marks	Guidance
1	(a)		acceleration = rate of <u>change</u> of <u>velocity</u>	B1	**Allow**: $a = \frac{v-u}{t}$ where *v* = final velocity, *u* = initial velocity and *t* = time **Allow**: 'acceleration = change in <u>velocity</u> over time' **Not**: 'acceleration = rate of change of <u>speed</u>' **Not**: mixture of quantity and unit, e.g. 'change of velocity per second'
	(b)	(i)	$a = \frac{v-u}{t}$ (Any subject) $a = \frac{0-6.0}{2400}$ *a* = (-) 2.5 × 10^{-3} (m s^{-2})	C1 C1 A1	**Allow**: $a = 6.0/2400$ Ignore sign
		(ii)	distance = <u>av speed</u> × time or $v^2 = u^2 + 2as$ distance = 3.0 × 2400 or $0 = 6.0^2 - (2 \times 2.5 \times 10^{-3} \times s)$ distance = 7200 (m)	C1 A1	Possible ecf. from **(b)(i)** **Allow**: $v^2 = u^2 + 2as$ with *v* = 6.0, *u* = 0 and *a* = 0.0025 **Allow**: Full credit for correct use of $s = ut + ½ at^2$ **Note**: Bald 7200 (m) scores 2 marks **Allow**: 1 mark for '*s* = (6 × 2400) + ½ × 0.0025 × 2400^2 = 21600 (m)'
		(iii)	Correct shape of curve of <u>decreasing</u> gradient starting from 0,0 Graph passes through 40, 7.2	M1 A1	Possible e.c.f. from **(b)(ii)** **Allow** the A1 mark if *x* is between 5-10 km at 40 min
	(c)	(i)	It has (constant) acceleration / It accelerates (down the ramp)	B1	**Allow**: Its velocity / speed increases
		(ii)	The time taken by ball to travel between (successive) bells is the same / 'same as first trolley' / 'there is no change' (AW) Acceleration is independent of mass / acceleration is the same (for the heavier trolley) (AW)	B1 B1	
			Total	**11**	

Question			Answers	Marks	Guidance
2	(a)		total energy of a (closed) system remains constant or Energy cannot be created or destroyed (it can only be transferred into other forms) or total initial energy = total final energy	B1	**Not**: 'Energy cannot be created / destroyed / lost'
	(b)		work done = force × distance moved in the direction of the force Unit: N m or J	M1 A1 B1	**Allow**: 'force × displacement' for the M1 mark **Note**: The unit mark is an independent mark
	(c)	(i)	kinetic energy → heat	B1	**Not**: friction / deformation / sound / KE of dust / KE of Earth
		(ii)	($E = \frac{1}{2}mv^2$) $8.4 \times 10^{16} = \frac{1}{2} \times 3.0 \times 10^8 \times v^2$ $v^2 = \frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}$ or $v = \sqrt{\frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}}$ ($v = 2.37 \times 10^4$ m s^{-1})	C1 C1 A0	**Note**: This mark is for correct substitution **Allow**: 2 marks for $v^2 = 5.6 \times 10^8$ **Allow**: 1 mark for a bald answer of 2.4×10^4
		(iii)	$8.4 \times 10^{16} = F \times 200$ $F = \frac{8.4 \times 10^{16}}{200}$ force = 4.2×10^{14} (N)	C1 C1 A1	Possible ecf **Allow**: $a = (-)\frac{u^2}{2s}$ $a = (-)\frac{(2.37 \times 10^4)^2}{2 \times 200}$ or $a = (-)\frac{(2 \times 10^4)^2}{2 \times 200}$ C1 $a = 1.4 \times 10^6$ (m s^{-2}) or $a = 1.0 \times 10^6$ (m s^{-2}) C1 $F = 3.0 \times 10^8 \times 1.4 \times 10^6$ or $F = 3.0 \times 10^8 \times 1.0 \times 10^6$ force = 4.2×10^{14} (N) or force = 3.0×10^{14} (N) A1
			Total	**10**	

Question			Answers	Marks	Guidance
3	(a)		A straight line through the origin	B1	**Ignore** graph after 0.5 s.
	(b)		The speed (of the car) is constant	B1	**Note**: This can only be scored if **(a)** is correct
	(c)		The distance travelled by the car after the brakes are applied until the car stops	B1	**Note**: Must have reference to car 'stopping' to score the mark
	(d)				**Must use tick or cross on Scoris to show if the mark is awarded**
			Mass (of car) ($\frac{1}{2}$ $mv^2 = Fx$, hence braking) distance $\propto$ mass	M1 A1	**Allow**: weight (of car) **Not**: 'distance increases with mass' **Allow**: distance $\propto m$
			Speed / velocity (of car) ($\frac{1}{2}$ $mv^2 = Fx$, hence braking) distance $\propto$ speed^2	M1 A1	**Not**: 'distance increases with speed' **Allow**: distance $\propto v^2$
	(e)				**Must use tick or cross on Scoris to show if the mark is awarded**
			Increases time (of impact / to slow down) / increases the distance (travelled by the driver)	B1	
			Smaller deceleration / acceleration	B1	**Not**: 'slow down acceleration'
			Force is smaller because $F = ma$ and a is smaller or force is smaller because $F = E_k/x$ and x is bigger or force is smaller because $F = \frac{\Delta p}{\Delta t}$ and Δt is bigger	B1	**Allow**: $E_k = Fx$ and x is bigger **Not**: Prevent crashing into windscreen / steering wheel
			Total	**10**	

Question			Answers	Marks	Guidance
4	(a)		moment = force × perpendicular distance from point / pivot ✎**The term *perpendicular* to be included and spelled correctly to gain the B1 mark**	B1	**Must use tick or cross on Scoris to show if the mark is awarded**
	(b)		Net force = 0 Net moment / torque = 0	B1 B1	**Not**: 'All forces are equal' or 'forces are balanced' or 'total forces up = total forces down' **Allow**: 'sum of clockwise moments = sum of anticlockwise moments'
	(c)	(i)	The point where the weight (appears) to act	B1	**Not**: 'The point where gravity acts' or 'point where mass acts/is concentrated'
		(ii)	moment = (0.150 × 18) + (0.460 × 30) moment = 16.5 (N m)	C1 A1	**Allow**: 2 sf answer of 17 N
		(iii)	1 Same / equal to 16.5 (N m) / equal to clockwise moment 2 (perpendicular) distance between elbow and (the line of action of) *F* decreases or (the vertical force) $F\cos\theta$ is the same or $F\cos\theta$ = 412.5 or $F \propto \frac{1}{\cos\theta}$ Hence the force increases	B1 M1 A1	Possible ecf
			Total	**9**	

Question			Answers	Marks	Guidance
5	(a)		mass = $\frac{590}{9.8(1)}$ (= 60 kg)	B1	**Allow**: weight = 60 × 9.8(1) **Allow**: 60 × 9.8(1) = 588 (N) or 60 × 9.8(1) = 590 (N)
	(b)		net force = 60 × 0.50 (= 30 N) *R* = 590 + 30 *R* = 620 (N)	 C1 A1	 **Allow**: 1 mark for '590 – 30 = 560 (N)'
	(c)		resultant force = 0 / '*a* = 0 and *F* = *ma* = 0'	B1	**Not**: Acceleration = 0 or 'forces are balanced'
	(d)		weight > *R* (for deceleration) / *R* = 590 – 60*a* / *R* = *mg* -*ma* Hence *R* decreases	M1 A1	**Allow**: *W* or *mg* for 'weight'
			Total	**6**	

Question			Answers	Marks	Guidance
6	(a)		The extension ∝ (applied) force (on spring) (as long as the elastic limit is not exceeded)	B1	
	(b)	(i)	Gradient / slope (of line / graph) / force divided by extension ✍ **The term *gradient /slope / divided* to be included and spelled correctly to gain the B1 mark**	B1	**Must use tick or cross on Scoris to show if the mark is awarded**
		(ii)	Area (under the graph / line)	B1	**Allow**: ½ × force × extension **Allow**: ½ × force constant × extension^2 if **(b)(i)** is correct
	(c)		The extension (for the combination) is doubled Force (for each spring) is the same / constant (force constant = force/extension, hence it is halved)	B1 B1	**Allow**: 1 mark for '*F* is the same, *x* is doubled' **Allow**: 2 marks for 'the springs need half the force to give the same (total) extension'
	(d)	(i)	Young modulus = stress/strain As long as the elastic limit is not exceeded / in the linear region of stress against strain graph / Hooke's law is obeyed	M1 A1	
		(ii) 1	stress = $\frac{4.2}{0.20\times10^{-6}}$ stress = 2.1×10^7 (Pa)	C1 A1	**Allow**: 1 mark for 2.1×10^n, $n \neq 7$
		(ii) 2	Young modulus = $\frac{2.1\times10^7}{0.015}$ Young modulus = 1.4×10^9 (Pa)	C1 A1	Possible ecf from **(ii)1**
		(ii) 3	energy = $\frac{1}{2}Fx$ $x = 0.70 \times 0.015$ / $x = 0.0105$ (m) energy = $\frac{1}{2}\times4.2\times(0.70\times0.015)$ energy = 2.2×10^{-2} (J)	C1 C1 A1	
			Total	**14**	

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