OCR
RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced Subsidiary GCE

Unit **G481:** Mechanics

Mark Scheme for January 2011

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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.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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1. 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 words must be present in answer to score a mark
ecf	=	error carried forward
AW	=	alternative wording
ora	=	or reverse argument

2. Annotations: the following annotations are available on SCORIS.

✓	=	correct response
✗	=	incorrect response
AE	=	arithmetic error
BOD	=	benefit of the doubt (where professional judgement has been used)
NBOD	=	benefit of the doubt **not** given
ECF	=	error carried forward
^	=	information omitted
CON	=	contradiction (in cases where candidates contradict themselves in the same response)
RE	=	rounding error
SF	=	error in the number of significant figures
POT	=	error in the power of 10 in a calculation
?	=	wrong physics or equation
NAQ	=	not answered question
FT	=	follow through

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.

Q 1	Expected Answers	Marks	Additional Guidance
a	work done $\rightarrow$ N m stress $\rightarrow$ N m^{-2} density $\rightarrow$ kg m^{-3}	B2	**Allow** 2 marks if all correct **Allow** 1 mark if one or two responses are correct
b(i)	weight / gravitational force	B1	**Not** 'gravity'
b(ii)	(force =) 4.8×9.81 (= 47.1 N) pressure = $\frac{4.8 \times 9.81}{0.085 \times 0.085}$ pressure = 6.52×10^3 (Pa)	C1 A1	**Note:** 2 marks for bald 2 sf answer of 6.5×10^3 (Pa) **Allow** 1 mark for '$48/0.085^2 = 6.64 \times 10^3$'; *g* taken as 10 (N kg^{-1}) **Allow** 1 mark for '$4.8 \times 9.81/8.5^2 = 0.65$' **Not '**mass/area' since it is 'wrong physics'.
b(iii)	8 4 2	B1 B1 B1	 This must be consistent with the values for mass and cross-sectional area.
	Total	**8**	

Q2	Expected Answers	Marks	Additional Guidance
a	The <u>distance</u> travelled (by the car) from when the driver sees a problem and the brakes are applied	B1	**Note**: There must be reference to 'stimulus' and brakes. **Not**: 'speed × reaction time'
b	Distance / displacement	B1	
c(i)	distance = 20 × 0.5 distance = 10 (m)	B1	
c(ii)	distance = area under graph distance = ½ × 20 × 3.5 distance = 35 (m)	 C1 A1	 **Allow** 1 mark if stopping distance of 45 m quoted No marks for an answer of '20 × 3.5 = 70 (m)'
d(i)	gradient = 'acceleration' / $a = \frac{v-u}{t}$ / $a = \frac{\Delta v}{\Delta t}$ $a = (-)\frac{20}{3.5}$ deceleration = 5.71(4) ≈ 5.7 (m s^2)	C1 A1	The first mark is for selecting correct equation or stating a = gradient **Note**: Ignore negative sign
d(ii)	force = 910 × 5.71 force ≈ 5200 (N)	C1 A1	 Possible ecf from **(d)(i)**
e	Increases by a factor of 4 Braking distance ∝ speed^2 / '$Fx = ½ mv^2$' / speed doubles <u>and</u> time doubles	B1 B1	

Q2	Expected Answers	Marks	Additional Guidance
f			**Must use ticks on Scoris to show where the marks are awarded**
	Large deceleration / rapid decrease in speed (triggers the air bag)	B1	**Not** 'quick / sudden / rapid deceleration' **Not** 'large acceleration'
	Prevent collision with steering wheel / windscreen / dashboard	B1	
	Time (for stopping) is more / distance (for stopping) is more	B1	
	Smaller deceleration / acceleration (of person)	B1	**Allow**: 'smaller rate of change of momentum' **Not** 'smaller <u>rate</u> of deceleration'
	Total	**15**	

Q3	Expected Answers	Marks	Additional Guidance
a	work (done) = force × distance moved in the direction of force	B1	**Allow**: work = force × displacement in direction of force **Not**: work (done) = energy transfer
b(i)	(Net /total /resultant force is) zero The acceleration is zero	B1 B1	 **Not** 'a = 0'
b(ii)	$9.0 \times 10^3 \cos 83°$ or $9.0 \times 10^3 \sin 7°$ 1.1×10^3 (N)	C1 A1	 **Not** '$9.0 \times 10^3 \cos 7°$'
b(iii)	work done per second = 300 × 18 work done per second = 5400 ($J\ s^{-1}$)	 B1	
b(iv)	(total force down slope =) 1100 + 300 (N) (power =) 1400 × 18 (power =) 2.52×10^4 (W) or 2.5×10^4 (W) or rate of work done against weight = $1.1 \times 10^3 \times 18$ (= 19800 W) power = 19800+ 5400 power = 2.52×10^4 (W) or 2.5×10^4 (W)	C1 C1 A1 C1 C1 A1	**Allow**: 1400 (N) Possible ecf from **(b)(ii)** **Allow**: '$Fx\cos\theta = 9.0 \times 10^3 \times 18 \times \cos 83°$' Possible ecf from **(b)(ii)** and **(b)(iii)**
	Total	**9**	

Q4	Expected Answers	Marks	Additional Guidance
a	kinetic energy = ½ × mass × speed^2	B1	**Allow** KE = ½ mv^2, where m = mass and v = speed **Allow** velocity instead of speed **Not**: KE = ½ mv^2 on its own
b(i)	initial KE = ½ × 3.0 × 10^{-2} × 200^2 (= 600 J) final KE = ½ × 3.0 × 10^{-2} × 50^2 (= 37.5 J) Loss in KE = 600 – 37.5 Loss in KE = 562.5 (J) ≈ 560 (J)	C1 C1 A1	 **Special case**: 1 mark for 'KE = ½ $m\underline{v}^2$ ... loss in KE = (½ × 3.0 × 10^{-2} × 200 - ½ × 3.0 × 10^{-2} × 50 =) 2.25 (J)' **Note:** No marks for 337.5 (J) when Δv used in the KE equation (½ × 3.0 × 10^{-2} × 150^2 = 337.5 J)
b(ii)	work done = (loss in) KE / $a = (v^2 - u^2)/2s$ F × 1.5 × 10^{-2} = 562.5 / a = (-) 1.25 × 10^6 force = 3.75 × 10^4 (N)	 C1 A1	 Possible ecf from **(b)(i)** **Allow**: A 2 sf answer of either 3.8 × 10^4 (N) or 3.7 × 10^4 (N)
	Total	**6**	

Q5	Expected Answers	Marks	Additional Guidance
a	…incorrect Mass (of the particle) increases (as it approaches speed of light)	M1 A1	**In question 5, use tick or cross on Scoris to show if the mark is awarded** **Not**: mass *changes*
b	….correct KE is changed into (G)PE or (G)PE is changed into KE or change in KE = change in (G)PE (AW)	M1 A1	 **Note**: This mark is for stating the transfer of energy between kinetic and (gravitational) potential
c	…incorrect Weight is equal to drag / air resistance / friction (and not acceleration of free fall)	M1 A1	Allow **alternative** response: ……. incorrect M1 Acceleration and weight are not the same quantities (AW) A1
d	…incorrect The technique is trilateration ✎ **The term *trilateration* to be included and spelled correctly to gain the A1 mark**	M1 A1	 **Note** 1 mark if ‘trilateration’ is misspelled but candidate has mentioned that the statement is incorrect
	Total	**8**	

Q6	Expected Answers	Marks	Additional Guidance
a	A pair of <u>equal</u> and <u>opposite</u> forces (with their lines of action separated by a distance) ✎ **The term *opposite* to be included and spelled correctly to gain mark**	B1	**Must use tick or cross on Scoris to show if the mark is awarded** No mark can be scored if there is no reference 'opposite'. (Allow 'opposing')
b(i)	moment = force × <u>perpendicular</u> distance from pivot / axis / point	B1	
b(ii)	(clockwise moment =) 20 × 0.60 <u>and</u> (anticlockwise moments =) 10 × 0.20 + 30 × 0.30 (Not in equilibrium because) clockwise moment ≠ anticlockwise moment / clockwise moment > anticlockwise moment / 12 (Nm) > 11 (Nm) / 12 (Nm) ≠ 11 (Nm)	M1 A1	**Allow** a correct moments equation involving all three forces
	Total	**4**	

Q7	Expected Answers	Marks	Additional Guidance
a(i)	**Y** (is brittle)	B1	
a(ii)	(Both) obey Hooke's law	B1	**Allow** (For both) stress ∝ strain / elastic (behaviour) / 'not plastic (behaviour)' / force ∝ extension **Not**: 'straight line(s)'
a(iii)	Gradient (of the linear section) is equal to Young Modulus / gradient is largest **X** (has largest Young modulus)	B1 B1	**Allow**: 'slope' for 'gradient'
b	(force increases by a factor of) 30^2 force = 240×30^2 force = 2.16×10^5 (N)	C1 A1	 **Allow**: 1 mark for value of breaking stress of $1.2(2) \times 10^9$ (Pa)
	Total	**6**	

Q8	Expected Answers	Marks	Additional Guidance
a	time = 1.2/8.0 time = 0.15 (s)	M1 A0	**Note**: The mark is for dividing the distance by the speed – hence must be seen
b	$s = ut + \frac{1}{2}at^2$ and $u = 0$ / $s = \frac{1}{2}at^2$ / $h = \frac{1}{2} \times 9.81 \times 0.15^2$ h = 0.11 (m)	C1 A1	
c	They both have same (vertical) acceleration / same acceleration of free fall / acceleration of 9.8 ms^{-2} (and zero initial vertical velocity)	B1	**Note**: Must have reference to both objects
	Total	**4**	

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