OCR
RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced Subsidiary GCE

Unit **G481:** Mechanics

Mark Scheme for June 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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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.

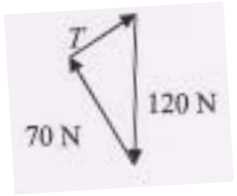
A marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

Significant figures are rigorously assessed in the practical skills.
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.

Question			Expected Answers	Marks	Additional Guidance
1	a	i	work (done) / (elastic potential) energy	B1	**Not:** heat / gravitational potential energy / kinetic energy
		ii	displacement / distance	B1	
	b		Any two from: • Torque (of a couple) • Moment (of a force) • Work (done) / energy	B1×2	**Not**: 'Couple' for 'torque' **Allow**: PE / KE
			Total	**4**	

Question			Expected Answers	Marks	Additional Guidance
2	a		density = mass/volume or 'density is mass per (unit) volume'	B1	**Allow**: $\rho = \frac{M}{V}$, where M = mass and V = volume **Not**: mass per m^3
	b	i	Dramatic change(s) in density (at 3.0 Mm and 5.1 Mm) (AW)	B1	**Not**: There are three (distinct) layers / Each layer has different density
		ii	mass = $0.18 \times 6.0 \times 10^{24}$ ($=1.08 \times 10^{24}$ kg) or radius = 1.3×10^6 (m) volume = $\frac{4}{3}\pi \times (1.3 \times 10^6)^3$ density = $\frac{1.08 \times 10^{24}}{9.20 \times 10^{18}}$ density = 1.2×10^5 (kg m^{-3})	C1 C1 A1	**Note**: The first C1 mark is for determining the mass or the radius of core Possible 10^n errors **Bald** answer of 1.2×10^5 (kg m^{-3}) or 1.17×10^5 (kg m^{-3}) scores 3 marks **Allow**: 2 marks for $\frac{6.0 \times 10^{24}}{9.20 \times 10^{18}} = 6.5 \times 10^5$ (factor of 0.18 missed out) **Note**: The last two C1 and A1 marks cannot be scored if incorrect radius is used. Hence no further marks for $\frac{1.08 \times 10^{24}}{\frac{4}{3}\pi \times (6.4 \times 10^6)^3}$ or $\frac{1.08 \times 10^{24}}{\frac{4}{3}\pi \times (5.1 \times 10^6)^3}$, etc
			Total	**5**	

Question			Expected Answers	Marks	Additional Guidance
3	a		A quantity with magnitude / size and direction Suitable example: displacement / velocity / acceleration / force / weight etc	B1 B1	
	b	i	$F_x = F\cos\theta$ $7.0 = F \times \cos 30$ F = 8.1 (N) or 8.08 (N)	C1 A1	**Allow**: 1 mark for 'radian' error; answer is 45.3 (N) **Note**: No marks for '7.0 × cos30 = 6.06 N'
		ii	**1** $W = 7.0 \times 5.0$ or $W = 8.08 \times 5.0 \times \underline{\cos 30}$ work done = 35 (J) **2** 'power' = 35/4.2 = 8.3 (W)	C1 A1 B1	Possible ecf **Note**: If answer for **(b)(i)** is 6.06 (N), then '6.06 × 5.0 × cos30 = 26.2 (J)' scores 2/2 because of ecf Possible ecf
	c	i	Magnitude is 120 (N) / equal to weight Direction is (vertically) up / opposite to weight	B1 B1	
		ii	Correct diagram Correct detail on diagram  $120^2 = 70^2 + T^2$ T = 97 (N) or 97.5 (N)	M1 A1 C1 A1	**Note**: For the M1 mark, the basic diagram must have all sides labelled (70, 120 and T) and the angle between 70 (N) and T is judged by eye to be 90° **Note**: For the A1 mark, all the arrows are marked and cyclic **Note**: For the C1 A1 marks, $T = \sqrt{120^2 + 70^2} = 140$ scores zero **Allow:** 2 marks for T in the range of 94 (N) to 100 (N) if scale drawing is done
			Total	**13**	

Question			Expected Answers	Marks	Additional Guidance
4	a		Any <u>two</u> from: • area • speed / velocity • viscosity (of air) / temperature / density • (surface) texture / 'aerodynamic' (shape)	B1×2	**Not**: shape / size **Allow**: 'streamlining'
	b	i	Correct <u>directions</u> of arrows *W* and *D*	B1	Award the mark for two arrows in opposite directions as long as <u>one</u> of them is labelled
		ii	weight = 75 × 9.81 weight = 736 (N) or 740 (N)	 B1	**Reminder**: weight can be quoted to more than 2 sf (e.g: 735.75) **Not**: '75 × 10 = 750 N'
		iii	$D = 0.30 \times 20^2$ (= 120 N) $736 - 120 = 75a$ $a = 8.2$ (m s^{-2})	C1 C1 A1	 **Allow**: Answer to 2sf or more **Bald** answer of 8.2 or 8.21 scores 3 marks **Note**: Using 740 (N) gives an answer 8.3 (m s^{-2})
		iv	(*D* and *W* are) equal	B1	**Not**: *D* and *W* are 'balanced/equilibrium'
		v	drag = weight $736 = 0.30 \times v^2$ v = 49.5 (m s^{-1}) or 50 (m s^{-1})	 C1 A1	 **Bald** answer of 49.5 (m s^{-1}) or 50 (m s^{-1}) scores 2 marks
			Total	**10**	

Question			Expected Answers	Marks	Additional Guidance
5	a		**Measurements**: height (of wall) time (of fall) **Instruments**: ruler / tape (measure) stopwatch / timer / clock /video $g = \frac{2s}{t^2}$ / g = 2 × gradient of s-t^2 graph **Note**: Allow full credit if candidate has used alternative approaches using $v^2 = u^2 + 2as$ or $v = u + at$. Any <u>two</u> from: g is an estimate because • air resistance / drag ignored • parallax problems with 'landing time' • starting / stopping the clock	 B1 B1 B1 B1 B1 B1×2	**Must use tick or cross on Scoris to show if the mark is awarded** **Allow:** 'distance (of fall)' instead of 'height' ✎ **The 4th B1 can only be scored if *stopwatch* / *timer* / *clock* / *video* (camera) is spelled correctly** **Allow:** Use of 'a' instead of 'g' **Note**: a must be the subject **Allow:** 'wind resistance'/'resistive force' for first bullet point **Allow**: 'reaction time' but **not** 'human error' for the third bullet point
	b	i	Radio (waves) / microwaves	B1	
		ii	Time taken for the signal to travel from satellite to car is determined / 'delay' time for signal is determined distance = c × (delay) time	M1 A1	 **Allow**: speed of light / 3.0×10^8 <u>m s^{-1}</u> instead of c **Note:** Distance must be the subject for the second B1 mark

Question			Expected Answers	Marks	Additional Guidance
		iii	Mention of circles / spheres / shells	B1	**Note**: This mark can be scored if a diagram shows circles / arcs (no label required)
			The position of the car is where the circles intersect / trilateration mentioned	B1	**Note**: This mark can be scored on a diagram if it shows intersecting circles / arcs and the intersection point is marked 'car'
			Total	**12**	

Question			Expected Answers	Marks	Additional Guidance
6	a		Energy can neither be created nor destroyed (but it can be transformed from one form to another) or Total energy of a closed system remains constant	B1	
	b	i	loss in PE = $0.10 \times 9.81 \times 0.60$ = 0.59 (J) or 0.589 (J)	 B1	
		ii	$v^2 = 2as$ / $v^2 = 2 \times 2.8 \times 0.60$ / $v^2 = 3.36$ $v = \sqrt{2 \times 2.8 \times 0.60}$ or $v = 1.8\underline{33}$ or $v = 1.8\underline{3}$ $v = 1.8$ (m s^{-1})	M1 M1 A0	
		iii	(KE =) $\frac{1}{2}mv^2$ / (KE =) $\frac{1}{2} \times 0.25 \times 1.8^2$ kinetic energy = 0.405 (J) or 0.41 (J)	C1 A1	Possible ecf from **(b)(ii)** **Note**: The answer is 0.42 (J) when 1.83 m s^{-1} is used **Allow:** 1 mark for 0.162 (J) if 0.10 kg mass is used or for 0.567 (J) if 0.35 kg is used
		iv	KE of 0.10 kg mass is not taken into account (AW)	B1	**Not:** 'There is friction'
			Total	**7**	

Question			Expected Answers	Marks	Additional Guidance
7	a	i	Extension is proportional to force (applied as long as the elastic limit is not exceeded)	B1	**Must use tick or cross on Scoris to show if the mark is awarded** ✎ This B1 can only be scored when '***extension'*** is spelled correctly **Note:** If '*change in length'* or 'Δ *length'* used instead of '*extension'*, then ***length*** must be spelled correctly **Allow:** stress $\propto$ strain as BOD (stress or stain must be spelled correctly)
		ii	$p \rightarrow 10^{-12}$ $n \rightarrow 10^{-9}$ $k = \frac{F}{x}$ / $k = \frac{210\times10^{-12}}{0.16\times10^{-9}}$ force constant = 1.3 (N m^{-1}) or 1.31 (N m^{-1})	C1 C1 A1	Possible ecf **Allow:** 1 mark for '210/0.16 =1312.5'
	b	i	E = gradient / E = stress/strain (linear section) $E = \frac{70\times10^{6}}{0.8\times10^{-3}}$ E = 8.8 × 10^{10} (Pa) or 8.75 × 10^{10} (Pa) unit: N m^{-2} or Pa	C1 A1 B1	**Allow**: An answer in the range (8.3 to 9.1) × 10^{10} (Pa) **Allow**: 1 mark for an answer 8.75 × 10^{n}, n ≠ 10 **Note**: This is an independent mark
		ii	breaking stress = 6.0 × 10^{7} (Pa) $A = \frac{19}{6.0\times10^{7}}$ (Any subject) A = 3.2 × 10^{-7} (m^2) or 3.17 × 10^{-7} (m^2)	 C1 A1	 **Allow:** 1 mark 3.17 × 10^{n} (m^2) , n ≠ -7 **Note:** No marks if breaking stress of $\underline{6.0}$ × 10^{n} is not used
			Total	**9**	

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