OCR
RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced Subsidiary GCE

Unit **G481/01:** Mechanics

Mark Scheme for June 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.

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1. **Annotations** available in Scoris

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

2. The following questions should be annotated with ticks to show where marks have been awarded in the body of the text:
One tick per mark. All questions must have appropriate annotation.

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 and rounding errors:

If the data given in a question is to 2 sf, then allow answers to 2 or more sf. 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 Guidance.

Penalise a rounding error once only in the entire paper.

Question			Answer	Marks	Guidance
1	(a)		N m^{-2} or N/m^2 or Pa m s^{-2} or m/s^2 or (kg) m s^{-2} 1000	B2	**Allow** any prefix given **Allow**: 2 marks if all three correct; 1 mark if one is correct or two are correct
	(b)		(volume =) 82 - 75 (cm^3) or 7 (cm^3) density = $\frac{1.6\times10^{-2}}{7\times10^{-6}}$ density = 2.3 $\times$ 10^3 (kg m^{-3})	C1 A1	 **Allow**: 1 mark for 2.3 $\times$ 10^n, n $\neq$ 3
			Total	**4**	

Question			Answer	Marks	Guidance
2	(a)		It has **direction** (and magnitude/size)	B1	**Note:** ✍ ***direction*** must be spelled correctly for the mark
	(b)	(i)	perpendicular component = 8.0 $\times$ 10^{-5} cos30 perpendicular component = 6.9 $\times$ 10^{-5} (N) parallel component = 8.0 $\times$ 10^{-5} sin30 parallel component = 4.0 $\times$ 10^{-5} (N) or 4 $\times$ 10^{-5} (N)	B1 B1	**Allow**: 1 mark if the correct numerical values of the components have been swapped **Note**: Penalise POT error once only; eg 6.9 and 4 respectively scores 1 mark **Note**: Calculator in radian mode gives 1.23 $\times$ 10^{-5} and (-) 7.90 $\times$ 10^{-5} (N); this scores 1 mark
		(ii)	(*F* =) 4.0 $\times$ 10^{-5} (N) The net force parallel to windscreen = 0 or *F* is equal to the parallel component (of the weight down the windscreen) or parallel forces must be equal and opposite or *F* = 8.0 $\times$ 10^{-5} sin30	B1 B1	Possible ecf from **(b)(i)** **Allow**: Total force down/up the windscreen/slope is zero **Not**: 'net force = 0' – this is an incomplete answer
			Total	**5**	

Question			Answer	Marks	Guidance
3	(a)		force/extension or force per (unit) extension	B1	**Allow**: force/compression **Not**: $F = kx$ and the labels are defined, because k is not the subject
	(b)	(i)	Arrow showing the force exerted by **A** is to the <u>left</u> on Fig.3.1	B1	**Allow** an unlabelled arrow
		(ii)	**1** (F_A =) 14 × 0.30 (= 4.2 N) or (F_B =) 14 × 0.50 (= 7.0 N) or (net force =) 2.8 (N)	C1	**Allow**: (net force =) 14 × [0.50 – 0.30] = 2.8 (N) **Allow**: acceleration of either 5.25 (m s^{-2}) or 8.75 (m s^{-2})
			a = 2.8/0.80	C1	**Allow** this C1 mark for a = 8.75 – 5.25
			acceleration = 3.5 (m s^{-2})	A1	**Note**: $a = \frac{7.0 + 4.2}{0.80} = 14$ (m s^{-2}) scores 1 mark **Note**: $a = \frac{14 \times 0.80}{0.80} = 14$ (m s^{-2}) scores zero
			2 $E = ½ Fx$ or $E = ½ kx^2$ or 1.75 (J) or 0.63 (J)	C1	**Note**: Using $E = Fx$ scores zero because of wrong physics
			ratio = $\left(\frac{0.50}{0.30}\right)^2 = 2.8$	A1	**Note**: Answer to 3 sf is 2.78 **Allow** fractions (Ignore any units given for the ratio)
		(iii)	The <u>resultant</u> force (on the trolley) is smaller (AW)	B1	
		(iv)	The acceleration decreases Correct reasoning, eg: For the same (net force) F, a = F/m (therefore a is smaller) For the same (net force) F, $a \propto 1/m$ (therefore a is smaller)	M1 A1	 **Allow**: $F = ma$. As m increases then a must decrease because F is constant
			Total	**10**	

Question			Answer	Marks	Guidance
4	(a)		$(s = \frac{1}{2}at^2)$; 0.700 = ½ × 9.81 × t^2	C1	**Allow**: a = 9.8 (m s^{-2})
			$t^2 = \frac{2 \times 0.700}{9.81} (= 0.1427)$	C1	
			t = 0.378 (s) or 0.38 (s)	A1	**Note**: Using a = 10 (m s^{-2}) gives 0.374 (s) or 0.37 (s); this scores 2 marks **Allow** full credit for correct use of $v^2 = 2as$ and $v = at$
	(b)	(i)	acceleration or deceleration displacement or distance	B1	
		(ii)	A tangent drawn on Fig. 4.2 at point **A**	B1	**Note**: This is an independent mark
			Determine the gradient of the tangent	M1	
			Deceleration value in the range 13.0 to 17.0 (m s^{-2})	A1	**Note**: Ignore sign **Special case**: Allow 1 mark for using a chord about t = 0.05 seconds to determine the deceleration and the value lies in the range 13.0 to 17.0 (m s^{-2})
		(iii)	At **A:** Drag > weight The ball is decelerating/'slowing down'	 B1 B1	 **Allow**: 'friction'/'resistive force' for drag **Allow**: upward/negative acceleration
			At **B**: Drag = weight The ball has zero acceleration/has reached terminal velocity/has reached constant velocity	 B1 B1	 **Note:** Allow full credit if *upthrust* and *drag* are both mentioned and applied correctly at points **A** and/or **B**
		(iv)	The (gravitational) potential energy/(G)PE (of the ball) is converted into heat/thermal (energy)	B1	
			Total	**12**	

Question			Answer	Marks	Guidance
5	(a)		A point where the (entire) weight of the object (appears to) act	B1	**Not**: 'where the weight of an object acts'
	(b)		moment of force = force × perpendicular distance (of line of force) from point/axis/pivot/fulcrum	B1	
	(c)	(i)	net force = 0 net moment = 0 or net torque = 0	B1 B1	**Allow**: (For this rod) upward force = (sum of the) forces down **Allow**: (For this rod sum of) clockwise moment(s) = (sum of) anticlockwise moment(s)
		(ii)	Evidence of $0.12x$ or $0.35(0.50 - x)$ $0.12x = 0.35(0.50 - x)$ $x = \frac{0.35 \times 0.50}{0.12 + 0.35}$ $x = 0.37$ (m)	C1 C1 A1	
		(iii)	force = 0.47 (N)	B1	
			Total	**8**	

Question			Answer	Marks	Guidance
6	(a)		(1 watt is equal to) 1 joule (of energy transferred) per second	B1	**Allow**: (1) J s^{-1} **Not**: '1 J (of energy transferred) in 1 s' because the per or rate idea is not clear **Note**: Do not allow mixture of quantity and unit. Eg: '1 J per unit time' or 'energy per second'
	(b)	(i)	$E_p = 700 \times 9.81 \times 8.5$ $E_p = 5.8(4) \times 10^4$ (J)	B1	
		(ii)	output power = $\frac{5.84 \times 10^4}{45}$ output power = 1.3×10^3 (W)	B1	Possible ecf from **(i)**
		(iii)	input power = $1.3 \times 10^3 / 0.3$ input power = 4.3×10^3 (W)	B1	Possible ecf from **(ii)**
			Total	**4**	

Question			Answer	Marks	Guidance
7	(a)	(i)	(work done =) Fx and $F = ma$ (Allow any subject)	B1	**Allow**: d or s instead of x
		(ii)			
			(E_k =) max or (work done =) max (Allow any subject)	B1	**Note**: This mark is for substituting 'ma' into the equation 'Fx'
			$v^2 = 2ax$	B1	
			Use of $v^2 = 2ax$ and $E_k = max$ to show KE = ½ mv^2	B1	**Note**: This B1 mark is for manipulation of equations leading to KE = ½ mv^2 **Allow** full credit for alternative approaches
	(b)		The (braking) distance is more (than 50m)	B1	
			KE = Fx	B1	Alternative: Fx = ½ mv^2 B1
			Correct reasoning for longer braking distance, eg: (KE increases and) $x \propto$ KE	B1	*Correct reasoning for longer braking distance, eg:* $x \propto m$ B1
			Or		
			The (braking) distance is more (than 50m)	B1	
			The van has smaller deceleration (for the same force)	B1	**Allow**: smaller acceleration
			Correct reasoning for longer braking distance in terms of $v^2 = u^2 + 2as$	B1	**Allow**: Correct reasoning for longer distance in terms of equations of motion
			Total	**7**	

Question			Answer	Marks	Guidance
8	(a)	(i)	Young modulus = gradient (in the linear region) $E = 1.5 \times 10^9/0.008$ $E = 1.9 \times 10^{11}$ (Pa)	C1 C1 A1	**Allow**: (E =) stress/strain for this C1 mark **Note**: Deduct 1 mark for incorrect value or omission of the prefix G. Also deduct another mark for incorrect conversion of 0.80% strain.
		(ii)	**1** Obeys Hooke's law/elastic (behaviour) (AW)	B1	**Allow**: stress $\propto$ strain
		(ii)	**2** Plastic (deformation) (AW)	B1	
		(iii)	No change (to the linear section)/gradient is the same because the Young modulus is the same (and independent of length)	M1 A1	
	(b)		Polymer or polymeric or rubber Any <u>one</u> from: • The material is elastic/there is no strain when the stress is removed/material returns to its original size or shape when forces are removed (AW) • The work done on the material > energy returned back by the material or area under loading graph > area under unloading graph (AW) The aeroplane/tyres do not bounce (too much on landing)	B1 B1 B1	✎ ***polymer/polymeric/rubber*** must be spelled correctly to gain the first B1 mark **Not**: 'Monomer' **Allow**: material/graph shows 'hysteresis' **Allow**: Material 'absorbs' energy/material gets hot (AW)
			Total	**10**	

Appendix – Additional Guidance

Question	Additional Guidance
1b	**Allow:** 1 mark for 2.3 g/cm^3 **Note**: The **volume** mark is for seeing '7' – ignore any POT (Do not allow 7^3)
2a	If only F=ma is used they need to state acceleration has direction **and** mass is a scalar/has no direction
2bii	**Allow**: $F = W\sin30$ or $F = mg\sin30$ for the last option No credit for 'forces are balanced' or 'forces are in equilibrium'
3bi	Ignore any arrows on Fig 3.2 If the arrow to the left on Fig 3.1 starts from the support/is to the left of the support this scores 0.
3bii1	**Allow** (net force =) $14 \times 0.2 = 2.8$ (N) for the first C1 mark
3biii	**Note** ' force on B decreases and force on A increases' is **not** sufficient to gain a mark **Allow**: net/total/sum of/overall/Σ
4a	The first C1 mark is for substitution, the second C1 mark is for rearrangement **Alternative**: $v^2 = 2as$ $v^2 = 2 \times 9.81 \times 0.70$ or $v = 3.7(06)$ m s^{-1}) C1 $t = 3.706/9.81$ C1 time = 0.378 (s) or 0.38 (s) A1
4bii	A mark is lost for a graph mis-read, so please check the co-ordinates (± 1 small square). This may lead to an ECF falling outside the range but do not penalise twice. A mark will also be lost for any AE in the calculation.
4biii	**Note**: Do not allow 'gravity' for weight. 'Force of gravity' is OK In 4biii2, allow constant speed for constant velocity
4biv	**Do not allow:** potential energy **to kinetic energy** to heat **Allow**: potential energy to kinetic energy **of oil**
5a	**Do not allow:** place, position, where, location
5ci	**Do not allow:** ΣF = 0 and ΣM = 0 **Allow**: ΣForces = 0 and ΣMoments = 0
6a	**Allow**: base units, kgm^{2}s^{-3} or other alternatives.
7aii	**Allow**: W for KE in the final stage of the derivation
7b	For the second answer route and the third B1 mark: **Allow**: correct reasoning for longer distance in terms of equations of motion: $a = \Delta v/\Delta t$ to explain more t and $s = ½(u + v)t$ to explain more s. **Allow**: explanation in terms of momentum including the equation. **IF THE CANDIDATE ANSWERS VIA BOTH ROUTES THEN AWARD THE HIGHER MARK.**
8aii1	**Allow**: force ∝ extension, elastic in words i.e. returns to original length when **unloaded**.
8aii2	**Allow:** inelastic, plastic in words i.e. does not return to original length when **unloaded** **Allow**: permanently deformed
8aiii	For the A1 mark allow the 'ratio of stress to strain is the same'
8b	**Allow**: Elastomer for the first B1 mark if spelled correctly. Watch for CONs, e.g 'the material is elastic and ductile' cannot score the second B1 mark. **QWC** - Allow the mark if one spelling word is incorrectly spelled and another is correctly spelled.

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