

**Physics A**

Advanced Subsidiary GCE

Unit **G481/01**: Mechanics

**Mark Scheme for June 2013**

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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.

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1. **Annotations** available in Scoris

<b>Annotation</b>	<b>Meaning</b>
	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)

<b>Annotation</b>	<b>Meaning</b>
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
<b>reject</b>	Answers which are not worthy of credit
<b>not</b>	Answers which are not worthy of credit
<b>IGNORE</b>	Statements which are irrelevant
<b>ALLOW</b>	Answers that can be accepted
( )	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
<b>ecf</b>	Error carried forward
<b>AW</b>	Alternative wording
<b>ORA</b>	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 <sup>-2</sup> or N/m <sup>2</sup> or Pa m s <sup>-2</sup> or m/s <sup>2</sup> or (kg) m s <sup>-2</sup> 1000	B2	<b>Allow</b> any prefix given  <b>Allow:</b> 2 marks if all three correct; 1 mark if one is correct or two are correct
	(b)	(volume =) 82 - 75 (cm <sup>3</sup> ) or 7 (cm <sup>3</sup> ) density = $\frac{1.6 \times 10^{-2}}{7 \times 10^{-6}}$ density = 2.3 × 10 <sup>3</sup> (kg m <sup>-3</sup> )	C1  A1	<b>Allow:</b> 1 mark for 2.3 × 10 <sup>n</sup> , n ≠ 3
<b>Total</b>			<b>4</b>	

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

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


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



Question		Answer	Marks	Guidance
5	(a)	A <u>point</u> where the (entire) <u>weight</u> of the object (appears to) act	B1	<b>Not:</b> 'where the weight of an object acts'
	(b)	moment of force = force $\times$ 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	<b>Allow:</b> (For this rod) upward force = (sum of the) forces down <b>Allow:</b> (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	
<b>Total</b>			<b>8</b>	

Question		Answer	Marks	Guidance
6	(a)	(1 watt is equal to) 1 joule (of energy transferred) <u>per</u> second	B1	<b>Allow:</b> (1) J s <sup>-1</sup> <b>Not:</b> '1 J (of energy transferred) <u>in</u> 1 s' because the <u>per</u> or <u>rate</u> idea is not clear <b>Note:</b> 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 = $1.3 \times 10^3$ (W)	B1	Possible ecf from (i)
	(iii)	input power = $1.3 \times 10^3 / 0.3$ input power = $4.3 \times 10^3$ (W)	B1	Possible ecf from (ii)
<b>Total</b>			<b>4</b>	

Question			Answer	Marks	Guidance
7	(a)	(i)	(work done =) $Fx$ and $F = ma$ (Allow any subject)	B1	<b>Allow:</b> $d$ or $s$ instead of $x$
		(ii)	$(E_k =) \text{max}$ or (work done =) $\text{max}$ (Allow any subject) $v^2 = 2ax$ Use of $v^2 = 2ax$ and $E_k = \text{max}$ to show $\text{KE} = \frac{1}{2}mv^2$	B1 B1 B1	<b>Note:</b> This mark is for substituting ' $ma$ ' into the equation ' $Fx$ '  <b>Note:</b> This B1 mark is for manipulation of equations leading to $\text{KE} = \frac{1}{2}mv^2$  <b>Allow</b> full credit for alternative approaches
	(b)		The (braking) distance is more (than 50m) $\text{KE} = Fx$ Correct reasoning for longer braking distance, eg: (KE increases and) $x \propto \text{KE}$ Or The (braking) distance is more (than 50m) The van has smaller deceleration (for the same force) Correct reasoning for longer braking distance in terms of $v^2 = u^2 + 2as$	B1 B1 B1 B1 B1 B1	Alternative: $Fx = \frac{1}{2}mv^2$ B1 Correct reasoning for longer braking distance, eg: $x \propto m$ B1  <b>Allow:</b> smaller acceleration  <b>Allow:</b> Correct reasoning for longer distance in terms of equations of motion
<b>Total</b>				<b>7</b>	

Question		Answer	Marks	Guidance	
8	(a)	(i)	Young modulus = gradient (in the linear region)	C1	<b>Allow:</b> ( $E =$ ) stress/strain for this C1 mark  <b>Note:</b> Deduct 1 mark for incorrect value or omission of the prefix G. Also deduct another mark for incorrect conversion of 0.80% strain.
			$E = 1.5 \times 10^9 / 0.008$	C1	
			$E = 1.9 \times 10^{11}$ (Pa)	A1	
		(ii)	1 Obeys Hooke's law/elastic (behaviour) (AW)	B1	<b>Allow:</b> 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	B1	 <b>polymer/polymeric/rubber</b> must be spelled correctly to gain the first B1 mark <b>Not:</b> 'Monomer'
		Any <u>one</u> from:	B1	<b>Allow:</b> material/graph shows 'hysteresis'	
		<ul style="list-style-type: none"> <li>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)</li> <li>The work done on the material &gt; energy returned back by the material or area under loading graph &gt; area under unloading graph (AW)</li> </ul>			
			The aeroplane/tyres do not bounce (too much on landing)	B1	<b>Allow:</b> Material 'absorbs' energy/material gets hot (AW)
			<b>Total</b>	<b>10</b>	

## Appendix – Additional Guidance

Question	Additional Guidance
1b	<b>Allow:</b> 1 mark for $2.3 \text{ g/cm}^3$ <b>Note:</b> The <b>volume</b> 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 <b>and</b> mass is a scalar/has no direction
2bii	<b>Allow:</b> $F = W\sin 30$ or $F = mg\sin 30$ 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	<b>Allow</b> (net force =) $14 \times 0.2 = 2.8 \text{ (N)}$ for the first C1 mark
3biii	<b>Note</b> 'force on B decreases and force on A increases' is <b>not</b> sufficient to gain a mark <b>Allow:</b> net/total/sum of/overall/ $\Sigma$
4a	The first C1 mark is for substitution, the second C1 mark is for rearrangement  <b>Alternative:</b> $v^2 = 2as$ $v^2 = 2 \times 9.81 \times 0.70$ or $v = 3.7(06 \text{ m s}^{-1})$ 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 ( $\pm 1$ 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	<b>Note:</b> Do not allow 'gravity' for weight. 'Force of gravity' is OK In 4biii2, allow constant speed for constant velocity
4biv	<b>Do not allow:</b> potential energy to kinetic energy to heat <b>Allow:</b> potential energy to kinetic energy of oil
5a	<b>Do not allow:</b> place, position, where, location
5ci	<b>Do not allow:</b> $\Sigma F = 0$ and $\Sigma M = 0$ <b>Allow:</b> $\Sigma \text{Forces} = 0$ and $\Sigma \text{Moments} = 0$
6a	<b>Allow:</b> base units, $\text{kgm}^2\text{s}^{-3}$ or other alternatives.
7aii	<b>Allow:</b> W for KE in the final stage of the derivation
7b	For the second answer route and the third B1 mark: <b>Allow:</b> correct reasoning for longer distance in terms of equations of motion: $a = \Delta v/\Delta t$ to explain more t and $s = \frac{1}{2}(u + v)t$ to explain more s. <b>Allow:</b> explanation in terms of momentum including the equation.  <b>IF THE CANDIDATE ANSWERS VIA BOTH ROUTES THEN AWARD THE HIGHER MARK.</b>
8aii1	<b>Allow:</b> force $\propto$ extension, elastic in words i.e. returns to original length when <b>unloaded</b> .
8aii2	<b>Allow:</b> inelastic, plastic in words i.e. does not return to original length when <b>unloaded</b> <b>Allow:</b> permanently deformed
8aiii	For the A1 mark allow the 'ratio of stress to strain is the same'
8b	<b>Allow:</b> 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.  <b>QWC</b> - Allow the mark if one spelling word is incorrectly spelled and another is correctly spelled.

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