



**GCE**

**Physics A**

Unit **G481/01**: Mechanics

Advanced Subsidiary GCE

**Mark Scheme for June 2015**

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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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## Annotations

Annotation	Meaning
	Blank Page – this annotation <b>must</b> be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
	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 or reading/transcription error <span style="float: right;"><i>(dual purpose)</i></span>
	Error in number of significant figures
	Correct response
	Arithmetic error
	Wrong physics or equation

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Abbreviations used in detailed mark scheme

<b>Abbreviation</b>	<b>Meaning</b>
/	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
<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

**Subject-specific Marking Instructions***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.

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Question		Answer	Marks	Guidance
1	a	velocity against time	B1	<b>Not</b> 'speed' for velocity <b>Not</b> time against velocity Ignore units
	b	stress against strain	B1	Ignore units
	c	force / load / tension against length (of wire)	B1	<b>Not</b> force against <u>extension</u> <b>Not</b> 'weight' for force <b>Not</b> 'distance' for length Ignore units
		<b>Total</b>	<b>3</b>	

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Question		Answer	Marks	Guidance
2	a	pressure and stress or pressure and Young modulus or stress and Young modulus or moment (of a force) and torque (of a couple)	B1	<b>Allow</b> other correct combinations <b>Allow</b> the following: <ul style="list-style-type: none"> <li>e.m.f. and p.d.</li> <li>Any two from frequency, activity, decay constant and Hubble constant because of the <math>s^{-1}</math></li> </ul> <b>Ignore</b> any units given (even if incorrect)  <b>Special case:</b> Allow quantities with no units, e.g. strain and efficiency. <b>Not</b> any combination of length, distance and extension
	b	i	x-component = 6.0 (N) and y-component = 2.0 (N)	B1 <b>Allow</b> 1 sf answers <b>Allow</b> tolerance $\pm 0.1$ N <b>Not</b> x-component = 2.0 (N) and y-component = 6.0 (N)
		ii	resultant components are 8.0 (N) and 5.0 (N)  $F^2 = 8.0^2 + 5.0^2$ force = 9.4 (N)	C1  C1 A1 <b>Allow:</b> 1 sf values for this C1 mark Possible ecf from <b>(b)(i)</b> with x-components = 2 + <b>b(i)</b> and y-component = 3 + <b>b(i)</b> .  <b>Note:</b> Answer is 9.43 to 3sf <b>Not</b> an answer left in square root form, e.g. $\sqrt{89}$  <b>Allow</b> full credit for a scale drawing; marks awarded as below: <ul style="list-style-type: none"> <li>A dot / cross / mark at 8.0,5.0 (<math>\pm 0.1</math>) C1</li> <li>Line drawn from 0,0 to 8.0,5.0 C1</li> <li>force = 9.4 <math>\pm 0.1</math> (N) A1</li> </ul>
	c	i	Down	B1 <b>Allow</b> a downward arrow on Fig. 2.2

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Question		Answer	Marks	Guidance
	ii	Horizontal component of the velocity is constant  There is no <u>horizontal force</u>	B1  B1	<b>Allow:</b> There is no horizontal <u>acceleration</u>  <b>Allow:</b> Weight / $g$ has no horizontal component or Weight / $g$ is $90^\circ$ to the horizontal or Weight / $g$ is vertical or 'there is <u>only</u> a vertical force'  ( <b>Not</b> 'gravity' for 'weight'; allow 'force of gravity')
	iii	Any <u>two</u> from: <ul style="list-style-type: none"> <li>• It decreases from <b>X</b> to <b>Y</b></li> <li>• It is zero at <b>Y</b> / It has the same magnitude at <b>X</b> and <b>Z</b></li> <li>• It increases from <b>Y</b> to <b>Z</b></li> <li>• It is positive from <b>X</b> to <b>Y</b> and negative from <b>Y</b> to <b>Z</b> (or vice versa)</li> </ul>	B1 × 2	<b>Ignore</b> description in terms of acceleration or deceleration  <b>Allow</b> it changes sign / direction from <b>X</b> to <b>Z</b>
<b>Total</b>			<b>10</b>	



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Question			Answer	Marks	Guidance
3	a	i	Length from <b>A</b> to <b>B</b> = 8.0 (cm)  displacement = 400 (km) or time = 1500 (s)  average velocity = $400 \times 10^3 / 1500$  average velocity = 270 (m s <sup>-1</sup> )	C1  C1  A1	<b>Allow</b> $\pm 0.1$ cm  Possible ecf within the calculation for an incorrect value for length <b>AB</b> .  <b>Note</b> no credit if distance is used.
		ii	(The average speed is different because) the <u>distance</u> (travelled) is different / not the same / greater than the <u>displacement</u>	B1	
	b	i	distance = $2 \times \pi \times 4.2 \times 10^8$ speed = $\frac{2 \times \pi \times 4.2 \times 10^8}{1.5 \times 10^5}$ speed = $1.8 \times 10^4$ (m s <sup>-1</sup> )	C1  A1	<b>Note:</b> Answer to 3 sf is $1.76 \times 10^4$ (m s <sup>-1</sup> ) <b>Not</b> $5600\pi$ (m s <sup>-1</sup> )
		ii	$(0 = v^2 - 2as)$ $(1.3 \times 10^3)^2 = 2 \times a \times 470 \times 10^3$ (Any subject) $a = \frac{(1.3 \times 10^3)^2}{2 \times 470 \times 10^3}$ (a must be the subject)  acceleration = 1.8 (m s <sup>-2</sup> )	C1  C1  A1	<b>Allow</b> full credit for ' $mgh = \frac{1}{2} mu^2$ ' approach <b>Ignore</b> signs  <b>Allow:</b> 2 marks for $1.8 \times 10^n$ ; $n \neq 0$
<b>Total</b>				<b>9</b>	

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Question		Answer	Marks	Guidance
4	a	GPE linked to 'position' / height (in a gravitational field)	B1	<b>Allow:</b> GPE linked to an object 'raised' / 'lowered' (on the Earth)
	b	i		
		$v^2 = u^2 + 2as$ $v^2 = 15^2 + (2 \times 9.81 \times 2.8)$ or $v = \sqrt{280}$ speed = 17 (m s <sup>-1</sup> )	C1 A1	<b>Allow</b> other correct methods  <b>Note:</b> Answer is 16.7 m s <sup>-1</sup> to 3sf
		ii		
		(initial energy =) $\frac{1}{2} \times 0.20 \times 16.7^2$ or (initial energy =) $0.20 \times 9.81 \times 2.8 + \frac{1}{2} \times 0.20 \times 15^2$  (final energy =) $\frac{1}{2} \times 0.20 \times 12^2$  energy lost = 14 (J)	C1  C1  A1	Possible ecf from <b>(b)(i)</b>   <b>Special case:</b> 1 mark for 8.1 (J); the difference in the initial KE ( $\frac{1}{2} \times 0.20 \times 15^2$ ) and the final KE ( $\frac{1}{2} \times 0.20 \times 12^2$ )
		iii		
		change in velocity = 17 + 12 (= 29 m s <sup>-1</sup> ) or 16.7 + 12 (= 28.7 m s <sup>-1</sup> )  $F = ma$ force = $0.20 \times \frac{29}{0.065}$ or force = $0.20 \times \frac{28.7}{0.065}$  force = 89 (N) or force = 88 (N)	C1    A1	Possible ecf from <b>(b)(i)</b>    <b>Allow</b> 1 mark for 'force = $0.20 \times \frac{(b)(i) - 12}{0.065}$ ', calculated with an answer.
			<b>Total</b>	<b>8</b>

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Question	Answer	Marks	Guidance
5	<p>Any <u>one</u> from:</p> <ul style="list-style-type: none"> <li>• Mass obtained using a balance / scales</li> <li>• Weight / load obtained using a newtonmeter / spring balance</li> <li>• Distance / height obtained using a ruler / metre stick / measuring tape</li> </ul> <p>Time obtained using a clock / (stop)watch / timer or light-gate <u>and</u> timer or light-gate <u>and</u> data-logger</p> <p>(output power =) 'mass <math>\times</math> <math>g</math> <math>\times</math> distance'/time or 'weight <math>\times</math> distance/time' or 'weight <math>\times</math> speed'</p> <p>input power = output power/0.15</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p>	<p> The term <b>clock / (stop)watch / timer /data-logger</b> must be spelled correctly to gain this mark</p> <p><b>Allow</b> symbols, e.g <math>mgh/t</math>, <math>Wh/t</math> and <math>Wv</math></p>
	<b>Total</b>	<b>4</b>	

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Question		Answer	Marks	Guidance
6	a	$F \rightarrow \text{kg m s}^{-2}$ or $A \rightarrow \text{m}^2$ <u>and</u> $v \rightarrow \text{m s}^{-1}$	M1	<b>Alternative:</b> (units on rhs:) $\text{kg m}^{-3} \times \text{m}^2 \times \text{m}^2 \text{s}^{-2}$
		Manipulation leading to $k \rightarrow \text{kg m}^{-3}$	M1	or (unit for lhs:) = $\text{kg m s}^{-2}$ M1 Manipulation leading to same units on both sides M1
		$k \rightarrow \text{kg m}^{-3}$	A0	<b>Allow</b> other correct methods
	b	i	B1	<b>Ignore</b> position and length of arrow
		ii	B1	<b>Not</b> $D$ and $W$ are at $90^\circ$
		iii	M1 A1	
	c	At the start, acceleration = $g$ (because there is no drag)	B1	<b>Allow</b> $9.8(1) \text{ m s}^{-2}$ / acceleration of free fall / acceleration due to gravity ( <b>Not</b> 'gravity' on its own) <b>Not</b> rate of acceleration is $g$
		Drag increases (as its speed increases / accelerates)	B1	
		net force decreases or net force < weight	B1	
		(As it falls) acceleration decreases / (As it falls) acceleration < $g$	B1	<b>Not</b> 'rate of acceleration decreases' unless it is qualified or 'acceleration slows down'
<b>Total</b>			<b>10</b>	

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Question			Answer	Marks	Guidance
7	a	i	mass = $2400 \times (0.80 \times 1.2 \times 15)$ / mass = $3.46 \times 10^4$ (kg) weight = $3.46 \times 10^4 \times 9.81$ weight = $3.4 \times 10^5$ (N)	C1 A1	
		ii	pressure = $3.4 \times 10^5 / (15 \times 0.80)$ pressure = $2.8 \times 10^4$ (Pa)	C1 A1	Possible ecf from <b>(a)(i)</b>
	b	i	Net moment is zero (about any point / axis).	B1	<b>Allow</b> 'clockwise moment(s) = anticlockwise moment(s)' <b>Allow</b> net torque is zero
		ii	The force exerted (at <b>X</b> ) decreases.  Correct explanation, e.g: The moment must be the same (about the other wall / pivot) and the distance (from it) has increased.	M1 A1	<b>Allow</b> 'force $\times$ (perpendicular) distance' for moment
			<b>Total</b>	<b>7</b>	

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Question		Answer	Marks	Guidance
8	a	The material is <u>elastic</u> / strain is zero when stress is <u>removed</u> / returns to its original shape when force is <u>removed</u> / there is no <u>plastic</u> deformation	B1	 The term <b>elastic</b> / <b>remove(d)</b> / <b>plastic</b> must be spelled correctly to gain this mark <b>Ignore</b> 'polymeric' <b>Not</b> 'it is ductile <u>and</u> elastic'
		It does not obey Hooke's law	B1	<b>Allow:</b> Stress is not proportional to strain / force is not proportional to extension
		The loading and unloading graphs are different (AW)	B1	<b>Allow:</b> It shows hysteresis / heat produced (when loaded and unloaded)
	b	i	<p>(breaking) stress = <math>\frac{16}{0.012 \times 0.018 \times 10^{-3}}</math> or <math>7.41 \times 10^7</math> (Pa)</p> <p>strain = <math>\frac{7.41 \times 10^7}{7.1 \times 10^{10}}</math> or <math>1.04 \times 10^{-3}</math></p> <p>extension = <math>1.04 \times 10^{-3} \times 0.15</math></p> <p>extension = <math>1.6 \times 10^{-4}</math> (m)</p> <p>assumption: Hooke's law obeyed / elastic limit is not exceeded / not plastically deformed / (cross-sectional) area is the same / thickness is the same / width is the same / no 'necking' / material is brittle</p>	<p>C1</p> <p>C1</p> <p>A1</p> <p>B1</p> <p><b>Alternative:</b>  <math>x = \frac{FL}{EA}</math> (Any subject) C1            extension = <math>\frac{16 \times 0.15}{7.1 \times 10^{10} \times (0.012 \times 0.018 \times 10^{-3})}</math> C1            extension = <math>1.6 \times 10^{-4}</math> (m) A1</p>
		ii	<p>(breaking) stress = same</p> <p><math>\frac{F}{\pi \times (0.60 \times 10^{-2})^2} = 7.41 \times 10^7</math></p> <p>force = <math>8.4 \times 10^3</math> (N)</p>	<p>C1</p> <p>A1</p> <p><b>Allow</b> other correct methods Possible ecf from <b>(b)(i)</b></p>
<b>Total</b>			<b>9</b>	

**OCR (Oxford Cambridge and RSA Examinations)**  
1 Hills Road  
Cambridge  
CB1 2EU

**OCR Customer Contact Centre**

**Education and Learning**

Telephone: 01223 553998

Facsimile: 01223 552627

Email: [general.qualifications@ocr.org.uk](mailto:general.qualifications@ocr.org.uk)

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**OCR (Oxford Cambridge and RSA Examinations)**  
Head office  
Telephone: 01223 552552  
Facsimile: 01223 552553

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