OCR
Oxford Cambridge and RSA

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.

Annotations

Annotation	Meaning
BP	Blank Page – this annotation **must** 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.
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
FT	Follow through
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error or reading/transcription error (*dual purpose*)
SF	Error in number of significant figures
	Correct response
AE	Arithmetic error
	Wrong physics or equation

Abbreviations used in detailed mark scheme

Abbreviation	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

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.

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

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	**Allow** other correct combinations **Allow** the following: • e.m.f. and p.d. • Any two from frequency, activity, decay constant and Hubble constant because of the s^{-1} **Ignore** any units given (even if incorrect) **Special case**: Allow quantities with no units, e.g. strain and efficiency. **Not** any combination of length, distance and extension
	b	i	*x*-component = 6.0 (N) and *y*-component = 2.0 (N)	B1	**Allow** 1 sf answers **Allow** tolerance $\pm$ 0.1 N **Not** *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	**Allow**: 1 sf values for this C1 mark Possible ecf from **(b)(i)** with *x*-components = 2 + **b(i)** and *y*-component = 3 + **b(i)**. **Note**: Answer is 9.43 to 3sf **Not** an answer left in square root form, e.g $\sqrt{89}$ **Allow** full credit for a scale drawing; marks awarded as below: • A dot / cross / mark at 8.0,5.0 ($\pm$ 0.1) C1 • Line drawn from 0,0 to 8.0,5.0 C1 • force = 9.4 $\pm$ 0.1 (N) A1
	c	i	Down	B1	**Allow** a downward arrow on Fig. 2.2

Question			Answer	Marks	Guidance
		ii	Horizontal component of the velocity is constant There is no <u>horizontal</u> <u>force</u>	B1 B1	**Allow**: There is no horizontal <u>acceleration</u> **Allow**: Weight / *g* has no horizontal component or Weight / *g* is 90° to the horizontal or Weight / *g* is vertical or 'there is <u>only</u> a vertical force' (**Not** 'gravity' for 'weight'; allow 'force of gravity')
		iii	Any <u>two</u> from: • It decreases from **X** to **Y** • It is zero at **Y** / It has the same magnitude at **X** and Z • It increases from **Y** to **Z** • It is positive from **X** to **Y** and negative from **Y** to **Z** (or vice versa)	B1 × 2	**Ignore** description in terms of acceleration or deceleration **Allow** it changes sign / direction from **X** to **Z**
			Total	**10**	

Question			Answer	Marks	Guidance
3	a	i	Length from **A** to **B** = 8.0 (cm) displacement = 400 (km) or time = 1500 (s) average velocity = $400 \times 10^3/1500$ average velocity = 270 (m s^{-1})	C1 C1 A1	**Allow** $\pm$ 0.1 cm Possible ecf within the calculation for an incorrect value for length **AB**. **Note** 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 = $\frac{2\times\pi\times4.2\times10^8}{1.5\times10^5}$ speed = 1.8×10^4 (m s^{-1})	C1 A1	**Note**: Answer to 3 sf is 1.76×10^4 (m s^{-1}) **Not** 5600π (m s^{-1})
		ii	($0 = u^2 - 2as$) $(1.3\times10^3)^2 = 2\times a\times470\times10^3$ (Any subject) $a = \frac{(1.3\times10^3)^2}{2\times470\times10^3}$ (a must be the subject) acceleration = 1.8 (m s^{-2})	C1 C1 A1	**Allow** full credit for '$mgh = ½ mu^2$' approach **Ignore** signs **Allow**: 2 marks for 1.8×10^n; $n \neq 0$
			Total	**9**	

Question			Answer	Marks	Guidance
4	a		GPE linked to 'position' / height (in a gravitational field)	B1	**Allow**: 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^{-1})	C1 A1	**Allow** other correct methods **Note**: Answer is 16.7 m s^{-1} to 3sf
		ii	(initial energy =) ½ × 0.20 × 16.7^2 or (initial energy =) 0.20 × 9.81 × 2.8 + ½ × 0.20 × 15^2 (final energy =) ½ × 0.20 × 12^2 energy lost = 14 (J)	C1 C1 A1	Possible ecf from **b(i)** **Special case:** 1 mark for 8.1 (J); the difference in the initial KE (½ × 0.20 × 15^2) and the final KE (½ × 0.20 × 12^2)
		iii	change in velocity = 17 + 12 (= 29 m s^{-1}) or 16.7 + 12 (= 28.7 m s^{-1}) *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)(i)** **Allow** 1 mark for 'force = $0.20 \times \frac{(b)(i) - 12}{0.065}$' calculated with an answer.
			Total	**8**	

Question			Answer	Marks	Guidance
5			Any <u>one</u> from: • Mass obtained using a balance / scales • Weight / load obtained using a newtonmeter / spring balance • Distance / height obtained using a ruler / metre stick / measuring tape	B1	
			Time obtained using a clock / (stop)watch / timer or light-gate <u>and</u> timer or light-gate <u>and</u> data-logger	B1	✎ The term **clock** / **(stop)watch / timer /data-logger** must be spelled correctly to gain this mark
			(output power =) 'mass × *g* × distance'/time or 'weight × distance/time' or 'weight × speed'	B1	**Allow** symbols, e.g *mgh/t*, *Wh/t* and *Wv*
			input power = output power/0.15	B1	
			Total	**4**	

Question			Answer	Marks	Guidance
6	a		$F \rightarrow$ kg m s^{-2} **or** $A \rightarrow$ m^2 <u>and</u> $v \rightarrow$ m s^{-1} Manipulation leading to $k \rightarrow$ kg m^{-3} $k \rightarrow$ kg m^{-3}	M1 M1 A0	**Alternative**: (units on rhs:) kg $m^{-3} \times m^2 \times m^2$ s^{-2} **or** (unit for lhs:) = kg m s^{-2} M1 Manipulation leading to same units on both sides M1 **Allow** other correct methods
	b	**i**	Arrow directly opposite to *D* on Fig. 6.1	B1	**Ignore** position and length of arrow
		ii	The ball is not at terminal velocity, since *D* and *W* are not (directly) opposite / The ball is not at terminal velocity because there is a net force	B1	**Not** *D* and *W* are at 90°
		iii	It is travelling (vertically) upwards It will slow down / It decelerates / It accelerates (vertically) downwards / There is a net downward force / drag opposes motion	M1 A1	
	c		At the start, acceleration = *g* (because there is no drag) Drag increases (as its speed increases / accelerates) net force decreases or net force < weight (As it falls) acceleration decreases / (As it falls) acceleration < *g*	B1 B1 B1 B1	**Allow** 9.8(1) <u>m s^{-2}</u> / acceleration of free fall / acceleration due to gravity (**Not** 'gravity' on its own) **Not** rate of acceleration is *g* **Not** '<u>rate</u> of acceleration decreases' unless it is qualified or 'acceleration slows down'
			Total	**10**	

Question			Answer	Marks	Guidance
7	a	i	mass = 2400 × (0.80 × 1.2 × 15) / mass = 3.46×10^4 (kg) weight = $3.46 \times 10^4 \times 9.81$ weight = 3.4×10^5 (N)	C1 A1	
		ii	pressure = $3.4 \times 10^5/(15 \times 0.80)$ pressure = 2.8×10^4 (Pa)	C1 A1	Possible ecf from **(a)(i)**
	b	i	Net moment is zero (about any point / axis).	B1	**Allow** 'clockwise moment(s) = anticlockwise moment(s)' **Allow** net torque is zero
		ii	The force exerted (at **X**) 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	 **Allow** 'force × (perpendicular) distance' for moment
			Total	**7**	

Question			Answer	Marks	Guidance
8	a		The material is elastic / strain is zero when stress is removed / returns to its original shape when force is removed / there is no plastic deformation	B1	✍ The term **elastic / remove(d) / plastic** must be spelled correctly to gain this mark **Ignore** 'polymeric' **Not** 'it is ductile and elastic'
			It does not obey Hooke's law	B1	**Allow**: Stress is not proportional to strain / force is not proportional to extension
			The loading and unloading graphs are different (AW)	B1	**Allow**: It shows hysteresis / heat produced (when loaded and unloaded)
	b	i	(breaking) stress = $\frac{16}{0.012\times0.018\times10^{-3}}$ or 7.41×10^{7} (Pa)	C1	**Alternative:** $x=\frac{FL}{EA}$ (Any subject) C1
			strain = $\frac{7.41\times10^{7}}{7.1\times10^{10}}$ or 1.04×10^{-3}	C1	extension = $\frac{16\times0.15}{7.1\times10^{10}\times(0.012\times0.018\times10^{-3})}$ C1
			extension = $1.04\times10^{-3}\times0.15$		extension = 1.6×10^{-4} (m) A1
			extension = 1.6×10^{-4} (m)	A1	
			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	B1	
		ii	(breaking) stress = same $\frac{F}{\pi\times(0.60\times10^{-2})^{2}}=7.41\times10^{7}$	C1	**Allow** other correct methods Possible ecf from **(b)(i)**
			force = 8.4×10^{3} (N)	A1	
			Total	**9**	

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