OCR
Oxford Cambridge and RSA

GCE

Physics A

Unit **G481/01**: Mechanics

Advanced Subsidiary GCE

Mark Scheme for June 2014

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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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These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

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.
	correct response
	incorrect response
BOD	benefit of the doubt (where professional judgement has been used)
NBOD	benefit of the doubt **not** given
ECF	error carried forward
^	information omitted
CON	contradiction (in cases where candidates contradict themselves in the same response)
FT	follow through
SF	error in number of significant figures
POT	error in the power of 10 in calculation
AE	arithmetic or calculation error
NAQ	not answered question
?	wrong physics
RE	reading error

Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/ = alternative and acceptable answers for the same marking point
(1) = separates marking points
allow = answers that can be accepted
not = answers which are not worthy of credit
reject = answers which are not worthy of credit
ignore = statements which are irrelevant
( ) = words which are not essential to gain credit
__ = underlined word (or the equivalent) 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 <u>independent</u> 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 <u>method</u> 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 <u>compensatory</u> 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 <u>answer</u> marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

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.

IMPORTANT UPATE:

ADDITIONAL OBJECTS: You **must** annotate the additional objects for each script you mark. If no credit is to be awarded for the additional object, please use annotation as agreed at the SSU, likely to be 'seen', a cross or the highlighting tool.

CROSSED OUT, RUBRIC ERROR (OPTIONAL QUESTIONS) AND MULTIPLE RESPONSES
Crossed-out Responses: Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.
Rubric Error Responses – Optional Questions: Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*
Multiple Choice Question Responses: When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.
Contradictory Responses: When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**): Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

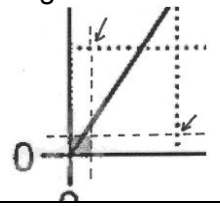
Short Answer Questions (requiring a more developed response, worth **two or more marks**): If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response): Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

Question			Answers	Marks	Guidance
1	(a)		velocity = rate of <u>change</u> of displacement	B1	**Allow** $v = \frac{\Delta s}{\Delta t}$ where Δs = <u>change</u> in displacement Δt = time (taken) **Allow** displacement travelled/time **Allow** 'velocity = displacement/time' when followed by 'velocity = rate of change of displacement' **Not** 'velocity = displacement/time' or 'distance/time' **Not** mixture of quantity and unit, e.g. change of displacement per second **Not** 'speed in a specific direction'
	(b)	(i)	speed = 70000/3600	C1	**Note**: speed = 19.4... (m s^{-1}) will score this C1 mark
			KE = $\frac{1}{2} \times 130 \times \left(\frac{70000}{3600}\right)^2$	C1	
			kinetic energy = 2.5×10^4 (J)	A1	**Note**: Using 19.4 (m s^{-1}) gives 2.446.. $\times 10^4$ (J); hence an answer of 2.4×10^4 (J) will score full marks **Allow** maximum of 2 marks if 19 (m s^{-1}) is used – answer is 2.34… $\times 10^4$ (J) **Allow** 1 mark for ½ × 130 × (70000/60)^2 = 8.84(7) × 10^7 (J) **Note**: No credit for ½ × 130 × v^2 with any other incorrect value for v, including v = 70 and 70000 **Note**: Bald answer of 2.5×10^4 (J) scores full marks **Note**: If the correct equation for KE is written and then the squaring of the speed is omitted, allow ecf as shown below: E = ½ mv^2 = ½ × 130 × 19.4 = 1.3×10^3 (J) ✓× ✓ 2 marks

Question			Answers	Marks	Guidance
	(b)	(ii)	Mass of Mononykus is 1/8 (of the mass of an ostrich) or mass of Mononykus is 16 (kg). Correct reasoning: Volume decreases by (a factor of) 8 **and** density assumed to be the same.	B1 B1	 **Allow** use of *V* for volume and ρ for density
			Total	**6**	

Question			Answers	Marks	Guidance
2	(a)		$5.1\times\cos40\times0.75$ or $d\times1.2\times g$ $5.1\times\cos40\times0.75=d\times1.2\times9.81$ $d=\dfrac{5.1\times\cos40\times0.75}{1.2\times9.81}$ d = 0.25 (m)	C1 C1 A1	**Allow** 2 marks if sine of the angle is used instead of cosine; this gives an answer of 0.21 (m). **Allow** use of 9.8 (m s^{-2}) **Note**: '5.1 × 0.75 = d × 1.2 × 9.81; d = 0.32.. (m)' scores 1 mark because of the first C1
	(b)		The string provides a horizontal force (to the left), hence there must be a horizontal force at the support (to the right, therefore the force at the support cannot be vertical). (AW) Or If the force was just vertical at the support then the object would move to the left (and so will not be in equilibrium). (AW) Or Force at support is at an angle and passes through the point of intersection (of the lines of action) of the weight and the tension. (AW)	B1	**Allow** Tsin40 for the horizontal force
			Total	**4**	

Question			Answers	Marks	Guidance
3	(a)	(i)	The material is brittle. The material is also elastic.	B1 B1	**The term *brittle* to be included and spelled correctly to gain the first B1 mark.** **Allow** 'does not show plastic (deformation)'
		(ii)	Straight line through origin followed by correct curve to show plastic behaviour. Straight line has greater gradient than **X**.	B1 B1	**Note:** Tolerance for the origin is shown below 
	(b)	(i)	strain = $\frac{1.8\times10^{7}}{2.0\times10^{11}}$ (Any subject) strain = 9.0×10^{-5}	C1 A1	The mark is for the correct use of strain = stress ÷ E **Allow** 1 sf answer **Ignore** any unit given
		(ii)	$1.8\times10^{7}=\frac{T}{\pi\times(2.6\times10^{-2})^{2}}$ (Any subject) tension = 3.8×10^{4} (N)	C1 A1	The mark is for the correct use of stress = $\frac{F}{A}$
		(iii)	$2T\sin12=W$ weight = $2\times3.8\times10^{4}\times\sin12$ (Any subject) weight = 1.6×10^{4} (N)	C1 C1 A1	 Possible ecf from **(ii)** **Allow** 2 marks for 7.9×10^{3} (N); factor of 2 omitted **Special case:** Using cos12 instead of sin12 gives 7.4..$\times10^{4}$ (N), allow maximum of 2 marks **Allow** full credit for correct calculation using the sine or the cosine rule **Allow** full credit for an answer using a correct scale drawing: Correct sketch of vector diagram C1; correct vector diagram drawn to scale C1; weight = $(1.6\pm0.2)\times10^{4}$ (N) A1
			Total	**11**	

Question			Answers	Marks	Guidance
4	(a)	(i)	There is only a vertical force / weight is vertical / no horizontal force(s) / acceleration is vertical	B1	**Not** 'horizontal acceleration is zero' – since horizontal velocity is constant is given in the question
		(ii)	1 Correct sketch of the rebound path.	B1	**Note**: The ball must hit the ground closer to wall. The rebound path should be curved and below the original path.
			2 The time is the same.	M1	
			For both, the height / vertical distance and (vertical) acceleration are the same.	A1	**Allow** $s = \frac{1}{2}at^2$ with *s* and *a* are the same (for both)
	(b)		Drop the ball from a given height **and** measure time of fall.	B1	
			$s = ut + \frac{1}{2}at^2$ **and** $u = 0$ or $s = \frac{1}{2}at^2$	B1	**Allow** $a \equiv g$ and $h \equiv s$
			(The acceleration of free fall is determined using) $a = 2s/t^2$	B1	**Note:** *a* must be the subject to gain this B1 mark **Note**: $a = 2s/t^2$ will score the last two B1 marks **Allow** full credit for graphical approach: Drop ball from different heights & measure the times of fall (B1) ; plot a graph of *s* against t^2 (B1) ; $g = 2 \times$ gradient (B1)
	(c)	(i)	Constant deceleration or uniform deceleration or constant negative acceleration or constant rate (of change) of velocity	B1	**Allow** constant / uniform acceleration / acceleration is 2.66.. ($m\ s^{-2}$) **Allow** 'constant rate of deceleration or acceleration' **Not** 'slowing down'
			(Momentarily) stops at 1.5 (s) or reaches maximum height at 1.5 (s)	B1	
			Clear idea of returning back. (AW)	B1	**Allow**: (The ball) goes up and (then) down (the ramp) **Not**: velocity changes sign or direction changes
		(ii)	distance = $\frac{1}{2} \times 4.0 \times 1.5$	C1	**Note**: Speed in range 3.0 to 5.0 ($m\ s^{-1}$) and $v \neq 4.0$ ($m\ s^{-1}$), then possible ecf
			distance = 3.0 (m)	A1	**Allow** 1 sf answer **Allow** full credit for correct use of equation(s) of motion **Special case:** total distance travelled is calculated; allow 1 mark for an answer of 6.0 (m)
			Total	**12**	

Question			Answers	Marks	Guidance
5	(a)	(i)	9.8(1) $\underline{\text{m s}^{-2}}$ / g / acceleration of free fall The only force acting is weight / drag force is zero	B1 B1	
		(ii)	(The maximum velocity when) drag = weight	B1	
		(iii)	The golf ball experiences greater drag (at terminal velocity to equal its larger weight) (AW) Drag increases with speed or drag $\propto v^2$ or the golf ball takes longer time to reach its terminal velocity or the golf ball accelerates for longer time The golf ball (has greater terminal velocity)	B1 B1 B1	
	(b)	(i)	drag = 2000 (N) from the graph net force = 3200 - 2000 (N) / net force = 1200 (N) acceleration = 1200/8000 acceleration = 0.15 (m s^{-2})	C1 C1 A1	Possible ecf if reading off graph is incorrect No credit for 3200/8000 = 0.4(0 m s^{-2}) or 2000/8000 = 0.25 (m s^{-2})
		(ii)	The drag force will be greater than the (constant) forward force (which cannot be) or at 32 (m s^{-1} drag) force is 3200 $\pm$ 100 (N) or at 40 (m s^{-1} drag) force is 5100 $\pm$ 100 (N)	B1	**Allow** maximum speed is 32 (m s^{-1})
	(c)		The time taken (for the driver) to stop is more or distance travelled (by the driver) is greater. $F = ma$ a decreases (hence F is smaller) or $Fx = KE$ KE is the same (hence F is smaller) or $F = \Delta p/\Delta t$ Δp is the same (hence F is smaller)	B1 B1 B1 B1 B1 B1 B1	**Allow** 'it takes longer to stop' or 'increases impact time' **Not** slower acceleration KE $\equiv$ W (for work done)
			Total	**13**	

Question			Answers	Marks	Guidance
6	(a)		force × distance <u>moved</u> / <u>travelled</u> in the direction of the force	B1	**Allow** force × displacement in direction of force
	(b)		(Work done against friction generates) heat / thermal energy / internal energy	B1	**The term *heat* / *thermal* / *internal* to be included and spelled correctly to gain the B1 mark.**
	(c)		1 J (of work done) <u>per</u> second	B1	**Allow** (1 W = 1) J s^{-1} or J/s **Allow** (1) joule<u>s</u> per second **Not** W = 1 J <u>in</u> 1 s **Allow** full credit as long as the definition for the 'watt' is not confused with the definition for 'power' (Examples: • power = rate of work done; W = 1 J s^{-1} ✓ • The rate of work done. It is J per s × • watt = rate of work done, W = 1 J s^{-1} ×)
	(d)	(i)	vertical distance = $(75^2 - 45^2)^{1/2}$ or vertical distance = 60 (m) work done = 5200 × 9.81 × 60 or work done = 3.06×10^6 (J) power = $3.06 \times 10^6/90$ power = 3.4×10^4 (J s^{-1})	C1 C1 A1	 **Allow** 2 marks for an answer of 2.04×10^6 (J s^{-1}); 1.5 used instead of 90 s No credit for [5200 × *g* × 75]/90 or [5200 × *g* × 45]/90
		(ii)	efficiency = $\frac{34}{170} \times 100$ efficiency = 20 %	B1	Possible ecf from **(i)**
			Total	**7**	

Question			Answers	Marks	Guidance
7	(a)		force constant = $\frac{3.0}{0.06}$ (Any subject) force constant = 50 (N m^{-1})	M1 A0	**Not** 3.0/6.0 = 50 (N m^{-1}) **Note**: There is no mark for the answer because it is given on the paper; the mark is for the working.
	(b)	(i)	(E_i =) ½ × 50 × 0.06^2 or ½ × 3.0 × 0.06 or 0.09 (J) (E_f =) ½ × 50 × 0.10^2 or ½ × 5.0 × 0.10 or 0.25 (J) ΔE = 0.25 – 0.09 ΔE = 0.16 (J)	C1 C1 A1	**Special case** '½ × 50 × (0.10 - 0.06)^2 = 0.04 (J)' mark or '½ × 50 × (0.12 - 0.08)^2 = 0.04 (J)' scores 1
		(ii)	tension in spring = 50 × 0.10 or tension in spring = 5.0 (N) net force = 5.0 – 3.0 and mass of object = 3.0/9.81 *a* = 2.0/(0.3058..) *a* = 6.5 (m s^{-2})	C1 C1 A1	**Special case:** 5.0/(3.0/9.81) = 16.35 (m s^{-2}) scores 1 mark because of the first C1 mark **Note**: *a* = 16.35 – 9.81 = 6.5(4 m s^{-2}) scores full marks
			Total	**7**	

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