OCR
Oxford Cambridge and RSA

GCE

Physics A

Unit **G481**: Mechanics

Advanced Subsidiary GCE

Mark Scheme for June 2016

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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 available in RM Assessor

Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
TE	Transcription error
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
SF	Error in number of significant figures
	Correct response
	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

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:

If the data given in a question is to 2 sf, then allow 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.

Q 1	Answer	Marks	Guidance
(a)	(Acceleration =) rate of change of <u>velocity</u>	B1	**Allow**: Equations $a = \frac{v-u}{t}$ and $a = \frac{\Delta v}{t}$ as long as labels, *v*, *u*, Δv and *t* are defined. **Not**: 'speed' instead of 'velocity'
(b)	It has <u>direction</u> (and magnitude)	B1	**Must use ticks on Scoris to show where the marks are awarded** ✎ '***direction'*** must be spelled correctly to gain the mark.
(c)(i)	**1** Increasing acceleration **2** Constant deceleration	B1 B1	**Not:** answers using rate of acceleration - for either mark **Not**: Constant acceleration **Allow**: constant negative acceleration **Allow:** uniform /steady deceleration
(c)(ii)	The area under the graph from *t* = 0 to *t* = 2 s is smaller (AW)	B1	
(d)	$s = \frac{1}{2}(v+u)t$ $0.020 = \frac{1}{2}(0.26) \times t$ time = 0.15 (s)	C1 A1	Arriving at an acceleration of 1.69 m s^{-2} and no further works scores zero. **Allow**: Alternative approaches **Note**: Answer to 3 sf is 0.154 (s) **Note**: '0.020/0.26 = 0.77 (s)' scores zero
	Total	**7**	

Q 2	Answer	Marks	Guidance
(a)	Aristotle: Heavier/massive objects fall faster (AW) Galileo: All objects (irrespective of their mass) fall at the same rate / have same acceleration (of free fall)	B1 B1	 **Allow**: 'the same rate of acceleration' for this B1 mark
(b)(i)	Any **two** from: • speed • area • density of air / viscosity of air • streamlining / texture of clothing	B1	**Not**: 'wind' for 'speed' **Allow:** surface / frontal area
(b)(ii)	Acceleration is equal to 9.8(1) $\underline{\text{m s}^{-2}}$ / *g* There is no drag / net force = weight / 'only force acting is *mg*'	B1 B1	
(b)(iii)	Correct shape curve with finite value at $t = 0$ Value of $F = 0$ after 10 s	B1 B1	 **Allow** a tolerance of +/- 0.5 of a square
(b)(iv)	weight = 80×9.81 or 784.8 (N) or (net force) = 80×3 or 240 (N) (80×9.81) – drag = 240 drag = 540 (N)	C1 C1 A1	**Note**: The first C1 mark is either for the weight or the net force **Note**: Answer to 3sf is 545 (N) and 544.8 (N) to 4sf
	Total	**10**	

Q 3	Answer	Marks	Guidance
(a)	$E_p = 190 \times 9.81 \times 25$ $E_p = 4.7 \times 10^4$ (J)	B1	**Note**: Answer is 4.66×10^4 to 3sf
(b)	$E_k = ½ \times 190 \times 30^2$ $E_k = 8.6 \times 10^4$ (J)	B1	**Note:** Answer is 8.55×10^4 to 3sf
(c)	Work done by the motorbike / energy from the engine (AW)	B1	**Note**: There must be reference to work or energy **Allow:** chemical energy to kinetic energy / E_K
(d)	work done = change in energy force $\times$ 120 = (8.55 – 4.66) $\times 10^4$ force = 320 (N)	C1 A1	Possible ecf from **(a)** and **(b)**
(e)(i)	($s = ½ at^2$ – for the vertical fall) $9.5 = ½ \times 9.81 \times t^2$ (Any subject) $t = \sqrt{(2 \times 9.5)/9.81}$ or 1.39 time = 1.4 (s)	M1 M1 A0	
(e)(ii)	Horizontal velocity = 30 m s^{-1} distance = 1.4 $\times$ 30 or 42 (m) (number of cars =) 42/1.8 (number of cars =) 23	C1 A1	**Allow**: 23.3 cars **Allow:** 22 if height of last car is mentioned
	Total	**9**	

Q 4	Answer	Marks	Guidance
(a)	The resultant force is zero There is no acceleration	B1 B1	**Not** 'in equilibrium' **Not**: constant velocity; since this is in the question
(b)	(moment of a force =) force × <u>perpendicular</u> distance from point / pivot	B1	**Must use ticks on Scoris to show where the marks are awarded** ✎ '***perpendicular'*** must be spelled correctly to gain the mark.
(c)	Forces are in the same direction / The forces are not opposite / The forces are not equal (in magnitude)	B1	
(d)	(clockwise moments =) (720 × 0.40) + (180 × 0.60) or 396 (N m) sum of clockwise moments = sum of anticlockwise moments 396 = 1.3 *F* *F* = 300 (N)	C1 C1 A1	 **Allow**: 2 marks for '720 × 0.40 = 1.3 × *F*, *F* = 221 (N)' or 180 × 0.60 = 1.3 × *F*, *F* = 83 (N)' **Note**: Answer is 305 (N) to 3 sf and 304.6 (N) to 4 sf
(e)	The force at **X** decreases The force at **Y** increases / greater clockwise moment / $F_X + F_Y = 900$ (N)	B1 B1	 **Allow**: the rider's centre of gravity / mass moves further from **X**
	Total	**9**	

Q 5	Answer	Marks	Guidance
(a)(i)	The driver's head will bounce back / 'whiplash'	B1	**Allow**: suffocation **Allow**: the airbag will be (too) rigid / not collapse so the force on the head will still be large (AW)
(a)(ii)	Time to stop is longer Magnitude of deceleration is smaller *F* = *ma* used correctly to explain why the force is smaller **Alternative** Time to stop is longer $F = \frac{mv - mu}{\Delta t}$ or $F = \frac{\Delta mv}{\Delta t}$ used to explain why the force is smaller Change in momentum is constant	B1 B1 B1 B1 B1 B1	 **Allow**: 'smaller acceleration' **Allow**: use of $F \propto a$ **Allow:** p for mv **Allow:** omissions of delta
(b)(i)	$x \propto u^2$ or doubling the speed increases the distance by a factor of 4	B1	
(b)(ii)	thinking distance = 30 × 0.6 or 18 (m) braking distance = 0.08 × u^2 or 0.08 × 30^2 or 72 (m) stopping distance = 18 + 72 stopping distance = 90 (m)	C1 C1 A1	
(c)(i)	Circle shows the possible position(s) of the car from a satellite	B1	**Allow:** 'where' a car can be. **Allow**: The car is at the intersection of the spheres. **Not:** the area / region / space where a car can be
(c)(ii)	The time taken for (coded) signal to travel from satellite to the receiver is determined The distance is calculated by multiplying the time by *c* / 3 × 10^8 $\underline{\text{m s}^{-1}}$ / speed of light / radio waves / microwaves	B1 B1	**Not**: if any signal travels from the GPS in the car to the satellite
	Total	**11**	

Q 6	Answer	Marks	Guidance
(a)(i)	force/extension or force/change in length	B1	**Allow**: force per unit extension or force per unit compression
(a)(ii)	Tension/force in each spring is halved so the extension (of each spring) is also halved. (Therefore the force constant is twice that of one spring.)	B1	**Allow**: the extension of each spring is halved, the force is the same (for the system, hence the force constant doubles)
(b)	Measure the thickness of the strip (using the micrometer) and calculate its (cross-sectional) area Load the hanger until the strip breaks. Calculate the (maximum) weight of the masses using $W = mg$. breaking stress = (maximum) weight/(cross-sectional) area	B1 B1 B1	**Not**: <u>surface</u> area **Allow**: 'force' for 'weight' **Allow:** breaking stress = (maximum) force/(cross-sectional) area **Allow**: F/A if the words force and area have been used in the answer
(c)(i)	Any **one** from: Elastic (behaviour) / obeys Hooke's law / stress is proportional to strain	B1	
(c)(ii)	It will be longer / permanent strain / suffer plastic deformation (AW)	B1	
(c)(iii)	The statement is incorrect because the Young modulus can only be determined from the linear region of the graph.	B1	**Allow**: Young modulus only applies to elastic behaviour **Allow:** stress is not proportional to strain as the line is curved **Not:** stress is not proportional to strain
	Total	**8**	

Q 7	Answer	Marks	Guidance
(a)	weight = $2.8 \times 10^4 \times 9.81$ or 2.75×10^5 (N) stress in each cable = $\frac{1}{4} \times \frac{2.75 \times 10^5}{4.5 \times 10^{-4}}$ or 1.53×10^8 (Pa) strain = $\frac{1.53 \times 10^8}{2.1 \times 10^{11}}$ or 7.28×10^{-4} extension = $7.52 \times 10^{-4} \times 32$ or 0.023 (m) extension = 23 (mm)	C1 C1 C1 A1	If g is omitted do not award the first mark but allow ECF for a possible maximum of 3/4 marks. Use FT on the calculation. **Allow**: 3 marks for 93 (mm) – factor of 4 omitted **Alternative approach:** weight = = $2.8 \times 10^4 \times 9.81$ or 2.75×10^5 (N) C1 extension = $\frac{FL}{AE}$ any subject C1 extension = $\frac{0.25 \times 2.75 \times 10^5 \times 32}{4.5 \times 10^{-4} \times 2.1 \times 10^{11}}$ C1 extension = 23 (mm) A1
(b)	Extension will increase The tension > weight (for acceleration)	B1 B1	**Allow**: the tension increases to cause the acceleration **Allow**: Net force is upwards so tension / force in the cables increases
	Total	**6**	

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