OCR
RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced Subsidiary GCE

Unit **G481/01:** Mechanics

Mark Scheme for January 2013

Oxford Cambridge and RSA Examinations

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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
	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 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

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text.

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			Lines joining density to 'kg m^{-3}' pressure to 'kg m^{-1} s^{-2}' power to 'kg m^{2} s^{-3}'	B1×2	**Note**: All correct – 2 marks, deduct 1 mark for each error or omission. (Minimum score = 0)
			Total	**2**	

Question			Answer	Marks	Guidance
2	(a)		Difference: Velocity / vector has direction (and speed does not) or speed / scalar does not have direction (velocity has) Similarity: Both have the same unit / both have m s^{-1} (as the unit) / both have magnitudes	B1 B1	**Not** 'velocity is a vector / speed is a scalar' since it is stated in the question
	(b)	(i)	distance = $2 \times \pi \times 0.60$ (= 3.77 m) / speed = $\frac{3.77}{12}$ speed = 0.31 (m s^{-1})	C1 A1	**Note**: Answer to 3 sf is 0.314 (m s^{-1})
		(ii)	$s^2 = 0.60^2 + 0.60^2$ s = 0.85 (m)	C1 A1	**Note**: Answer to 3 sf is 0.849 (m) **Note**: 0.72 scores 1 mark (square root omitted)
		(iii)	The (change in) displacement is zero	B1	
		(iv)	The direction changes (even though the magnitude is the same)	B1	
			Total	**8**	

Question			Answer	Marks	Guidance
3	(a)		a = 3600/1200 a = 3.0 (m s^{-2})	B1	**Allow** 1 sf answer (Ignore sign)
	(b)		$v^2 = u^2 + 2as$ $0 = 18^2 + (2 \times -3.0 \times s)$ / $s = \frac{18^2}{6.0}$ s = 54 (m)	C1 C1 A1	Possible ecf **Allow** '$v^2 = 2as$, $18^2 = 2 \times 3.0 \times s$' **Allow** other approaches, examples: t = 6 (s) C1 $s = (18 \times 6.0) + ½ \times (-3.0) \times 6.0^2$ C1 s = 54 (m) A1 Or $½\ mv^2 = Fs$ C1 $½ \times 1200 \times 18^2 = 3600 \times s$ C1 s = 54 (m) A1
	(c)		(The distance is) greater There is a component of the weight of the car acting down the slope / component of weight against the resistive force / reference to $W \sin\theta$ (AW) Net force is less / reference to 3600 – $W \sin\theta$ / (magnitude of) deceleration is smaller	B1 B1 B1	**Allow** the following for the last two B1 marks: • The same force has to do more work • Work done is the sum of initial kinetic energy and change in GPE (due to vertical downward movement)
	(d)		Reference to radio waves or microwaves (transmitted from satellites) There is a 'delay time' of signal from satellite to GPS device / car Distance (between satellite and GPS device / car) calculated using 'delay time $\times$ c' **Trilateration** / intersecting **shells** / **circles** / **spheres** (used to locate position of car)	B1 B1 B1 B1	**Use ticks on Scoris to show where the marks are awarded** **Allow**: 'delay time' of signal between satellite and GPS device / car (**Not** from GPS device / car to satellite) ***Trilateration*** / ***shell(s)*** / ***circle(s)*** / ***sphere(s)*** must be spelled correctly to gain the mark. **Note**: Allow full range of marks for other sensible alternative approaches
			Total	**11**	

Question			Answer	Marks	Guidance
4	(a)		acceleration = rate of <u>change of velocity</u> (or acceleration = <u>change in velocity</u> / time)	B1	**Allow** '$a = (v - u)/t$' *or* $\Delta v/t$ if v, u and t or Δv and t are defined
	(b)		Mass and (net) force	B1	
	(c)	(i)	**1** acceleration **2** deceleration / negative acceleration Detail mark: Constant used in either 1 or 2 or reaches maximum height at 25 (s) or stops at 25 (s)	B1 B1 B1	**Allow**: velocity / speed increases **Allow**: velocity / speed decreases **Allow**: 'uniform / same' for 'constant'
		(ii)	height = area under graph from 0 to 25 (s) height = ½ × 25 × 200 height = 2500 (m)	C1 C1 A1	**Allow** 1 mark for either 500 (m) or 2000 (m)
		(iii)	A sensible suggestion, for example: • $v^2 = 2 \times g \times 2500$, $v = 220$ (m s^{-1}) – allow $g = 10$ (m s^{-2}) • For 200 (m s^{-1}) at ground, the (maximum) height would only be 2040 (m) (with $g = 9.81$ m s^{-2}) or 2000 (m) (with $g = 10$ m s^{-2}) • (Burning) rocket fuel does work on the rocket (AW)	B1	
			Total	**9**	

Question			Answer	Marks	Guidance
5	(a)		Drag increases with speed (ORA) / drag $\propto$ speed^2	B1	
	(b)		Galileo dropped different mass balls / rolled different mass balls (down a ramp)	B1	**Allow** object / trolley instead of ball
			Balls hit the ground / reached the bottom (of ramp) at the same time	B1	
			(Galileo -) All objects fall with the same acceleration and (Aristotle -) Heavy / massive objects fall faster / quicker (than light objects)	B1	
	(c)	(i)	(The two forces are weight and drag) weight = drag	B1	**Not** 'gravity' for weight **Allow**: weight = drag + upthrust
		(ii)	When the parachute is opened, drag increases / drag is greater than the weight	B1	
			Drag decreases as the speed decreases / net force decreases	B1	
			The (magnitude of the) deceleration decreases (between 50 m s^{-1} and 4 m s^{-1})	B1	
			(At 4 m s^{-1}) deceleration or acceleration = 0	B1	
			Total	**9**	

Question			Answer	Marks	Guidance
6	(a)		work done = force × distance <u>moved</u> in the direction of force	B1	**Allow**: work done = force × displacement in direction of force
	(b)	(i)	mass = 700/9.81 or mass = 71.4 (kg) kinetic energy = ½ × 71.4 × 15^2 kinetic energy = 8.0×10^3 (J)	C1 A1	 **Note**: Answer to 3 sf is 8.03×10^3 (J) **Note**: '½ × 700 × 15^2 = 7.9×10^4' scores zero **Allow**: 1 sf answer
		(ii)	GPE = *mgh* 700 × 32 / 2.24×10^4 (J) work done = $2.24 \times 10^4 - 8.03 \times 10^3$ resistive force = $\frac{1.44 \times 10^4}{120}$ resistive force = 120 (N)	 C1 C1 A1	 Possible ecf **Note**: Dividing the work done by 32 (m) gives 450 (N). This answer scores 2 marks.
			Total	**6**	

Question			Answer	Marks	Guidance
7	(a)		Object moves into region 3 (net) force to left / 1 (N) to the left / 8 (N) > 7 (N) and (net) force down / 2 (N) down / 12 (N) > 10 (N)	M1 A1	 **Allow** use of labelled arrows, e.g ↓ 2 (N)
	(b)		(When an object is in equilibrium the) sum of clockwise moments (about a point) = sum of anticlockwise moments (about the same point)	B1	**Allow**: summation sign Σ
	(c)		50 × 46 = weight × 14 weight = 164 (N) mass = 164/9.81 mass = 16.7 (kg) or 17 (kg)	C1 C1 A1	 Possible ecf for weight calculated. **Note**: Using '50 × 46 = weight × 32' gives an incorrect weight of 71.9 (N). However, 1 mark can be scored through ecf for a mass of 7.3 (kg) **Allow**: 3 marks for 'weight = 160 N, mass = 16.3 kg or 16 kg'
			Total	**6**	

Question			Answer	Marks	Guidance
8	(a)		The graph is a straight line through the origin / *F* proportional to *x* / force is proportional to extension	B1	**Use ticks on Scoris to show where the marks are awarded** ✍ ***origin*** / ***proportional*** must be spelled correctly to gain the mark **Not**: $F \propto x$
	(b)		force constant	B1	**Allow**: spring constant
	(c)		stress = $\frac{100}{\pi \times (2.8\times10^{-4})^2}$ (= 4.06×10^8 Pa) strain = $\frac{4.0\times10^{-3}}{1.60}$ (= 2.5×10^{-3}) $E = \frac{4.06\times10^{8}}{2.5\times10^{-3}}$ Young modulus = 1.6×10^{11} (Pa)	C1 C1 A1	**Allow** use of any other point on the graph. **Alternative method:** $E = \frac{FL}{Ax}$ C1 (Any subject) $E = \frac{100\times1.60}{\pi\times(2.8\times10^{-4})^2\times4.0\times10^{-3}}$ C1 $E = 1.6 \times 10^{11}$ (Pa) A1 **Allow** 2 marks for 1.6×10^n, $n \neq 11$ (POT error)
	(d)		(Straight line) with quarter gradient Correct reasoning, for example: • gradient = *EA*/*L* and *A* decreases by a factor of 4 • *A* decreases by a factor of 4 and the same force gives 4 times the extension	B1 B1	**Note**: No need to define the labels
	(e)		½ kx^2 = ½ mv^2 Manipulation leading to $v \propto x$, for example: • taking square root of both sides (gives $v \propto x$) • $v^2 \propto x^2$ (hence $v \propto x$) • $v = (\sqrt{k/m})x$ (and therefore $v \propto x$)	M1 A1	**Note**: No need to define the labels
			Total	**9**	

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