OCR
RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced GCE

Unit **G484:** The Newtonian World

Mark Scheme for January 2012

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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.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

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

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

The use of ticks to indicate where marks are awarded is strongly advised in all questions but the following questions **must always** be annotated with ticks.
Q3(a)(i), Q4(a), Q5(a)(ii), Q5(a)(iii)

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 answers to 2 or more significant figures.

(Significant figures are rigorously assessed in the practical skills.)

Question			Answer	Marks	Guidance
1	(a)	(i)	(linear momentum =) mass x velocity	B1	**Allow**: momentum = *m v* where *m* is mass and *v* is velocity **Not**: mass x speed
		(ii)	Any **two** from: momentum / vector has magnitude and direction velocity is a vector A product of a scalar and vector is a vector	B1 x 2	
	(b)	(i)1	$a = \Delta v / \Delta t = 7.5 / 0.28$ $a = 27$ (m s^{-2})	A1	Ignore sign
		2	$F = ma$ $F = 850 \times 27$ $= 2.3 \times 10^4$ (N)	C1 A1	Possible ecf from b(i) for acceleration
		(ii)	$E = \frac{1}{2}mv^2$ $0.45 \times 10^6 = ½ \times 850 \times v^2$ $v = \sqrt{(2 \times 0.45 \times 10^6 / 850)}$ $v = 33$ (m s^{-1})	C1 A1	Mark is for correct substitution **Note**: Possible POT error
	(c)		$m_1u = (m_1 + m_2)v$ $850 \times 7.5 = (850 + 1200)\ v$ $v = 850 \times 7.5 / 2050$ $v = 3.1$ (m s^{-1})	C1 A1	Mark is for correct substitution
			Total	**10**	

Question			Answer	Marks	Guidance
2	(a)	(i)	amplitude = 0.4(0) (m) **and** period = 5.(0) (s)	B1	**Note**: Both values are required. **Allow** 1 sf values
		(ii)	$\omega = (2\pi f) = 2\pi / \tau$ $\omega = 2\pi / 5.0 = (2\pi \times 0.2)$ $\omega = 1.3$ (rad s^{-1})	 C1 A1	Possible ecf from a(i) for period Mark is for correct substitution
	(b)	(i)	V clearly marked at any point where graph crosses time axis	B1	
		(ii)	A clearly marked at any point where graph crosses time axis	B1	
		(iii)	P clearly marked at any point where graph crosses time axis	B1	
	(c)	(i)	Selecting from data sheet $a = -(2\pi f)^2 x$ $a_{max} = (-)(2\pi \times 2.4 \times 10^3)^2 \times 1.8 \times 10^{-3}$ $a_{max} = 4.1 \times 10^5$ (m s^{-2})	C1 C1 A1	**Allow**: $a = (-)\omega^2 x$ **Note**: Ignore sign of a **Allow**: 2 marks for 4.1×10^n, $n \neq 5$ [POT error]
		(ii)	Work done = mean force x distance moved For ¼ oscillation distance moved = 1.8 mm, Work done $= 0.25 \times 1.8 \times 10^{-3}$ ($= 4.5 \times 10^{-4}$ J) Time taken $\Delta t = ¼ T = ¼ (1/2.4 \times 10^3) = 1.04 \times 10^{-4}$ Power = work done / $\Delta t = 0.25 \times 1.8 \times 10^{-3} / 1.04 \times 10^{-4}$ = **4.3 W** Power = 4.3 (W)	 C1 C1 A1	**Allow:** other correct values of distance moved and compatible time taken. Eg 7.2 (mm) and 4.17×10^{-4} (s) for 1 complete oscillation
			Total	**12**	

Question			Answer	Marks	Guidance
3	(a)	(i)	**geostationary** or **synchronous** **The term geostationary** or **synchronous to be included and spelled correctly to gain the B1 mark**	B1	**Must use tick or cross on Scoris to show if the mark is awarded**
		(ii)	So that they stay: above the same point (at all times) at same point in the sky	B1	**Allow**: travel at same (angular) speed / period and same direction as the Earth
		(iii)	Dish can be fixed to point in one (specific) direction/ Dish does not have to track the satellite (across the sky)	B1	**Allow**: Receiver / aerial for dish
		(iv)	Select from data sheet $T^2 = (4\pi^2/GM)r^3$ $r^3 = T^2 (GM/4\pi^2)$ $r^3 = (8.64 \times 10^4)^2 (6.67 \times 10^{-11} \times 6.0 \times 10^{24} / 4\pi^2)$ any subject $(= 7.56 \times 10^{22})$ $r = 4.2 \times 10^7$ (m) $r \approx 4 \times 10^7$ (m)	C1 C1 A1 A0	**Allow**: Full credit if candidate assumes r = 4×10^7 and shows T is approx 1 day. 1 day = 8.64×10^4 s G = 6.67×10^{-11} N m^2 kg^{-2} Mark for radius can only be awarded if suitable working is shown
	(b)	(i)	The cube of the planets distance (from the Sun) divided by the square of the (orbital) period is the same (for all planets) (WTTE)	B1	**Allow**: radius for distance., **Allow:** $T^2 \propto r^3$ or r^3 / T^2 = constant provided *T* and *r* are identified
		(ii)	$\text{ratio}^3 = \left(\frac{27.3}{1}\right)^2$ $\text{ratio} = (27.3)^{2/3}$ ratio = 9.1	C1 A1	**Allow:** 1 mark for correct value of distance of Moon from Earth's centre 3.8×10^8(m) **Note**: Full credit for 4×10^7 (m) used from (a)(iv)
			Total	**9**	

Question			Answer	Marks	Guidance
4	(a)		latent heat of **fusion** ✍**The term fusion to be included and spelled correctly to gain the B1 mark**	B1	**Allow**: Specific latent heat of fusion **Allow**: (Specific) latent energy of fusion **Must use tick or cross on Scoris to show if the mark is awarded**
	(b)	(i)	Total / sum of randomly (distributed) kinetic energy and potential energy of molecules/atoms	B2	**Allow**: 1 mark only if molecules / atoms and/or randomly are omitted
		(ii)	Potential energy of the molecules increases Kinetic energy of molecules is the same for water and steam (since the temperature is the same) / work is done in moving molecules apart	B1 B1	**Allow** : work is done to break the bonds (between molecules)
	(c)	(i)	Mass of air = volume x density = 15 x 1.2 (= 18 kg) Heat energy transferred to air in one hour Q = 12 x 60 x 60 (= 43200 J) $\Delta\theta = Q / mc$ = 12 x 60 x 60 / 18 x 990 Temperature rise in one hour = 2.4 K	C1 C1 A1	 **Allow**: any subject Treat a transcription error as one AE. **Allow**: 2 K as question asks for an estimate
		(ii)	Any **two** from • Heat lost to structure of greenhouse / contents • Heat lost through glass / from the greenhouse / surroundings • Average rate of loss of heat reduces (as temperature falls)	B1 x 2	
			Total	**10**	

Question			Answer	Marks	Guidance
5	(a)	(i)	Collision in which kinetic energy is conserved	B1	**Allow**: no ke lost (wtte)
		(ii)	Any **four** from • Many molecules collide with the walls • A change in momentum occurs when molecule(s) collide with (and rebound from) the walls of container • Force is rate of change of momentum • The force exerted by the molecule(s) on wall is equal to force exerted by the wall on the molecule(s) (by Newton's third law) • pressure (on wall) = (total) force (on wall) / area (of wall)	B1 x 4	Symbols must be defined in formulae
		(iii)	Any **two** from • Molecules move faster/have greater kinetic energy (at higher temperature) • There is an increased rate of collision / more collisions occur per second / collisions occur more often • Each collision involves a greater change in momentum	B1 x 2	**Not**: greater force **Not**: harder collisions
	(b)	(i)	$P_1V_1/T_1 = P_2V_2/T_2$ with T stated in Kelvin or clearly shown in subsequent working $P_2 = 105 \times 5\times10^3 \times (273 - 30)/(273 + 20) \times 1.2 \times 10^4$ $P_2 = 36$ (kPa)	C1 C1 A1	Temperatures must be in kelvin to score this mark. **Allow** : consistent working in pascal
		(ii)	Risk that balloon will burst (with further increase in volume)	B1	**Allow**: pop / explode
			Total	**11**	

Question			Answer	Marks	Guidance
6	(a)		Mass of one hydrogen molecule = $2.02 \times 10^{-3} / 6.02 \times 10^{23}$ Mass = 3.4×10^{-27} **(**kg)	C1 A1	
	(b)		Mean k.e = $3kT/2$ Mean ke = $3/2 \times 1.38 \times 10^{-23} \times 1100$ Mean ke = 2.3×10^{-20} (J) Mean ke ≈ 2×10^{-20} (J)	 B1 B1 A0	
	(c)		$E_k = ½ mv^2$ $2.3 \times 10^{-20} = ½ \times 6.6 \times 10^{-27} v^2$ $v^2 = (2 \times 2.3 \times 10^{-20} / 6.6 \times 10^{-27})$ $v = (2 \times 2.3 \times 10^{-20} / 6.6 \times 10^{-27})^{1/2}$ $v = 2.6 \times 10^3$ (m s^{-1})	 M1 A1	**Note**: Full credit to be given for the use of 2×10^{-20} (J) from (b) giving $v = 2.5 \times 10^3$ (ms^{-1}) **Note:** If 3.36×10^{-27} is used from (a) (hydrogen molecules) then speed = 3.68×10^3 m s^{-1} and scores max 1 mark
	(d)		Helium atoms have a range of speeds / kinetic energies Hence some atoms have a velocity greater than 11 km s^{-1} / escape velocity	M1 A1	Accept equivalent wording or suitable diagram .
			Total	**8**	

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

www.ocr.org.uk

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Facsimile: 01223 552553