



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.

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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 |

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| 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 |
| <u> </u> | 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)

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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.)

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| Question | | | Answer | Marks | Guidance |
|--------------|-----|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------------------------------------------------------------------------------|
| 1 | (a) | (i) | (linear momentum =) mass x <u>velocity</u> | B1 | Allow: momentum = $m v$ where m is <u>mass</u> and v is <u>velocity</u> 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 | $a = \Delta v / \Delta t = 7.5 / 0.28$ $a = 27 \text{ (m s}^{-2}\text{)}$ | A1 | Ignore sign |
| | | 2 | $F = ma$ $F = 850 \times 27$ $= 2.3 \times 10^4 \text{ (N)}$ | C1 A1 | Possible ecf from b(i) for acceleration |
| | | (ii) | $E = \frac{1}{2}mv^2$ $0.45 \times 10^6 = \frac{1}{2} \times 850 \times v^2$ $v = \sqrt{(2 \times 0.45 \times 10^6 / 850)}$ $v = 33 \text{ (m s}^{-1}\text{)}$ | C1 A1 | Mark is for correct substitution Note: Possible POT error |
| | (c) | | $m_1u = (m_1 + m_2)v$ $850 \times 7.5 = (850 + 1200) v$ $v = 850 \times 7.5 / 2050$ $v = 3.1 \text{ (m s}^{-1}\text{)}$ | C1 A1 | Mark is for correct substitution |
| Total | | | | 10 | |

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| Question | | | Answer | Marks | Guidance |
|----------|-----|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 | (a) | (i) | amplitude = 0.4(0) (m) and period = 5.(0) (s) | B1 | Note: <u>Both</u> values are required. Allow 1 sf values |
| | | (ii) | $\omega = (2\pi f) = 2\pi / \tau$ $\omega = 2\pi / 5.0 = (2\pi \times 0.2)$ $\omega = 1.3 \text{ (rad s}^{-1}\text{)}$ | 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 $a = - (2\pi f)^2 x$ $a_{\max} = (-)(2\pi \times 2.4 \times 10^3)^2 \times 1.8 \times 10^{-3}$ $a_{\max} = 4.1 \times 10^5 \text{ (m s}^{-2}\text{)}$ | 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 $\frac{1}{4}$ oscillation distance moved = 1.8 mm, Work done = $0.25 \times 1.8 \times 10^{-3} (= 4.5 \times 10^{-4} \text{ J})$ Time taken $\Delta t = \frac{1}{4} T = \frac{1}{4} (1/2.4 \times 10^3) = 1.04 \times 10^{-4}$ Power = work done / $\Delta t = 0.25 \times 1.8 \times 10^{-3} / 1.04 \times 10^{-4} = 4.3 \text{ W}$ 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 | |

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| 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) | <u>Dish</u> can be fixed to point in one (specific) direction/ <u>Dish</u> 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 X 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 $r = 4 \times 10^7$ and shows T is approx 1 day. 1 day = 8.64×10^4 s $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ 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 $r^3/T^2 = \text{constant}$ provided T and r are <u>identified</u> |
| | | (ii) | ratio ³ = $\left(\frac{27.3}{1}\right)^2$ 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 | |

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| Question | | Answer | Marks | Guidance |
|----------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | (a) | <p>latent heat of fusion</p> <p> The term fusion to be included and spelled correctly to gain the B1 mark</p> | B1 | <p>Allow: Specific latent heat of fusion</p> <p>Allow: (Specific) latent energy of fusion</p> <p>Must use tick or cross on Scoris to show if the mark is awarded</p> |
| | (b) | (i) | B2 | Allow: 1 mark only if molecules / atoms and/or randomly are omitted |
| | | (ii) | B1 B1 | Allow : <u>work is done</u> to break the bonds (between molecules) |
| | (c) | (i) | C1 C1 A1 | <p>Allow: any subject</p> <p>Treat a transcription error as one AE.</p> <p>Allow: 2 K as question asks for an estimate</p> |
| | | (ii) | B1 x 2 | |
| | | | Total | 10 |

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| Question | | | Answer | Marks | Guidance |
|--------------|-----|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------------------------------------------------------------------------------------------|
| 5 | (a) | (i) | Collision in which <u>kinetic</u> energy is conserved | B1 | Allow: no ke lost (wtte) |
| | | (ii) | Any four from <ul style="list-style-type: none"> • <u>Many</u> 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 <ul style="list-style-type: none"> • Molecules move faster/have greater <u>kinetic</u> energy (at higher temperature) • There is an increased <u>rate</u> of collision / more collisions occur <u>per second</u> / collisions occur <u>more often</u> • Each collision involves a greater change in momentum | B1 x 2 | Not: greater force Not: harder collisions |
| | (b) | (i) | $P_1 V_1 / T_1 = P_2 V_2 / T_2$ with T stated in Kelvin or clearly shown in subsequent working $P_2 = 105 \times 5 \times 10^3 \times (273 - 30) / (273 + 20) \times 1.2 \times 10^4$ $P_2 = 36 \text{ (kPa)}$ | 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 | |

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| 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 $\approx 2 \times 10^{-20}$ (J) | B1 B1 A0 | |
| | (c) | $E_k = \frac{1}{2} mv^2$ $2.3 \times 10^{-20} = \frac{1}{2} \times 6.6 \times 10^{-27} v^2$ $v^2 = (2 \times 2.3 \times 10^{-20} / 6.6 \times 10^{-27})$ $v = (2 \times 2.3 \times 10^{-20} / 6.6 \times 10^{-27})^{1/2}$ $v = 2.6 \times 10^3$ (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 | |

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