

# **Mark Scheme for June 2010**

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| Question  | Expected Answers                                                                                                                                                                                                                                                                                                                       | Marks              | Additional guidance                                                                                              |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------------------------------------------------------------------------------------------------------|
| 1(a)      | The magnitude of the impulse on each object is the same<br>Total energy is conserved                                                                                                                                                                                                                                                   | B1<br>B1           | For 3 or 4 ticks mark and deduct 1 mark for each error.                                                          |
| (b) (i)   | Correct use of $\frac{1}{2}mv^2$<br>Loss of KE = $0.03(144-81) = \mathbf{1.9}$ (or 1.89) <b>J</b>                                                                                                                                                                                                                                      | C1<br>A1           | 0.27 J scores 1 <sup>st</sup> mark<br>Do not allow 1.8                                                           |
| (b) (ii)  | Change in momentum = $(0.06 \times 12) + (0.06 \times 9) = 1.26$ (Ns)<br>Average force = rate of change of momentum = $1.26/0.15 = \mathbf{8.4}$ (or 8) <b>N</b>                                                                                                                                                                       | C1<br>A1           | Award 1 mark for 1.2 N<br>ignore minus signs                                                                     |
| (b) (iii) | <b>8.4 N</b> (or - 8.4)                                                                                                                                                                                                                                                                                                                | B1                 | Allow ecf from (ii)                                                                                              |
| (c) (i)   | ANY 3 of the following<br>particles move with <u>rapid, random</u> motion (WTTE)<br>elastic collisions<br>negligible (or zero) volume of atoms (compared with volume of container)<br>no intermolecular forces (except during collisions)/all internal energy is KE<br>collision time negligible (compared to time between collision). | B1<br>B1<br>B1     | Allow<br>“gravitational force on molecules is negligible”<br>Do not allow a bare<br>“large number of particles”. |
| (c) (ii)  | molecules make <u>collisions with walls/surface</u> (WTTE)<br>(hence) exerts a force on the wall (or each collision has a change of momentum)<br>Pressure = force/area                                                                                                                                                                 | B1<br><br>B1<br>B1 | Do not allow a bare “molecules collide with each other”                                                          |
| Total     |                                                                                                                                                                                                                                                                                                                                        | 13                 |                                                                                                                  |

| Question  | Expected Answers                                                                                                                                                                                                                                                                                     | Marks          | Additional guidance                                                                                                                                    |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 (a) (i) | Horizontal <u>component</u> of <b>L</b> provides the centripetal force (WTTE)<br>Vertical <u>component</u> of <b>L</b> balances the weight (WTTE)                                                                                                                                                    | B1<br>B1       |                                                                                                                                                        |
| (a) (ii)  | $F = mv^2/r$ correct rearranged into $v = \sqrt{(Fr/m)}$<br>$v = \sqrt{(1.8 \times 10^6 \times 2000 / 1.2 \times 10^5)} = \mathbf{173 \text{ m s}^{-1}}$ (or 170)                                                                                                                                    | C1<br>A1       | Allow correct substitution of values into $F = mv^2/r$ for C1 mark                                                                                     |
| (b)       | $mv^2/r = GMm/r^2$<br>$T = 2\pi r/v$<br>Correct manipulation of equations to give $T^2 = \frac{4\pi^2 r^3}{GM}$                                                                                                                                                                                      | B1<br>M1<br>A1 | Do not allow a bare $v^2 = GM/r$ for the first mark – we need to see where this has come from.                                                         |
| (c) (i)   | <b>Equatorial</b> orbit (WTTE) (QWC mark)<br>Period is 24h/1day/same as Earth <b>OR</b> moves from West to East (WTTE)                                                                                                                                                                               | B1<br>B1       | QWC <u>equatorial</u> or <u>equator</u> must be spelled correctly                                                                                      |
| (c) (ii)  | Correct rearrangement of $T^2 = (4\pi^2 r^3 / GM)$ to give $r^3 = T^2 GM / 4\pi^2$<br>correct sub. $r^3 = \{6.67 \times 10^{-11} \times 6.0 \times 10^{24} \times (8.64 \times 10^4)^2\} / 4\pi^2 = 7.57 \times 10^{22}$<br>$r = \mathbf{4.23 \times 10^7 \text{ m}}$ (or 4.2 or $4.3 \times 10^7$ ) | C1<br>C1<br>A1 | (1 day = $8.64 \times 10^4$ s is given on the data sheet).<br>For those who use $g = GM/r^2$ with $g = 9.81$ award 1 mark for $r = 6.4 \times 10^6$ m. |
|           | Total                                                                                                                                                                                                                                                                                                | 12             |                                                                                                                                                        |

| Question  | Expected Answers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Marks                                                    | Additional guidance                                                                                                                                                                                                        |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3(a)      | Acceleration is (directly) proportional to the displacement/distance (from the equilibrium position/central pt)<br><br>Acceleration is always directed towards the equilibrium position/central point.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | B1<br><br>B1                                             | Allow “fixed point” or “point”<br>Allow acc. is in opposite direction to displacement (WTTE)<br>If formula is used: allow $a \propto -x$ for 1 <sup>st</sup> mark and 2 <sup>nd</sup> mark if x is stated as displacement. |
| (b) (i)   | Curve symmetrical about energy axis with maximum at 18 zero at +0.04 and – 0.04                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | B1<br>B1                                                 | Ignore points where graphs cross<br>Give bod if not labelled <b>K</b> but correct                                                                                                                                          |
| (b) (ii)  | Horizontal straight line passing 18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | B1                                                       | Give bod if not labelled <b>T</b> but correct                                                                                                                                                                              |
| (c) (i)   | 0.04 m                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | B1                                                       |                                                                                                                                                                                                                            |
| (c) (ii)  | $\frac{1}{2}m(v_{\max})^2 = 0.018$<br>$v_{\max} = \sqrt{(2 \times 0.018 / 0.12)} = \mathbf{0.55} \text{ ms}^{-1} (0.548)$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | C1<br>A1                                                 | Many will use 18 instead of 0.018. This results in 17.3 and scores 1 mark.<br>Allow ecf for cand's value of max KE.<br>Do not allow 0.54 for second mark.                                                                  |
| (c) (iii) | correct use of $v_{\max} = 2\pi fA$<br><br>$f = (0.55 / 0.04 \times 2\pi) = \mathbf{2.2}$ (or 2.19 or 2.18)Hz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | C1<br><br>A1                                             | Allow ecf for cand's values from (c)(i) and/or (c) (ii). E.g for 17.3 $f = 68.8 \text{ Hz}$ . This scores 2 marks e.c.f.<br>Do not allow 2.1                                                                               |
| (d)       | Award first mark for stating the ‘ <b>driver</b> ’ of the oscillations and the second mark for stating what is ‘ <b>driven</b> ’ i.e. oscillating useful applications: e.g.<br>Cooking: <u>micro waves</u> cause <u>water molecules</u> to resonate<br>Woodwind: <u>reed</u> causes <u>air column</u> to resonate<br>Brass: <u>lips</u> cause <u>air column</u> to resonate<br>MRI: <u>radio waves</u> (in a magnetic field) cause <u>nuclei/proton</u> to resonate<br>Radios: <u>radio waves</u> cause <u>electrons/current</u> to resonate<br>Person on swing: <u>intermittent pushes</u> cause <u>swing</u> to resonate<br><br>problem:<br>Bridges: <u>wind/walkers</u> causes <u>bridge</u> to resonate<br>Vehicles: <u>engine vibrations</u> cause <u>panels/mirrors</u> to resonate<br>Earthquakes: <u>ground vibrating</u> causes <u>buildings</u> to resonate | B1<br>B1<br><br><br><br><br><br><br><br><br><br>B1<br>B1 | No marks to be awarded for a bare statement of the example e.g MRI.<br><br>Please allow any other valid examples.                                                                                                          |
|           | Total                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 14                                                       |                                                                                                                                                                                                                            |

| Question   | Expected Answers                                                                                                                                                                                                                                  | Marks                | Additional guidance                                                                                                                                                                        |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 (a) (i)  | <b>Brownian</b> (motion) (QWC mark)                                                                                                                                                                                                               | B1                   | QWC <u>Brownian</u> spelled correctly                                                                                                                                                      |
| (a) (ii)   | ANY two from the following three:<br>air molecules are moving in different directions/randomly with different speeds<br>mass/size of air molecules is smaller than smoke particles                                                                | B1<br>B1             | Answers that refer to smoke particles only cannot score the marks.                                                                                                                         |
| (b) (i)    | vol = $(4/3) \pi r^3 = 5.58 \times 10^{-3}$<br>correct sub into $pV = nRT$ i.e. with T as 290K<br>$n = (2.6 \times 10^5 \times 5.58 \times 10^{-3}) / (8.31 \times 290) = 0.602$ moles<br>mass = $n \times 0.028 = \mathbf{0.0169}$ kg (0.016856) | C1<br>C1<br>A1<br>A1 | Allow ecf for wrong volume<br>Allow use of $pV = NkT$ and $n = N/N_A$<br>Allow ecf for cand's value for n<br>If 17° C used allow maximum of 2 marks for $n = 10.3$ moles and $m = 0.29$ kg |
| (b) (ii) 1 | no net heat flow between objects (WTTE)                                                                                                                                                                                                           | B1                   | Allow "they are at the same temp."                                                                                                                                                         |
| (b) (ii) 2 | correct use of $P/T = \text{constant}$ : e.g. $P = (273/290) \times 2.6 \times 10^5$<br>$P = \mathbf{2.45 \times 10^5}$ (or $2.4 \times 10^5$ or $2.5 \times 10^5$ ) Pa                                                                           | C1<br>A1             | Allow correct use of $pV = nRT$                                                                                                                                                            |
| Total      |                                                                                                                                                                                                                                                   | 10                   |                                                                                                                                                                                            |

| Question  | Expected Answers                                                                                                                                                                                                                                    | Marks                    | Additional guidance                                                                                                                                                                                                                                                                                         |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5(a) (i)  | Initial KE of car = $0.5 \times 970 \times 27^2 = \mathbf{3.5 \times 10^5 \text{ J}}$ (353565J)                                                                                                                                                     | B1                       |                                                                                                                                                                                                                                                                                                             |
| (a) (ii)  | Work done = Av Force x distance moved<br>Av Force = $3.5 \times 10^5 \text{ J} / 40 = \mathbf{8.8 \times 10^3 \text{ N}}$ ( or 8750 N)<br>(or $353565 / 40 = 8836.7 \text{ N}$ )<br>Assumption: <b>no air resistance</b>                            | C1<br>A1<br>B1           | If $v^2 = u^2 + 2as$ is used. accept<br>$a = 0.27^2 / (2 \times 40) = 9.113 \text{ ms}^{-2}$ C1<br>$F = ma = 970 \times 9.11 = 8.84 \times 10^3 \text{ N}$ A1<br>Allow air friction or drag                                                                                                                 |
| (b) (i)   | correct use of $E = mc\Delta\theta$ : $3.5 \times 10^5 / 4 = 1.2 \times 520 \times \Delta\theta$<br>$\Delta\theta = \mathbf{140^\circ\text{C}}$ (if 353565 is used $\Delta\theta = 142^\circ\text{C}$ )                                             | C1<br>A1                 | If cand. forgets to divide by 4 allow any value between 560 and 570 for 1 mark.                                                                                                                                                                                                                             |
| (b) (ii)  | <u>Air resistance</u> will be acting (slowing down the car)<br>(hence) <u>reducing the KE of the car</u> (WTTE)<br><br>The <u>discs are hotter</u> than the surroundings<br>(hence) <u>energy/heat</u> will be lost from <u>discs/brakes</u> (WTTE) | M1<br>A1<br><br>B1<br>B1 | Do not allow sound since only a tiny proportion of energy is lost in this way.<br>Allow other valid comments as alternative ways of scoring one or both of the 'B' marks: e.g. 'hot spots' on discs; discs are different. Try to credit a well argued case based upon correct physics- e.g. wheels locking. |
| (b) (iii) | Any valid suggestion: e.g. use a material with a higher s.h.c<br>use a disc with a higher heat capacity<br>Use discs of greater mass<br>put holes in the discs (to increase air flow)                                                               | B1                       | Confusion between shc and heat capacity should not be penalised.                                                                                                                                                                                                                                            |
| Total     |                                                                                                                                                                                                                                                     | 11                       |                                                                                                                                                                                                                                                                                                             |

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