

**Physics A**

Advanced GCE **G484**

The Newtonian World

**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 Total energy is conserved	B1 B1	For 3 or 4 ticks mark and deduct 1 mark for each error.
(b) (i)	Correct use of $\frac{1}{2}mv^2$ Loss of KE = $0.03(144-81) = \mathbf{1.9}$ (or 1.89) J	C1 A1	0.27 J scores 1 <sup>st</sup> mark Do not allow 1.8
(b) (ii)	Change in momentum = $(0.06 \times 12) + (0.06 \times 9) = 1.26$ (Ns) Average force = rate of change of momentum = $1.26/0.15 = \mathbf{8.4}$ (or 8) N	C1 A1	Award 1 mark for 1.2 N 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 particles move with <u>rapid, random</u> motion (WTTE) elastic collisions negligible (or zero) volume of atoms (compared with volume of container) no intermolecular forces (except during collisions)/all internal energy is KE collision time negligible (compared to time between collision).	B1 B1 B1	Allow “gravitational force on molecules is negligible” Do not allow a bare “large number of particles”.
(c) (ii)	molecules make <u>collisions with walls/surface</u> (WTTE) (hence) exerts a force on the wall (or each collision has a change of momentum) Pressure = force/area	B1 B1 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) Vertical <u>component</u> of <b>L</b> balances the weight (WTTE)	B1 B1	
(a) (ii)	$F = mv^2/r$ correct rearranged into $v = \sqrt{(Fr/m)}$ $v = \sqrt{(1.8 \times 10^6 \times 2000 / 1.2 \times 10^5)} = \mathbf{173 \text{ m s}^{-1}}$ (or 170)	C1 A1	Allow correct substitution of values into $F = mv^2/r$ for C1 mark
(b)	$mv^2/r = GMm/r^2$ $T = 2\pi r/v$ Correct manipulation of equations to give $T^2 = \frac{4\pi^2 r^3}{GM}$	B1 M1 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) ( <u>QWC</u> mark) Period is 24h/1day/same as Earth <b>OR</b> moves from West to East (WTTE)	B1 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 $r^3 = T^2 GM / 4\pi^2$ correct sub. $r^3 = \{6.67 \times 10^{-11} \times 6.0 \times 10^{24} \times (8.64 \times 10^4)^2\} / 4\pi^2 = 7.57 \times 10^{22}$ $r = \mathbf{4.23 \times 10^7 \text{ m}}$ (or 4.2 or $4.3 \times 10^7$ )	C1 C1 A1	(1 day = $8.64 \times 10^4$ s is given on the data sheet). 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)  Acceleration is always directed towards the equilibrium position/central point.	B1  B1	Allow “fixed point” or “point” Allow acc. is in opposite direction to displacement (WTTE) 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 B1	Ignore points where graphs cross 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)	$\frac{1}{2}m(v_{\max})^2 = 0.018$ $v_{\max} = \sqrt{(2 \times 0.018 / 0.12)} = \mathbf{0.55} \text{ ms}^{-1}$ (0.548)	C1 A1	Many will use 18 instead of 0.018. This results in 17.3 and scores 1 mark. Allow ecf for cand's value of max KE. Do not allow 0.54 for second mark.
(c) (iii)	correct use of $v_{\max} = 2\pi fA$  $f = (0.55/0.04 \times 2\pi) = \mathbf{2.2}$ (or 2.19 or 2.18)Hz	C1  A1	Allow ecf for cand's values from (c)(i) and/or (c) (ii). E.g for 17.3 $f = 68.8$ Hz. This scores 2 marks e.c.f. 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. Cooking: <b>micro waves</b> cause <b>water molecules</b> to resonate Woodwind: <b>reed</b> causes <b>air column</b> to resonate Brass: <b>lips</b> cause <b>air column</b> to resonate MRI: <b>radio waves</b> (in a magnetic field) cause <b>nuclei/proton</b> to resonate Radios: <b>radio waves</b> cause <b>electrons/current</b> to resonate Person on swing: <b>intermittent pushes</b> cause <b>swing</b> to resonate  problem: Bridges: <b>wind/walkers</b> causes <b>bridge</b> to resonate Vehicles: <b>engine vibrations</b> cause <b>panels/mirrors</b> to resonate Earthquakes: <b>ground vibrating</b> causes <b>buildings</b> to resonate	B1 B1          B1 B1	No marks to be awarded for a bare statement of the example e.g MRI.  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: air molecules are moving in different directions/randomly with different speeds mass/size of air molecules is smaller than smoke particles	B1 B1	Answers that refer to smoke particles only cannot score the marks.
(b) (i)	vol = $(4/3) \pi r^3 = 5.58 \times 10^{-3}$ correct sub into $pV = nRT$ i.e. with T as 290K $n = (2.6 \times 10^5 \times 5.58 \times 10^{-3}) / 8.31 \times 290 = 0.602$ moles mass = $n \times 0.028 = \mathbf{0.0169}$ kg (0.016856)	C1 C1 A1 A1	Allow ecf for wrong volume Allow use of $pV = NkT$ and $n = N/N_A$ Allow ecf for cand's value for n 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. $P = (273/290) \times 2.6 \times 10^5$ $P = \mathbf{2.45 \times 10^5}$ (or $2.4 \times 10^5$ or $2.5 \times 10^5$ ) Pa	C1 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 Av Force = $3.5 \times 10^5 \text{ J} / 40 = \mathbf{8.8 \times 10^3 \text{ N}}$ ( or 8750 N) (or $353565 / 40 = 8836.7 \text{ N}$ ) Assumption: <b>no air resistance</b>	C1 A1 B1	If $v^2 = u^2 + 2as$ is used. accept $a = 0.27^2 / (2 \times 40) = 9.113 \text{ ms}^{-2}$ C1 $F = ma = 970 \times 9.11 = 8.84 \times 10^3 \text{ N}$ A1 Allow air friction or drag
(b) (i)	correct use of $E = mc\Delta\theta$ : $3.5 \times 10^5 / 4 = 1.2 \times 520 \times \Delta\theta$ $\Delta\theta = \mathbf{140^\circ\text{C}}$ (if 353565 is used $\Delta\theta = 142^\circ\text{C}$ )	C1 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) (hence) <u>reducing the KE of the car</u> (WTTE)  The <u>discs are hotter</u> than the surroundings (hence) <u>energy/heat</u> will be lost from <u>discs/brakes</u> (WTTE)	M1 A1  B1 B1	Do not allow sound since only a tiny proportion of energy is lost in this way. 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 use a disc with a higher heat capacity Use discs of greater mass 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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