RECOGNISING ACHIEVEMENT

GCE

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 ½ mv^2 Loss of KE = 0.03(144-81) = **1.9** (or 1.89) **J**	C1 A1	0.27 J scores 1st mark Do not allow 1.8
(b) (ii)	Change in momentum = (0.06x12)+(0.06x9) = 1.26 (Ns) Average force=rate of change of momentum = 1.26/0.15 = **8.4** (or 8) **N**	C1 A1	Award 1 mark for 1.2 N ignore minus signs
(b) (iii)	**8.4 N** (or - 8.4)	B1	Allow ecf from (ii)
(c) (i)	ANY 3 of the following particles move with rapid, random 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 collisions with walls/surface (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 component of **L** provides the centripetal force (WTTE) Vertical component of **L** balances the weight (WTTE)	B1 B1	
(a) (ii)	$F = mv^2/r$ correct rearranged into $v = \sqrt{(Fr/m)}$ $v = \sqrt{(1.8 \times 10^6 \times 2000 / 1.2 \times 10^5)} =$ **173** 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)	**Equatorial** orbit (WTTE) (QWC mark) Period is 24h/1day/same as Earth **OR** moves from West to East (WTTE)	B1 B1	QWC equatorial or equator must be spelled correctly
(c) (ii)	Correct rearrangement of $T^2 = (4\pi^2 r^3/GM)$ to give $r^3 = T^2GM/4\pi^2$ correct sub. $r^3 = \{6.67 \times 10^{-11} \times 6.0 \times 10^{24} \times (8.64 \times 10^4)^2\}/4\pi^2 = 7.57 \times 10^{22}$ $r =$ **4.23×10^7 m** (or 4.2 or 4.3 x 10^7)	C1 C1 A1	(1 day = 8.64 x 10^4s 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 x 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 1st mark and 2nd 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 **K** but correct
(b) (ii)	Horizontal straight line passing 18	B1	Give bod if not labelled **T** but correct
(c) (i)	0.04 m	B1	
(c) (ii)	$\frac{1}{2}m(v_{max})^2 = 0.018$ $v_{max} = \sqrt{(2x0.018/0.12)} =$ **0.55** 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 $v_{max} = 2\pi fA$ $f = (0.55/0.04x2\pi) =$ **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 **'driver'** of the oscillations and the second mark for stating what is **'driven'** i.e. oscillating useful applications: e.g. Cooking: **micro waves** cause **water molecules** to resonate Woodwind: **reed** causes **air column** to resonate Brass: **lips** cause **air column** to resonate MRI: **radio waves** (in a magnetic field) cause **nuclei/proton** to resonate Radios: **radio waves** cause **electrons/current** to resonate Person on swing: **intermittent pushes** cause **swing** to resonate problem: Bridges: **wind/walkers** causes **bridge** to resonate Vehicles: **engine vibrations** cause **panels/mirrors** to resonate Earthquakes: **ground vibrating** causes **buildings** 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)	**Brownian** (motion) (QWC mark)	B1	QWC Brownian 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 = $(2.6\times10^5 \times 5.58\times10^{-3})/8.31\times290$ = 0.602 moles mass = n x 0.028 = **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^o 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 = constant: e.g. P = (273/290) x 2.6 x 10^5 P = **2.45×10^5** (or 2.4 x 10^5 or 2.5 x 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 = $0.5\times970\times27^2$ = **3.5×10^5 J** (353565J)	B1	
(a) (ii)	Work done = Av Force x distance moved Av Force = 3.5 x 10^5 J/40 = **8.8×10^3 N** (or 8750 N) (or 353565/40 = 8836.7 N) Assumption: **no air resistance**	C1 A1 B1	If $v^2 = u^2 + 2as$ is used. accept $a = 0\text{-}27^2/(2\times40) = 9.113$ ms^{-2} C1 F = ma = 970x9.11 = 8.84 x 10^3 N A1 Allow air friction or drag
(b) (i)	correct use of E = mc$\Delta\theta$: 3.5 x 10^5/4 = 1.2x520x$\Delta\theta$ $\Delta\theta$ = **140^{O}C** (if 353565 is used $\Delta\theta$ = 142^{O}C)	C1 A1	If cand. forgets to divide by 4 allow any value between 560 and 570 for 1 mark.
(b) (ii)	Air resistance will be acting (slowing down the car) (hence) reducing the KE of the car (WTTE) The discs are hotter than the surroundings (hence) energy/heat will be lost from discs/brakes (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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