RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced GCE

Unit **G484:** The Newtonian World

Mark Scheme for June 2011

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Q1	Expected Answers	Marks	Additional guidance
(a)(i)	A body will remain at rest or continue to move with constant velocity unless acted upon by a force (WTTE)	B1	Do not allow speed unless "speed in a straight line" is stated. Allow "uniform motion"
(a)(ii)	The force which gives a mass of 1 kg an acceleration of 1 m s^{-2}	B1	**Allow** 1N = 1 kg m s^{-2}
(b)(i)	Use of $v = u + at$ OR $a = (v - u) / t \Rightarrow a = (55 - 0) / 2.2$ $a = 25$ (m s^{-2})	C1 A1	
(b)(ii)	Use of $s = ut + ½\ at^2$ e.g. $s = 0 + ½ \times 25 \times 2.2^2$ $s = 60.5$ (m)	C1 A1	**Allow** other valid solutions e.g. using $v^2 = u^2 + 2as$
(b)(iii)	$F = ma = 3.2 \times 10^4 \times 25 = 8.0 \times 10^5$ (N)	A1	**Allow** ecf from (b)(i)
(c)(i)	towards the centre of the circle.	B1	Do not allow a bare "perpendicular to the velocity" Do not allow "in the same direction as the acceleration."
(c)(ii)	use $F = mv^2/r$ e.g. $F = (3.2 \times 10^4 \times 120^2)/870$ $F = 5.3 \times 10^5$ (529655) (N)	C1 A1	If 55 is used instead of 120 for the velocity $F = 1.1 \times 10^5$ ms^{-1} and scores 1 mark
(d)(i)	At top of the circle when the weight provides/equals the required centripetal force	M1 A1	**Allow** "when the resultant force = weight"
(d)(ii)	realisation that acc = g (OR 9.81) AND (hence) $v^2/r = g$ $\{v = \sqrt{(gr)} = \sqrt{(9.81 \times 1500)}\} \Rightarrow v = 120$ (m s^{-1}) (121.3)	M1 A1	**Accept** 121.24 as this corresponds to 9.8, do **not** allow 122.5 since this assumes $g = 10$ ms^{-2}
	Total	**14**	

Q2	Expected Answers	Marks	Additional guidance
(a)(i)	Force/acceleration is proportional to displacement **(**from equilibrium position**)** (Resultant force) force/acceleration is (always) towards equilibrium position (WTTE, e.g. allow fixed point).	B1 B1	**Allow** force/acceleration is in opposite direction to the displacement. **Allow** acc $\propto x$, provided x is identified as the displacement for 1st mark. 2nd mark only scored if –ve sign used and explained.
(a)(ii)	True; False False; False	B2	-1 for each error stop at zero Assume ✓ means true and X means false Do not credit blank spaces
(b)	***Measurements***: angle measured <u>with protractor</u> stated or shown on the diagram <u>stop-watch/ms timer/data-logger</u> to measure time stated or shown on the diagram ***Conclusion:*** compare periods for different angles stated/implied OR plot period against angle ***major difficulty:*** angle of swing decreases during the timing of the swing ***solution:*** e.g. measure time for ¼, ½ or 1 swing accurately (using electronic timer/datalogger) OR use data logger with motion sensor to record many swings and analyse how the period changes over time OR video the motion with onscreen timer and analyse	 B1 B1 B1 M1 A1	**Allow** ruler used to measure initial and subsequent displacement/amplitude if explained. **Allow** table of results with correct column headings i.e. at least angle and period Do not allow ‘time is short so measure nT and divide by n to reduce (%) error’.(WTTE)
	Total	**9**	

Q3	Expected Answers	Marks	Additional guidance
(a)	Force per unit mass (at a point in a gravitational field).	B1	Accept $g = F/m$ if F and m are identified
(b)(i)	Recognition that inverse square law needs to be verified: e.g. $g \propto 1/r^2$ hence gr^2 = constant $\Rightarrow$ $9.8 \times 6400^2 = 4.0 \times 10^8$ (or 4×10^{14}) AND $2.7 \times 10^{-3} \times (3.8 \times 10^5)^2 = 3.9 \times 10^8$ (or 3.9×10^{14}) (n.b values in brackets correspond to radius in metres) Any appropriate comment consistent with the calculations e.g. values are close enough (to verify the relationship).	B1 B1 B1	Do not accept a bare $g = GM/r^2$ unless G and M are stated as constants or following calculations shows this. They must use values in table and do both calculations for this mark **Allow** other valid approaches e.g. g ratio compared to $1/r^2$ ratio (3630 and 3530) OR (2.75×10^{-4} , 2.84×10^{-4} ,)
(b)(ii)	($mg = GmM / r^2 \Rightarrow M = gr^2 / G$) $M = 9.81 \times (6.4 \times 10^6)^2 / 6.67 \times 10^{-11}$ $M = 6.024 \times 10^{24}$ kg	 C1 A1	(this formula is given on data sheet) Correct substitution into formula **Allow** 6.018×10^{24} this is for $g = 9.8$ and allow any value between 6.0×10^{24} and 6.03×10^{24} but not $6x\ 10^{24}$ Also **allow** data for the moon to be used i.e $M_E = 2.7x10^{-3} \times 3.8 \times 10^8 / 6.67 \times 10^{-11}$ = 5.846×10^{24} kg $\approx 6 \times 10^{24}$ kg
(b)(iii)	volume = $(4/3)\pi r^3 = (4/3)\pi\ (6.4 \times 10^6)^3$ (= $1.10x10^{21}$ m^3) $\rho = M/V = 6.0 \times 10^{24} / 1.10 \times 10^{21} = 5500$ (5464)(kg m^{-3})	C1 A1	mark for correct substitution e.g. 6.4×10^6 (in m) used and not 6.4×10^3 (km) **allow** ecf from b(ii) for cand's value of M but no ecf for wrong volume <u>formula</u> If $r = 6.4\ x10^3$ is used V = $1.1\ x10^{12} \Rightarrow$ $\rho = 5.5x\ 10^{12}$ and scores 1 mark
	Total	**8**	

Q4	Expected Answers	Mark	Additional guidance
(a)(i)	Latent heat of <u>fusion</u>.	B1	QWC fusion spelled correctly ignore any reference to specific.
(a)(ii)	Latent heat of <u>vaporisation</u>.	B1	QWC Vaporisation spelled correctly. **Accept** vaporization but not vapourisation.
(b)(i)	E = $mc\Delta\theta$ used correctly e.g. 0.8 x 4200 x 82 = 2.8 x 10^5 (J) (275520)	C1 A1	0.8 x 4200 x (82+273) scores zero
(b)(ii)	Any two from: Some heat/energy used to heat kettle Some heat/energy lost to surroundings/air/environment. Some heat/energy used to boil water before kettle switches off	B1 B1	Do **not allow** "some heat lost" i.e. they must state where/how Do **not allow** "kettle if not 100% efficient". Do not allow "energy lost as sound/light"
(b)(iii)	1 kWh = 1000 x 3600 = 3.6 x 10^6 J Wastage per year = (2.8 x 10^5 x 365) / 3.6 x 10^6 = 28 kWh (27.9)	C1 A1	**Allow** 1 mark for energy lost per year = 1.02 x 10^8 <u>Joules</u> Allow ecf from (b)(i)
	Total	**8**	

Q5	Expected answers	Mark	Additional guidance
(a)(i)	A collision with no change / loss of kinetic energy.	B1	**Allow** coeff't of restitution = 1
(a)(ii)	Any 3 from Volume of particles negligible compared to volume of vessel OR molecules much smaller than distance between them No intermolecular forces acting (other than during collisions) OR molecules only have kinetic energy (and no PE) Particles travel in straight lines/at uniform velocity between collisions OR force of gravity on molecules is negligible time of collisions much smaller than time between collisions gas consists of a large number of molecules moving randomly (both needed for the mark)	 B1 B1 B1	 do not allow a bare "negligible volume of molecules " Do not allow "collisions between molecules are elastic" because this is given in the question. do not allow a bare "negligible time of collisions" Do not allow a bare "rapid random motion"
(b)(i)	$\Delta p = mv - mu$ $= 4.8 \times 10^{-26} [500 - (-500)] = 4.8 \times 10^{-23}$ kg m s^{-1}	C1 A1	 2.4×10^{-23} scores zero
(b)(ii)	(time between collisions = 0.4 /500 s) . Number of collisions/sec. = 500/0.4 = 1250	A1	Correct answer only
(b)(iii)	(Mean) force = $\Delta p/t$ OR Force = rate of change of momentum OR Impulse = change in momentum Force = $1250 \times 4.8 \times 10^{-23} / 1 = 6.0 \times 10^{-20}$ N	C1 A1	**Allow** ecf from (b)(i) and (b)(ii) e.g. if 2500 is used from (b)(ii) $F = 2500 \times 4.8 \times 10^{-23} = 1.2 \times 10^{-19}$ N and this scores 2 marks
(b)(iv)	Same value as candidate's (b)(iii) due to Newton's third law OR this force acts in opposite direction	B1	 OR –ve sign shown
(c)(i)	$3 \times 6 \times 10^{23} = 1.8 \times 10^{24}$	B1	1.806×10^{24} if 6.02 is used
(c)(ii)	(very) large number of particles that are moving randomly means that at any instant the number of collisions on each face will be the same (WTTE)	B1	Allow no gravitational forces and hence uniform density
(c)(iii)	(mean) KE/speed of molecules increases Increased rate of collisions with wall OR 'harder' collisions with wall	B1 B1	Also **allow** greater change of momentum per collision (WTTE) Not just "more collisions".
	Total	**14**	

Q6	Expected answers	Mark	Additional guidance
(a)(i)	Straight line (judged by eye)with positive slope AND passing through the origin	B1	correct answer only
(a)(ii)	8.31 (J mol^{-1} K^{-1})	B1	Allow *R* and molar gas constant, but do not allow *pV*/*T* OR *nR*
(b)(i)	-40 ^{o}C = 233 K, AND 250 ^{o}C = 523 K Use of $V_1/T_1 = V_2/T_2$ 2.4 x 10^{-2} / 233 = V_2 / 523 V_2 = 0.053(8) (m^3)	M1 C1 A1	No marks scored if 40^{o} C and/or 250^{o}C are used Accept other correct versions.
(b)(ii)	Use of $p = nRT/V$ = 1.5 x 8.31 x 233 / 2.4 x 10^{-2} = 1.21 x 10^5 (Pa)	C1 A1	Allow *T*= 523 and *V*= 0.053 hence *p* = 1.2 x10^5 Allow ecf from (b)(i)
	Total	**7**	

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