GCE

Physics A

Advanced GCE

Unit **G484:** The Newtonian World

Mark Scheme for January 2011

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G484 *The Newtonian World* JAN 2011 STANDARDISATION (SCORIS) mark-scheme

Question	Expected Answers	Marks	Additional guidance
1 (a)(i)	Total momentum is constant/conserved For a closed system/provided no external forces (WTTE)	B1 B1	"total momentum before = total momentum after" Allow $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ or equivalent Do not accept "momentum is constant" Do not accept "momentum is conserved"
(a)(ii)	Some loss of kinetic energy (OR KE OR E_K)(during the collision)	B1	Allow answers in terms of Coeff't of Res. Coeff't of Restitution < 1 e.g. speed of separation/speed of approach <1
(a)(iii) 1	(2.4x3.0) –(1.2x2.0) = 3.6*v* *v* = **1.3 m s^{-1}**	C1 A1	must see –ve sign hence 2.67 scores ZERO Allow 4/3 ms^{-1} and 1.34 but not 1.4
(a)(iii) 2	Any KE correctly calculated: 10.8J, 2.4J, (or 13.2 or 8.4), 3.18J **13.2** and **3.18** (or any value between 3.2 and 3.0) seen	C1 A1	ECF from a(iii)1 If 1.3 ms^{-1} is used KE after is 3.04 ECF from a(iii)1 provided final KE is less than initial KE Allow answers in terms of Coeff't of Res. e.g. speed of separation/speed of approach = 0/5 =0
(b)(i)	valid sub^n in $V = \pi r^2 h$: e.g. π x 5.0^{2}x12 x 5.0 (= 1500π /4710 m^3) m = Vρ = π x 5.0^2 x 12 x 5.0 x 1.3 = **6126** kg	C1 A1	 Do not accept a bald answer of 6000
(b)(ii) 1	momentum = 6130 x 12 = **7.4 (or 7.36) x 10^4** **(**kg m s^{-1})	B1	Allow 7.2x10^4 if 6000 kg used & ecf from (b)(i).
(b)(ii) 2	F = 73600/5 F = **14700 N**	C1 A1	 Accept 14400 if 7.2x10^4 is calculated in 1
(b)(ii) 3	mass of helicopter = 14700/9.81 = **1500** kg	B1	Allow ecf from (b)(ii)2. Allow g=10 N/kg
	Total	**13**	

Question	Expected Answers	Marks	Additional guidance
2 (a)(i)	resultant OR net OR overall force acts (on object) perpendicular to the velocity OR towards the centre of the circle	B1	Ignore any reference to "centripetal force"
(a)(ii)	velocity OR direction is always changing acceleration is in direction of force OR is towards the centre/perp. to velocity	B1 B1	Allow a (resultant) force is acting (hence there is an acceleration))
(b)	centripetal force OR $mv^2/r = GMm/r^2$ OR $v^2/r = GM/r^2$ $v^2 = GM/r \Rightarrow r = GM/v^2$ $r = 6.67 \times 10^{-11} \times 6 \times 10^{24} / 3700^2$ r = **2.92×10^7** m	C1 C1 C1 A1	
(c)(i)	Any mass ejected in the same direction as the satellite (WTTE)	B1	Idea of rocket motor pushing against direction of motion of satellite.
(c)(ii)	v^2r = constant OR $v^2 = GM/r$ OR $v = \sqrt{\{(6.67\times10^{-11}\times6 \times 10^{24})/2\times10^7\}}$ new $v = \sqrt{(3700^2 \times 2.94/2)}$ = **4500** m s^{-1} (4473)	C1 A1	
	Total	**10**	

Question	Expected Answers	Marks	Additional guidance
3(a)(i)	(1 kWh is) the **energy** used/provided by a 1 kW device in 1 hour	B1	Allow 1 kWh = 60x60x1000 = 3.6×10^6 J
(a)(ii)	Energy used in kWh = (70/1000) x (7 x 24) = 11.8 kWh Cost = 11.8 x 0.12 = **£1.41 (or £1.4)**	C1 A1	Any arithmetic error loses one mark
(b)(i)	use of E = mc Δθ e.g. E = 2 x 3800 x (18-3) = **1.14×10^5 J**	C1 A1	
(b)(ii)	Rate of energy loss = 1.14×10^5 /100x60 = **19** W	B1	Allow ecf for cand's (b)(i) value
(c)	1. 18 °C to 0 °C negative gradient line 2. horizontal line on time axis 3. 0°C to -18 °C line of **steeper –ve gradient** (judged by eye) than in 1	B1 B1 B1	
	Total	**9**	

Question	Expected Answers	Marks	Additional guidance
4(a)(i)	displacement is the distance (of the body) from an equilibrium position. amplitude is the maximum displacement.	B1 B1	Allow mean/rest/central/mid point Not original, fixed point This mark can only be gained if the word maximum/greatest/largest is spelled correctly. Allow distance
(a)(ii)	frequency is the number of oscillations/cycles per unit time/second angular frequency is product of 2π x frequency OR 2π/period.	B1 B1	Do not allow "swings" Allow $2\pi f$
(b)(i) 1	amplitude = (18 – 13)/2 = **2.5** m	B1	
(b)(i) 2	frequency = 1/(12.5 x 3600) = (1/45000) = **2.2(2) x 10^{-5}** Hz	C1 A1	Accept any valid sub^n of time for 1st mark Accept 0.08 h^{-1} OR 1.3×10^{-3} min^{-1} if unit is seen to replace Hz.
(b)(ii)	correct use of $v_{max} = 2\pi fA$ e.g. $2\pi \times 2.22 \times 10^{-5} \times 2.5$ = **3.5 x 10^{-4}** m s^{-1} (3.46 or 3.49)	C1 A1	Allow ecf from (b)(i)1 and 2 for full marks: if A=5 is used $v_{max} = 6.98 \times 10^{-4}$ (6.9 to 7) if A=18 is used $v_{max} = 2.5\times10^{-3}$
(b)(iii)	correct use of A(cos $2\pi ft$): e.g. 2.5 cos [$2\pi \times 2.22 \times 10^{-5}$ t] (= 2.5 cos (1.39 x 10^{-4} xt) d = 15.5 + 2.5 cos [$2\pi \times 2.22 \times 10^{-5}$ t] OR 15.5 + 2.5 cos (1.39×10^{-4} x t)	C1 A1	Allow 2.5 cos[2πt/45000] Accept A(sin $2\pi ft$) throughout Allow ecf from (b)(i) and (b)(ii)
	Total	**11**	

Question	Expected answers	Mark	Additional guidance
5(a)(i)	smoke particles move in random/haphazard/zig-zag/jiggling/jerky manner	B1	random/haphazard/zig-zag/ jiggling/jerky must be spelled correctly
(a)(ii)	ANY 3 of the following: B1 + B1 +B1 movement of smoke particles caused by (being hit by) **randomly moving air molecules** smoke particles are continuously moving because the **air molecules** are **continuously moving** smoke particles are visible but air molecules are not hence **air molecules must be (very) small**. small movement of smoke particles is due to the large numbers of **air molecules hitting from all sides**	 (B1) (B1) (B1) (B1) B3	 An observation must be **linked** to an appropriate conclusion Condone reference to "water molecules" in place of air molecules. Condone air atoms/particles. Max 3
(b)	(absolute) temp $\propto$ mean KINETIC ENERGY $½\, m_o\,(v_o)^2 = ½\, m_h\,(v_h)^2$ OR mv^2 is constant OR $v^2 \propto 1/m$ OR mean KE of oxygen = mean KE of hydrogen $v_o = \sqrt{(m_h/m_o)}$x1800 = $\sqrt{\{(.002/.032)\text{ x}1800\}}$ = **450** m s^{-1}.	C1 C1 A1	Allow (½)m<c^2> = (3/2)kT
	Total	**7**	

Question	Expected answer	Mark	Additional guidance
6(a)(i)	pressure is inversely proportional to volume (WTTE) for a fixed mass of gas at constant temperature (WTTE)	B1 B1	Accept $P \propto 1/V$ or PV = constant
(a)(ii) 1	hyperbolic (i.e.Boyles law) curve shape looks asymptotic to both axes i.e does not touch axes	B1 B1	
(a)(ii) 2	straight line through origin OR would extrapolate back to the origin	B1	
(b)(i)	correct sub^n in pV = nRT $\Rightarrow$ 5 x 10^5 x 0.040 = nx8.31x288 OR sub^n into pV = NkT $\Rightarrow$ 5 x 10^5 x 0.040 = Nx1.38x10^{-23}x288 (hence) n = 5 x 10^5 x 0.040 / (8.31 x 288) = **8.4 (8.36)** mol (hence) N = 5.03 x 10^{24} molecules $\Rightarrow$ **8.36 moles**	C1 A1	Any incorrect Kelvin temp (eg 188) correctly used treat as an AE. Allow 8.35 **Use of 15^{0}C scores ZERO**
(b)(ii)	from pV = nRT new n = 7.52 mol moles lost is 8.36 – 7.52 = 0.84 mol = **2.3 (2.34) x 10^{-2}** kg (0.023)	C1 C1 A1	Allow ecf from b(i) OR Pressure has dropped by 1/10 number of moles lost = 0.836 mol; Mass lost = 0.836 x 0.028 = 2.3 x 10^{-2} kg
	Total	**10**	

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