



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	B1	" <u>total</u> momentum before = <u>total</u> momentum after"
			Allow $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ or equivalent
			Do not accept "momentum is constant"
	For a closed system/provided no external forces (WTTE)	B1	Do not accept "momentum is conserved"
(a)(ii)	Some <u>loss</u> of <u>kinetic</u> 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) = 3.6v	C1	must see –ve sign hence 2.67 scores ZERO
	$v = 1.3 \text{ m s}^{-1}$	A1	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	C1	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
	13.2 and 3.18 (or any value between 3.2 and 3.0) <u>seen</u>	A1	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 = π r ² h: e.g. π x 5.0 ² x12 x 5.0 (= 1500 π /4710 m ³)	C1	
	m = Vρ = π x 5.0 ² x 12 x 5.0 x 1.3 = 6126 kg	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 7.2×10^4 if 6000 kg used & ecf from (b)(i).
(b)(ii) 2	F = 73600/5	C1	
	F = 14700 N	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	B1	Ignore any reference to
	velocity OR towards the centre of the circle		"centripetal force"
(a)(ii)	velocity OR direction is always changing	B1	Allow a (resultant) force is acting
	acceleration is in direction of force OR is towards the centre/perp. to	B1	(hence there is an acceleration))
	velocity		
(b)	centripetal force OR $mv^2/r = GMm/r^2$ OR $v^2/r = GM/r^2$	C1	
	$v^2 = GM/r \Rightarrow r = GM/v^2$	C1	
	$r = 6.67 \times 10^{-11} \times 6 \times 10^{24} / 3700^2$	C1	
	r = 2.92 x 10 ⁷ m	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)	$v^2r = constant OR v^2 = GM/r OR v = \sqrt{(6.67 \times 10^{-11} \times 6 \times 10^{24})/2 \times 10^7}$	C1	
	new v = $\sqrt{(3700^2 \text{ x} 2.94/2)}$ = 4500 m s ⁻¹ (4473)	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 = $60x60x1000$
			$= 3.6 \times 10^6 \text{ J}$
(a)(ii)	Energy used in kWh = (70/1000) x (7 x 24) = 11.8 kWh	C1	Any arithmetic error loses one
	Cost = 11.8 x 0.12 = £1.41 (or £1.4)	A1	mark
(b)(i)	use of E = mc Δθ e.g. E = 2 x 3800 x (18-3)	C1	
	= 1.14 x 10 ⁵ J	A1	
(b)(ii)	Rate of energy loss = 1.14 x 10 ⁵ /100x60 = 19 W	B1	Allow ecf for cand's (b)(i) value
(c)	1. 18 °C to 0 °C negative gradient line	B1	
	2. horizontal line on time axis	B1	
	3. 0°C to -18 °C line of steeper –ve gradient (judged by eye) than in	B1	
	1		
	Total	9	

Question	Expected Answers	Marks	Additional guidance
4(a)(i)	displacement is the distance (of the body) from an equilibrium	B1	Allow mean/rest/central/mid point
	position.		Not original, fixed point
		B1	This mark can only be gained if the
	amplitude is the <u>maximum</u> displacement.		word maximum/greatest/largest is
			spelled correctly. Allow distance
(a)(ii)	frequency is the number of oscillations/cycles per unit time/second	B1	Do not allow "swings"
	angular frequency is product of $2\pi x$ frequency OR 2π /period.	B1	Allow 2πf
(b)(i) 1	amplitude = (18 – 13)/2 = 2.5 m	B1	
(b)(i) 2	frequency = 1/(12.5 x 3600) = (1/45000)	C1	Accept any valid sub ⁿ of time for 1 st
	= 2.2(2) x 10 ⁻⁵ Hz	A1	mark
			Accept 0.08 h ⁻¹ OR 1.3x10 ⁻³ min ⁻¹ if unit
			is seen to replace Hz.
(b)(ii)	correct use of v_{max} = 2 π fA e.g. 2 π x 2.22 x 10 ⁻⁵ x 2.5	C1	Allow ecf from (b)(i)1 and 2 for full
	= 3.5 x 10⁻⁴ m s⁻¹ (3.46 or 3.49)	A1	marks:
			if A=5 is used v_{max} = 6.98 x10 ⁻⁴ (6.9 to
			7)
			if A=18 is used $v_{max} = 2.5 \times 10^{-3}$
(b)(iii)	correct use of A(cos 2π ft): e.g. 2.5 cos [2π x 2.22 x 10 ⁻⁵ t]	C1	Allow 2.5 cos[2πt/45000]
	$(=2.5 \cos(1.39 \times 10^{-4} \text{ xt}))$		Accept A(sin 2πft) throughout
	d = 15.5 + 2.5 cos $[2\pi \times 2.22 \times 10^{-5} \text{ t}]$ OR 15.5 + 2.5 cos (1.39×10^{-4})	A1	Allow ecf from (b)(i) and (b)(ii)
	x t)		
	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	(B1)	An observation must be linked to an appropriate conclusion
	smoke particles are continuously moving because the air molecules are	(B1)	
	continuously moving		Condone reference to "water
	smoke particles are visible but air molecules are not hence air molecules must be (very) small .	(B1)	molecules" in place of air molecules.
	small movement of smoke particles is due to the large numbers of air molecules hitting from all sides	(B1)	Condone air atoms/particles.
		B3	Max 3
(b)	(absolute) temp ∞ mean <u>KINETIC ENERGY</u>	C1	Allow $(\frac{1}{2})m < c^2 > = (3/2)kT$
	$\frac{1}{2} m_{o} (v_{o})^{2} = \frac{1}{2} m_{h} (v_{h})^{2} OR mv^{2}$ is constant OR $v^{2} \propto 1/m$	C1	
	OR mean KE of oxygen = mean KE of hydrogen		
	$v_o = \sqrt{(m_h / m_o) \times 1800} = \sqrt{(.002/.032) \times 1800} = 450 \text{ m s}^{-1}$	A1	
	Total	7	

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

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