OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

PHYSICS A G484 MS

Unit G484: The Newtonian World

Specimen Mark Scheme

The maximum mark for this paper is **60**.

Question Number	Answer	Max Mark
1(a)	The (net) force acting on an object is (directly) proportional to the rate of change of momentum and takes place in the direction of the force.	[B2]
(b)	According to Newton's third law: When two objects interact, the force acting on one of objects is equal but opposite to the force acting on the other object.	[B1]
	The time t of 'contact' for the objects is the same and since $\Delta p = Ft$,	[B1]
	the gain in momentum for one object is equal to the loss of momentum for the other object.	[B1]
(c)(i)	u= 32 (m s^{-1}) v = - 2/3 × 32 = - 21.33 (m s^{-1}) t = 0.50 s	[C1]
	$\Delta p = 800(-21.33 - 32) = -4.27 \times 10^4$ $\underline{\text{kg m s}^{-1}}$	[A1]
(ii)	$F = \Delta p / \Delta t$ / $F = 4.27 \times 10^4 / 0.50$	[C1]
	$F \approx 8.5 \times 10^4$ (N)	[A1]
	Direction: Opposite to the initial velocity / away from the wall	[B1]
(iii)	$N = pV / kT = (1.0 \times 10^5 \times 3.4 \times 10^{-2}) / (1.38 \times 10^{-23} \times 293)$	[C1]
	$N = 8.41 \times 10^{23}$	[C1]
	mass = $8.41 \times 10^{23} / 6.02 \times 10^{23}) \times 0.014$ mass = 0.0196 (kg) ≈ 0.020 kg	[A1]
2(a)	It is the force (of attraction) <u>per</u> unit mass.	[B1]
(b)(i)	The gravitational field strength g is not constant.	[B1]
	The student's value would be greater than the actual value (because the average magnitude of g is less than 9.81 m s^{-1}).	[B1]
(ii)	KE = $1/2mv^2$ $v = 2\pi r / T$	[C1]
	$v = 2 \times \pi \times (6800 + 6400) \times 10^3 / 8.5 \times 10^3$ / v = 9.76 × 10^3 (m s^{-1})	[C1]
	KE = $1/2 \times 1500 \times (9.76 \times 10^3)^2$ KE = 7.1(4) × 10^{10} (J)	[A1]
(iii)	A geostationary satellite stays above the same point on the Earth and as such can be used for radio communications. (the term *communications* to be included and spelled correctly to gain the mark). The satellite is not in geostationary orbit because its period is less than 1 day / 8.6 × 10^4 s.	[B1] [M1] [A1]
(c)(i)	r has been increased by a factor of 3 from the centre of planet.	[C1]
	$g = (40/3^2 =)4.4(4)$ (N kg^{-1})	[A1]
(ii)	$M = gr^2 / G$ $M = (40 \times [2.0 \times 10^7]^2) / 6.67 \times 10^{-11}$	[C1]
	$M = 2.4 \times 10^{26}$ (kg)	[A1]
(iii)	$M = \rho V = 4/3\pi r^3 \rho$	[M1]
	$g = GM / r^2 \propto r^3 / r^2$ (Hence $g \propto r$)	[A1]

Question Number	Answer	Max Mark
3(a)	The acceleration of the oscillator is directly proportional to the displacement (the term *displacement* to be included and spelled correctly to gain the mark). with the acceleration always directed to a fixed / equilibrium point	[B1] [B1]
b(i)	1. Measure the time t for N oscillations. frequency $f = N/t$ 2. Measure the amplitude A of the oscillations using the ruler. maximum speed is calculated using: $v_{max} = (2\pi f)A$	[M1] [A1] [M1] [A1]
(ii)	The maximum speed is doubled because the frequency is the same and $v_{max} \propto A$	[B1] [B1]
(iii)	$F = (-)\ kx$ and $F = ma$ Therefore $ma = (-)\ kx$ $\omega^2 = k/m$ $T = 2\pi\sqrt{(m/k)}$	[M1] [M1]
4(a)(i)	Internal energy is the total kinetic and potential energies of all the atoms moving randomly within the substance / system / body.	[B1] [B1]
(ii)	Specific heat capacity of a substance is the heat required to change the temperature of a unit mass by 1K / 1°C.	[B1]
(b)(i)	$E = mc\Delta\theta$ / $E = 2.0 \times 920 \times 293$ $E = 5.39 \times 10^5$ (J) $E \approx 540$ kJ	[C1] [A1] [A0]
(ii)	number of moles = $2.0/0.027 (= 74.1)$ number of atoms = $(2.0/0.027)N_A$ / number of atoms $= 4.46 \times 10^{25}$ average energy = $5.39 \times 10^5 / 4.46 \times 10^{25}$ average energy = $1.2(1) \times 10^{-20}$ (J)	[C1] [C1] [C1] [A0]
(iii)	energy per mole per K = $(1.2 \times 10^{-20} \times 6.02 \times 10^{23})/293$ energy per mole per K = 24.7 J mol^{-1} K^{-1}	[C1] [A1]
(c)	Time Delay: The block has to come to a “uniform” temperature. Energy is conducted from heater to block in a finite but short time. Thermometer is a finite distance from heater Maximum Temperature: The surroundings of the block are at room temperature so energy is transferred by conduction, convection and radiation from the block to the surroundings, so the block does not reach the “theoretical” maximum temperature expected.	[2] [2]

Question Number	Answer	Max Mark
5(a)	Any two from: Collisions between atoms is elastic Time between collisions is negligible compared with time of collisions Motion of atoms is random There are a very large number of atoms	[B1×2]
(b)	$1/2mv^2 \propto T$ ratio = $(10^9/4000)^{1/2}$ ratio = 500	 [C1] [A1]
(c)	They collide randomly and hence have a range of speeds.	[B1]
(d)(i)	$\Delta\lambda = 656.3 \times \sqrt{(2 \times 1.38 \times 10^{-23} \times 4000 / 1.7 \times 10^{-27} \times [3.0 \times 10^{8}]^{2})}$ $\Delta\lambda \approx 1.8 \times 10^{-2}$ (nm)	[C1] [A1]
(d)(ii)	Carbon atoms are more massive (and $\Delta\lambda \propto 1/\text{mass}$)	[B1]
	Paper Total	**[60]**