Name of the Student:_____
Max. Marks : 18 Marks **Time : 18 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable Answers		Additional Guidance	Mark
(i)	• use of $I = L / 4\pi d^2$	(1)	Example of calculation 3.25×10^{-11} W m^{-2} = $L / 4\pi(4.00 \times 10^{16}$ m$)^2$	3
	• $L = 6.53 \times 10^{23}$ W	(1)	$L = 6.53 \times 10^{23}$ W	
	• = 0.17% of Sun	(1)	6.53×10^{23} W / 3.85×10^{26} W = 0.17%	
(ii)	• use of $L = \sigma AT^4$	(1)	Example of calculation 6.53×10^{23} W = 5.67×10^{-8} W m^{-2} K^{-4} × 4π (9.81 × 10^7 m$)^2$ × T^4	3
	• T = 3124 (K)	(1)	T = 3124 K	
	• Statement relating calculated values of T and L to main sequence on H-R diagram	(1)		

Q2.

Question number	Acceptable answers	Additional guidance	Mark
(i)	**Either** • When x = R_0, F = GMm/R_0^2 **(1)** • F = GMmR_0/R_0^3 so k = mω^2 = GMm/R_0^3 **(1)** • Use of T=2π/ω **(1)** • $T^2 = 4\pi^2/\omega^2 = 4\pi^2 R_0^3/GM$ So $T = 2\pi\sqrt{(R_o^3/GM)}$ **(1)** **OR** • From graph F=-(g/R_o)r **(1)** • From which $\omega = \sqrt{(g/R_0)}$ **(1)** • Use of T=2π/ω **(1)** • So $T = 2\pi\sqrt{(R_o^3/g)}$ **(1)**		4

Question number	Acceptable answers	Additional guidance	Mark
(ii)	**Either** Centripetal force = $mv^2/R_0 = GMm/R_0^2$ **(1)** • $4\pi^2 R_0^2/ T^2R_0 = GM/R_0^2$ **(1)** • $T^2 = 4\pi^2/\omega^2 = 4\pi^2 R_0^3/GM$ So $T = 2\pi\sqrt{(R_o^3/GM)}$ **(1)** **OR** • $mg = mv^2/R_0 = m\,\omega^2R_0$ **(1)** • So $\omega = \sqrt{(g/R_0)}$ **(1)** • $T = 2\pi/\omega = 2\pi\sqrt{(R_0/g)}$ **(1)**		**3**

Q3.

Question Number	Acceptable answers	Additional guidance	Mark
(i)	• Use total mass / mass of D ion **(1)** • Use of $pV = NkT$ **(1)** • $p = 2.8 \times 10^4$ Pa **(1)**	Example of calculation $N = 5.0 \times 10^{-6}$ kg / 3.3×10^{-27} kg = 1.5×10^{21} $p = 1.5 \times 10^{21} \times 1.38 \times 10^{-23}$ J K^{-1} × 130 000 000 K / 98 m^3 $= 2.77 \times 10^4$ Pa	**3**
(ii)	• Use of ½ $m\langle c^2\rangle = 3/2\ kT$ **Or** $pV = 1/3\ (Nm\langle c^2\rangle)$ (ecf for N and p from (i)) **(1)** • $\sqrt{\langle c^2\rangle} = 1.3 \times 10^6$ m s^{-1} **(1)**	Example of calculation ½ $m\langle c^2\rangle = 3/2\ kT$ ½ × (3.3×10^{-27} kg) × $\langle c^2\rangle = 3/2 \times 1.38 \times 10^{-23}$ J K^{-1} × 130 000 000 K $\langle c^2\rangle = 1.6 \times 10^{12}$ m^2 s^{-2} $\sqrt{\langle c^2\rangle} = 1.28 \times 10^6$ m s^{-1}	**2**
(iii)	• Use of $\Delta\lambda / \lambda = v/c$ to determine $\Delta\lambda$ **(1)** • Adds shift to original wavelength **(1)** • 1.075×10^{-6} m **(1)**	Example of calculation $\Delta\lambda / 1.064 \times 10^{-6}$ m = 15×10^6 m s^{-1}/3.00×10^8 m s^{-1} $\Delta\lambda = 5.3 \times 10^{-9}$ m $\lambda + 2\Delta\lambda = 1.075 \times 10^{-6}$ m	**3**