Question			Expected Answers	Marks	Additional guidance
1	a		arrows (at least one) indicating direction is **towards** the planet. All lines looking as though they would meet at the centre judged by eye	B1 B1	 At least 4 drawn and care taken Some of the lines must be outside the planet.
	b	i	(mg = GMm/r^2 and hence) **M = gr^2/G** correct substitution M = 24.9x(7.14 x 10^7)^2/6.67x10^{-11} = **1.9 x 10^{27}** Kg (i.e about **2x10^{27}**)	C1 **M1** A1	Equation needs to be rearranged as shown for C1 mark
		ii	correct substitution into V=(4/3)πr^3 = (4/3)π(7.14x10^7)^3 {= 1.52 x 10^{24} m^3} density = mass/volume = 1.9 x10^{27}/1.52 x 10^{24} = **1250** kg m^{-3}	C1 A1	If m= 2 x 10^{27} kg is used d = 1312 scores 2 marks
			Total	**7**	

Question			Answer	Marks	Guidance
2	(a)		Mass of one hydrogen molecule $= 2.02 \times 10^{-3} / 6.02 \times 10^{23}$ Mass $= 3.4 \times 10^{-27}$ **(**kg)	C1 A1	
	(b)		Mean k.e $= 3kT/2$ Mean ke $= 3/2 \times 1.38 \times 10^{-23} \times 1100$ Mean ke $= 2.3 \times 10^{-20}$ (J) Mean ke $\approx 2 \times 10^{-20}$ (J)	 B1 B1 A0	
	(c)		$E_k = ½ mv^2$ $2.3 \times 10^{-20} = ½ \times 6.6 \times 10^{-27} v^2$ $v^2 = (2 \times 2.3 \times 10^{-20} / 6.6 \times 10^{-27})$ $v = (2 \times 2.3 \times 10^{-20} / 6.6 \times 10^{-27})^{1/2}$ $v = 2.6 \times 10^3$ (m s^{-1})	 M1 A1	**Note**: Full credit to be given for the use of 2×10^{-20} (J) from (b) giving $v = 2.5 \times 10^3$ (ms^{-1}) **Note:** If 3.36×10^{-27} is used from (a) (hydrogen molecules) then speed $= 3.68 \times 10^3$ m s^{-1} and scores max 1 mark
	(d)		Helium atoms have a range of speeds / kinetic energies Hence some atoms have a velocity greater than 11 km s^{-1} / escape velocity	M1 A1	Accept equivalent wording or suitable diagram .
			Total	**8**	