Oxford Cambridge and RSA

A Level Physics A

H556/01 Modelling physics

Question Set 11

1 (a) Write an expression for the gravitational potential V_g at the surface of a planet of mass M and radius r. $V_g = -\frac{GM}{r}$ **[1]**

(b) The table below shows some data for Mercury and Pluto.

	Mass / kg	Radius / m	Mean distance from Sun / m
Mercury	3.30×10^{23}	2.44×10^{6}	57.9×10^{9}
Pluto	0.131×10^{23}	1.19×10^{6}	5910×10^{9}

(i) Show that the escape velocity v of a gas molecule on the surface of Pluto is given by the equation

$$v = \sqrt{\frac{2GM}{r}}$$

where M is the mass of Pluto and r is its radius. **[2]**

Loss in KE = Gain in GPE

$\frac{1}{2}mv^2 = \frac{GMm}{r}$

$v^2 = \frac{2GM}{r} \rightarrow v = \sqrt{\frac{2GM}{r}}$

(ii) Calculate the escape velocity v of gas molecules on the surface of Pluto.

$v = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 0.131 \times 10^{23}}{1.19 \times 10^{6}}} = 1212$

$v =$ 1210 m s^{-1} **[1]**

(iii) Explain why Mercury has no atmosphere whilst Pluto still has a thin atmosphere. Use data from the table to support your explanation. **[3]**

- Mercury does have a higher escape velocity than pluto
- However, since mercury is close to the Sun and is much hotter than pluto, molecules in its atmosphere are much more likely to have a speed higher than the escape velocity.

Total Marks for Question Set 11: 7