1. A spacecraft S of mass m moves in a straight line towards the centre, O, of a planet.

The planet is modelled as a fixed sphere of radius R.

The spacecraft S is modelled as a particle.
The gravitational force of the planet is the only force acting on S.

When S is a distance x $(x \geqslant R)$ from O

- the gravitational force is directed towards O and has magnitude $\dfrac{mgR^2}{2x^2}$
- the speed of S is v

(a) Show that

$$v^2 = \frac{gR^2}{x} + C$$

where C is a constant.

(3)

When $x = 3R$, $v = \sqrt{3gR}$

(b) Find, in terms of g and R, the speed of S as it hits the surface of the planet.

(3)

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Question 1 continued

(Total for Question 1 is 6 marks)