5. The centre of the Earth is the point O and the Earth is modelled as a fixed sphere of radius R.
At time $t = 0$, a particle P is projected vertically upwards with speed U from a point A on the surface of the Earth.

At time t seconds, where $t \geqslant 0$

- P is a distance x from O
- P is moving with speed v
- P has acceleration of magnitude $\frac{gR^2}{x^2}$ directed towards O

Air resistance is modelled as being negligible.

(a) Show that $v^2 = \frac{2gR^2}{x} + U^2 - 2gR$

(6)

Particle P is first moving with speed $\frac{1}{2}\sqrt{gR}$ at the point B.

(b) Given that $U = \sqrt{gR}$ find, in terms of R, the distance AB.

(3)

(c) Find, in terms of g and R, the smallest value of U that would ensure that P never comes to rest, explaining your reasoning.

(3)

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Question 5 continued

(Total for Question 5 is 12 marks)