2 **(a)** Explain why the gravitational field strength near the surface of a planet is approximately constant for small changes in height.

....

....

.... [1]

(b) An isolated planet of uniform density has mass M and radius R.

Point P lies on a straight line passing through the centre of the planet, at a displacement x from the centre, as shown in Fig. 2.1.

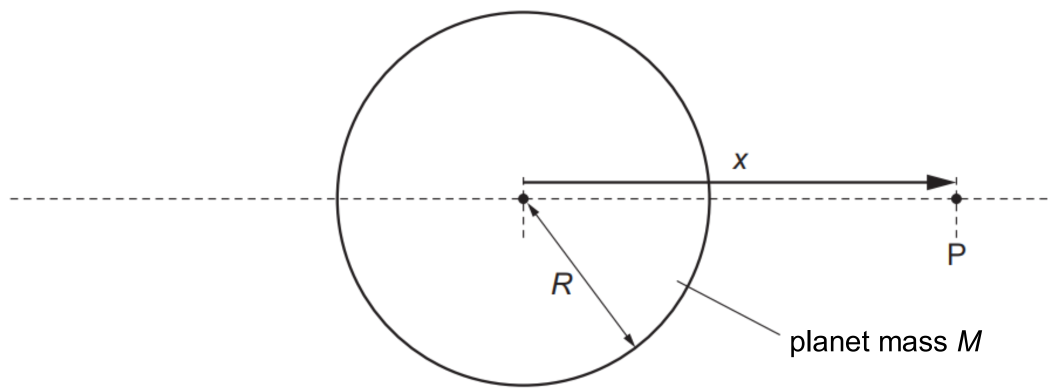

Fig. 2.1

Fig. 2.2 shows the variation with x of the gravitational field strength g at point P due to the planet for the values of x for which P is inside the planet.

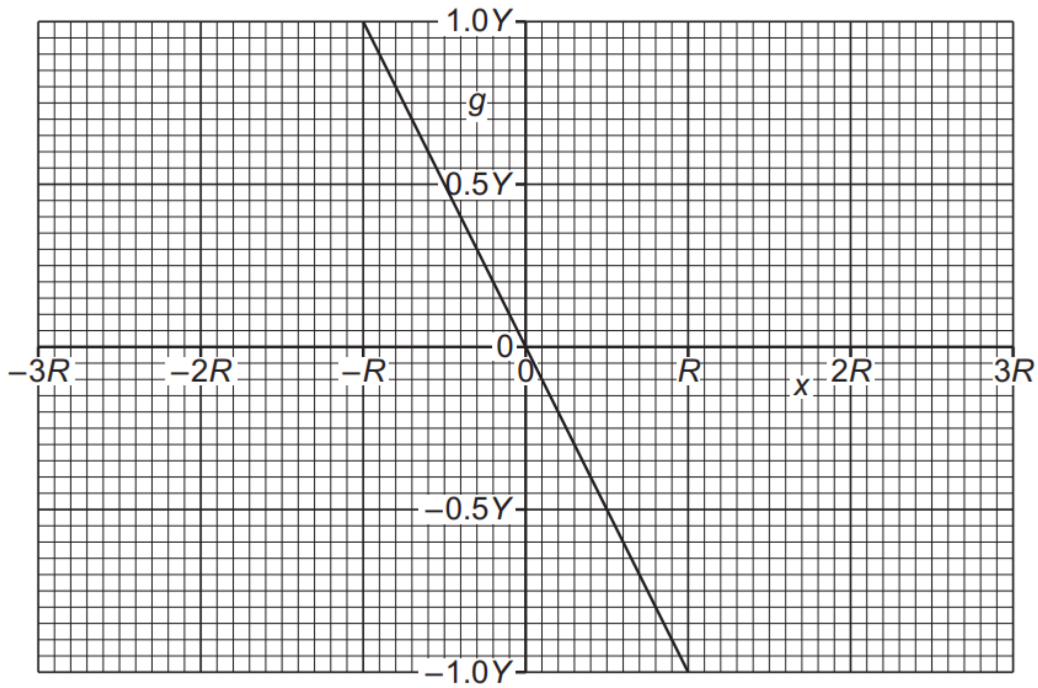

Fig. 2.2

The magnitude of the gravitational field strength at the surface of the planet is Y.

(i) State an expression for Y in terms of M and R. Identify any other symbols that you use.

[1]

(ii) Complete Fig. 2.2 to show the variation of *g* with *x* for values of *x*, up to $\pm 3R$, for which point P is outside the planet. [3]

(iii) A rock is projected vertically upwards from the surface of the planet with a speed of 4.7×10^{3} m s^{-1}. The mass *M* of the planet is 6.4×10^{23} kg and the radius *R* of the planet is 3.4×10^{6} m.

Calculate the distance travelled by the rock for it to lose half of its kinetic energy.

distance = ... m [3]