Answer **all** the questions in the spaces provided.

1 **(a)** Define *gravitational potential* at a point.

.....

.....

.....[2]

(b) A rocket is launched from the surface of a planet and moves along a radial path, as shown in Fig. 1.1.

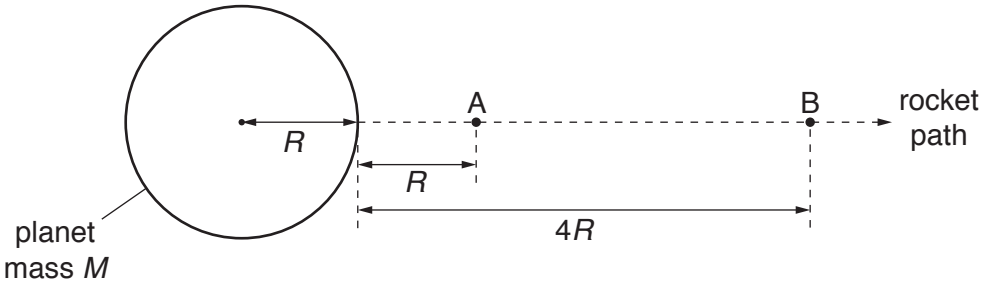

Fig. 1.1

The planet may be considered to be an isolated sphere of radius R with all of its mass M concentrated at its centre. Point A is a distance R from the surface of the planet. Point B is a distance $4R$ from the surface.

(i) Show that the difference in gravitational potential $\Delta\phi$ between points A and B is given by the expression

$$\Delta\phi = \frac{3GM}{10R}$$

where G is the gravitational constant.

[1]

(ii) The rocket motor is switched off at point A. During the journey from A to B, the rocket has a constant mass of 4.7×10^4 kg and its kinetic energy changes from 1.70 TJ to 0.88 TJ.

For the planet, the product GM is 4.0×10^{14} N m^2 kg^{-1}. It may be assumed that resistive forces to the motion of the rocket are negligible.

Use the expression in **(b)(i)** to determine the distance from A to B.

distance = ...m [3]

[Total: 6]