1 **(a)** Define gravitational potential energy of a mass at a point.

……

…… [1]

(b) A spherical planet has mass M and radius R. The planet may be considered to have all its mass concentrated at its centre.

A rocket is launched from the surface of the planet such that the rocket moves radially away from the planet. The rocket engines are stopped when the rocket is at a height R above the surface of the planet.

The mass of the rocket, after its engines have been stopped, is m.

(i) Show that, for the rocket to travel from a height R to a height $2R$ above the planet's surface, the change ΔU in magnitude of the gravitational potential energy of the rocket is given by the expression

$$\Delta U = \frac{GMm}{6R} .$$

[2]

(ii) During the ascent from a height R to a height $2R$, the speed of the rocket changes from 7600 m s^{-1} to 7320 m s^{-1}. The planet has a radius of 3.40 x 10^6 m.

Determine a value for the mass M of the planet.

M = ……... kg [3]

(iii) State two assumptions made in the determination in **(b)(ii)**.

……...

……...

…… [2]

(c) **(i)** A satellite is orbiting in a geostationary orbit around the Earth of mass M.

Explain why the satellite must be above the equator.

……...

……...

……...

…… [2]

(ii) Deduce the distance r of the geostationary satellite from the centre of the Earth in terms of M.

Explain your working clearly.

[2]