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

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..... [1]

(b) A satellite of mass m is in a circular orbit of radius r_1 around the Earth. It is transferred to a new circular orbit of radius r_2 as shown in Fig. 2.1 by firing its thrusters.

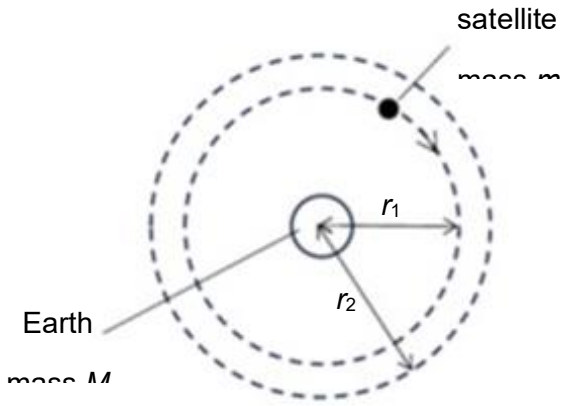

Fig. 2.1

The mass of the Earth is M and the gravitational constant is G.

(i) Show that the increase in potential energy $\otimes E_P$ of the satellite is given by

$$\Delta E_P = GMm\left(\frac{1}{r_1} - \frac{1}{r_2}\right).$$

[1]

(ii) The speed of the satellite at r_2 is smaller than at r_1. A student claims that by conservation of energy, the decrease in kinetic energy of the satellite is equal to the increase in gravitational potential energy. Explain why the student is not correct.

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…….. [2]

(c) A rock of mass m_r, initially at rest at infinity, falls towards the satellite orbiting at a radius of r_2. The gravitational force between the rock and the satellite is negligible. Determine the speed v of the rock as it hits the satellite in terms of G, M, m, m_r, r_1 and r_2. [3]

[Total: 7]