Q 01

A 400 kg satellite is in a circular orbit of radius $2R_E$ about the Earth. How much energy is required to transfer it to a circular orbit of radius $4R_E$? What are the changes in the kinetic and potential energies?

Sol. Initially,

$$E_i = -\frac{GM_E m}{4R_E}$$

While finally

$$E_f = -\frac{GM_E m}{8R_E}$$

The change in the total energy is

$$\Delta E = E_f - E_i$$

$$= \frac{GM_E m}{8R_E} = \left(\frac{GM_E}{R_E^2}\right)\frac{mR_E}{8}$$

$$\Delta E = \frac{gmR_E}{8} = \frac{9.81 \times 400 \times 6.37 \times 10^6}{8} = 3.13 \times 10^9 J$$

The kinetic energy is reduced and it mimics ΔE, namely, ΔK = K_f - K_i = -3.13 $\times$ 10^9 J.

The change in potential energy is twice the change in the total energy, namely

$$\Delta V = V_f - V_i = -6.25 \times 10^9 \text{J}$$