PROB. 13-90

FIND $\Delta e = \frac{\Delta E}{m}$ FOR $r_1 = (6370 + 600^{km}) = 6.97 \times 10^6 m$

AND $r_2 = (6370 + 6000^{km}) = 1.237 \times 10^7 m$

$R = 6370^{km} = 6.37 \times 10^6 m$

ON THE EARTH'S SURFACE

$E_e = T_e + V_e = 0 - \frac{gR^2 m}{R} = -gRm$

$e_e = \frac{E_e}{m} = -gR$

a) $E_1 = T_1 + V_1 = \frac{1}{2} m v_1^2 - \frac{gR^2 m}{r_1}$

$e_1 = \frac{1}{2} v_1^2 - \frac{gR^2}{r_1}$

$v_1^2 = \frac{gR^2}{r_1}$, $e_1 = \frac{1}{2}\left(\frac{gR^2}{r_1}\right) - \frac{gR^2}{r_1} = -\frac{gR^2}{2r_1}$

$\Delta e_1 = e_1 - e_e = -\frac{gR^2}{2r_1} - (-gR) = gR\left(1 - \frac{R}{2r_1}\right)$

$\Delta e_1 = \left(9.81 \frac{m}{s^2}\right)(6.37 \times 10^6 m)\left[1 - \frac{(6.37 \times 10^6 m)}{2(6.97 \times 10^6 m)}\right]$

$\Delta e_1 = 3.393 \times 10^7 \frac{J}{kg}$ $\boxed{= 33.93 \frac{MJ}{kg}}$

b) $\Delta e_2 = \left(9.81 \frac{m}{s^2}\right)(6.37 \times 10^6 m)\left[1 - \frac{(6.37 \times 10^6 m)}{2(1.237 \times 10^7 m)}\right]$

$\Delta e_2 = 4.640 \times 10^7 \frac{J}{kg}$ $\boxed{= 46.40 \frac{MJ}{kg}}$