

32. Energy conservation for this situation may be expressed as follows:

$$K_1 + U_1 = K_2 + U_2$$
$$K_1 - \frac{GmM}{r_1} = K_2 - \frac{GmM}{r_2}$$

where  $M = 5.0 \times 10^{23}$  kg,  $r_1 = R = 3.0 \times 10^6$  m and  $m = 10$  kg.

(a) If  $K_1 = 5.0 \times 10^7$  J and  $r_2 = 4.0 \times 10^6$  m, then the above equation leads to

$$K_2 = K_1 + GmM \left( \frac{1}{r_2} - \frac{1}{r_1} \right) = 2.2 \times 10^7 \text{ J.}$$

(b) In this case, we require  $K_2 = 0$  and  $r_2 = 8.0 \times 10^6$  m, and solve for  $K_1$ :

$$K_1 = K_2 + GmM \left( \frac{1}{r_1} - \frac{1}{r_2} \right) = 6.9 \times 10^7 \text{ J.}$$