CONSERVATION OF ENERGY - SOLUTIONS

1. GIVEN:

$m = 1.0\ kg$

$h_i = 90\ m$

$h_f = 70\ m$

$E_{K_i} = 0$

$E_{K_f} = ?$

$$E_i = E_f$$

$$E_{K_i} + E_{P_i} = E_{K_f} + E_{P_f}$$

$E_{K_i} = 0$

$$E_{K_i} + mgh_i = E_{K_f} + mgh_f$$

$$E_{K_f} = mgh_i - mgh_f$$

$$= mg(h_i - h_f)$$

$$= (1.0)(9.8)(90 - 70)$$

$$= 196\ J$$

$200\ J$

2. GIVEN:

$m = 0.50\ kg$

$E_{K_i} = 25\ J$

$E_{K_f} = 0$

$h_i = 0$

$h_f = ?$

V=0 at highest Point → $E_K = 0$

$$E_i = E_f$$

$$E_{K_i} + E_{P_i} = E_{K_f} + E_{P_f}$$

$h_i = 0$

$E_{K_f} = 0$

$$E_{K_i} + mgh_i = E_{K_f} + mgh_f$$

$$E_{K_i} = mgh_f$$

$$h_f = \frac{E_{K_i}}{mg}$$

$$= \frac{25}{(0.50)(9.8)}$$

$= 5.1\ m$

3. GIVEN:

$m = 1.00\,kg$

$v_i = 0$

$v_f = 12.0\,\frac{m}{s}$

$E_{p_i} = ?$

$E_{p_f} = 0$

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

($v_i = 0$, $E_{p_f} = 0$)

$$\frac{1}{2}mv_i^2 + E_{p_i} = \frac{1}{2}mv_f^2$$

$$E_{p_i} = \frac{1}{2}mv_f^2$$

$$= \frac{1}{2}(1.00)(12.0)^2$$

$$= 72.0\ J$$

4. a) GIVEN:

$m = 3.0\ kg$

$h = 3.0\ m$

$$E_p = mgh$$

$$= (3.0)(9.8)(3.0)$$

$$= 88\ J$$

b) GIVEN:

$m = 3.0\ kg$

$v_i = 0$

$v_f = ?$

$h_i = 3.0\ m$

$h_f = 1.0\ m$

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

($v_i = 0$)

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$\frac{1}{2}v_f^2 = gh_i - gh_f$$

$$v_f = \sqrt{2g(h_i - h_f)}$$

$$= \sqrt{2(9.8)(3.00 - 1.00)}$$

$$= 6.3\ \frac{m}{s}$$

c)

GIVEN:

$m = 3.0\ kg$

$v_i = 0$

$v_f = ?$

$h_i = 3.0\ m$

$h_f = 0$

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

($v_i = 0$, $h_f = 0$)

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$mgh_i = \frac{1}{2}mv_f^2$$

$$gh_i = \frac{1}{2}v_f^2$$

$$v_f = \sqrt{2gh_i}$$

$$= \sqrt{2(9.8)(3.00)}$$

$$= 7.7\ \frac{m}{s}$$

d) G : AT THAT POINT, ALL THE ENERGY IS POTENTIAL (SAME HEIGHT AS A).

5. GIVEN:

$m = 85.0\ kg$

$v_i = 6.00\ \frac{m}{s}$

$v_f = 0$

$h_i = 0$

$h_f = ?$

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

($h_i = 0$, $v_f = 0$)

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$\frac{1}{2}mv_i^2 = mgh_f$$

$$\frac{1}{2}v_i^2 = gh_f$$

$$h_f = \frac{v_i^2}{2g}$$

$$= \frac{(6.00)^2}{2(9.8)}$$

$$= 1.8\ m$$

6. a) GIVEN:

$m = 500.\ kg$

$v_i = 1.2\ \frac{m}{s}$

$v_f = ?$

$h_i = 30.0\ m$

$h_f = 25.0\ m$

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$\frac{1}{2}v_i^2 + gh_i = \frac{1}{2}v_f^2 + gh_f$$

$$\frac{1}{2}v_f^2 = \frac{1}{2}v_i^2 + gh_i - gh_f$$

$$v_f = \sqrt{2\left(\frac{1}{2}v_i^2 + gh_i - gh_f\right)}$$

$$= \sqrt{2\left[\frac{1}{2}(1.20)^2 + (9.8)(30.0) - (9.8)(25.0)\right]}$$

$$= 10.\ \frac{m}{s}$$

b) GIVEN:

$m = 500.\ kg$

$v_i = 1.2\ \frac{m}{s}$

$v_f = ?$

$h_i = 30.0\ m$

$h_f = 12.0\ m$

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$\frac{1}{2}v_i^2 + gh_i = \frac{1}{2}v_f^2 + gh_f$$

$$\frac{1}{2}v_f^2 = \frac{1}{2}v_i^2 + gh_i - gh_f$$

$$v_f = \sqrt{2\left(\frac{1}{2}v_i^2 + gh_i - gh_f\right)}$$

$$= \sqrt{2\left[\frac{1}{2}(1.20)^2 + (9.8)(30.0) - (9.8)(12.0)\right]}$$

$$= 19\ \frac{m}{s}$$

c) GIVEN:

$m = 500.\ kg$

$v_i = 1.2 \frac{m}{s}$

$v_f = ?$

$h_i = 30.0\ m$

$h_f = 0$

$E_i = E_f$

$E_{k_i} + E_{P_i} = E_{K_f} + E_{P_f}$ ($h_f = 0$)

$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$

$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2$

$\frac{1}{2}v_i^2 + gh_i = \frac{1}{2}v_f^2$

$v_f = \sqrt{2\left(\frac{1}{2}v_i^2 + gh_i\right)}$

$= \sqrt{2\left[\frac{1}{2}(1.20)^2 + (9.8)(30.0)\right]}$

$= 24 \frac{m}{s}$

7. GIVEN:

$v_i = ?$

$v_f = 0$

$h_i = 0$

$h_f = 5.20\ m$

$E_i = E_f$

$E_{k_i} + E_{P_i} = E_{K_f} + E_{P_f}$ ($h_i = 0$, $v_f = 0$)

$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$

$\frac{1}{2}mv_i^2 = mgh_f$

$\frac{1}{2}v_i^2 = gh_f$

$v_i = \sqrt{2gh_f}$

$= \sqrt{2(9.8)(5.20)}$

$= 10. \frac{m}{s}$

8. GIVEN:

$m = 65\,kg$

$v_i = ?$

$v_f = 0$

$h_i = 0$

$h_f = 5.5\,m$

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

($h_i = 0$, $v_f = 0$)

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$\frac{1}{2}mv_i^2 = mgh_f$$

$$v_i = \sqrt{2gh_f}$$

$$= \sqrt{2(9.8)(5.5)}$$

$$= 10.38\,m$$

10. m

9. GIVEN:

$m = 55\,kg$

$v_i = 0$

$h_i = 3.00\,m$

$h_f = 1.00\,m$

$E_{p_f} = ?$

$E_{k_f} = ?$

$$E_{p_f} = mgh_f$$

$$= (55)(9.8)(1.00)$$

$$= 539\,J$$

540J

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

($v_i = 0$)

$$\frac{1}{2}mv_i^2 + mgh_i = E_{k_f} + mgh_f$$

$$E_{k_f} = mgh_i - mgh_f$$

$$= mg(h_i - h_f)$$

$$= (55)(9.8)(3.00 - 1.00)$$

$$= 1078\,J$$

1100J

10. GIVEN:

$v_i = 0$

$v_f = 7.0 \frac{m}{s}$

$h_i = ?$

$h_f = 0$

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

($v_i = 0$, $h_f = 0$)

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$mgh_i = \frac{1}{2}mv_f^2$$

$$h_i = \frac{v_f^2}{2g}$$

$$= \frac{(7.0)^2}{2(9.8)}$$

$$= 2.5\ m$$

11. GIVEN:

$m = 7.50\ kg$

$v_i = 0$

$v_f = ?$

$h_i = 1.5m$

$h_f = 0$

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

($v_i = 0$, $h_f = 0$)

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$mgh_i = \frac{1}{2}mv_f^2$$

$$v_f = \sqrt{2gh_i}$$

$$= \sqrt{2(9.8)(1.5)}$$

$$= 5.4 \frac{m}{s}$$

12.

GIVEN:

$v_i = 6.0 \frac{m}{s}$

$v_f = 0$

$h_i = 2.0\ m$

$h_f = ?$

ONE WAY TO SOLVE THIS PROBLEM IS TO FIND THE MAXIMUM HEIGHT SHE CAN REACH (SET $v_f = 0$ AND SOLVE FOR h_f). IF $h_f \geq 4.0m$, SHE MAKES IT TO THE TOP OF THE HILL.

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f \quad (v_f = 0)$$

$$\frac{1}{2}mv_i^2 + mgh_i = mgh_f$$

$$h_f = \frac{\frac{1}{2}v_i^2 + gh_i}{g}$$

$$= \frac{\frac{1}{2}(6.0)^2 + (9.8)(2.0)}{(9.8)}$$

$$= 3.8\ m$$

NO, SHE WILL NOT MAKE IT UP THE 4.0m HILL.

13. GIVEN:

$m = m$

$v_i = 0$

$v_f = ?$

$h_i = h$

$h_f = 0$

$$E_i = E_f$$

$$E_{k_i} + E_{p_i} = E_{k_f} + E_{p_f}$$

($v_i = 0$, $h_f = 0$)

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$mgh_i = \frac{1}{2}mv_f^2$$

$$v_f = \sqrt{2gh_i}$$

$$= \sqrt{2(9.8)h}$$

$$= \sqrt{19.6h}$$

14. a)

x | y

$v = 5.0 \frac{m}{s}$

$v_i = 0$

$v_f = ?$

$d = 20.0\ m$

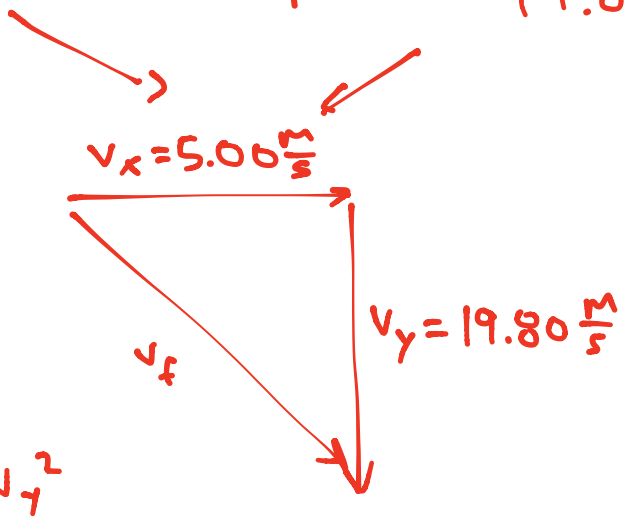
$a = 9.8 \frac{m}{s^2}$

$v_f^2 = v_i^2 + 2ad$ ($v_i = 0$)

$v_f = \sqrt{2ad}$

$= \sqrt{2(9.8)(20.0)}$

$= 19.80 \frac{m}{s}$



$v_f^2 = v_x^2 + v_y^2$

$v_f = \sqrt{v_x^2 + v_y^2}$

$= \sqrt{(5.00)^2 + (19.80)^2}$

$= 20. \frac{m}{s}$

b) GIVEN:

$v_i = 5.00 \frac{m}{s}$

$v_f = ?$

$h_i = 20.0\,m$

$h_f = 0$

$$E_i = E_f$$

$$E_{k_i} + E_{P_i} = E_{K_f} + E_{P_f} \qquad h_f = 0$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2$$

$$\frac{1}{2}v_i^2 + gh_i = \frac{1}{2}v_f^2$$

$$v_f = \sqrt{2\left(\frac{1}{2}v_i^2 + gh_i\right)}$$

$$= \sqrt{2\left[\frac{1}{2}(5.00)^2 + (9.8)(20.0)\right]}$$

$$= 20.\frac{m}{s}$$