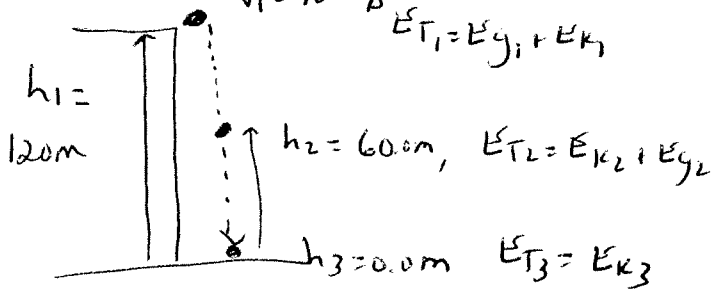
Energy Conservation Problems

$m = 6.5\,kg$

(1.)



$E_{T_1} = E_{g_1} + E_{K_1}$

$E_{T_2} = E_{K_2} + E_{g_2}$

$E_{T_3} = E_{K_3}$

a) $E_{K_1} = ?$

$E_{K_1} = \frac{1}{2} m v_1^2$

$= \frac{1}{2}(6.5\,kg)(18\,m/s)^2$

$= 1053\,J$

$\sim 1.1 \times 10^3\,J$

b) $E_{g_1} = ?$

$E_{g_1} = mgh_1$

$= (6.5\,kg)(9.81\,N/kg)(120\,m)$

$= 7651.8\,J$

$\sim 7.7 \times 10^3\,J$

c) $E_{T_1} = ?$

$E_{T_1} = E_{g_1} + E_{K_1}$

$= 7651.8\,J + 1053\,J$

$= 8704.8\,J$

d) $E_{K_2} = ?$

$E_{g_2} = ?$

$E_{T_2} = E_{T_1} = 8704.8\,J$

$E_{K_2} = E_{T_2} - E_{g_2}$

$= 8704.8\,J - mgh_2$

$= 8704.8\,J - (6.5\,kg)(9.81\,N/kg)(60.0\,m)$

$= 8704.8\,J - 3825.9\,J$

$= 4878.9\,J$

$\sim 4.9 \times 10^3\,J$

e) $v_2 = ?$

$E_{K_2} = \frac{1}{2} m v_2^2$

$v_2 = \sqrt{\frac{2E_{K_2}}{m}} = \sqrt{\frac{2(4878.9\,J)}{(6.5\,kg)}} = 38.7\,m/s \sim 39\,m/s$

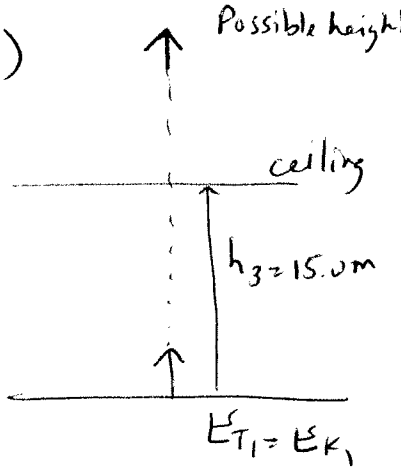
f) $v_3 = ?$

$E_{K_3} = E_{T_3} = 8704.8\,J$

$v_3 = \sqrt{\frac{2E_{K_3}}{m}} = \sqrt{\frac{2(8704.8\,J)}{(6.5\,kg)}} = 51.753\,m/s$

$\sim 52\,m/s$

(2) a)



$E_{T_1} = E_{K_1}$

$= \frac{1}{2} m v_1^2$

$= \frac{1}{2} (0.040\,kg)(30.0\,m/s)^2$

$= 18.0\,J$

$m = 0.040\,kg$

$v_1 = 30.0\,m/s$

$E_{g_2} = E_{T_2}$

$E_{g_2} = 18.0\,J$

$mgh_2 = 18.0\,J$

$h_2 = \frac{18.0\,J}{mg} = \frac{18.0\,J}{(0.040\,kg)(9.81\,N/kg)}$

$= 45.9\,m$

$\sim 46\,m$

b) $E_{K_3} = ?$

$h_3 = 15.0\,m$

$E_{T_3} = E_{K_3} + E_{g_3}$

$E_{K_3} = E_{T_3} - E_{g_3}$

$= 18.0\,J - mgh_3$

$= 18.0\,J - (0.040\,kg)(9.81\,N/kg)(15.0\,m)$

$= 18.0\,J - 5.886\,J$

$= 12.114\,J$

$\sim 12\,J$

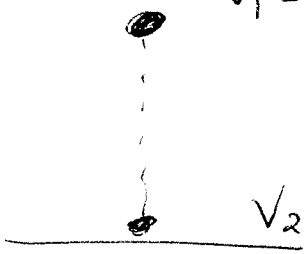
c) $v_3 = ?$

$\frac{1}{2} m v_3^2 = E_{K_3}$

$v_3 = \sqrt{\frac{2E_{K_3}}{m}} = \sqrt{\frac{2(12.0\,J)}{(0.040\,kg)}} = 24.495\,m/s$

$\sim 24\,m/s$

(3) $m = 240\,g = 0.240\,kg$



$E_{g_1} = 70.0\,J$

$V_1 = 20.0\,m/s$, $E_{K_1} = ?$

$E_{T_1} = E_{g_1} + E_{K_1}$

$V_2 = ?$ $E_{K_2} = E_{T_2}$

$E_{T_1} = E_{K_1} + E_{g_1}$

$= \frac{1}{2}mv_1^2 + 70.0\,J$

$= \frac{1}{2}(0.240\,kg)(20.0\,m/s)^2 + 70.0\,J$

$= 48.0\,J + 70.0\,J$

$= 118.0\,J$

$E_{K_2} = E_{T_2}$

$E_{K_2} = 118\,J$

$\frac{1}{2}mv_2^2 = 118\,J$

$V_2 = \sqrt{\frac{2(118\,J)}{(0.240\,kg)}} = 31.36\,m/s$

$\sim 31\,m/s$

∴ it hits the ground with a speed of 31 m/s.

(4) $E_T = 1.08 \times 10^5\,J$

$m = 1.00 \times 10^3\,kg$

a) $E_{g_1} = 1.96 \times 10^4\,J$

$E_{K_1} = ?$

$E_{K_1} + E_{g_1} = E_T$

$E_{K_1} = E_T - E_{g_1}$

$= 1.08 \times 10^5\,J - 1.96 \times 10^4\,J$

$= 88{,}400\,J$

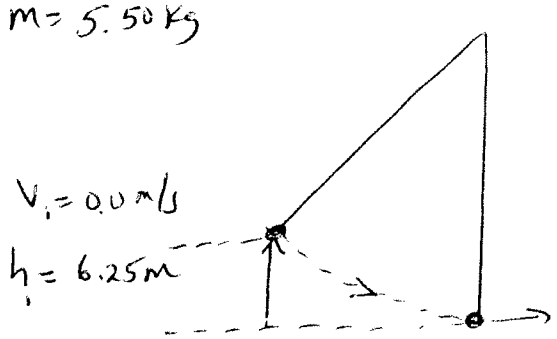
$= 8.84 \times 10^4\,J$

b) $V_1 = ?$

$V_1 = \sqrt{\frac{2E_{K_1}}{m}} = \sqrt{\frac{2(8.84 \times 10^4\,J)}{(1.00 \times 10^3\,kg)}} = 13.2966\,m/s \sim 13.3\,m/s$

∴ the roller coaster has a kinetic energy of $8.84 \times 10^4\,J$ and a speed of 13.3 m/s at that moment.

5. $m = 5.50\ kg$



$E_{T_1} = E_{g_1}$

$E_{T_2} = E_{K_2}$, $h_2 = 0.0m$

$V_2 = V_{max}!$

$$E_{T_1} = mgh_1$$
$$= (5.50kg)(9.81\ N/kg)(6.25m)$$
$$= 337.22\ J$$

$$E_{T_2} = E_{T_1} = 337.22J$$

$$E_{K_2} = E_{T_2}$$

$$\frac{1}{2}mV_2^2 = E_{T_2}$$

$$V_2 = \sqrt{\frac{2E_{T_2}}{m}}$$

$$= \sqrt{\frac{2(337.22J)}{(5.50kg)}} = 11.074\ m/s$$
$$\sim 11.1\ m/s.$$

∴ the maximum speed is 11.1 m/s.

This occurs as the bob swings through the rest position as the height and potential energy are zero.