Serway & Vuille 8th Edition

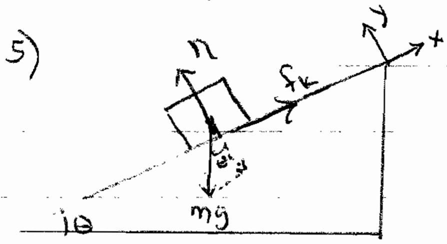
Chapter 5 Homework

2) $m = 281.5\,kg$
$h = 17.1\,cm = 0.171\,m$

a) $W = \vec{F}\cdot\vec{s} = mgh$
$= (281.5\,kg)(.171\,m)(9.80\,m/s^2)$
$= 472\,J$

b) $F = mg = (281.5\,kg)(9.80\,m/s^2) = 2.76\times10^3\,N$

5)



$V_0 = 0$ $\theta = 30.0°$
$m = 5.00\,kg$ $\mu_k = 0.436$
$s = 2.50\,m$

$\Sigma F_y = 0 \therefore \eta = mg\cos 30.0° = (5.00\,kg)(9.80\,m/s^2)(.866) = 42.4\,N$

a) $F_{gravity_x} = mg\sin\theta = (5.00\,kg)(9.80\,m/s^2)(.500) = 24.5\,N$

$W = (24.5\,N)(2.50\,m) = 61.3\,J$

b) $W_{friction} = \vec{f_k}\cdot\vec{s} = \mu_k \eta s\cos 180°$
$= (0.436)(42.4\,N)(2.50\,m)(-1)$
$= -46.3\,J$

c) $W_{normal} = \vec{\eta}\cdot\vec{s} = \eta s\cos 90° = 0$

13) $m = 70\,kg$
$V_0 = 4.0\,m/s$
$V_f = 0$
$\mu_k = 0.70$

a) $W = \Delta KE = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2$
$= 0 - \frac{1}{2}(70.0\,kg)(4.0\,m/s)^2$
$= -560\,J$

b) $W = f_k s\cos 180° = \mu_k mgs(-1) = -560\,J$
$(.70)(70\,kg)(9.8\,m/s^2)s = 560\,J$
$\therefore s = 1.2\,m$

15) $m = 7.80g = 7.80 \times 10^{-3} kg$ a) $f_{ave} = ?$

$V_0 = 575 m/s$

$S = 5.50 cm = 0.0550 m$ $W_f = \Delta KE = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_0^2$

$V_f = 0$

$$f_{ave}\ s \cos 180^\circ = -\frac{1}{2} m v_0^2$$

$$f_{ave} (.0550 m) = \frac{1}{2}(7.80 \times 10^{-3} kg)(575 m/s)^2$$

$$\therefore f_{ave} = 2.34 \times 10^4 N$$

b) $\bar{V} = \frac{V_0 + V_f}{2} = \frac{575 m/s}{2} = 287.5 m/s$

$x = \bar{v} t \therefore t = \frac{x}{\bar{v}} = \frac{.0550 m}{287.5 m/s} = 1.91 \times 10^{-4} s$

or calculate the constant acceleration, $a = f/m$ and substitute into $V_f = V_0 + at$ to find t

16) $m = 0.60 kg$ a) $KE_A = \frac{1}{2} m v_A^2 = \frac{1}{2}(.60 kg)(2.0 m/s)^2 = 1.2 J$

$V_A = 2.0 m/s$

$KE_B = 7.5 J$ b) $KE_B = \frac{1}{2} m v_B^2 = \frac{1}{2}(.60 kg)(V_B^2) = 7.5 J$

$$\therefore V_B = 5.0 m/s$$

c) $W = \Delta KE = KE_B - KE_A = 7.5 J - 1.2 J = 6.3 J$

17) $m = 2000 kg$ $F_{net} = 1000 N - 950 N = 50 N$

$F_1 = 1000 N$ $W = \vec{F}_{net} \cdot \vec{S} = (50 N)(20 m) = 1000 J$

$F_2 = -950 N$ resistive

$W = \Delta KE = KE_f - KE_0$

$S = 20 m$

$1000 J = \frac{1}{2} m v_f^2 - 0 = \frac{1}{2}(2000 kg) V_f^2$

$V_0 = 0$

$$\therefore V_f = 1.0 m/s$$

25) $V_1 = 35.0 \text{ m/s}$

$V_2 = 33.0 \text{ m/s}$

$\Delta y = y_2 - y_1$ (let $y_1 = 0$ at end of ramp)

$\therefore \Delta y = y_2$

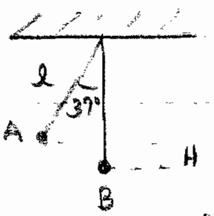
$$ME_1 = ME_2$$

$$\frac{1}{2}\cancel{m}v_1^2 + \cancel{m}g\cancel{y_1} = \frac{1}{2}\cancel{m}v_2^2 + \cancel{m}gy_2$$

$$\frac{1}{2}(35.0 \text{ m/s})^2 = \frac{1}{2}(33.0 \text{ m/s})^2 + (9.80)y_2$$

$$y_2 = \frac{(35.0)^2 - (33.0)^2}{2(9.80)} \text{ m} = 6.94 \text{ m}$$

37)



$$H = l - l\cos 37.0° = (30.0 \text{ m})(1 - \cos 37.0°)$$

$$= 6.04 \text{ m}$$

$l = 30.0 \text{ m}$

a) $\cancel{m}gH_A = \frac{1}{2}\cancel{m}v_B^2 \quad \therefore \quad V_B = \sqrt{2gH_A}$

$$V_B = \sqrt{2(9.80 \text{ m/s}^2)(6.04 \text{ m})} = 10.9 \text{ m/s}$$

b) $\frac{1}{2}\cancel{m}v_A^2 + \cancel{m}gH_A = \frac{1}{2}\cancel{m}v_B^2$

$$\frac{1}{2}(4.00 \text{ m/s})^2 + (9.80 \text{ m/s}^2)(6.04 \text{ m}) = \frac{1}{2}v_B^2$$

$$\therefore V_B = 11.6 \text{ m/s}$$

Note: v_B should be increased in part b because additional energy was available to transfer into KE

39) a) All energy is initially stored as elastic potential energy in the spring. Then it becomes kinetic energy and it has some gravitational PE. At the maximum height, the $v = 0$ $\therefore$ $KE = 0$ and all of the energy is PE due to gravity.

b) $x = 0.120 \text{ m}$

$h = 20.0 \text{ m}$

$m = 20.0 \text{ g} = .0200 \text{ kg}$

$v_0 = 0$

PE stored in spring = PE due to gravity

39b) continued: $\frac{1}{2}kx^2 = mgh$

$$\frac{1}{2}k(.120m)^2 = (.0200\,kg)(9.80\,m/s^2)(20.0m)$$

$$\therefore k = 544\ N/m$$

c) $h' = 0.120$

$$\frac{1}{2}kx^2 = mgh' + \frac{1}{2}mv^2$$

$$\frac{1}{2}(544\,N/m)(.120\,m)^2 = (.0200\,kg)(9.80\,m/s^2)(.120\,m) + \frac{1}{2}(.0200\,kg)v^2$$

$$3.92\,J = .0235\,J + .0100\,v^2 \quad \therefore \quad v = 19.7\ m/s$$

44) a) $m = 25.0\,kg$ $\quad H = l - l\cos\theta = l[1-\cos\theta]$

$l = 2.00m$ $\quad H = 2.00m(1-\cos 30.0°)$

$\theta = 30.0°$ $\quad = 0.268\,m$

By Conservation of Energy:

$$mgH = \frac{1}{2}mv^2 \quad \therefore \quad v = \sqrt{2gH}$$

$$v = \sqrt{2(9.80\,m/s^2)(.268m)} = 2.29\ m/s$$

b) $PE_{original} = mgH = (25.0\,kg)(9.80\,m/s^2)(.268\,m)$
$= 65.7\,J$

$KE_{final} = \frac{1}{2}mv_f^2 = \frac{1}{2}(25.0\,kg)(2.00\,m/s)^2 = 50.0\,J$

$\therefore$ Energy lost is $50.0J - 65.7J = -15.7\,J$

lost

50) $m = 70\,kg$ a) $h = s(\sin 30°) = (60\,m)(.50) = 30\,m$

$S = 60\,m$ $PE_{gain} = mgh = (70\,kg)(9.8\,m/s^2)(30\,m)$

$\theta = 30°$

$V = 2.0\,m/s$ (constant) $= 2.06 \times 10^4\,J \approx 21\,kJ$

$\Delta KE = 0 \therefore W_{nc} = 21\,kJ$

b) $s = vt \Rightarrow$

$t = 60\,m / 2.0\,m/s = 30\,s$ $\quad \bar{P} = W/t = \dfrac{2.06 \times 10^4\,J}{30\,s}$

$= 686\,\text{Watt}\left(1\,hp / 746\,\text{Watt}\right)$

$= 0.92\,hp$

57) $m = 1.50 \times 10^3\,kg$ a) $a = \dfrac{\Delta V}{\Delta t} = \dfrac{18.0\,m/s}{12.0\,s} = 1.50\,m/s^2$

$V_o = 0$

$V_f = 18.0\,m/s$ $\sum F = ma$

$\Delta t = 12.0\,s$ $F_{engine} - F_{air} = ma$

$F_{air} = 400\,N$ $\therefore F_{engine} = (1.50 \times 10^3\,kg)(1.50\,m/s^2) + 400\,N$

$= 2.65 \times 10^3\,N$

$\bar{V} = \dfrac{V_f + V_o}{2} = 9.00\,m/s \quad \therefore \quad \bar{P} = F_{engine}\,\bar{V} = (2.65 \times 10^3\,N)(9.00\,m/s)$

$= 2.39 \times 10^5\,\text{Watt}\left(\dfrac{1\,hp}{746\,\text{Watt}}\right)$

b) At $t = 12.0\,s$ $V_f = 18.0\,m/s$ $= 32.0\,hp$

$P = (F_{engine})V$

$= (2.65 \times 10^3\,N)(18.0\,m/s)\left(1\,hp / 746\,\text{Watt}\right) = 63.9\,hp$

60) Graph on p. 157 Work = area under Curve $(m = 3.00\,kg)$

a) $x = 0$ to $x = 5.00\,m$ $W = \frac{1}{2}(5.00\,m)(3.00\,N) = 7.50\,J$

b) $x = 5.00\,m$ to $x = 10.0\,m$ $W = (5.00\,N)(3.00\,N) = 15.0\,J$

c) $x = 10.0\,m$ to $x = 15.0\,m$ $W = \frac{1}{2}(5.00\,m)(3.00\,N) = 7.50\,J$

Note: $x = 0$ to $x = 15.0\,m$ Add up Work in a, b + c :

You could find total work $W_{total} = 7.50\,J + 15.0\,J + 7.50\,J$

$= 30.0\,J$

d) $V = 0.500\,m/s$ at $x = 0$ $\quad W = \frac{1}{2}mV_f^2 - \frac{1}{2}mV_i^2 = \frac{1}{2}m\left[V_f^2 - V_i^2\right]$

$7.50\,J\,(2/3.00\,kg) = V_f^2 - (.500\,m/s)^2 \quad \therefore V_f = 2.29\,m/s$

$W_{total} = 30.0\,J = \frac{1}{2}m\left[V_f^2 - V_i^2\right] \quad \therefore \quad V_f = 4.50\,m/s$