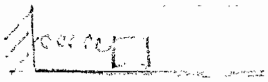
Serway + Vuille 8th Edition
Chapter 13 Homework

1. 

$m = 0.60\,kg$

$k = 130\,N/m$

$V_0 = 0$

$x = 0.13\,m$

a) $F = -kx$

$= -(130\,N/m)(.13\,m)$

$= -17\,N$

If mass is pulled to the right, the force is to the left.

b) $\frac{F}{m} = a = -\frac{17\,N}{.60\,kg} = -28\,m/s^2$ (to the left)

10. $x = 0.400\,m$

$F = 230\,N$

a) $k = \frac{F}{x} = \frac{230\,N}{.400\,m} = 575\,N/m$

b) $W = \frac{1}{2}kx^2 = \frac{1}{2}(575\,N/m)(.400\,m)^2 = 46.0\,J$

13. $m_b = 10.0\,g = 0.0100\,kg$

$m_{block} = 2.00\,kg$

$k = 19.6\,N/m$

$V_b = 300\,m/s$

Conservation of momentum:

$m_b V_b = (m_b + m_{block}) V_f$

$V_f = \frac{(.0100\,kg)(300\,m/s)}{(2.01\,kg)} = 1.49\,m/s$

Use Conservation of energy "after" collision:

$\frac{1}{2}(m_b + m_{block}) V_f^2 = \frac{1}{2}kx^2$

$(2.01\,kg)(1.49\,m/s)^2 = (19.6\,N/m)\,x^2 \quad \therefore x = 0.477\,m$

20. $m = 50.0\,g = 0.0500\,kg$

$k = 10.0\,N/m$

$x = 25.0\,cm = 0.250\,m = A$

$V_0 = 0$

$V = ?$ when $x = A/2 = 0.125\,m$

$V = \sqrt{\frac{k}{m}(A^2 - x^2)}$

$V = \sqrt{\frac{(10.0\,N/m)[(.250)^2 - (.125)^2]\,m^2}{(.0500\,kg)}}$

$\therefore V = 3.06\,m/s$

22. $R = 20.0\,cm = 0.200\,m$

$T = 2.00\,s$

a) $v = \frac{2\pi R}{T} = \frac{2\pi(.200m)}{2.00s} = 0.628\,m/s$

b) $f = 1/T = 0.500\,s$

c) $\omega = 2\pi f = 2\pi(.500\,Hz) = 3.14\,rad/s$

32. $x = 3.00\,cm = 3.00 \times 10^{-2}\,m$

$F = 7.50\,N$

$m = 0.500\,kg$

$A = 5.00\,cm = 5.00 \times 10^{-2}\,m$

$v_0 = 0$ at $t = 0$

a) $k = F/x = 7.50N / 3.00 \times 10^{-2}\,m$

$= 250\,N/m$

b) $T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{.500kg}{250N/m}} = .281\,s$

$f = 1/T = 3.56\,Hz$

$\omega = 2\pi f = 22.4\,rad/s$

c) $E = \frac{1}{2}kA^2 = \frac{1}{2}(250\,N/m)(.0500m)^2 = 0.313\,J$

d) $x_{max} = A = 5.00\,cm = 5.00 \times 10^{-2}\,m$

e) ~~$v_{max} = \omega A = (22.4\,rad/s)(5.00 \times 10^{-2}\,m) = 1.12\,m/s$~~

$a_{max} = \omega^2 A = (22.4\,rad/s)^2(5.00 \times 10^{-2}\,m) = 25.1\,m/s^2$

f) $x = ?$ at $t = 0.500\,s$

$x = A\cos(\omega t) = (0.0500m)\cos[(22.4)(.500)] = 0.0102\,m$

round off difference, using $\omega = \sqrt{k/m}$

$x = A\cos\left[\left(\sqrt{\frac{250N/m}{.500kg}}\right)(.500s)\right] = 0.00919\,m = .919\,cm$

g) Find v & a at 0.500s

$v = -A\omega\sin(\omega t) = -(1.12\,m/s)\sin\left[\left(\sqrt{\frac{250}{.500}}\right)(.500)\right] = +1.10\,m/s$

$a = -A\omega^2\cos(\omega t) = -(25.1\,m/s^2)\cos\left(\left(\sqrt{\frac{250}{.500}}\right)(.500)\right) = -4.61\,m/s^2$

37. $g_E = 9.80\, m/s^2$ and $g_m = 1.63\, m/s^2$

a) T is proportional to $\frac{1}{\sqrt{g}}$ ∴ lower "g" ⟹ larger time between ticks of the clock ⟹ clock runs slow

b) $\frac{T_M}{T_E} = \frac{2\pi\sqrt{l/g_m}}{2\pi\sqrt{l/g_E}} = \sqrt{\frac{g_E}{g_M}} = \sqrt{\frac{9.80\, m/s^2}{1.63\, m/s^2}} = 2.45$

∴ $T_M = 2.45\, T_E$

↑ time between ticks on the moon clock

24.0 hr passed on earth ∴ $\frac{24.0}{2.45} = 9.80$ hours passed on the moon

9 hours and $.80\left(\frac{60\, min}{hour}\right)$ ∴ 48 minutes

∴ clock reads 9:48 AM

42. See the graph on p. 455

a) $A = 2.00cm$ b) $T = 4.00s$ c) $\omega = \frac{2\pi}{T} = \frac{2\pi}{4.00} = \frac{\pi}{2} = 1.57 \frac{rad}{s}$

d) $|V_{max}| = \omega A = \left(\frac{\pi}{2}\right)(2.00cm) = (\pi) cm/s$

e) $|a_{max}| = \omega^2 A = \left(\frac{\pi}{2}\right)^2 (2.00)\, cm/s^2 = 4.93\, cm/s^2$

f) $x = A\sin(\omega t) = \left[(2.00)\sin\left(\frac{\pi}{2}t\right)\right] cm$

51. $L = 6.30m$ a) $V = \sqrt{\frac{T}{m/L}} = \sqrt{\frac{TL}{m}} = \sqrt{\frac{(12.0N)(6.30m)}{.150kg}}$

$m = 0.150 Kg$

$F = T = 12.0N$ $\therefore V = 22.4 m/s$

b) $t = \frac{L}{V} = \frac{6.30m}{22.4 m/s} = 0.281 s$

53. $V = 50.0 m/s$ a) $V = \sqrt{\frac{F}{\mu}} = \sqrt{\frac{F\ell}{m}}$

$\ell = 5.00m$

$m = 0.0600 kg$ $\therefore V^2 = \frac{F\ell}{m} \Rightarrow F = \frac{mV^2}{\ell}$

$F = \frac{(.0600kg)(50.0 m/s)^2}{(5.00m)} = 30.0N$

b) $T = F = 8.00N$ $V = \sqrt{\frac{(8.00N)(5.00m)}{(.0600kg)}} = 25.8 m/s$

56. $\ell_1 = 50.0cm = 0.500m$ $\ell_2 = \ell_1 = 0.500m$

$m_1 = 3.00g = 3.00 \times 10^{-3} kg$ $m_2 = m_1/2 = 1.50 \times 10^{-3} kg$

$V_1 = 5.00 m/s$

Assume $F_1 = F_2$ $\therefore V_2 = ?$

$F = \frac{mv^2}{\ell}$ (see problem 53 above) $\therefore \frac{m_1 v_1^2}{\ell_1} = \frac{m_2 v_2^2}{\ell_2}$

$V_2^2 = \frac{m_1 V_1^2}{m_2}$ $\therefore V_2 = \sqrt{\frac{m_1 V_1^2}{m_2}} = \sqrt{\frac{m_1}{m_2}}\, V_1 = \sqrt{\left(\frac{m_1}{m_1/2}\right)}\, V_1$

$V_2 = \sqrt{2}\, V_1 = \sqrt{2}\,(5.00 m/s) = 7.07 m/s$

66. $m = 500g = 0.500kg$ $mgh = \frac{1}{2}kx^2$ (stored in spring)

$h = 2.00m$ $(.500kg)(9.80 m/s^2)(2.00m) = \frac{1}{2}(20.0 N/m)\, x^2$

$k = 20.0 N/m$

Use Conservation of Energy $\therefore X = 0.990m$