1. a) $K_{Block} = \frac{1}{2}mv^2 \Rightarrow \frac{1}{2}(5kg)(6\frac{m}{s})^2 = 90\,J$

$U_s = \frac{1}{2}kx^2$

$\frac{1}{2}kx^2 = 90\,J \Rightarrow \frac{1}{2}(500\frac{N}{m})x^2 = 90$

$x = 0.6\,m$

b) $U_s = K_{Block}$

$\frac{1}{2}(500\frac{N}{m})(0.150)^2 = \frac{1}{2}(5kg)(v^2)$

$v = 1.50\,m/s.$

2. a) $7500\,L \times \frac{1\times10^{-3}\,m^3}{1L} = 7.5\,m^3$ $\quad (1\,L = 1000\,cm^3)$

$(7.5\,m^3)(1.05\times10^3\,kg/m^3) = 7875\,kg.$

$\Delta U = mgh = (7875\,kg)(9.8\frac{N}{kg})(1.63\,m) = 125,795\,J$

b) $P_{AVG} = \frac{\Delta W}{\Delta t} = \frac{125,795\,J}{(24h)(3600\,s/h)} = 1.46\,W$

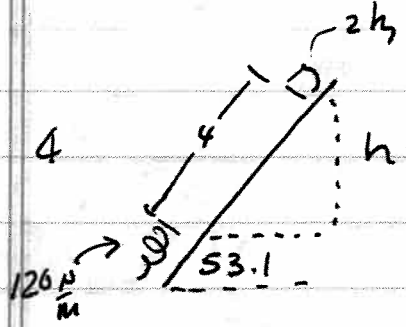
3. a) $10W = \frac{10J}{s\cdot kg}$; $25W = 25\,J/s\cdot kg \times 0.07\,kg$

Power ~~Energy~~: $0.7\,J/s < K/s < 1.75\,J/s.$

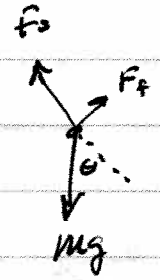
at 10 beats/s, $0.07\,J/beat < 0.175\,J/beat$

b) $\frac{560W}{70kg} = 7.14\frac{W}{kg}$ ← less than the 10W/kg to fly.

$\frac{1.4\times10^3W}{70kg} = 20\frac{W}{kg}$ ← too short of a time



$h = 4\sin(53.1) = 3.2\,m$



$F_s = mg\cos(53.1)$

$U_0 + K_0 + W = U_f + K_f$

$mgh - (F_f)(4m) = K_f$

$(2kg)(9.8\frac{N}{kg})(3.2m) - (2.35N)(4m) =$

$62.72J - 9.4J = 53.32J$

$53.32J = \frac{1}{2}mv^2 \Rightarrow 53.32J = \frac{1}{2}(2kg)v^2$

$v = 7.3\,m/s.$

$F_f = \mu_k F_s = \mu_k mg\cos(53.1)$

$F_f = (0.2)(9.8)(2kg)(0.6)$

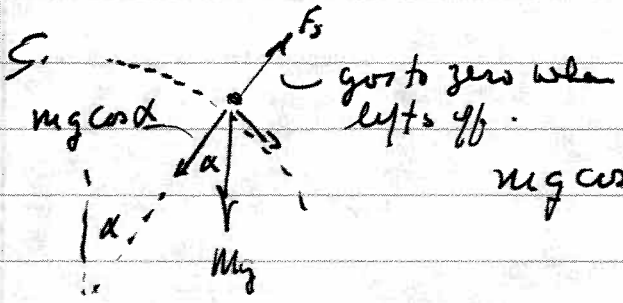
$F_f = 2.35\,N$

b) $W_{FRICTION} = -F_f(4+x)$

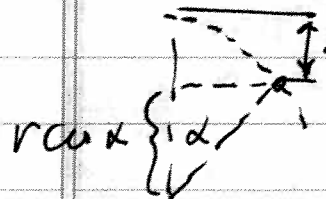
$mg(4+x)\sin\theta - \mu_k mg\cos\theta(4+x) = \frac{1}{2}kx^2$

$x = 1.06\,m$

c)



$mg\cos\alpha = \frac{mv^2}{r} \Rightarrow v^2 = gr\cos\alpha$



$\Delta h = r - r\cos\alpha$

$U_0 = mgr$; $U_f = mgr\cos\alpha$

$K_0 = 0$; $K_f = \frac{1}{2}mv^2$

$mgr = \frac{1}{2}mv^2 + mgr\cos\alpha$

$v^2 = 2rg(1-\cos\alpha) \Rightarrow 2rg(1-\cos\alpha) = gr\cos\alpha$

$3\cos\alpha = 2 \Rightarrow \cos\alpha = \frac{2}{3} \quad \alpha = 48.2°$

6 a) $x = x_0 \cos \omega t$, $y = y_0 \sin \omega t$

$$a_x = \frac{d^2x}{dt^2}, \quad a_y = \frac{d^2y}{dt^2}, \quad U = -\int F \cdot dx$$

$$a_x = -\omega^2 x, \quad a_y = -\omega^2 y \Rightarrow F_x = -m\omega^2 x, \quad F_y = -m\omega^2 y$$

b) $$U = -\left(\int F_x dx + \int F_y dy\right)$$

$$U = m\omega^2 \int x\,dx + m\omega^2 \int y\,dy = \frac{1}{2} m\omega^2 (x^2 + y^2)$$

c) $$v_x = \frac{dx}{dt} = -x_0 \omega \sin \omega t \qquad v_y = \frac{dy}{dt} = +y_0 \omega \cos \omega t$$

from a) $\sin \omega t = \frac{y}{y_0}$ $\qquad \cos \omega t = \frac{x}{x_0}$

$$v_x = -x_0 \omega \frac{y}{y_0} \qquad v_y = y_0 \omega \frac{x}{x_0}$$

$$K = \frac{1}{2} m (v_x^2 + v_y^2), \quad U = \frac{1}{2} m\omega^2 (x^2 + y^2)$$

$$E = K + U$$

when $x = x_0$ and $y = 0$ $\quad v_x = 0, \quad v_y = y_0 \omega$

$$K = \frac{1}{2} m y_0^2 \omega^2, \quad U = \frac{1}{2} m \omega^2 x_0^2$$

$$E = \frac{1}{2} m\omega^2 (y_0^2 + x_0^2)$$

7 a) $K_0 + U_0 + W = K_f + U_f$

$K_0 = 0$, $K_f = \frac{1}{2}mv^2$

$U_0 = 0$, $U_f = \frac{1}{2}kx^2$ $(x = 0.25m) = \frac{1}{2}\left(40\frac{N}{m}\right)(.25m)^2 = 1.25J$

$W = Fx = (20N)(0.25m) = 5J$

$5J = 1.25J + \frac{1}{2}mv^2 = 1.25J + \frac{1}{2}(0.5kg)v^2$

$v = 3.87 m/s.$

b) $5J = \frac{1}{2}kx^2$

$5J = 0.5\left(40\frac{N}{m}\right)x^2$

$x = 0.5$

block is $0.6 - 0.5$ from wall $= 0.1 m.$

8. $\frac{1}{2}k_1x^2 + \frac{1}{2}k_2x^2 = \frac{1}{2}mv^2$

$\frac{1}{2}\left(2500\frac{N}{m}\right)(0.15m)^2 + \frac{1}{2}\left(200\frac{N}{m}\right)(0.15m)^2 = \frac{1}{2}(3kg)v^2$

$v = 5.81 m/s.$ when both springs are at their undisturbed length

b. Same compression as displacement

$x = 0.15m.$