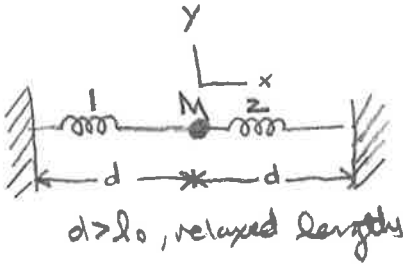
BB 1.3

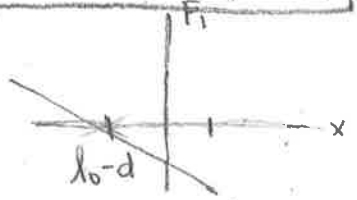


$d > l_0$, relaxed lengths

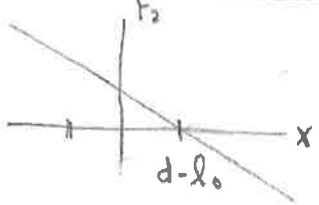
(6 pts)

a) Find F_1 and F_2 when M displaced x_0 to the right.

$$\boxed{F_1 = -k(x-(l_0-d))}$$



$$\boxed{F_2 = -k(x-(d-l_0))}$$



$$F(x=x_0) = -k(x_0 - \cancel{l_0} + \cancel{d} + x_0 - \cancel{d} + \cancel{l_0}) = \boxed{-2kx_0}$$

b) $$M\frac{d^2x}{dt^2} = F_1 + F_2$$

$$= -2kx$$

$$\boxed{\frac{d^2x}{dt^2} + \frac{2k}{M}x = 0}$$

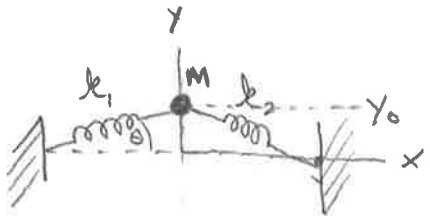
c) $x(t=0) = x_0$

$v(t=0) = 0$

$x = A\cos\omega_0 t + \cancel{B}^{\,0}\sin\omega_0 t$

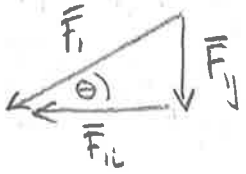
$x_0 = A$, $\omega_0 = \frac{2k}{M}$

$$\boxed{x = x_0\cos\left(\sqrt{\frac{2k}{M}}\,t\right)}$$

d) 

$k_1 = k_2$

Net restoring force on M?



$$F_1 \approx -k(d-l_0)$$

$$F_{1i} = F_1 \cos\theta = F_1 \frac{d}{\sqrt{d^2+Y_0^2}} \approx F_1$$

$$F_{1J} = F_1 \sin\theta = F_1 \frac{Y_0}{\sqrt{d^2+Y_0^2}} \approx F_1 \frac{Y_0}{d}$$

$$\bar{F}_{Net} = \bar{F}_{1J} + \bar{F}_{2J} = \boxed{\frac{-2k(d-l_0)Y_0}{d}\hat{J}}$$

e) Period $T_y = \frac{1}{f_y} = \frac{2\pi}{\omega_{oy}} = 2\pi\sqrt{\frac{M}{k_y}} = 2\pi\sqrt{\frac{Md}{2k(d-l_0)}}$

$$\boxed{T_y = \sqrt{\frac{2\pi^2 Md}{k(d-l_0)}}}$$