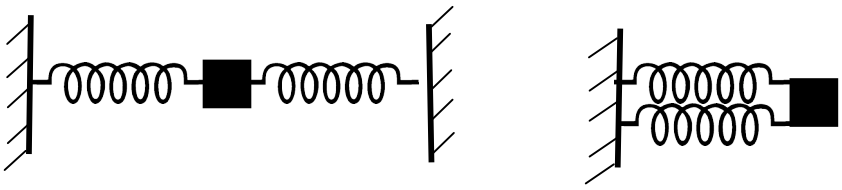
# PHYSICS 180

**Problem set #4** **due: October 11, 2006**

*"Nature and nature's laws lay hid in night"*
*God said 'Let Newton be!' an all was light."*
*.....Alexander Pope (1688-1744)*

1) Harsh, Bosco and Fiona, who are traveling on the TGV (*Train á Grande Vitesse*) between Bourges and Lyon in France, are willing to tolerate acceleration magnitudes as large as 0.2 g. The driver wants to change speeds from 250 to 300 km $hr^{-1}$ on a curved piece of track. If the radius of curvature of the piece of track is 5 km, what is the minimum time the driver can use to change speeds?

2) Franklin has two systems that consists of two springs with spring constant $k_1$ and $k_2$ attached to a mass, M as shown below. What does he find to be the resonance frequencies if the mass moves horizontally?



b) A spring with "spring constant" $k$ is cut in half. What is the new spring constant of either half? A $H_2$ molecule (each nucleus has one proton) vibrates with a frequency $\omega = 6x10^{14}\ s^{-1}$. Deduce the effective spring constant of the molecule.

3. Esther finds that the motion of an object along a straight line can be described by an equation of the form $R\frac{d^2x}{dt^2} = -Bx + C$. What is the equilibrium position of the object? What is the resonance frequency of the object? Assume R= 0.2 kg, B= 2 N/m and C=0.1 m. If x = .5 at t = 0 and $v_x$ = -1 m/s at t = 1 s, what is the acceleration of the object at t = 3 s?

4. A block is at the bottom of an incline that makes an angle of $45^0$ relative to the horizontal. The coefficient of kinetic friction between the block and the incline varies as 0.1 + 0.03L, where L is the distance in metres from the bottom of the incline. If Amy launches the block from the bottom with a speed of 5 m/s up the incline, what is the block's speed when it returns to the bottom?