STAEDTLER® No. 937 811E Engineer's Computation Pad

•••26 In Fig. 15-36, two springs are joined and connected to a block of mass 0.245 kg that is set oscillating over a frictionless floor. The springs each have spring constant k = 6430 N/m. What is the frequency of the oscillations?

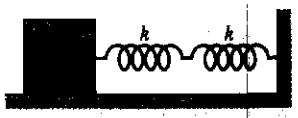
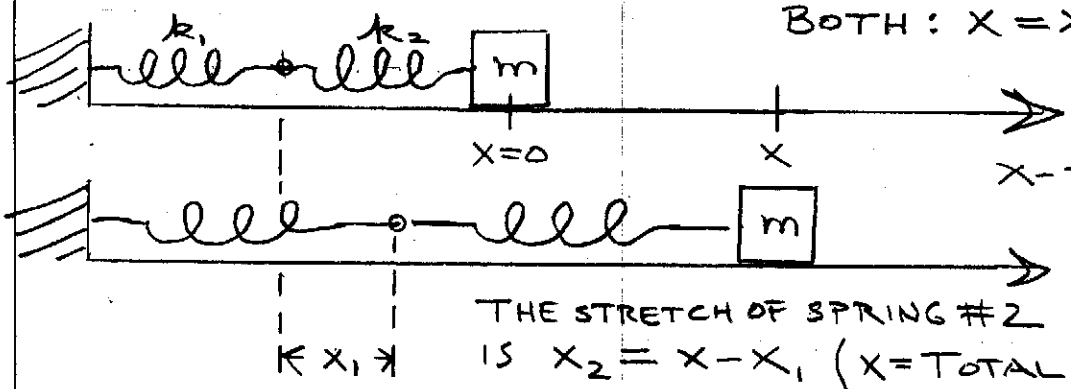


FIG. 15-36 Problem 26.

CONSIDER A DISPLACEMENT FROM EQUILIBRIUM I.E. UNSTRETCHED SPRINGS FOR BOTH TO STRETCHE SPRINGS FOR BOTH: $X = X_1 + X_2$ (SPRING 1, SPRING 2)



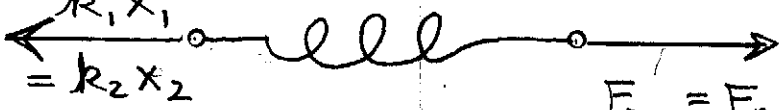
THE STRETCH OF SPRING #2 IS $X_2 = X - X_1$ (X = TOTAL STRETCH)

LOOKING AT MAGNITUDES: $F^{net}_{on\ m} = k_{effective} X = k_e X$

LOOK AT THE FORCE THAT ONE SPRING EXERTS ON THE OTHER — WHERE THEY JOIN!
1 = SPRING 1 & 2 = SPRING 2

NEWTON'S 3rd LAW $\vec{F}_{2,1} = -\vec{F}_{1,2} \Rightarrow F_{2,1} = F_{1,2}$ HOOKE'S LAW $\Rightarrow k_1 X_1 = k_2 X_2$

THE NET FORCE ON THE MASSLES SPRING #2 IS.



$F_{2,m} = F_{m,2} = F^{spring}_2 = k_2 X_2$

$\vec{F}^{net}_{spring\ 2} = \vec{F}_{2,1} + \vec{F}_{2,m} = m_{SPRING\ 2} a_2 \equiv 0$

2ND LAW $\Rightarrow \vec{F}_{2,m} = -\vec{F}_{2,1} \Rightarrow k_1 X_1 = k_2 X_2 = F_{2,m} = F_{m,2}$

ALL THE FORCES ARE EQUAL IN MAGNITUDE — IN PARTICULAR: $F^{net}_{on\ m} = F_{m,2} = F = k_1 X_1 = k_2 X_1$

$X = X_1 + X_2$

$\frac{F}{k_e} = \frac{F}{k_1} + \frac{F}{k_2} \Rightarrow \frac{1}{k_e} = \frac{1}{k_1} + \frac{1}{k_2}$ HOW SPRINGS IN SERIES ADD

$k_1 = k_2 = k$ IN THIS PROBLEM $\Rightarrow \frac{1}{k_e} = \frac{2}{k} \Rightarrow k_e = \frac{k}{2}$

$\omega^2 = k_e/m = k/2m \Rightarrow \omega = \frac{1}{\sqrt{2}}\sqrt{\frac{k}{m}} = \sqrt{\frac{6430}{.245}}/\sqrt{2}$

$\omega = 162/\sqrt{2} = 115 \frac{rad}{s} \Rightarrow f = \frac{\omega}{2\pi} = 18.2 \left(\frac{osc}{s} = Hertz = Hz\right)$