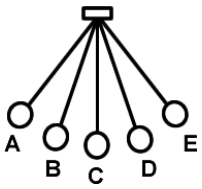
Harmonic Motion Basics

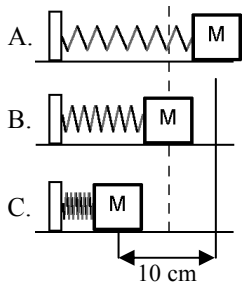


1. A. Where is the equilibrium position for this pendulum?
   B. If the pendulum swings 40º from side-to-side (A to E), what is its amplitude?

   C. How many times does it pass point C in 1 cycle?

(The amplitude is always from the center to one of the sides OR 1/2 side-to-side.)

A moving spring



2. A spring-mass system is moving back and forth as shown at the left.
   A. Where is its equilibrium position?
   B. If the spring starts at position A, how much of a cycle does it complete from A to C?

   C. If the spring moves 10 cm from C to A (side to side), how big is it's amplitude?

   The spring moves back-and-forth 45 times in 52 seconds.
   D. What is its period?

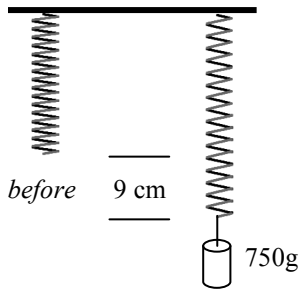
   E. What is its frequency?

3. An spring has a period of 4 seconds. What is its frequency?

4. A pendulum has a frequency of 3 Hz. What is its period?

5. A pendulum has a length of 65 cm. What is its period?

6. A spring-mass system has a frequency of 5 Hz (times per second) when there is a 350 g mass on it.
   A. The mass must be in kg. m =
   B. You do not have an equation for frequency, just for period. Realizing this, solve for k.



7. A. How far did the spring stretch?
   B. What type of force is pulling the spring?
   C. Calculate the force stretching the spring.

   D. Find the spring constant of the spring.

   (Now without the graphic.)

8. A 600 g mass causes a spring to pull down 12 cm. Calculate the spring constant.

9. A person yells into a deep cavern. The sound comes back to them 2 seconds later. If the speed of sound is 340 m/s how deep is the cavern?

10. A person strikes a wood rail. The wood rail is 1200 meters long, in total. It comes back to the person after 1.1 second. What is the speed of sound in the rail?

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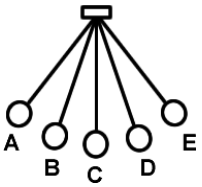
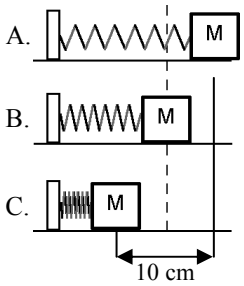


1. A. Where is the equilibrium position for this pendulum? *Point C*
   B. If the pendulum swings 40º from side-to-side (A to E), what is its amplitude? *20 degrees*
   C. How many times does it pass point C in 1 cycle? *2 times*

   (The amplitude is always from the center to one of the sides OR 1/2 side-to-side.)

A moving spring



2. A spring-mass system is moving back and forth as shown at the left.
   A. Where is its equilibrium position? *B (the middle position)*
   B. If the spring starts at position A, how much of a cycle does it complete from A to C? *1/2 a cycle. A full cycle is from A to C and back to A.*
   C. If the spring moves 10 cm from C to A (side to side), how big is it's amplitude? *5 cm (half of side to side)*

   The spring moves back-and-forth 45 times in 52 seconds.
   D. What is its period? *T = #sec/#cycle = 52/45 = 1.16 sec*

   E. What is its frequency? *f = 1/T or #cycle/#sec = .862 Hz*

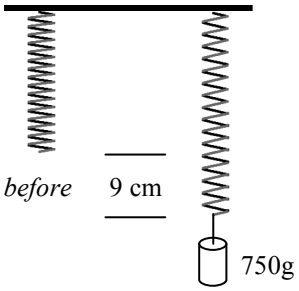
3. An spring has a period of 4 seconds. What is its frequency?
   f = 1/T = 1/4 = .25 sec

4. A pendulum has a frequency of 3 Hz. What is its period?
   T = 1/f = 1/3 = .33 sec

5. A pendulum has a length of 65 cm. What is its period? $T = 2\pi\sqrt{\frac{\ell}{g}}$
   T = 1.6 sec (used g = 10)

6. A spring-mass system has a frequency of 5 Hz (times per second) when there is a 350 g mass on it.
   A. The mass must be in kg. *m = 0.35 kg*
   B. You do not have an equation for frequency, just for period. Realizing this, solve for k.

$$\frac{1}{f} = 2\pi\sqrt{\frac{m}{k}} \quad \frac{1}{5} = 6.28\sqrt{\frac{.35}{k}} \quad 0.2 = 6.28\sqrt{\frac{.35}{k}} \quad \frac{0.2}{6.28} = \sqrt{\frac{.35}{k}} \quad \left(\frac{0.2}{6.28}\right)^2 = \frac{.35}{k} \quad 0.001 = \frac{0.35}{k} \quad k = \frac{0.35}{0.001} = 345\text{N/m}$$



7. A. How far did the spring stretch? *x = 0.09m (decimal moves over 2)*
   B. What type of force is pulling the spring? *Weight due to gravity*
   C. Calculate the force stretching the spring.
   F = mg = .75(10) = 7.5 N

   D. Find the spring constant of the spring.

$$F = -kx$$
$$7.5 = -k(.09)$$
$$k = 83.3\ \text{N/m}$$

And k is always positive.
(Now without the graphic.)

8. A 600 g mass causes a sprig to pull down 12 cm. Calculate the spring constant.
   F = 0.6(10) = 6 N
   x = 0.12 m

$$F = -kx$$
$$6 = -k(.12)$$
$$k = 50\ \text{N/m}$$

9. A person yells into a deep cavern. The sound comes back to them 2 seconds later. If the speed of sound is 340 m/s how deep is the cavern?
   S = D/T t = 2 sec (for there and back, so for 2D) S = 340 m/s,
   so S = 2D/T and 2D = ST, so D = ST/2 = 340(2)/2 = 340 m

10. A person strikes a wood rail. The end of the wood rail is 1200 meters away. It comes back to the person after 1.1 second. What is the speed of sound in the rail? S = 2D/T = 2(1200)/1.1 = 2181 m/s