Example

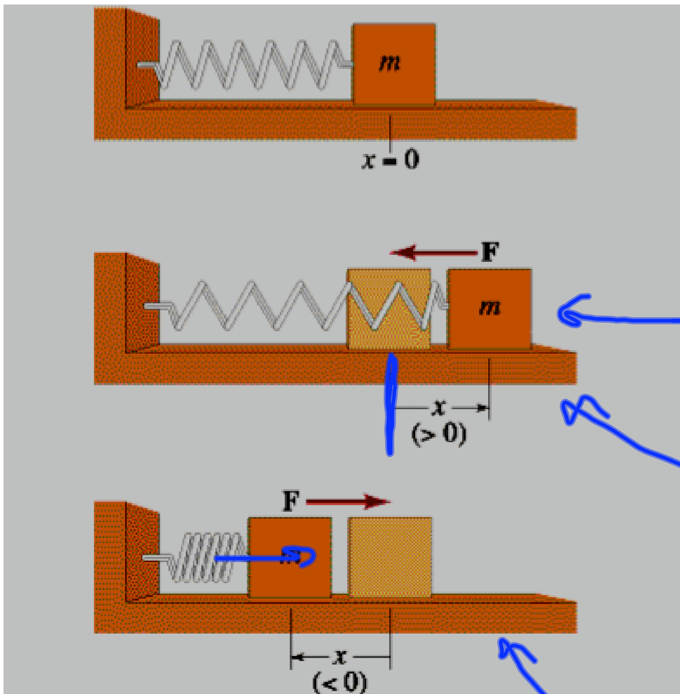
- Suppose a mass on a horizontal surface is connected to a spring. Its period and amplitude of oscillation is 3.00s and 4.0cm, respectively. Assume v=0 at t=0s.
  - Write x=x(t),v=v(t), and a=a(t)
  - Find t, when x=A/2 and -A/2.
  - When is a= zero the first time?
  - When does v reach a first maximum?
  - How do you determine k?
  - What if v=4.00cm/s and x=0 at t=0?
- Discuss its motion if the mass were vertical.

Reminders 1-15-07:
-Log onto Webassign ASAP!!!
-Log onto Computers!!!
-Read Syllabus
-Get lab software from desktop of computers in lab.
-Check course web page once a week.
-All lab reports worth 20 points, require a cover sheet, and are to be turned in at beginning of lab meeting.
-Sign prerequisite certificate form
-Login & Log out of Physics Tutoring Center or S-107 (lab)
-Read Chapter 13
-Sign up for Physics 2Y. Homework will be discussed in this class, not (generally) during lecture.

Objectives:
-Kinematics and Dynamics of Simple Harmonic Motion for the Mass on a Spring

+5pts

$$\frac{1.5(H.G.) + 4.5(E.G) + 1.5(FEG) + 2(LG)}{10}$$

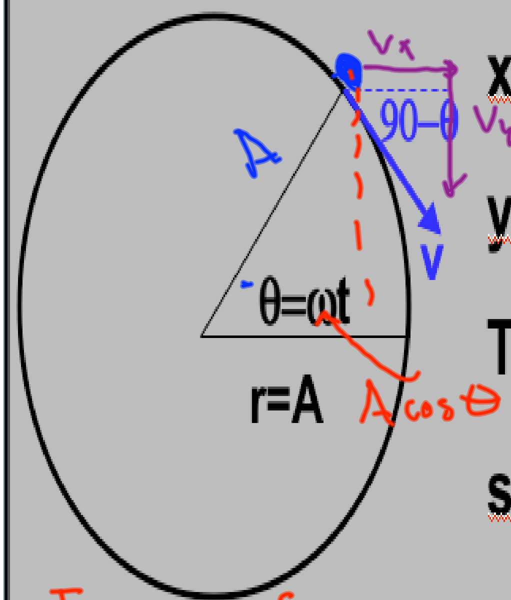


$F = -kx = ma$

$a = -\frac{k}{m}x$

max. velocity

slows down



$$T = \frac{\text{circumference}}{\text{speed}}$$

$x = A\cos\theta = A\cos\omega t$

$y = A\sin\theta = A\sin\omega t$

$T = 2\pi A/v = 2\pi/\omega; v = \omega A$

$\sin\theta = (A^2 - x^2)^{1/2}/A = v_x/v$

$v_x = v(A^2 - x^2)^{1/2}/A = \omega(A^2 - x^2)^{1/2}$

$$V = \frac{\Delta x}{\Delta t} \qquad \frac{\Delta\theta}{\Delta t} = \omega$$

$$\Delta x = v\Delta t = vt \qquad \Delta\theta = \omega\Delta t = \omega t$$

angular speed

$$2\pi = \omega T$$

T = period

$$\omega = \frac{2\pi}{T} = 2\pi f \; ; \; f = \frac{1}{T}$$

$$V = \frac{\text{dist}}{\text{time}} \qquad T = \frac{\text{dist}}{V} = \frac{2\pi A}{V} = \frac{2\pi}{\omega}$$

$$\frac{A}{V} = \frac{1}{\omega}$$

$$V = A\omega$$

$$a = -\frac{k}{m}x = -\omega^2 x$$

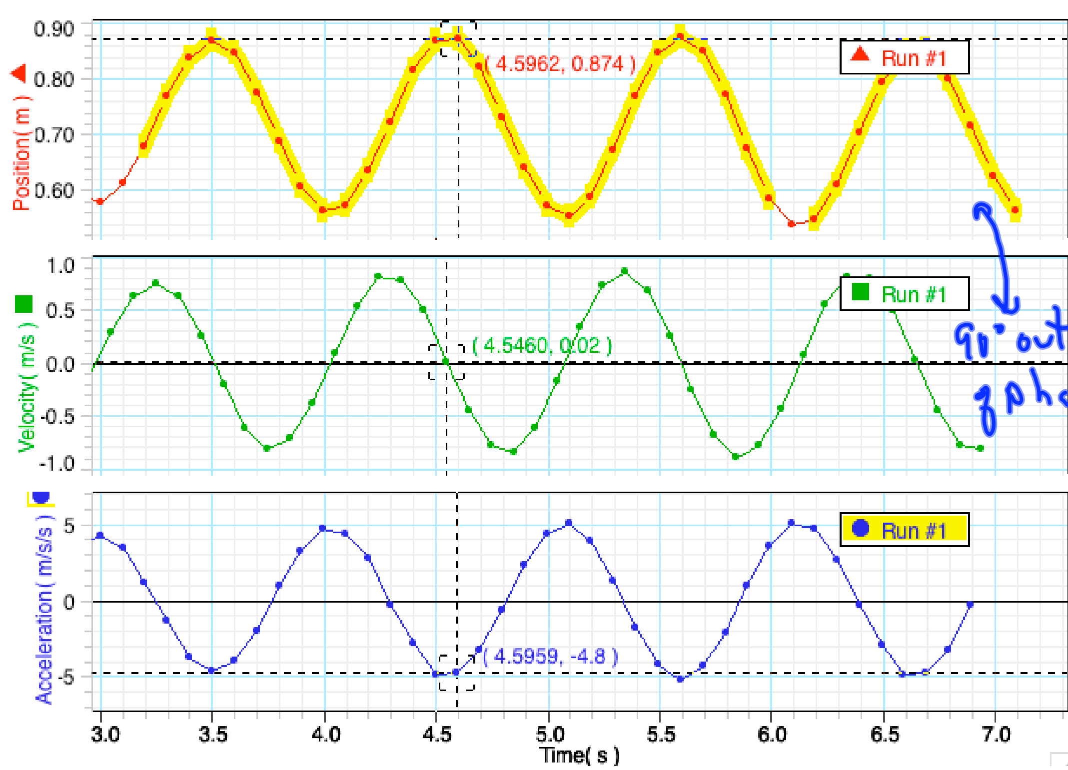
$$x = A\cos \omega t$$

$$a = -\omega^2 A\cos \omega t$$

$$\omega = \sqrt{\frac{k}{m}} = 2\pi f = \frac{2\pi}{T}$$

T = period; time for 1 cycle

ω = angular speed



180° out of phase

90° out of phase

Mass on Spring Characteristics

- $F=ma= -kx$, so $a=-kx/m=-\omega^2 x$
- Assuming $x(t=0)= A$, then $x=A\cos\omega t$, where $\omega =2\pi f= (m/k)^{1/2}$.
  - Period is $T=2\pi/\omega=1/f= 2\pi\ (m/k)^{1/2}$
  - Amplitude- max. distance from equilibrium position (A).
  - At maximum displacements $a=\pm kA/m$, assuming $x(t=0)= \pm A$
  - $a= -\omega^2 x= -\omega^2 A\cos\omega t$ (180^o out of phase with x).

Mass on Spring Characteristics

- From conservation of energy

$$\tfrac{1}{2}kA^2 = \tfrac{1}{2}mv^2 + \tfrac{1}{2}kx^2 \text{ and}$$

$$v = [(k/m(A^2 - x^2)]^{\frac{1}{2}} = [(k/m(A^2 - (A\cos\omega t)^2)]$$

$$[(k/m(A^2 - A^2\cos^2\omega t)]^{\frac{1}{2}} = [(kA^2/m)(1 - \cos^2\omega t)]^{\frac{1}{2}}$$

$$v = [(k/m(A\sin\omega t)^2)]^{\frac{1}{2}} = \omega A \sin\omega t$$

  - V is 90° out of phase with x.
  - Maximum <u>speed</u> $v = (kA/m)^{\frac{1}{2}}$

- What if $x=0$ at $t=0s$?

remember $\boxed{\frac{k}{m} = \omega^2 \,!}$