

The Details of Simple Harmonic Motion

Pre-Class Questions

Problem Set (due next time)
Ch 11 - 29, 32, 36, 39

Lecture Outline

1. Energy Flow in SHM
2. The Conditions for SHM

Follow the Bouncing Ball

The nine images at the right were taken sequentially with a video camera as the ball oscillated back and forth on the end of the spring. Rank them from largest to smallest. If some are equal to others put an equal sign between them.

Rank the frequency of oscillation of the system:

Rank the acceleration vector of the ball:

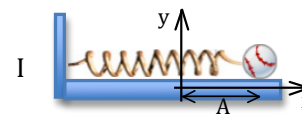
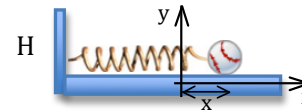
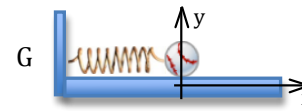
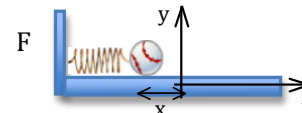
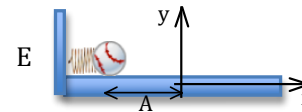
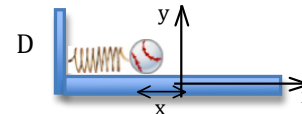
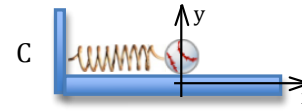
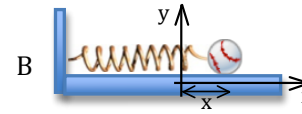
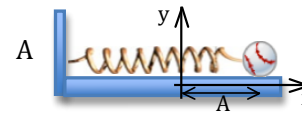
Rank the speed of the ball:

Rank the velocity of the ball:

Rank the ball's kinetic energy:

Rank the spring's potential energy:

Rank the total energy of the system:



Example 1: A 0.15kg baseball is on the end of a spring with spring constant 8.0N/m. The ball is pulled horizontally 20cm from equilibrium and released. When the ball is 10cm from equilibrium, find its speed.

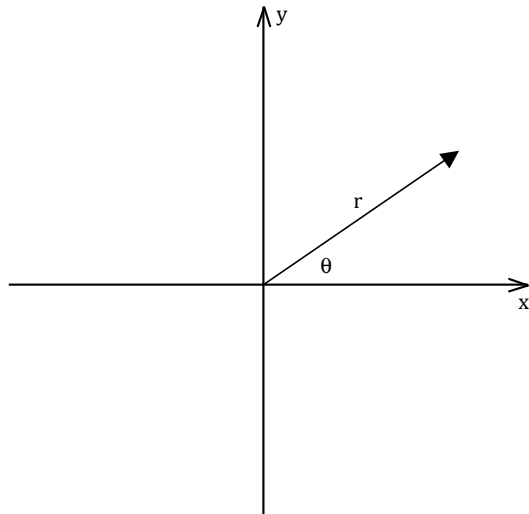
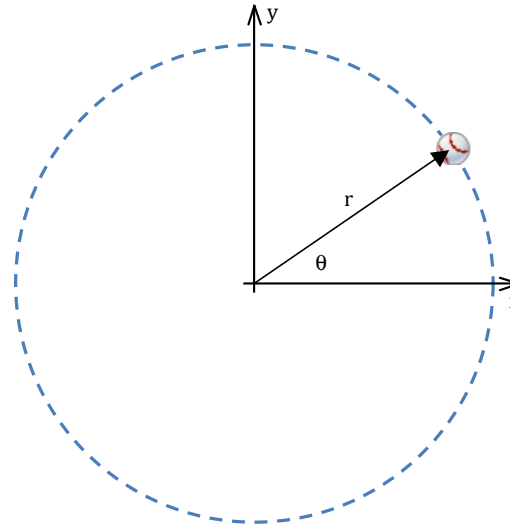
Gonna Go Round in Circles...

The baseball is going in circular motion counterclockwise at a constant angular speed ω . At $t = 0$, the ball is along the x-axis.

1. If the time to go all the way around is T and the angle once around the circle is 2π , express θ in terms of time t by completing the ratio,

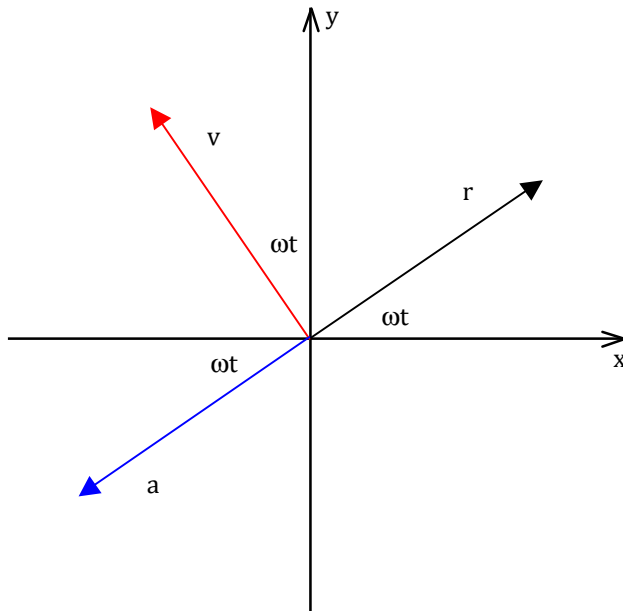
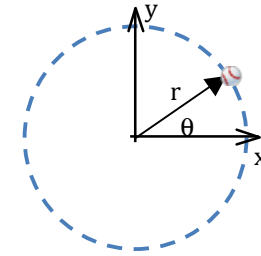
$$\frac{\theta}{2\pi} = \frac{t}{\square}.$$

2. Use the ratio above to express θ in terms of ω and t .
3. Draw the velocity and acceleration vectors for the ball in the drawing above.
4. Redraw the displacement, velocity, and acceleration vectors on the coordinates below.



Gonna Go Round in Circles II...

The baseball is going in circular motion counterclockwise at a constant angular speed ω . At $t = 0$, the ball is along the x-axis.



5. Write the x-components of all three vectors in terms of trig functions, ω , and t .

$$x = r \cos \omega t$$

$$v_x =$$

$$a_x =$$

6. Write the speed and acceleration for circular motion in terms of r and ω .

$$v = \frac{2\pi r}{T} =$$

$$a = \frac{v^2}{r} =$$

7. Substitute the results from part 6 into part 5.

$$x = r \cos \omega t$$

$$v_x =$$

$$a_x =$$

8. Write a_x in terms of x . Explain the connection between this answer and SHM.

Example 2: A 0.15kg baseball is on the end of a spring with spring constant 8.0N/m. The ball is pulled horizontally 20cm from equilibrium and released. Find (a) the angular frequency, (b) the period, and (c) the amplitude.

Lecture 28 - Summary

The Law of Conservation of Energy is quite useful in SHM.

The requirement for SHM is $a = -\omega^2 x$

For a spring $\omega = \sqrt{\frac{k}{m}}$