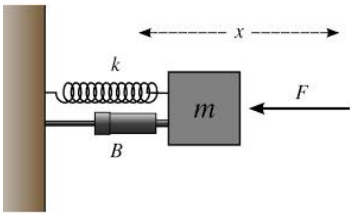
# 6.3 - Mass-Spring Systems

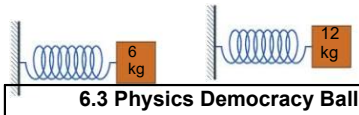



Fix Ballot example a bit - make it other than 12 and 14 kg.

Fix Examples 3 and 4

# 1. Intro. Physics Democracy

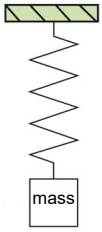
Ballot Measure 1! Which system has more mechanical energy, a mass-spring system with 6 kg or one with 12 kg on it, if they both have *k* of 82 N/m and are displaced 0.25m? Write down why you chose your vote.
Ballot Measure 2! Which has more velocity as it passes through the equilibrium position? Why?




| 6.3 Physics Democracy Ballot | | | |
|---|---|---|---|
| | 6 kg | Same | 12 kg |
| Ballot Measure 1 | | | |
| Ballot Measure 2 | | | |

# 2. Try This Out!

Take the ring stand, hang a spring from it, and suspend different masses.
Compare their periods: which is longer?




# Mass-Spring Systems

Def: a mass connected to a spring (duh).

The period and frequency of a mass-spring system relate to the spring's constant, and the mass.

| AP Equation | |
|---|---|
| $T = 2\pi\sqrt{\frac{m}{k}}$ | m = mass (kg)<br>k = spring constant (N/m) |
| $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ | |

Note: you may encounter problems involving horizontal mass-spring systems that involve friction between the mass and sliding surface.

# Mass-Spring System: Energy

Energy is proportional to displacement squared:

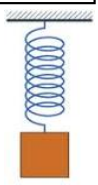
| | |
|---|---|
| $E = \frac{1}{2}kx^2$ | E = Joules<br>k = Spring Constant (N/m)<br>x = Displacement (m) |

# Mass-Spring System: Speed

The speed (m/s) of a mass-spring system changes with displacement:

| | |
|---|---|
| $v = \pm\sqrt{\frac{k}{m}\left(A^2 - x^2\right)}$ | k = spring constant (N/m)<br>A = maximum displacement (m)<br>x = displacement from eq. (m)<br>m = mass (kg) |

The +/- applies to the mass' direction.

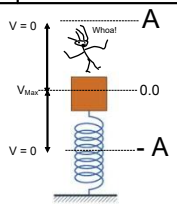


## One More Equation

At no displacement of an oscillating system, x = 0, so velocity is greatest at that point.

$$v_{max} = \pm A\sqrt{\frac{k}{m}}$$

A = maximum displacement (m)
k = spring constant (N/m)
m = mass (kg)



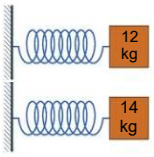

## Mass-Spring Example

3. What **is** the mechanical energy of a mass-spring system with any mass on it, with *k* of 82 N/m, pulled down 0.25 m from equilibrium and released?

4. What is the velocity of the 6 kg and 12 kg masses as they pass through the equilibrium position?

$$E = \frac{1}{2}kx^2$$

$$E = 2.6J$$




$$v_{max} = \pm A\sqrt{\frac{k}{m}}$$

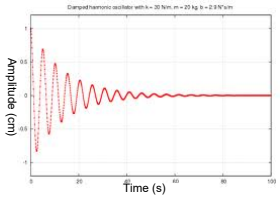
$$v_{12kg} = \pm 0.65\frac{m}{s}$$

$$v_{14kg} = \pm 0.61\frac{m}{s}$$

## Damped Harmonic Motion

Definition: Decreasing energy of a harmonic system over time, due to friction.
Ex: A car's shock absorbers stop bouncing a couple seconds after hitting a pothole.


Needed for Alaska's Roads!



Amplitude vs. Time in a Dampened System

## Homework

DO NOT Preview 6.4

6.3 Problems
Due: Next Class