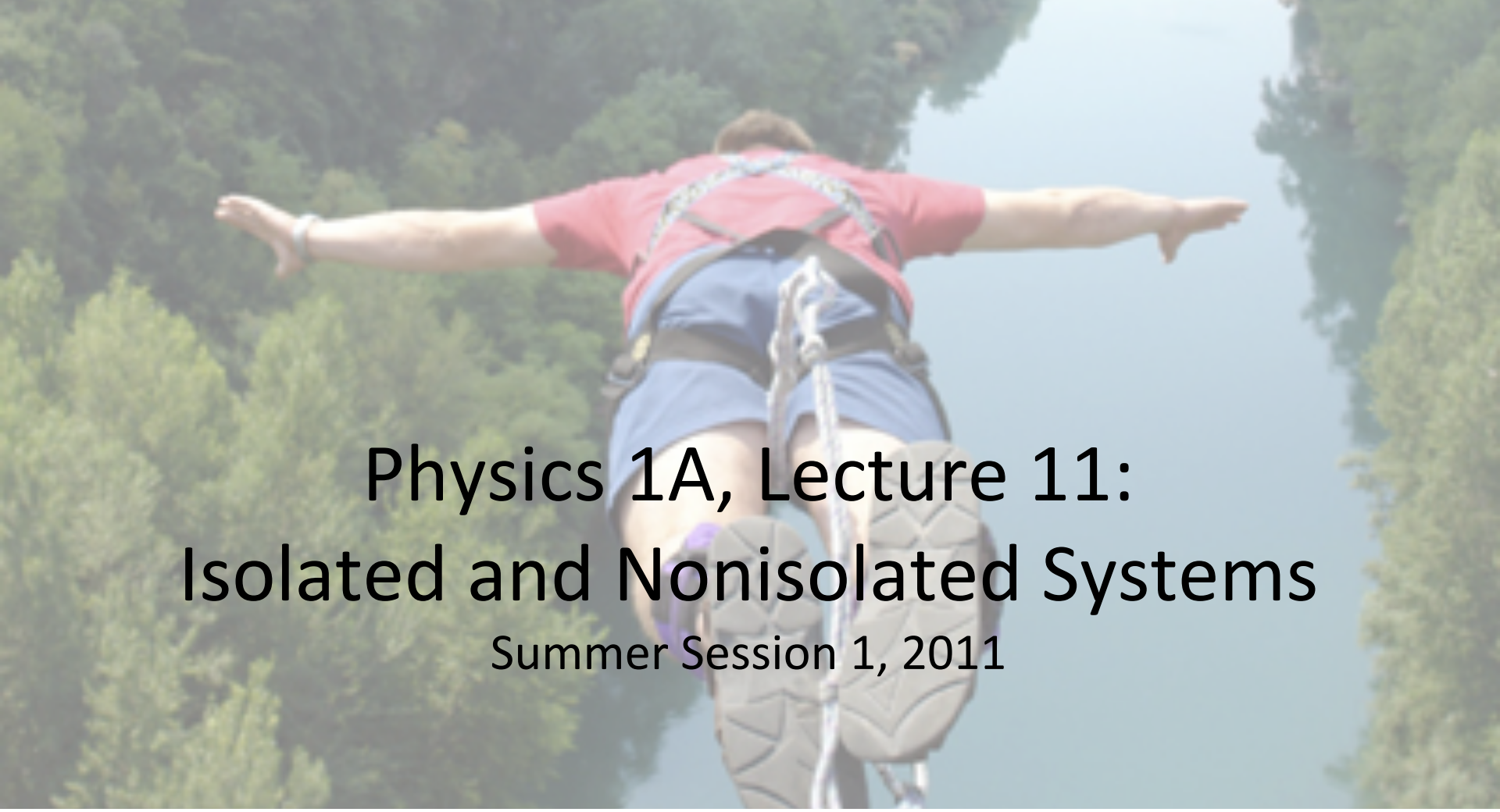


Physics 1A, Lecture 11: Isolated and Nonisolated Systems

Summer Session 1, 2011

The quiz will commence at 9:33 AM.

Key Questions: (Discuss with neighbors before quiz)

1) The unit of power is the watt (W). What is one watt in terms of the other units we have used in this class?

2) What is an isolated system?

3) What is the difference between a conservative and a non-conservative force?

Reading Quiz #9-1

The unit of power is the watt (W). What is one watt in terms of the other units we have used in this class?

A. N m

B. J / s

C. N / m

D. kg m/s^2

E. N / s

Reading Quiz #9-2

- What is an isolated system?

A) A system that does not loose or gain energy.

B) A system that is far away from all field forces.

C) A system that does not include engines or animate objects.

D) A system that includes conservative and non-conservative forces.

Reading Quiz #9-3

Fill in the blanks. Gravity is a _____ force.
Friction is a _____ force.

A. conservative, conservative

B. conservative, non-conservative

C. non-conservative, conservative

D. non-conservative, non-conservative

Announcements

- HW #4 is due tomorrow
- Office hours tonight 5-6pm in Mayer 5623
- Pick up old homework

Anonymous poll

- How helpful have the reading quizzes been?

A) Really helpful. I like knowing what I need to prepare to understand lecture
B) I don't mind them but I don't think they are necessary.
C) I don't mind them but they don't help me because the questions are tricky and unfair.
D) I hate them. The questions are tricky and unfair.

Clicker Question 9-1

- Which of these can be negative?

$$KE = \frac{1}{2}mv^2$$

$$PE_g = mgh$$

A) Only Kinetic Energy (KE)

B) Only Potential Energy (PE)

C) Only Work

D) Only Work and Potential Energy (PE)

E) All three can be negative

Clicker Question 9-2

- Which of these can be negative?

$$\Delta KE = KE_f - KE_0$$

$$\Delta PE = PE_f - PE_0$$

A) Only change in Kinetic Energy (ΔKE)

B) Only change in Potential Energy (ΔPE)

C) Only Work

D) Only Work and change in Potential Energy (ΔPE)

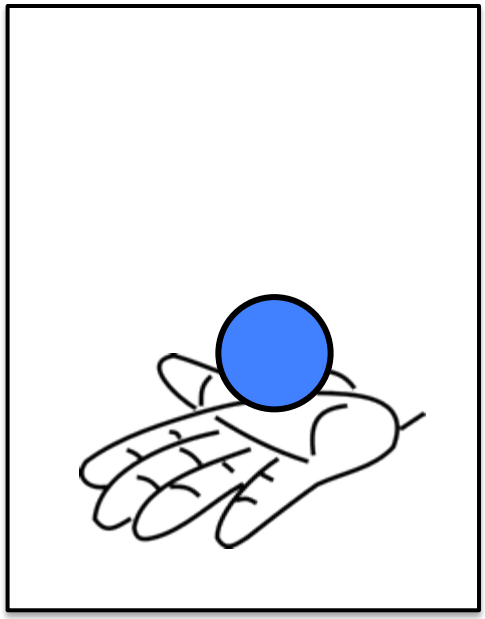
E) All three can be negative

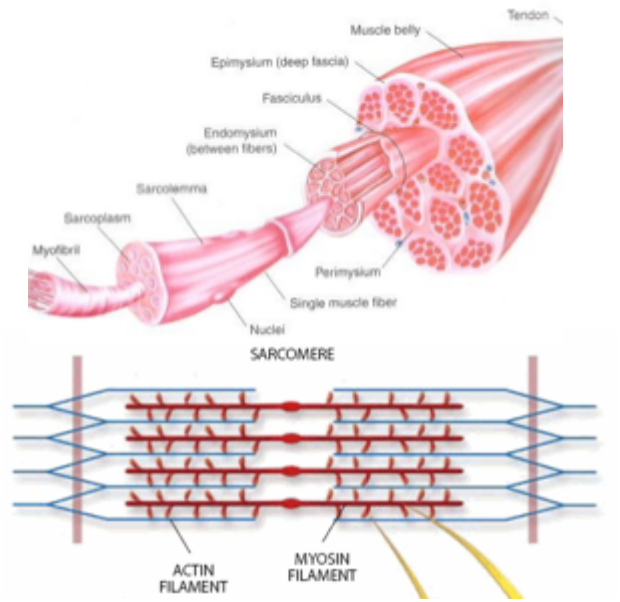
Isolated systems

C Concept

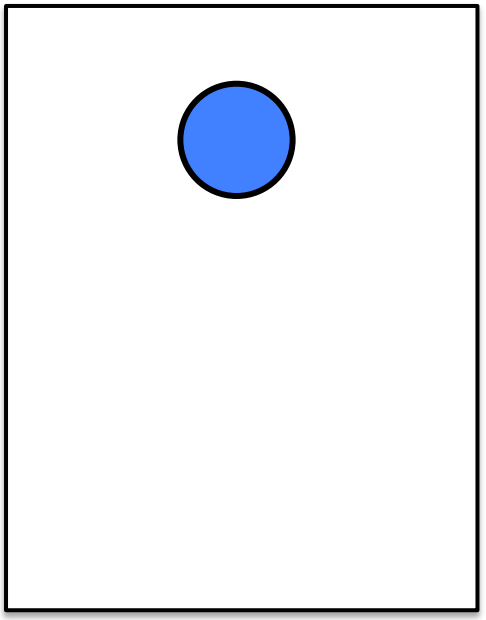
- System where total energy does not change over time (Energy is not added or dissipated away)
- Example:

Not an isolated system





An isolated system



Isolated systems

C Concept

- System where total energy does not change over time (Energy is not added or dissipated away)
- Example:

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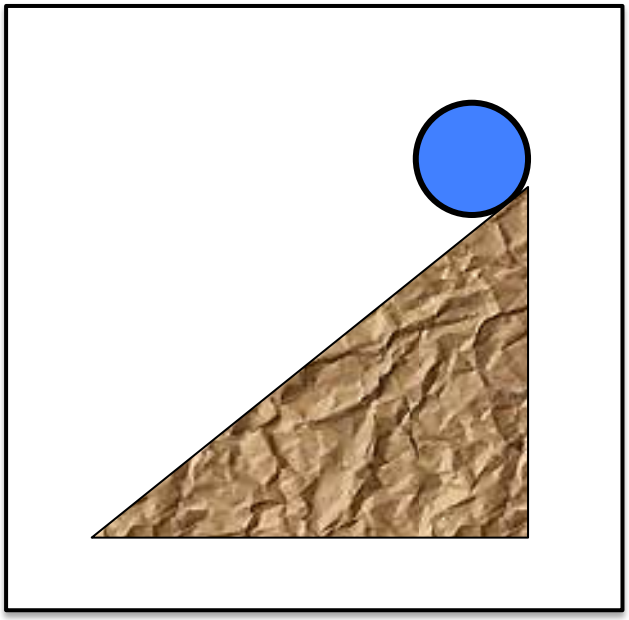
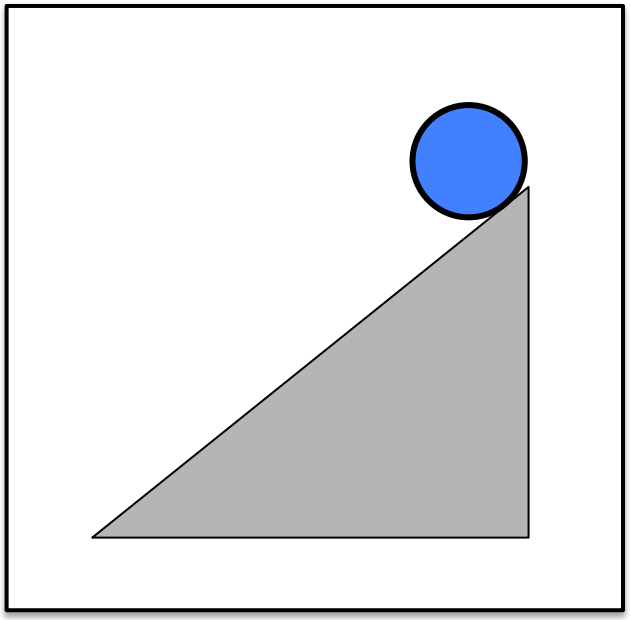


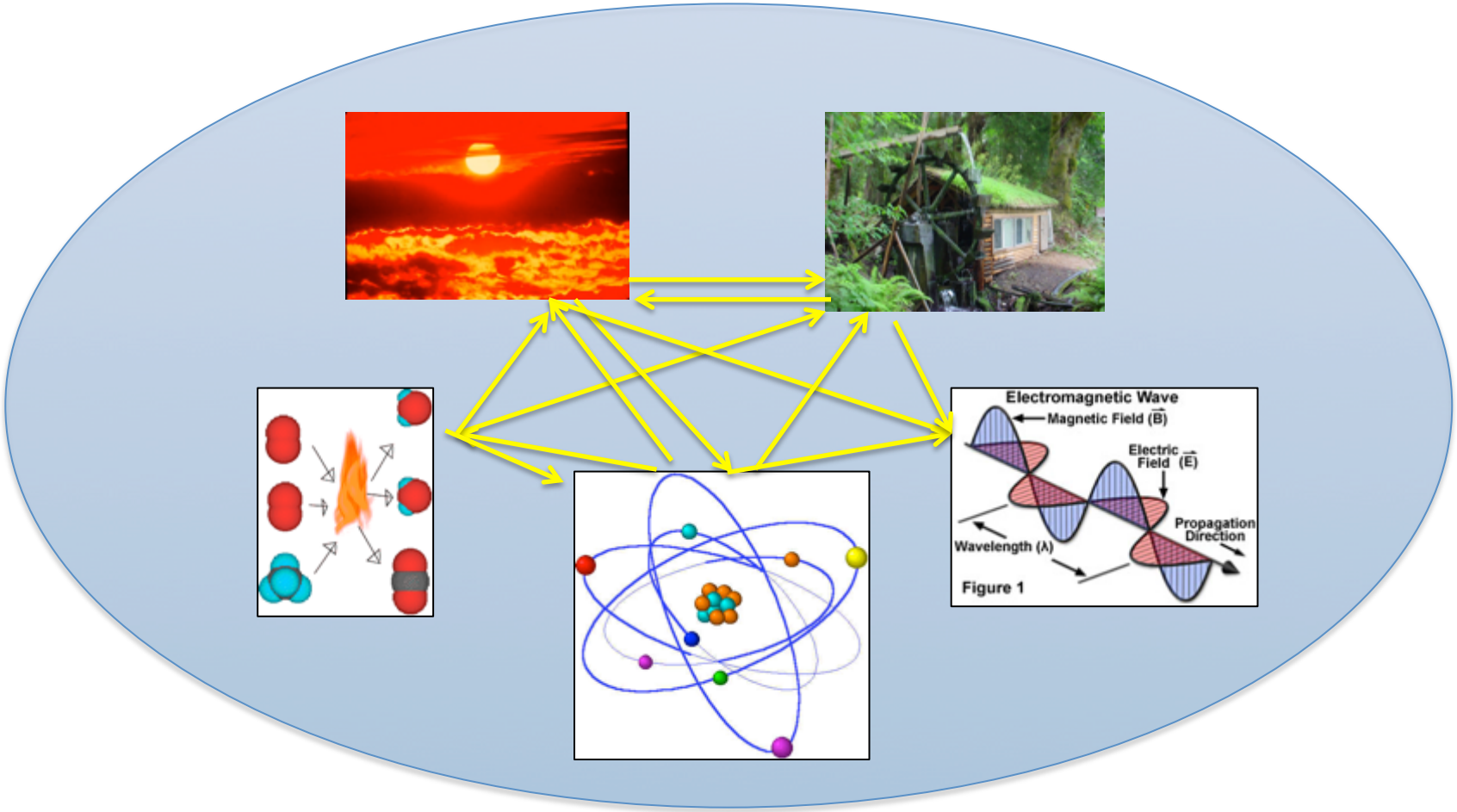
An isolated system



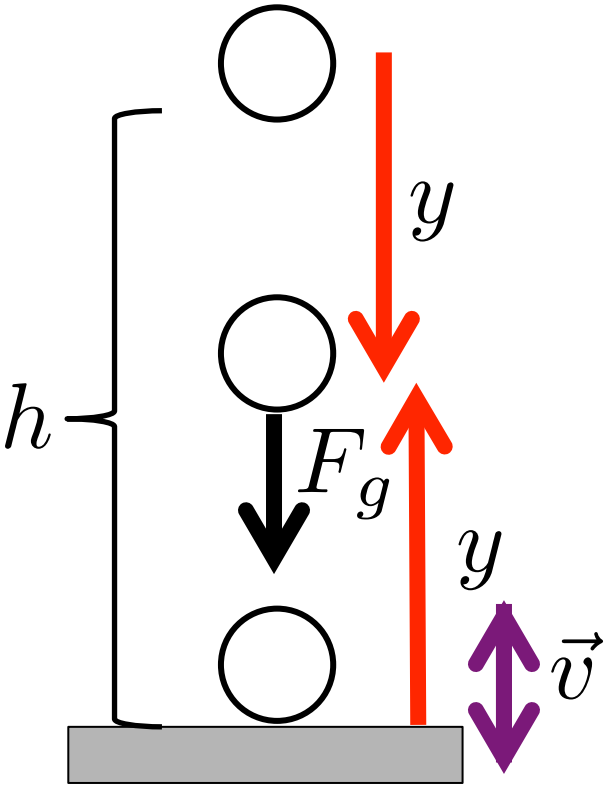
Isolated systems

C Concept

- The universe is an isolated system:



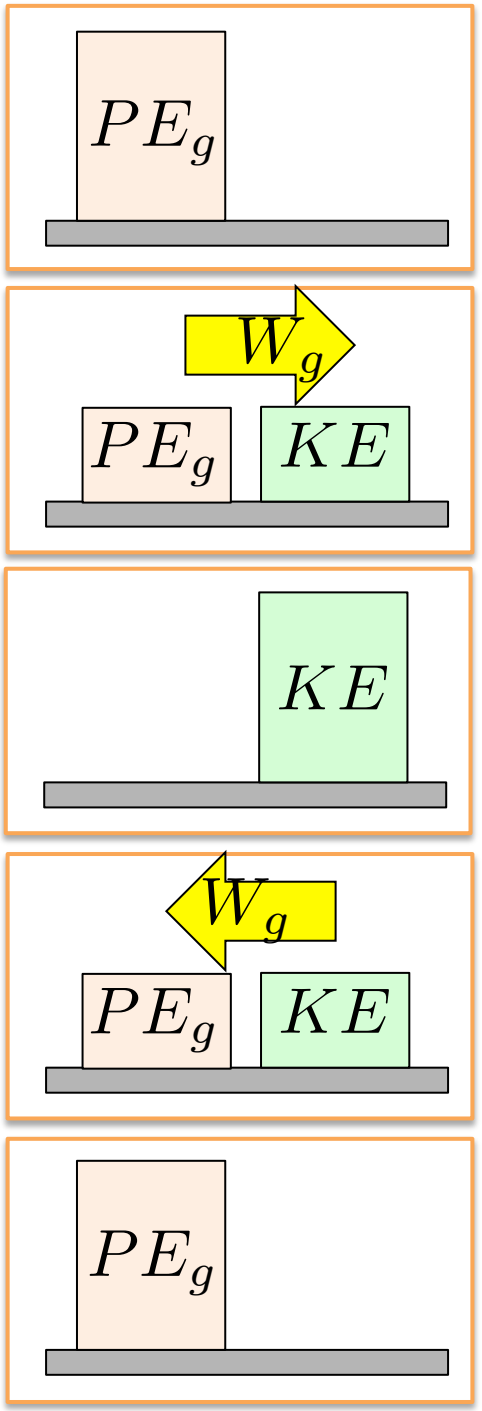
Bouncing ball isolated system



$$PE_g = mgh$$

$$KE = \frac{1}{2}mv^2$$

No energy lost to the floor during the bounce!



Practice solving problems with energy conservation

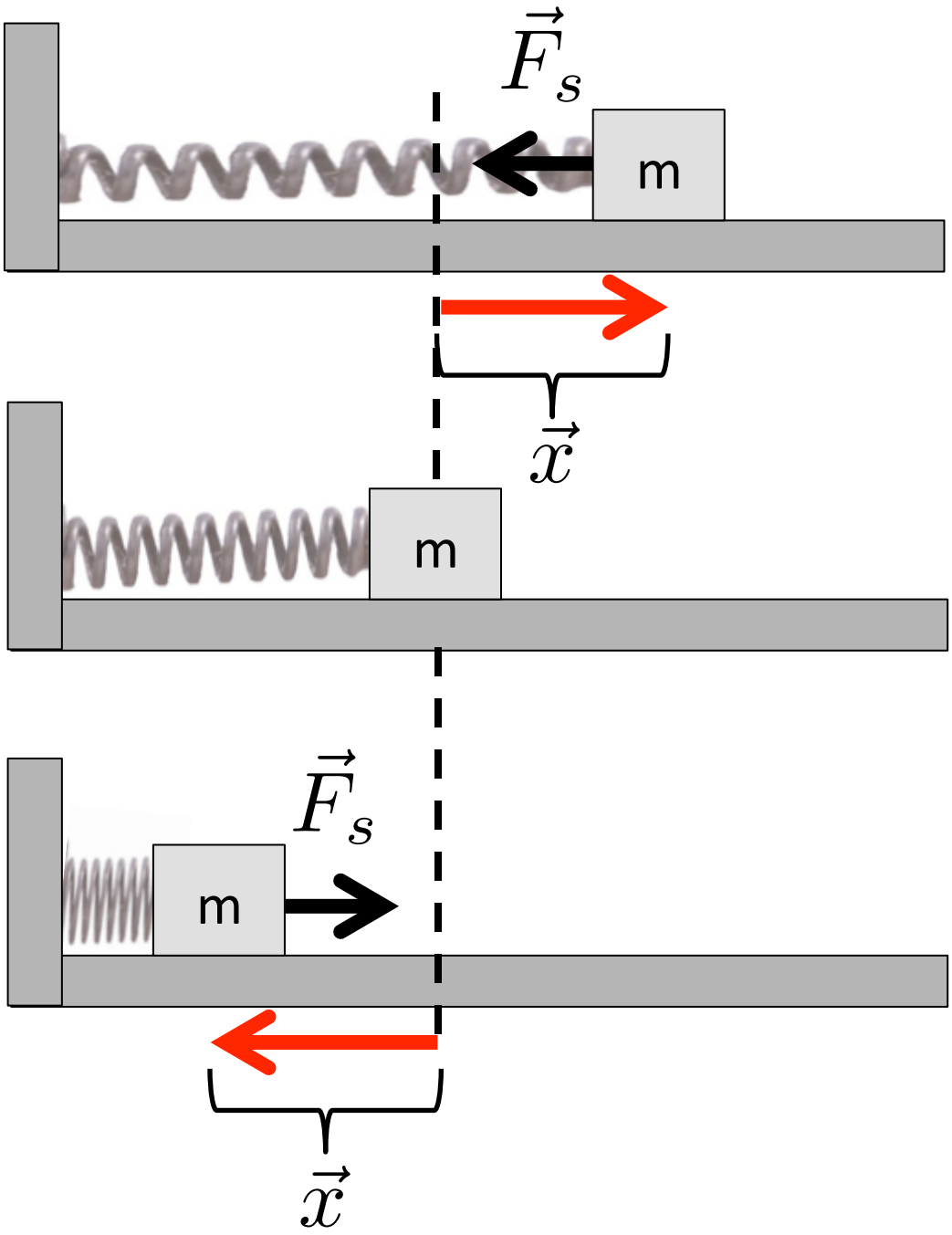
- A projectile is shot with an initial velocity 10 m/s at an angle 60^o from the horizontal. Neglecting air resistance, what is the maximum height that it achieves?

(1) Draw a picture with a coordinate system for *both* the initial and final condition.

(2) Fill out an energy chart.

(3) Write out equation for conservation of energy.

(4) Solve algebra.



C

Concept

Hooke's Law

$$\vec{F}_s = -k\vec{x}$$

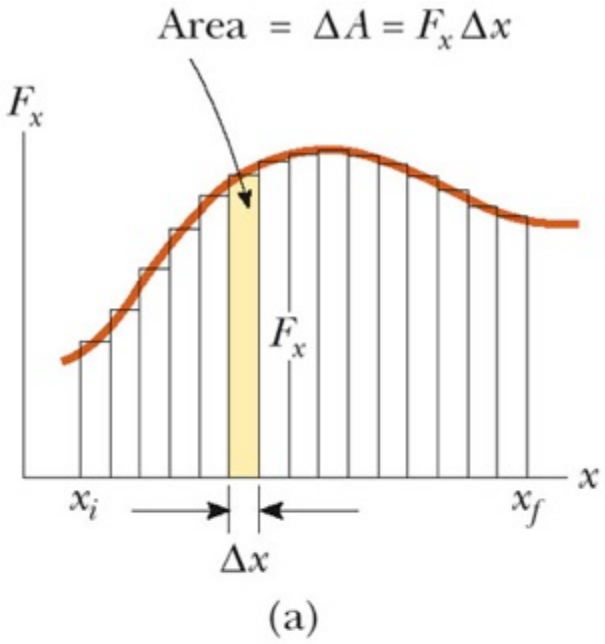
Work for force that depends on displacement

- When Force in direction of displacement is constant:

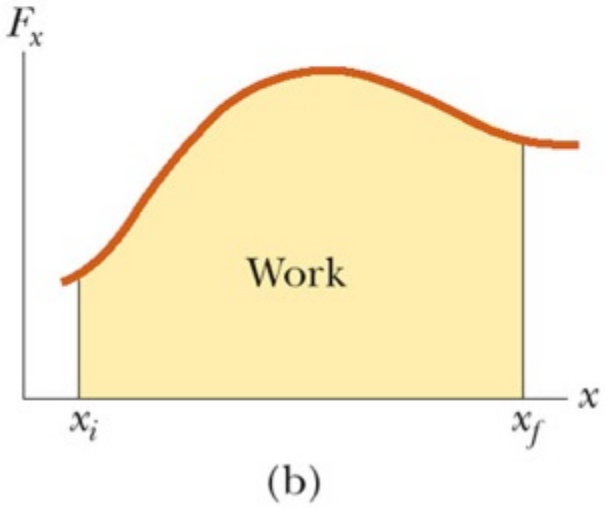
$$W = F_x \cdot x$$

- When Force in direction of displacement depends on displacement

$$W = \int F_x(x) \cdot dx$$



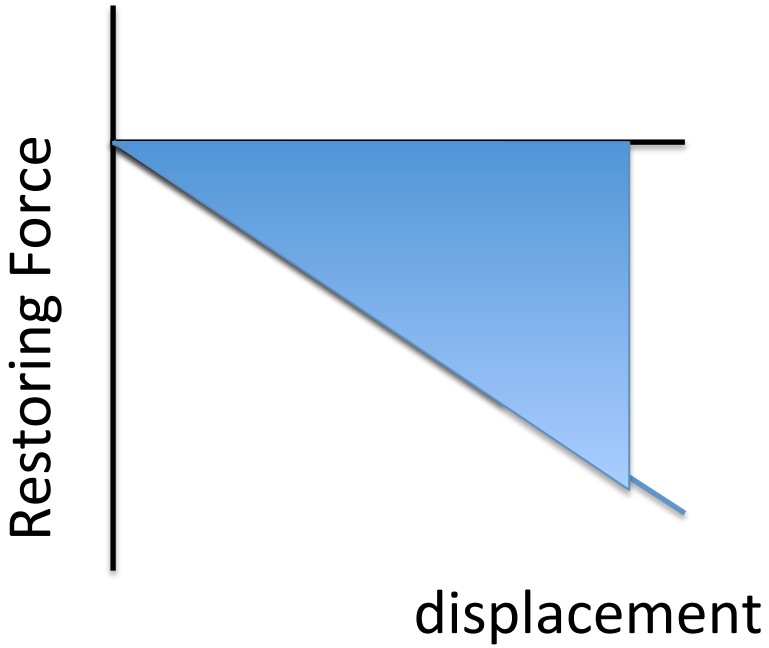
(a)

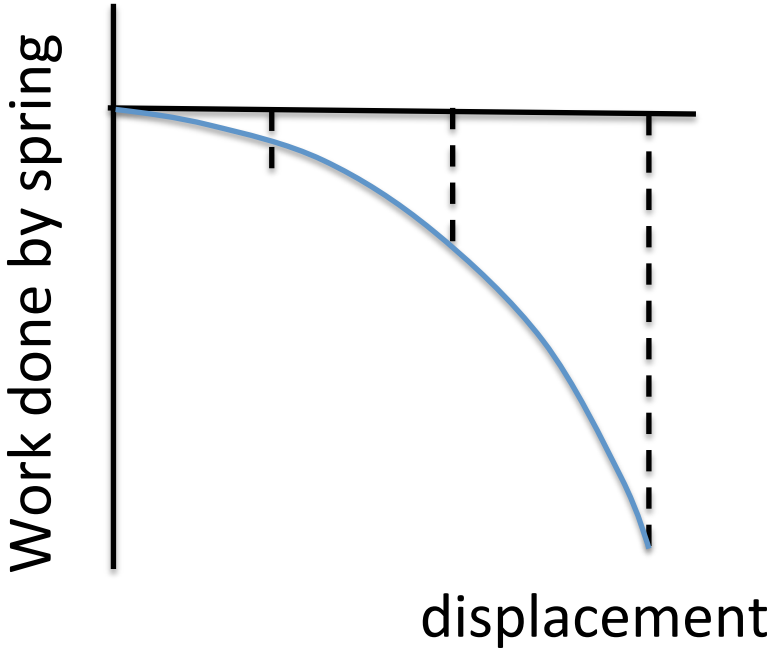


(b)

Calculus Review:
Area under a curve and Integrals

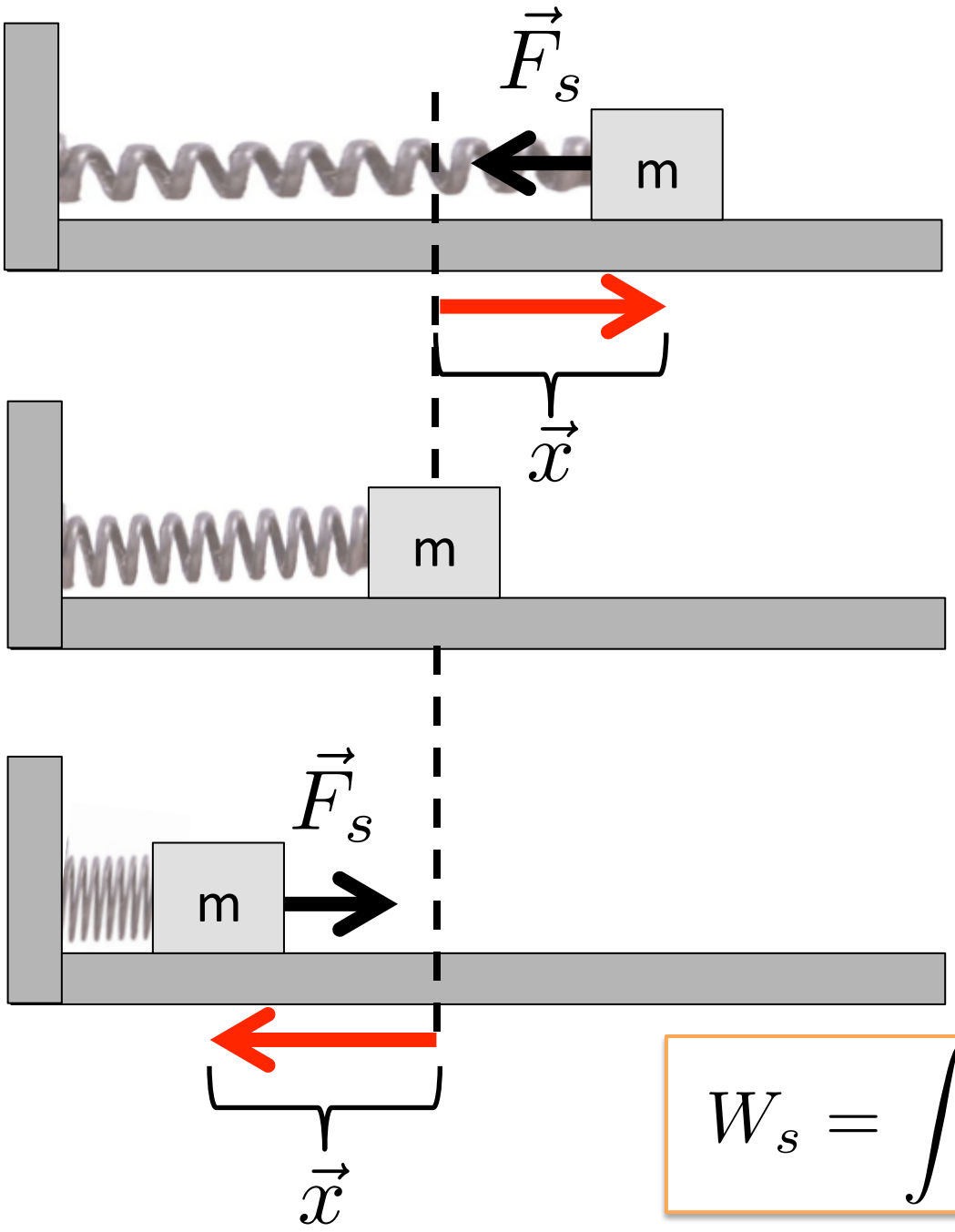
Work done by spring when it is stretched:





$$W = \int F_x(x) \cdot dx$$

$$PE = -\int F_x(x) \cdot dx$$



C Concept

Hooke's Law

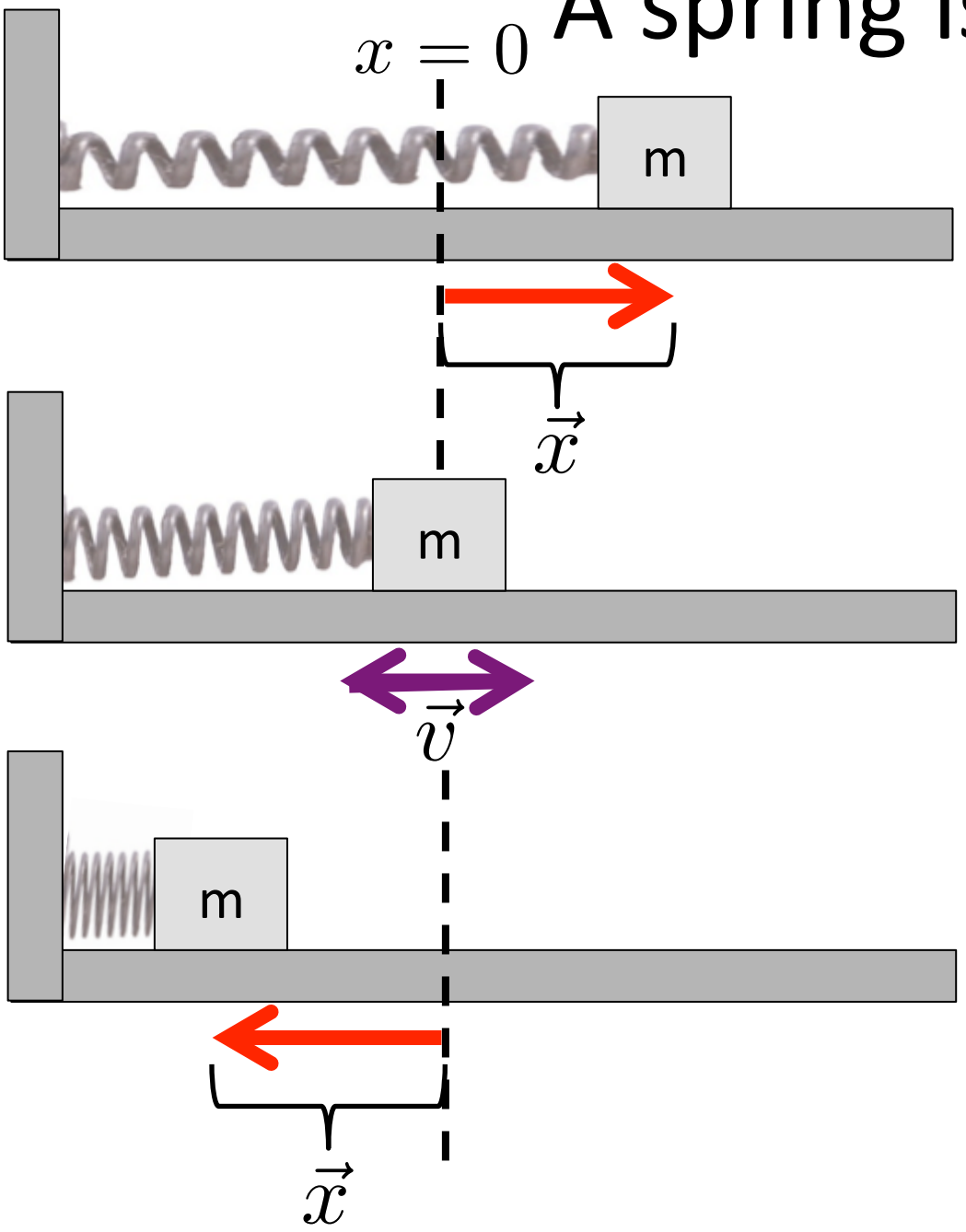
$$\vec{F}_s = -k\vec{x}$$

If force depends on displacement:

$$W = \int \vec{F} dx$$

$$W_s = \int (-kx) dx = -\frac{1}{2} k x^2$$

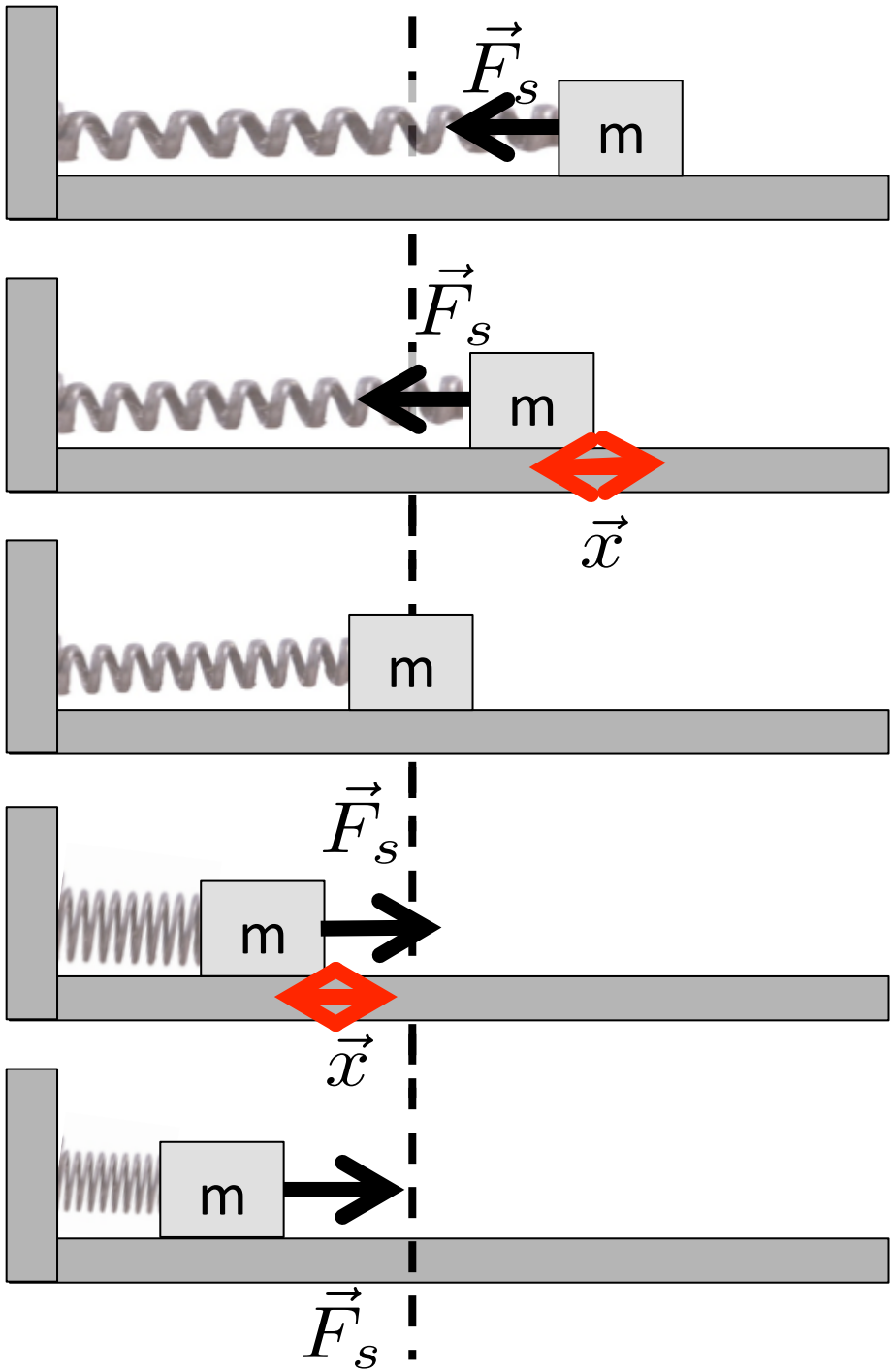
A spring isolated system

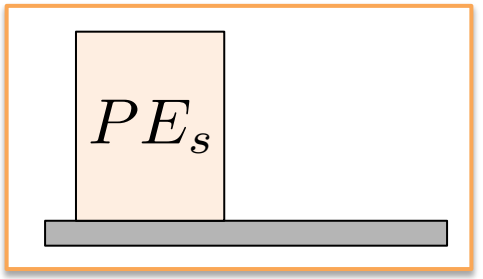


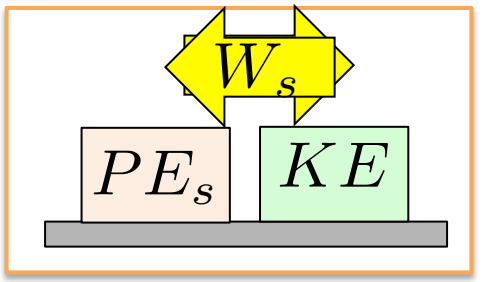
$$PE_s = \frac{1}{2}kx^2$$

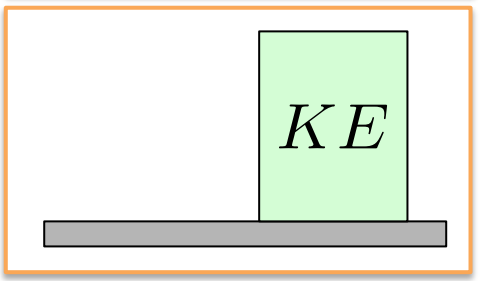
$$KE = \frac{1}{2}mv^2$$

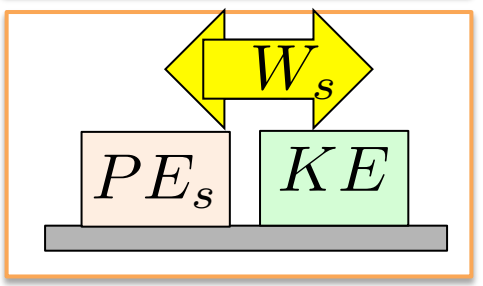
$$PE_s = \frac{1}{2}kx^2$$

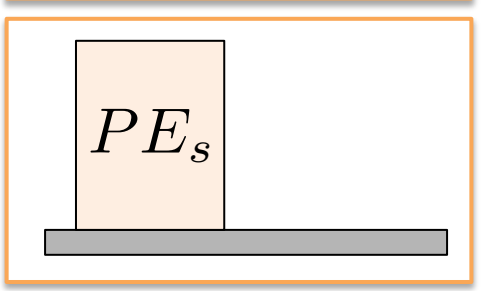

$\vec{F}_s$
m
$\vec{F}_s$
m
$\vec{x}$
m
$\vec{F}_s$
m
$\vec{x}$
m
$\vec{F}_s$


PE_s


W_s
PE_s
KE


KE


W_s
PE_s
KE


PE_s

Clicker Question 9-3

- A box with mass *m* slides along a frictionless surface with a constant velocity *v* and collides with a spring with spring constant *k*. How much will the spring compress?

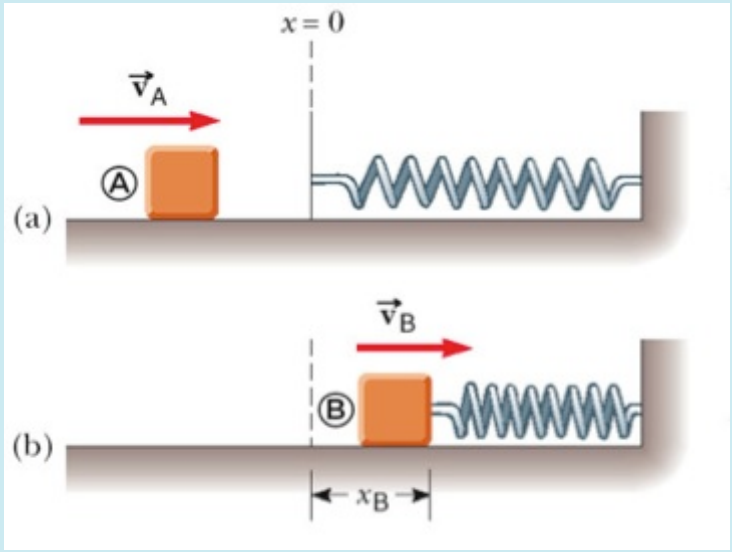
$A)\quad x = v\sqrt{\dfrac{k}{m}}$

$B)\quad x = v\sqrt{\dfrac{m}{k}}$

$C)\quad x = \dfrac{mv^2}{2k}$

$D)\quad x = \dfrac{kv^2}{2m}$

$E)\quad x = \dfrac{mv}{k}$



Clicker Question 9-4

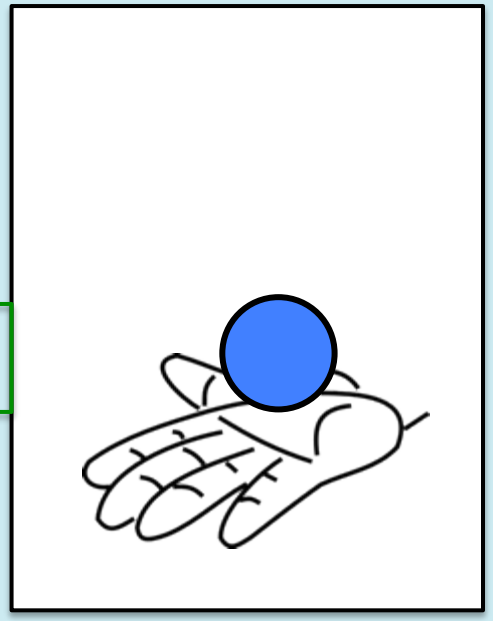
- A hand lifts a ball of mass m to a height h. What is the work done by gravity and the work done by the hand?

$A)\ \ W_g = +mgh, \qquad W_h = +mgh$

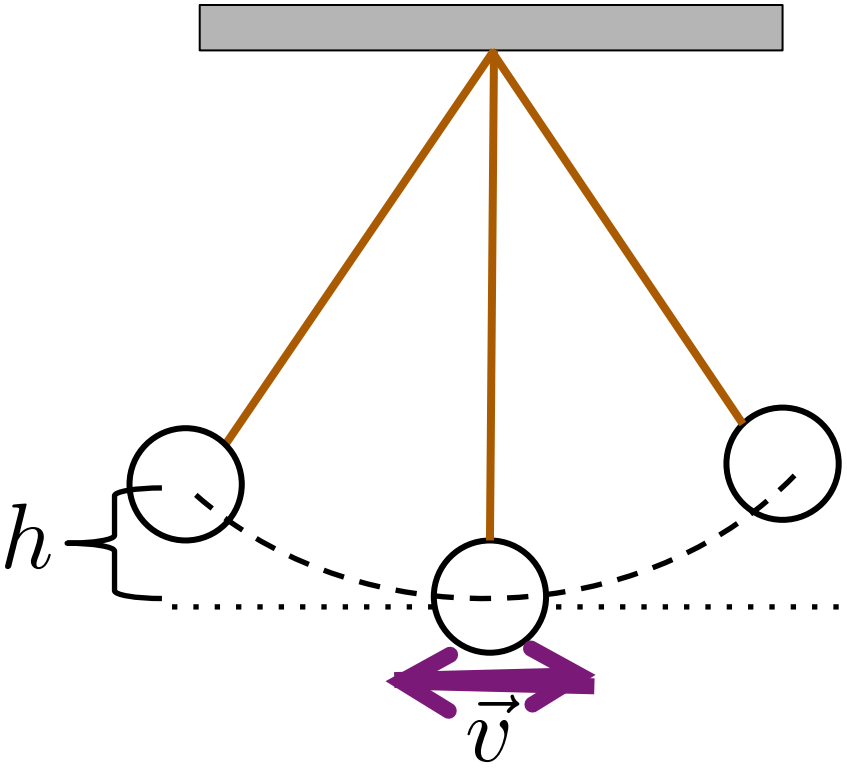
$B)\ \ W_g = +mgh, \qquad W_h = -mgh$

$C)\ \ W_g = -mgh, \qquad W_h = +mgh$

$D)\ \ W_g = -mgh, \qquad W_h = -mgh$



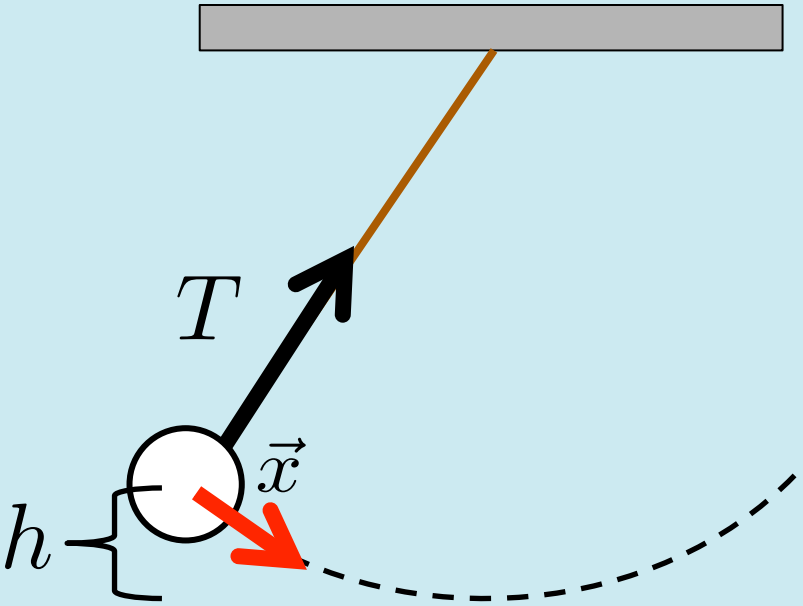
A pendulum isolated system



$$KE = \frac{1}{2}mv^2$$

$$PE_g = mgh$$

Clicker question 9-5



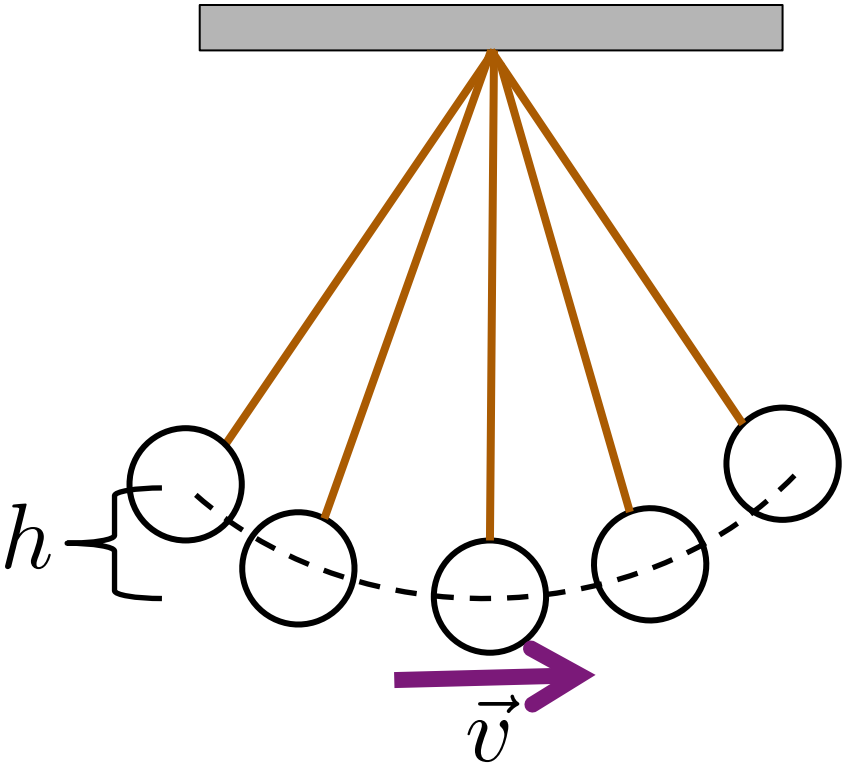
What is the sign of the work done by the tension in the rope when the pendulum is on its way to the right?

A) positive

B) negative

C) zero

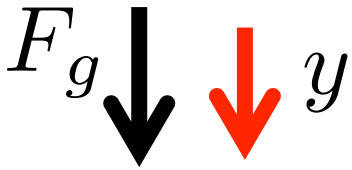
A pendulum isolated system

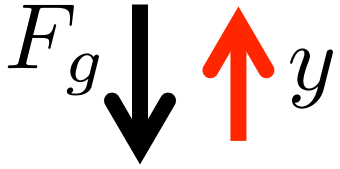


$$KE = \frac{1}{2}mv^2$$

W_g W_g

$$PE_g = mgh$$





Average Power

- Power = rate of change of Energy over time

$$P = \frac{\Delta E}{\Delta t}$$

- SI unit is the Watt. 1 W= 1 J/s

Clicker Question 9-6

- An escalator is used to move 20 people (60 kg each) per minute from the first floor of a department store to the second floor, 5m above. Neglecting friction, the power required is approximately:

A) 100 W
B) 200 W
C) 1000 W
D) 2000 W
E) 60,000 W

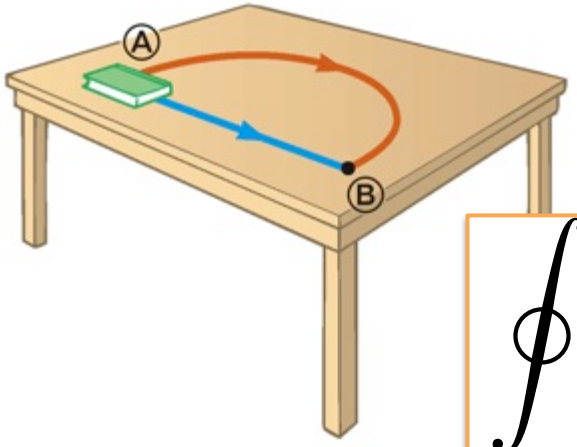
Conservative vs. Non conservative

Conservative Forces

- Work done is independent of the path taken
- Reversible

Non-conservative Forces

- Work done is not independent of the path taken
- Irreversible



$$\oint F_c \cdot dx = 0$$

Homework

- HW #4 is due tomorrow
- Reading quiz tomorrow
- Office hours Mayer 5623 tonight at 5pm
- Pick up old homework