I lift a box, carry it over somewhere (while not changing its height), and set it down.
What is the **sign of the work that I do** when…

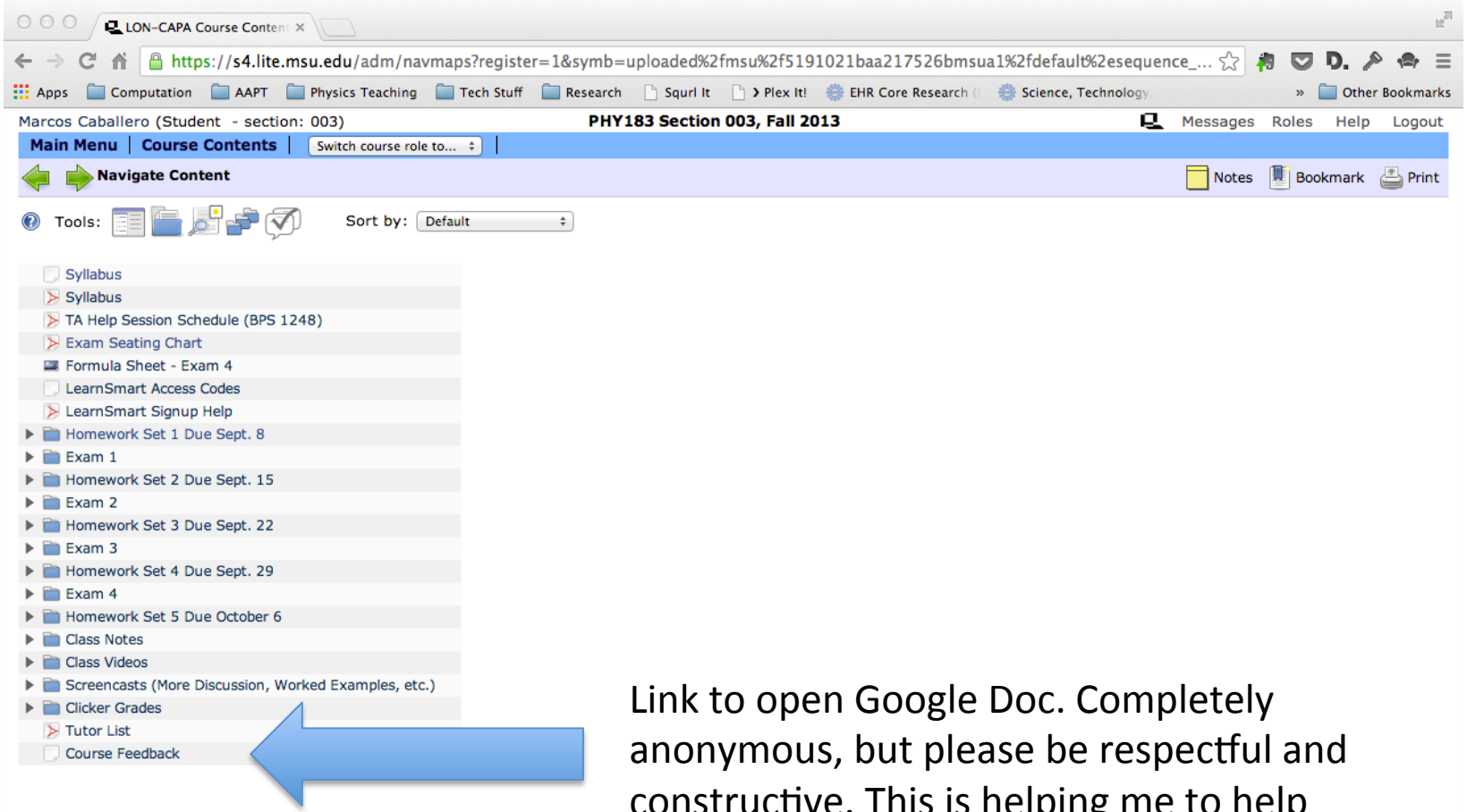
| | | | |
|---|---|---|---|
| I lift it up? | A) + | B) - | C) 0 |
| I carry it over? | A) + | B) - | C) 0 |
| I set it down? | A) + | B) - | C) 0 |

Carefully consider the following statement:
**(silently first)**
*I like the exam-a-week model, and would not prefer fewer exams in this course.*

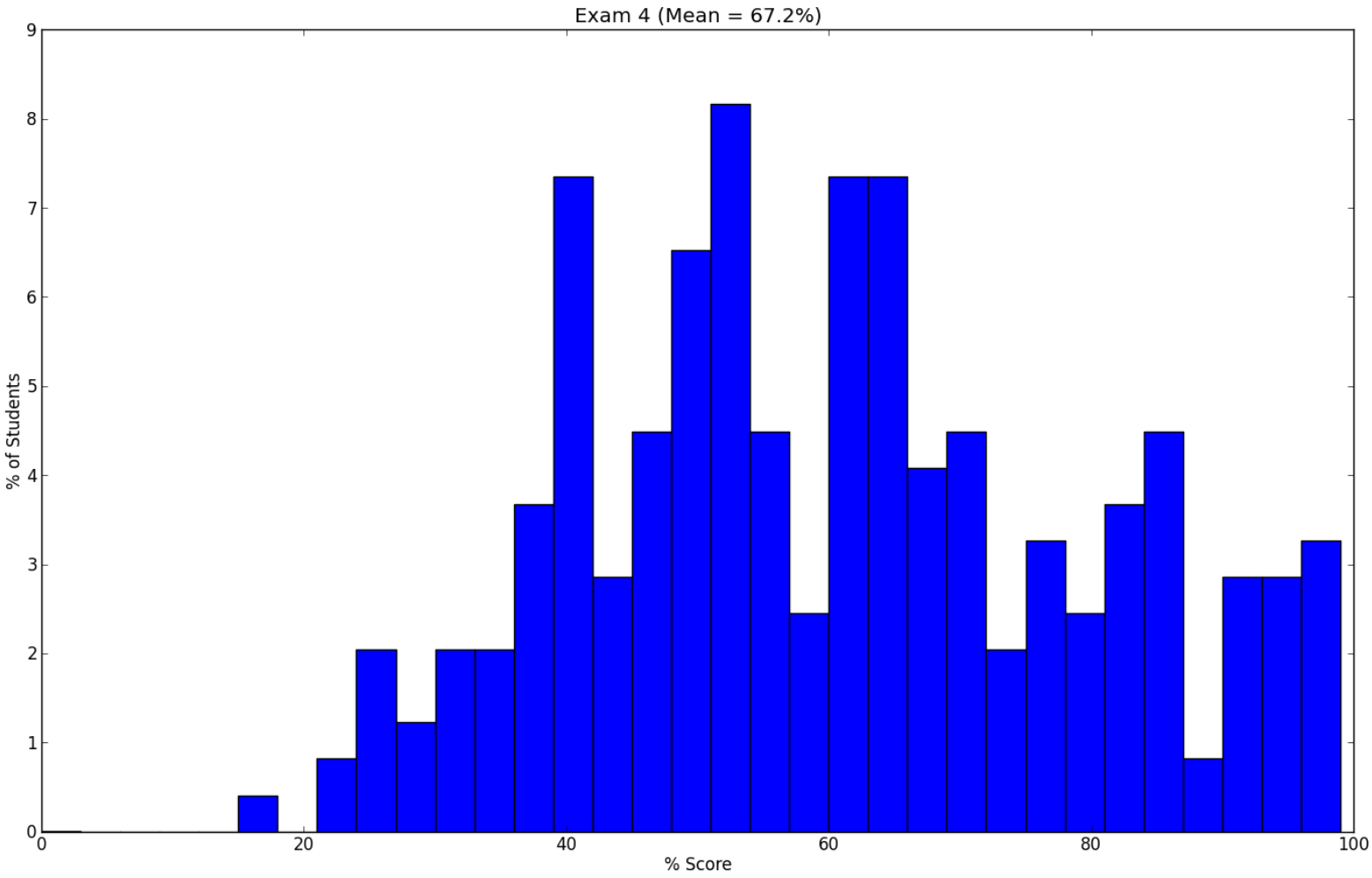
A) Strongly agree
B) Agree
C) Neutral/Doesn't matter
D) Disagree
E) Strongly disagree

Carefully consider the following statement:
**(discuss with your neighbors before voting)**
*I like the exam-a-week model, and would not prefer fewer exams in this course.*

A) Strongly agree
B) Agree
C) Neutral/Doesn't matter
D) Disagree
E) Strongly disagree

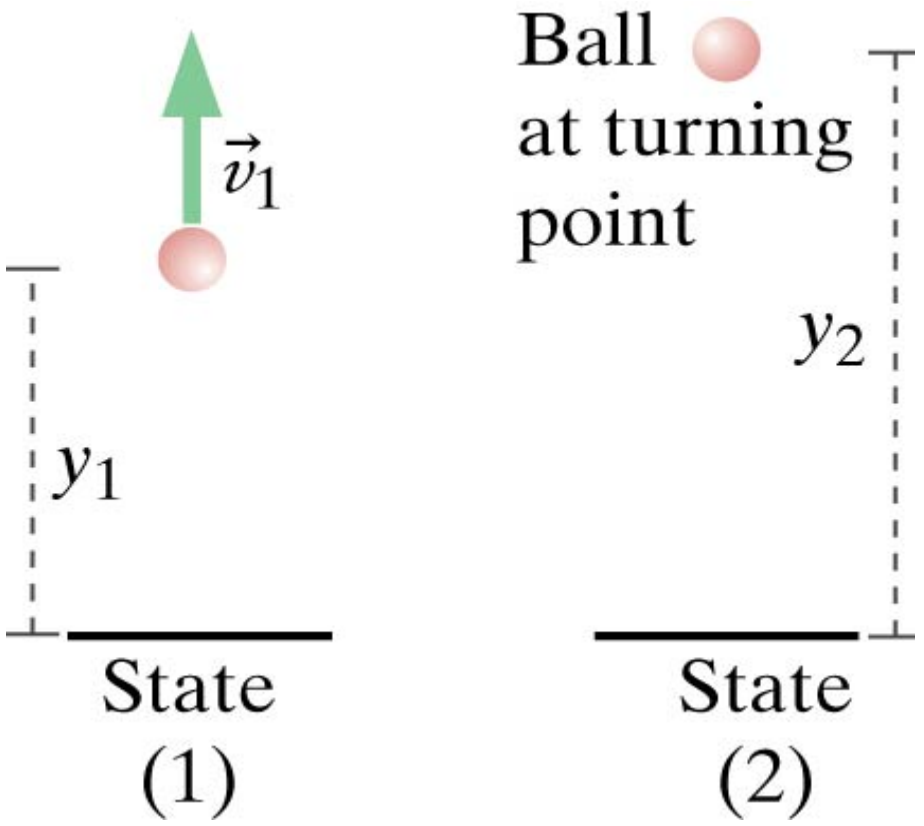



Link to open Google Doc. Completely anonymous, but please be respectful and constructive. This is helping me to help you and future students. Thanks!


Exam 4 (Mean = 67.2%)
% of Students
% Score
0
1
2
3
4
5
6
7
8
9
0
20
40
60
80
100

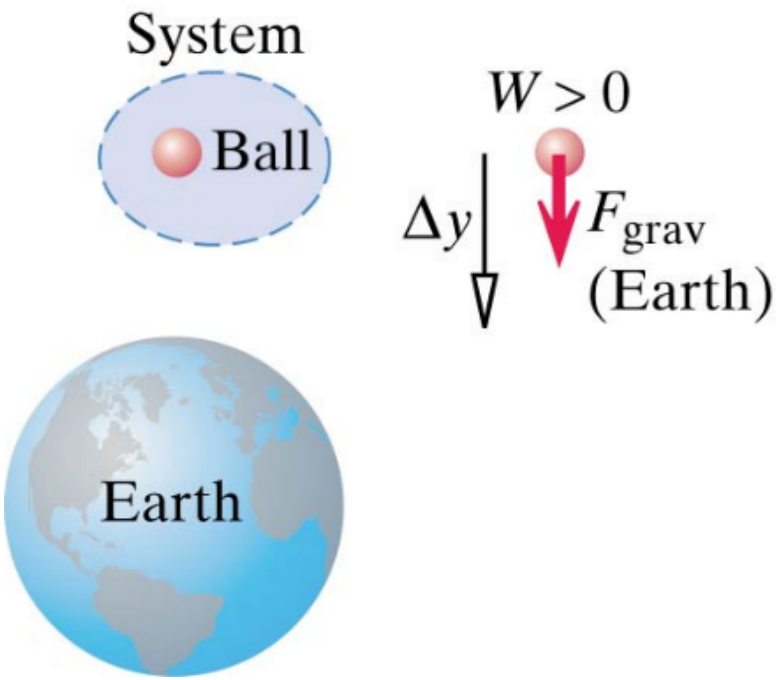
6-1) A thrown ball heads straight up. Choose your system to be the ball and the Earth. What is the work done by the surroundings?

A) 0
B) +mgΔy
C) -mgΔy
D) Something else

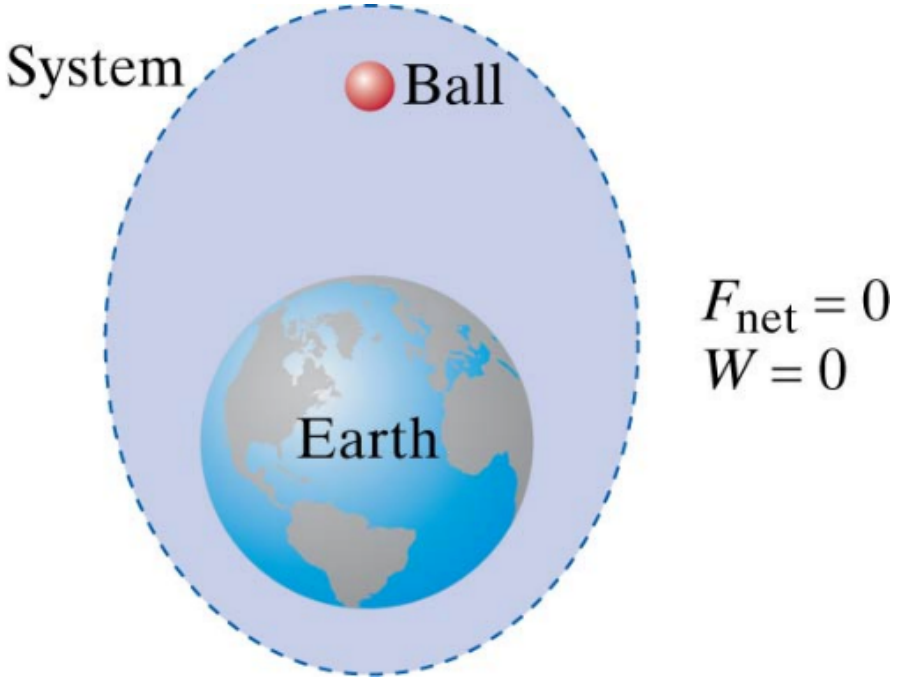


6-2) **A puzzle:** Consider a ball initially at rest that begins to fall towards the Earth.

System: Ball

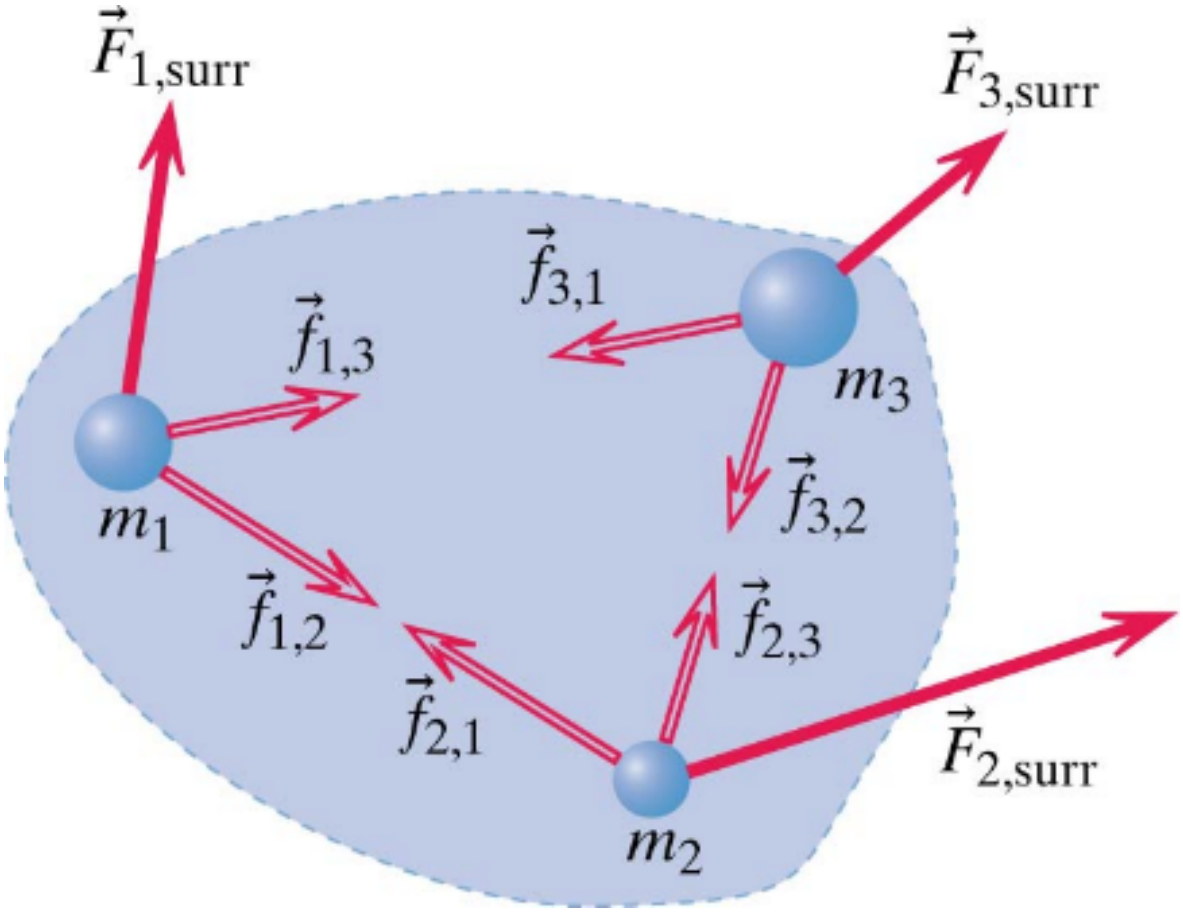



System: Ball + Earth




In both cases, there is an increase in kinetic energy.
How do we resolve this? Discuss.

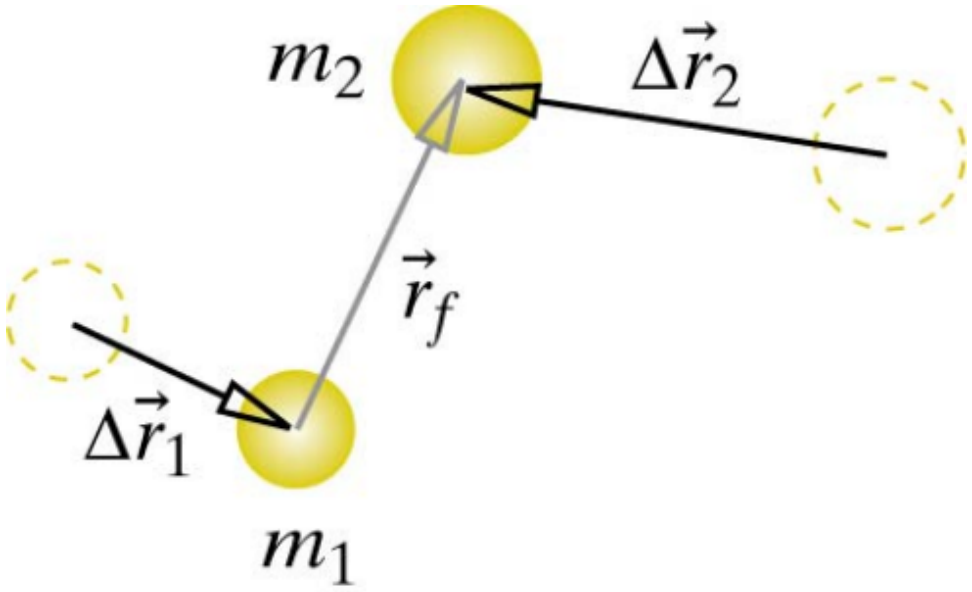
# What is potential energy?



6-3) A spacecraft travels from near the Earth toward the Moon. Choose your system to be the Earth, Moon and Spacecraft. How many gravitational potential energy terms are there?

A) 0
B) 1
C) 2
D) 3
E) 4

# Potential energy depends on separation not location



6-4a) A block is pushed on a horizontal surface from location A to location B and back to A in a straight line. The work done by friction in going from A to B is $W_{fric}$. What is the total work done by friction?

A) 0
B) $W_{fric}$
C) $2W_{fric}$
D) Something else

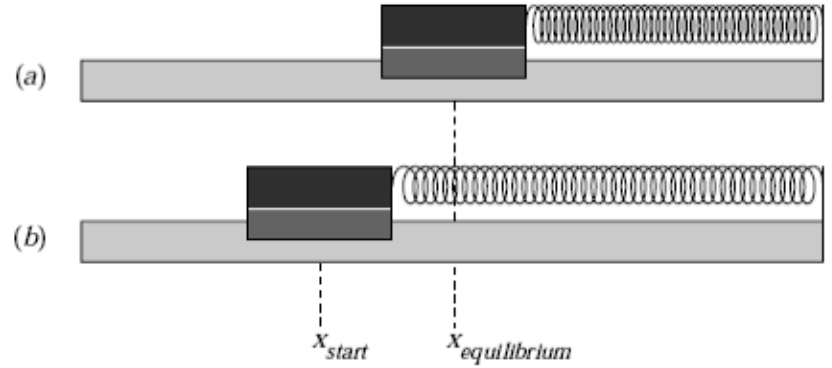
6-4b) A block is slides down a ramp **at constant speed**. The height of the ramp is h, what is the work done by friction?

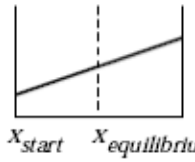
A) 0
B) +mgh
C) -mgh
D) Something else

6-16) Two balls are roll down a set of very low friction tracks, taking different paths, but ending at the same vertical height. The ball reaches the end of Track B before it reaches the end of Track A. Which ball is moving faster at the end of each track?

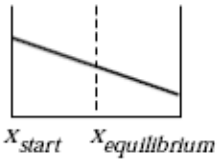
A) Ball on track A
B) Ball on track B
C) Same for both
D) Can't tell

6-14) An air track cart attached to a spring rests on the track at the position $x_{equilibrium}$ and the spring is relaxed (a). In (*b*), the cart is pulled to the position $x_{start}$ and released. It then oscillates about $x_{equilibrium}$. Which graph correctly represents the potential energy of the spring as a function of the position of the cart?

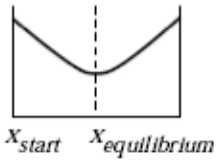


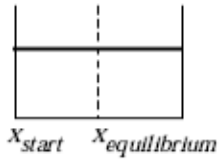

A



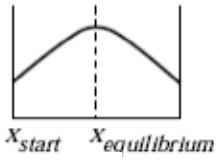

B




C

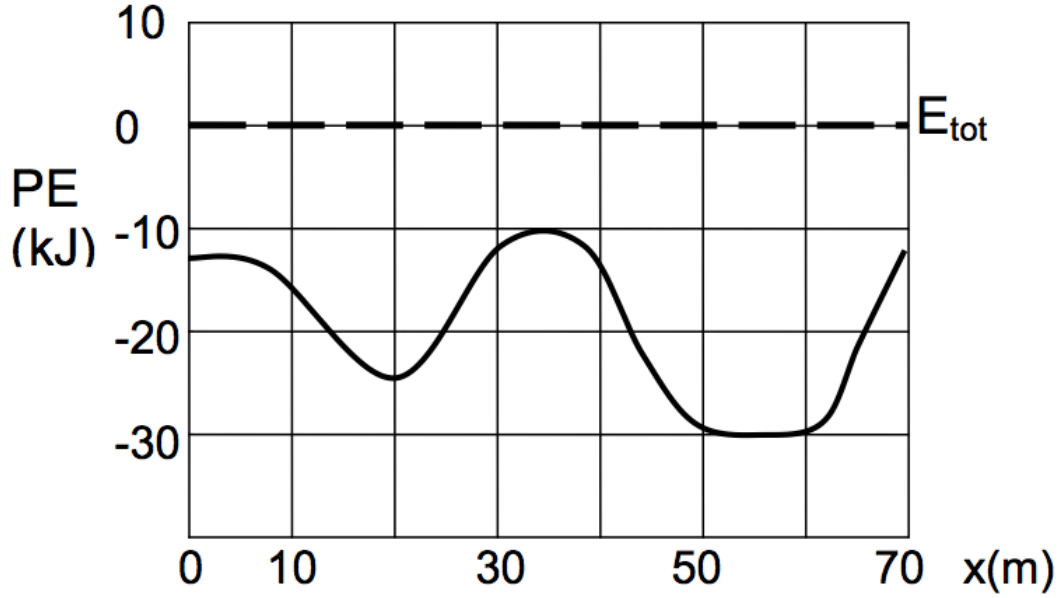



D




E

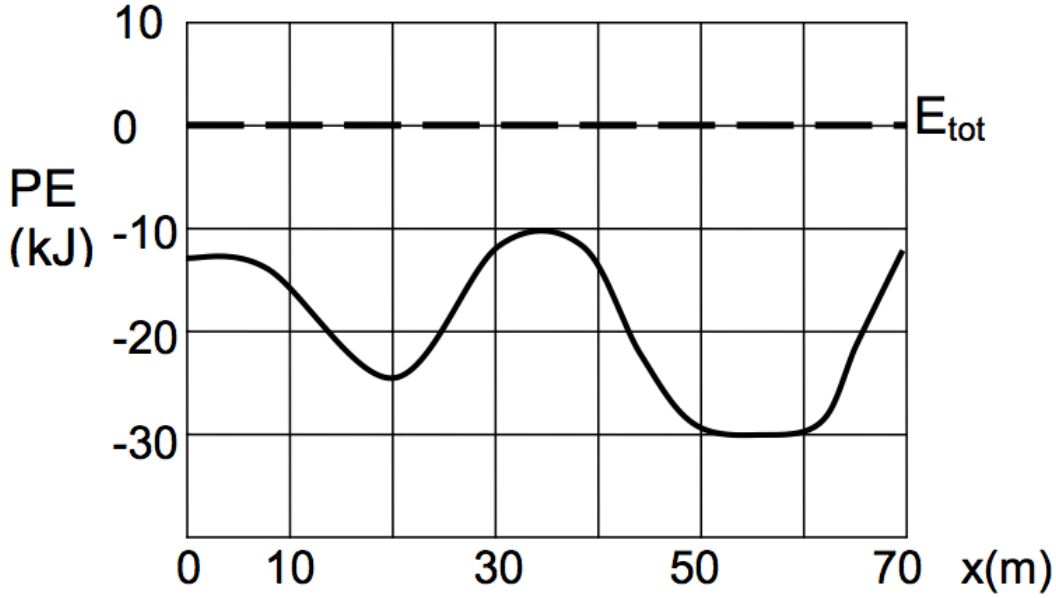
6-9a) A cart rolls without fiction along a track. The graph of U vs. position is shown. The total mechanical energy (K+U) is 0 kJ.




What is the maximum K of the cart during its journey (to within 5 kJ)?

A) 30 kJ  B) 50 kJ  C) -30 kJ  D) 10kJ  E) None of these

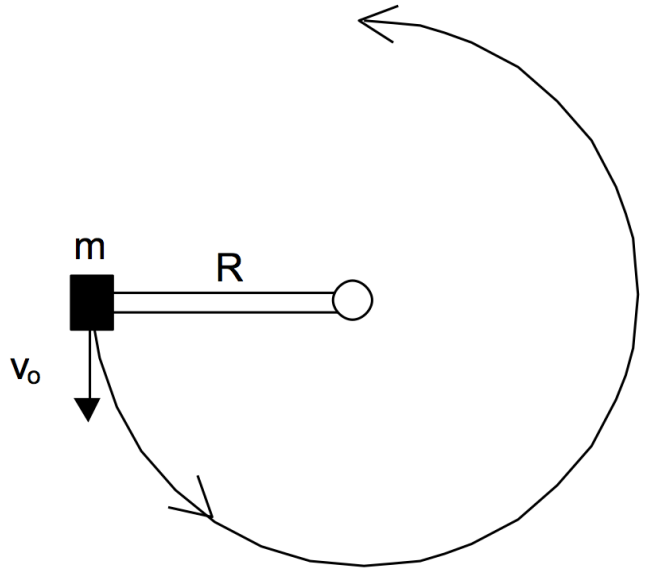
6-9b) Suppose the cart is at position x = 20 m, is moving right, and has total energy $E_{tot}$ = –15 kJ. Will the cart make it over the hill at x=34 m?




A) Yes B) No

6-5) A mass m is at the end of light (massless) rod of length R, the other end of which has a frictionless pivot so the rod can swing in a vertical plane. The rod is initially horizontal and the mass is pushed down with an initial speed $v_0$. What initial kinetic energy is required for the mass to pivot 270° to the vertical position?

A) mgR
B) mg(2R)
C) mg(3R)
D) None of these

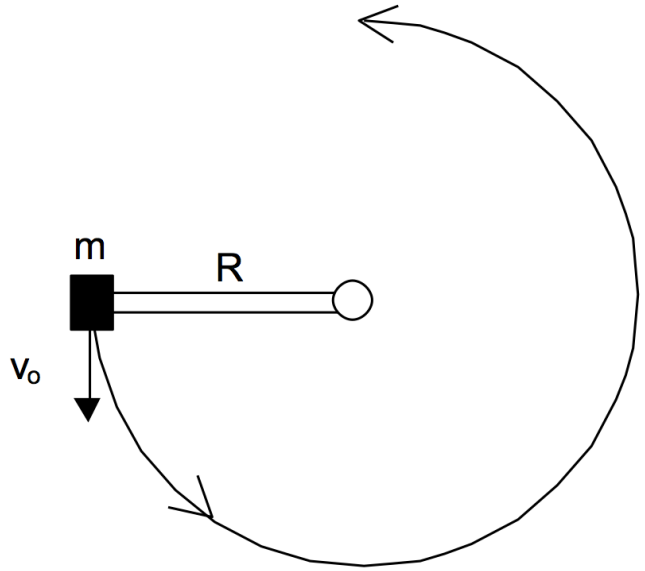


# Example: The Jumper

After earning an 'A' in PHY 183 you land a job with the ACME Bungee Jump company  They need to know what spring stiffness $\mathbf{k_s}$ to make the cords so that a jumper of mass 200 kg will only fall 30 m.  The standard length of an un-stretched cord is just 10 m.

6-5) A mass m is at the end of light (massless) rod of length R, the other end of which has a frictionless pivot so the rod can swing in a vertical plane. The rod is initially horizontal and the mass is pushed down with an initial speed $v_0$. What initial kinetic energy is required for the mass to pivot 270° to the vertical position?

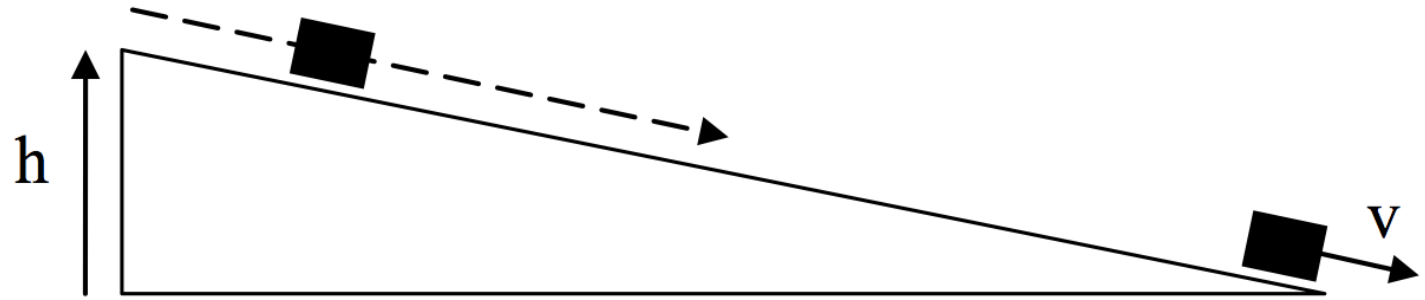
A) mgR
B) mg(2R)
C) mg(3R)
D) None of these



6-6) A projectile is fired with an initial speed $v_0$ at an angle $\theta$ from the horizontal. What is the KE of the projectile when it is on the way down at a height h above the ground? (Assume no air resistance.)

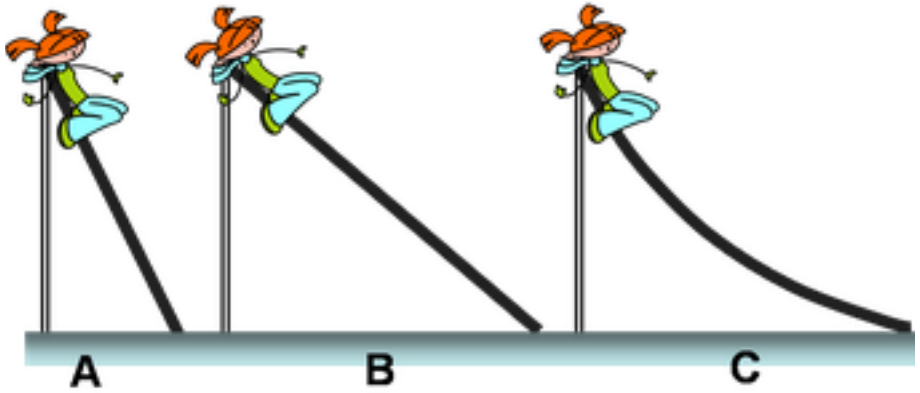
A) $(1/2)\, mv_0^2 + mgh$
B) $mgh$
C) $(1/2)\, mv_0^2 - mgh$
D) Impossible to tell

6-7a) A block initially at rest is allowed to slide down a frictionless ramp and attains a speed v at the bottom. To achieve a speed 2v at the bottom, how many times higher must the new ramp be?




A) $\sqrt{2} \cong 1.4$
B) 2
C) 3
D) 4
E) Something else

6-7b) A child can slide down 3 different frictionless ramps with different shapes but all with the same height *h*. How does the speed of the child at the bottom of the ramps compare?




A) $v_A > v_B > v_C$
B) $v_B > v_A > v_C$
C) $v_C > v_B > v_A$
D) $v_A = v_B = v_C$
E) None of these

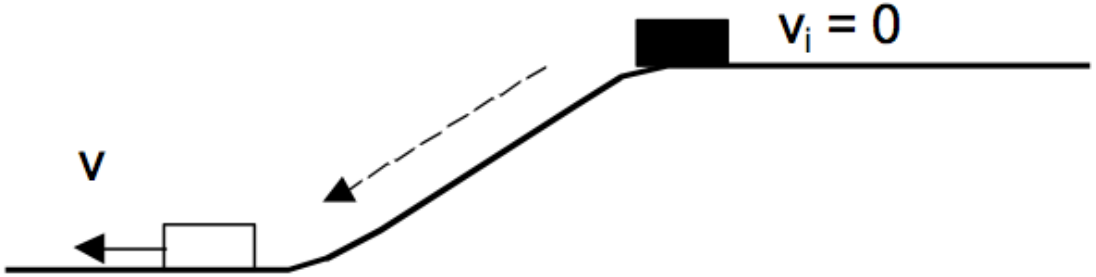
6-13) A 10-kg weight is suspended from the ceiling by a spring. The weight-spring system is at equilibrium with the bottom of the weight about 1 m above the floor. The spring is then stretched until the weight is just above the eggs. When the spring is released, the weight is pulled up by the contracting spring and then falls back down under the influence of gravity. On the way down, it

A) reverses its direction of travel well above the eggs
B) reverses its direction of travel precisely as it reaches the eggs.
C) makes a mess as it crashes into the eggs.

6-15) A horizontal spring has a mass attached which can move with negligible friction. You stretch the spring and release the mass from rest. For the resulting motion, which of the following statements are TRUE?

A) When the spring is (momentarily) fully compressed, K has its largest value.
B) When the spring (momentarily) has its relaxed length, U has its largest value.
C) When the spring (momentarily) has its relaxed length, K has its smallest value.
D) When K is large, U is small, and vice versa.
E) When K is large, U is large, and vice versa.

6-8) A mass slides down a <u>rough</u> ramp (with friction) of height h. Its initial speed is zero. It's final speed at the bottom of the ramp is v.




While the mass is descending, the kinetic energy:

A) Increases B) Decreases C) Remains constant

While the mass is descending, the potential energy:

A) Increases B) Decreases C) Remains constant

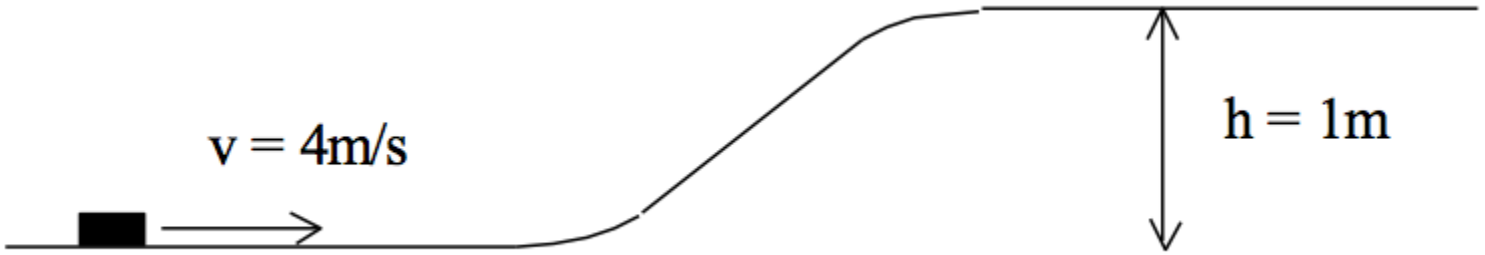
While the mass is descending, the total mech. energy:

A) Increases B) Decreases C) Remains constant

6-10) A spring-loaded toy dart gun is used to shoot a dart straight up in the air, and the dart reaches a maximum height of 24 m. The same dart is shot from the same gun a second time, but this time the spring is compressed only half as far before firing. How far up does the dart go this time, neglecting air resistance and assuming an ideal spring?

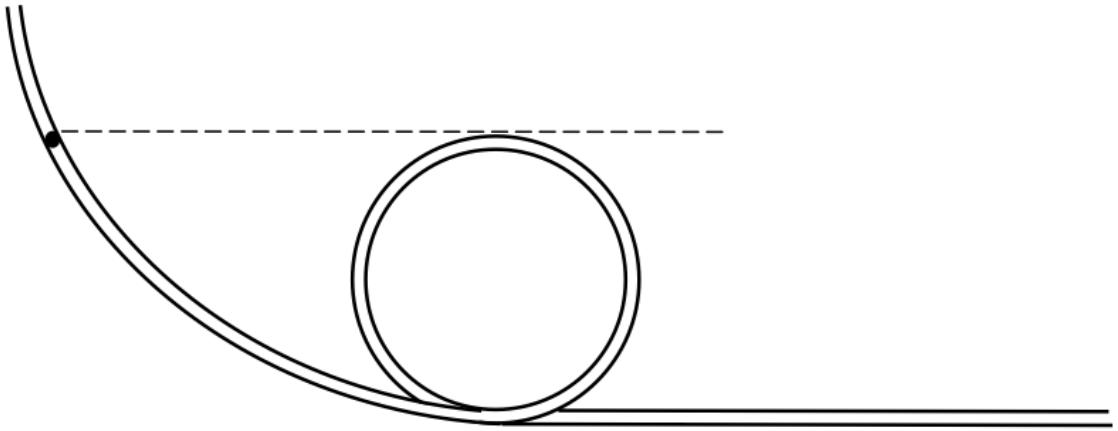
A) 48 m
B) 24 m
C) 12 m
D) 6 m
E) 3 m

6-11) A hockey puck slides without friction along a frozen lake toward an ice ramp and plateau as shown. The speed of the puck is 4m/s and the height of the plateau is 1m. Will the puck make it all the way up the ramp?




A) Yes
B) No
C) Impossible to tell

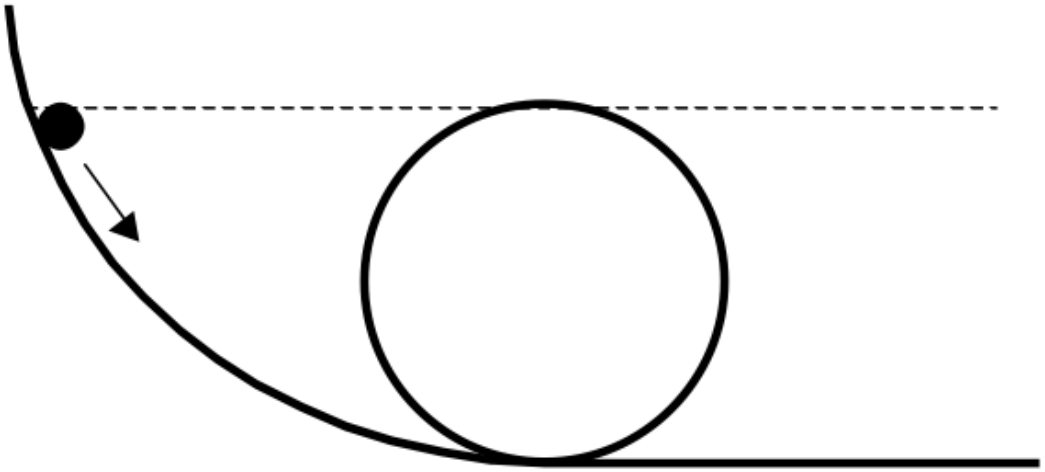
6-12a) A small mass, starting at rest, slides without friction in a tube to a loop-de-loop as shown. The maximum height of the loop is the same as the initial height of the mass.



Will the ball make it to the top of the loop?

A) Yes B) No C) Impossible to tell

6-12b) Same question, but the tube is replaced by a rail. Will the ball make it to the top of the loop?



A) Yes  B) No  C) Impossible to tell

# Example: Sledding

A little girl is riding her sled on a hill. If she starts a distance *d* up the hill, which makes an angle θ with the horizontal, how far will she travel along the flat snowy ground?


The total mass of the sled and child is *m*; there's a small bit of friction between the rails of the sled and the snow ($\mu_k$).

6-17a) In the sledding example, what should we include in our system?

I. Kid+Sled
II. Earth
III. Snow

A) I only B) II only C) III only D) I & II E) I,II,&III

# 6-17b) Discuss: What are the initial and final states?

6-17c) For the sled problem, what is (yf-yi) in terms of what we know?

A) d cos(θ)
B) d sin(θ)
C) -d cos(θ)
D) -d sin(θ)
E) Something else

Are we ok? Is *x* positive? It should be, right?
When is $\sin(\theta) > \mu_k \cos(\theta)$?