You can draw here

Physics 111 - Class 9C
PE & Energy Conservation

Do not draw in/on this box!

November 5, 2021

You can draw here

You can draw here

Class Outline

- Logistics / Announcements
- HW8 Reflection
- Conservation of Energy
- Clicker Questions
- Worked Problems
- One more thing: Bullet Block Problem

Logistics/Announcements

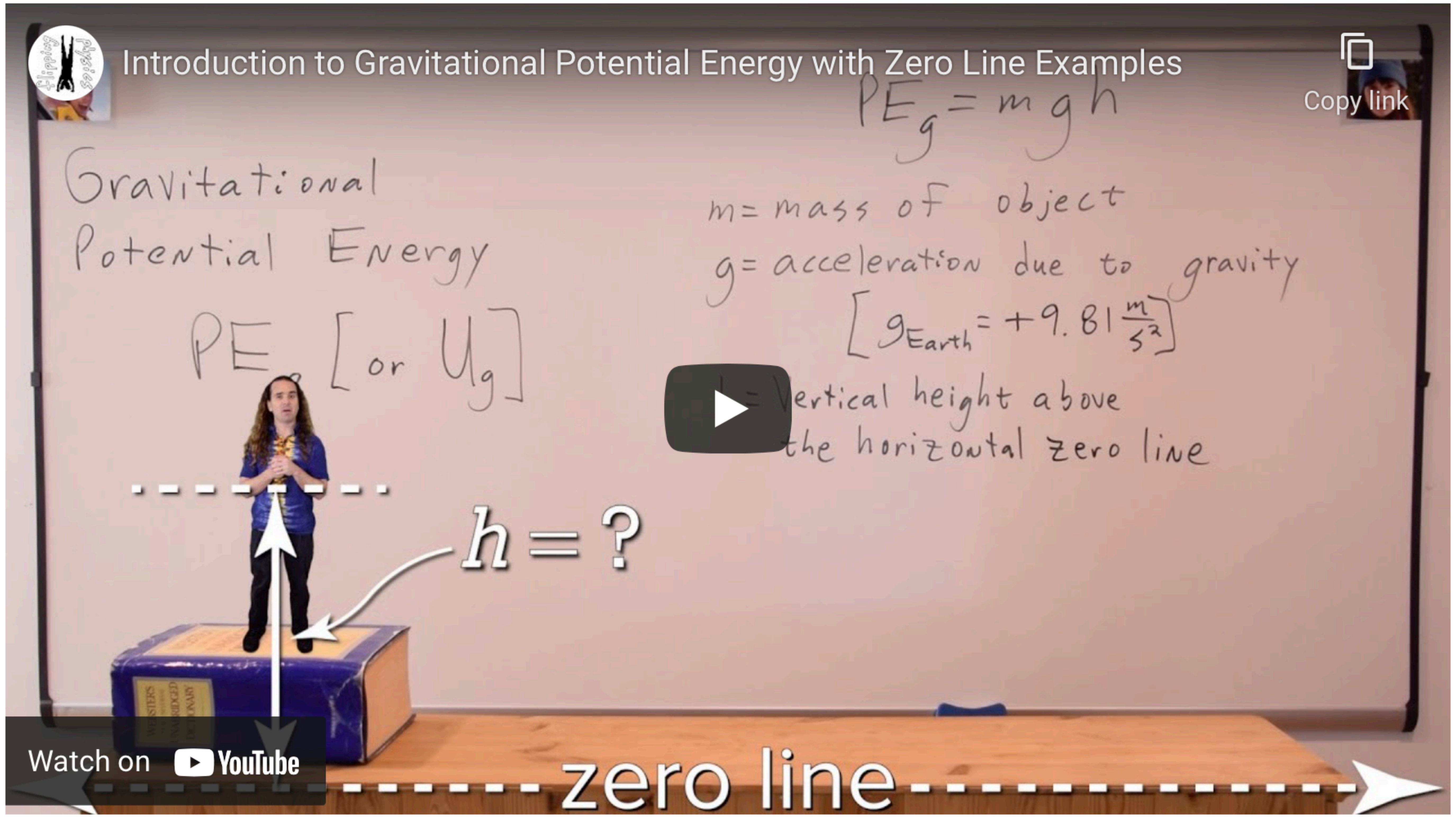
- Lab this week: Lab 6
- HW8 due this week on Thursday at 6 PM
- Learning Log 8 due on Saturday at 6 PM
- HW and LL deadlines have a 48 hour grace period
- Test/Bonus Test: Bonus Test 3 available this week (Chapters 5 & 6)
    - Test Window: Friday 6 PM - Sunday 6 PM

Videos

Below are the assigned videos for this week. The videos are collapsible so once you're done with one, you can move to the next one. In the sidebar on the right, you can use the checklists to keep track of what's done.

Required Videos

1. Introduction to Gravitational Potential Energy with Zero Line Examples



- Notes
- Direct link to Mr. P's page

Checklist of items

- [x] Video 1
- [x] Video 2
- [ ] Video 3
- [ ] Video 4
- [x] Video 5
- [ ] Video 6
- [ ] Video 7
- [x] Video 8
- [ ] Video 9
- [ ] Video 10

Mon

Fri

Wed

Search this book

My highlights

Figure 8.1 Shown here is part of a Ball Machine sculpture by George Rhoads. A ball in this contraption is lifted, rolls, falls, bounces, and collides with various objects, but throughout its travels, its kinetic energy changes in definite, predictable amounts, which depend on its position and the objects with which it interacts. (credit: modification of work by Roland Tanglao)

Chapter Outline

In George Rhoads' rolling ball sculpture, the principle of conservation of energy governs the changes in the ball's kinetic energy and relates them to changes and transfers for other types of energy associated with the ball's interactions. In this chapter, we introduce the important concept of potential energy. This will enable us to formulate

Friday's Class

8.3 Conservation of Energy

HW 8 Reflection

Most confusing concepts:

Conservative & Non-conservative forces

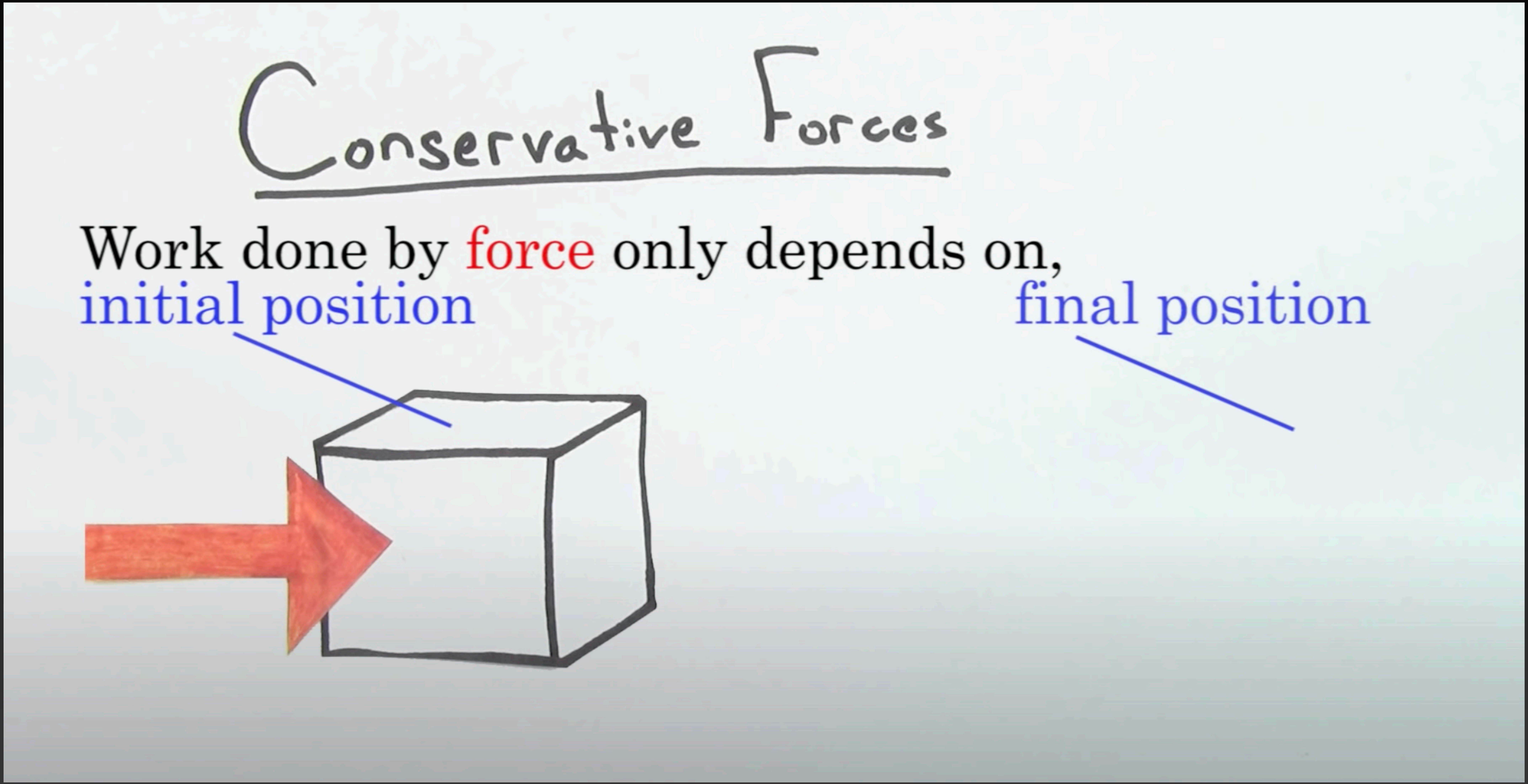
Conservation of Energy: what is conserved for which forces?

Conservation of Energy in springs

Visualizing U(x) for a spring

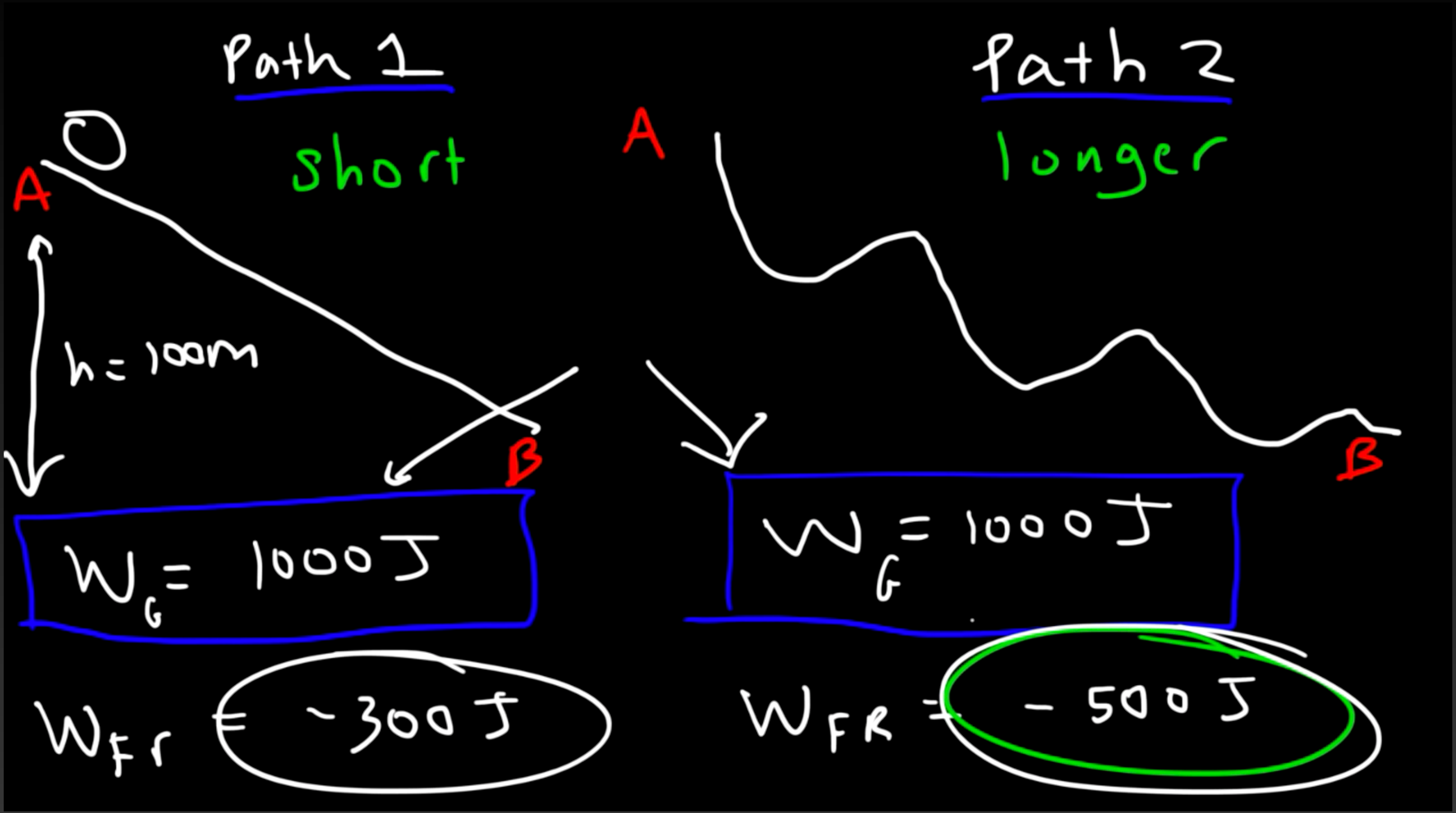
HW 8.10!!!

Review: Conservative and Non-Conservative Forces



Source: Khan Academy

Review: Conservative and Non-Conservative Forces

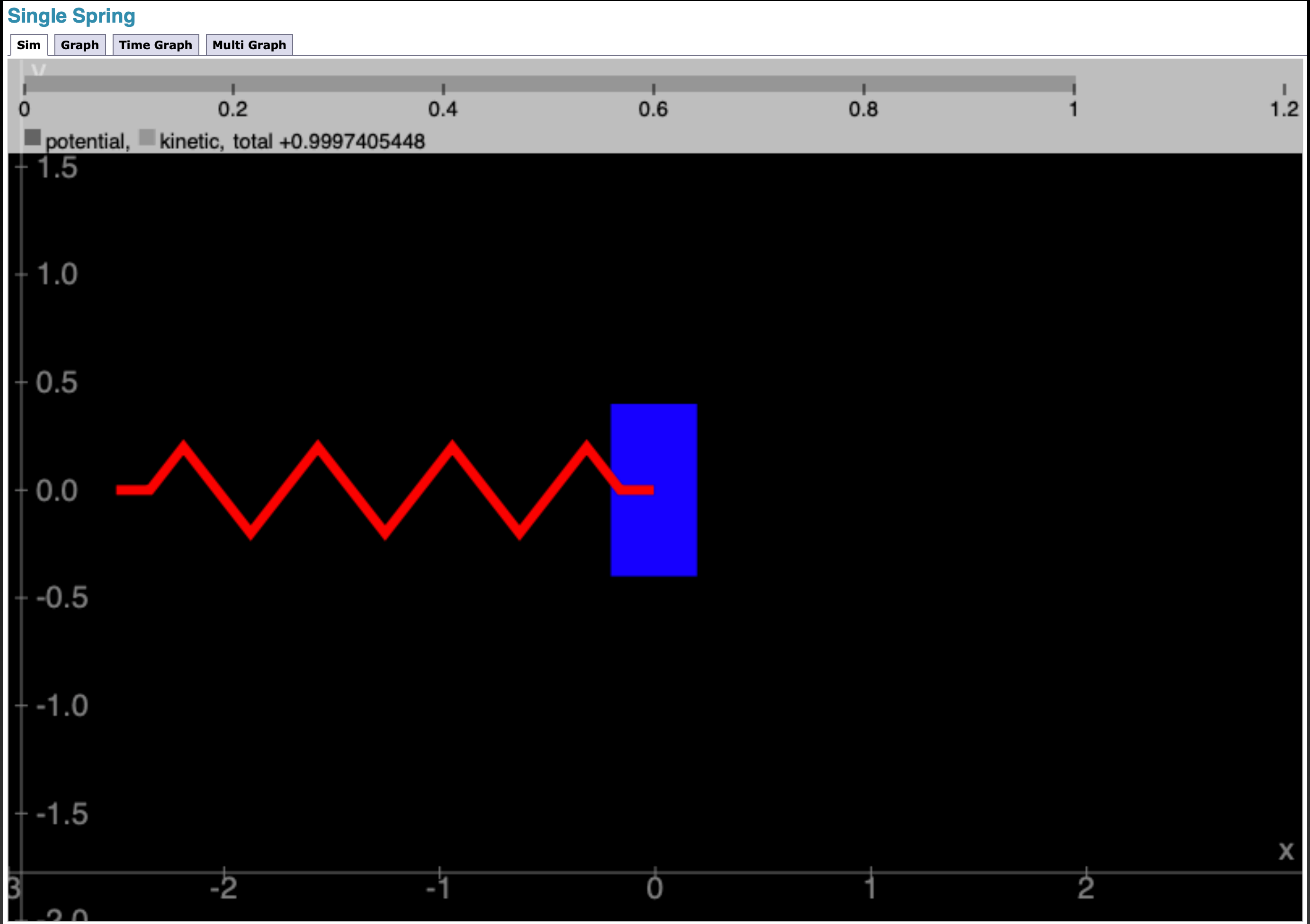


Gravity:
Conservative

Friction:
NON-Conservative

Source: Organic Chemistry Tutor

Energy in Springs



Source: [Single Spring Simulation]()

Conservation of Energy

CONSERVATION OF ENERGY

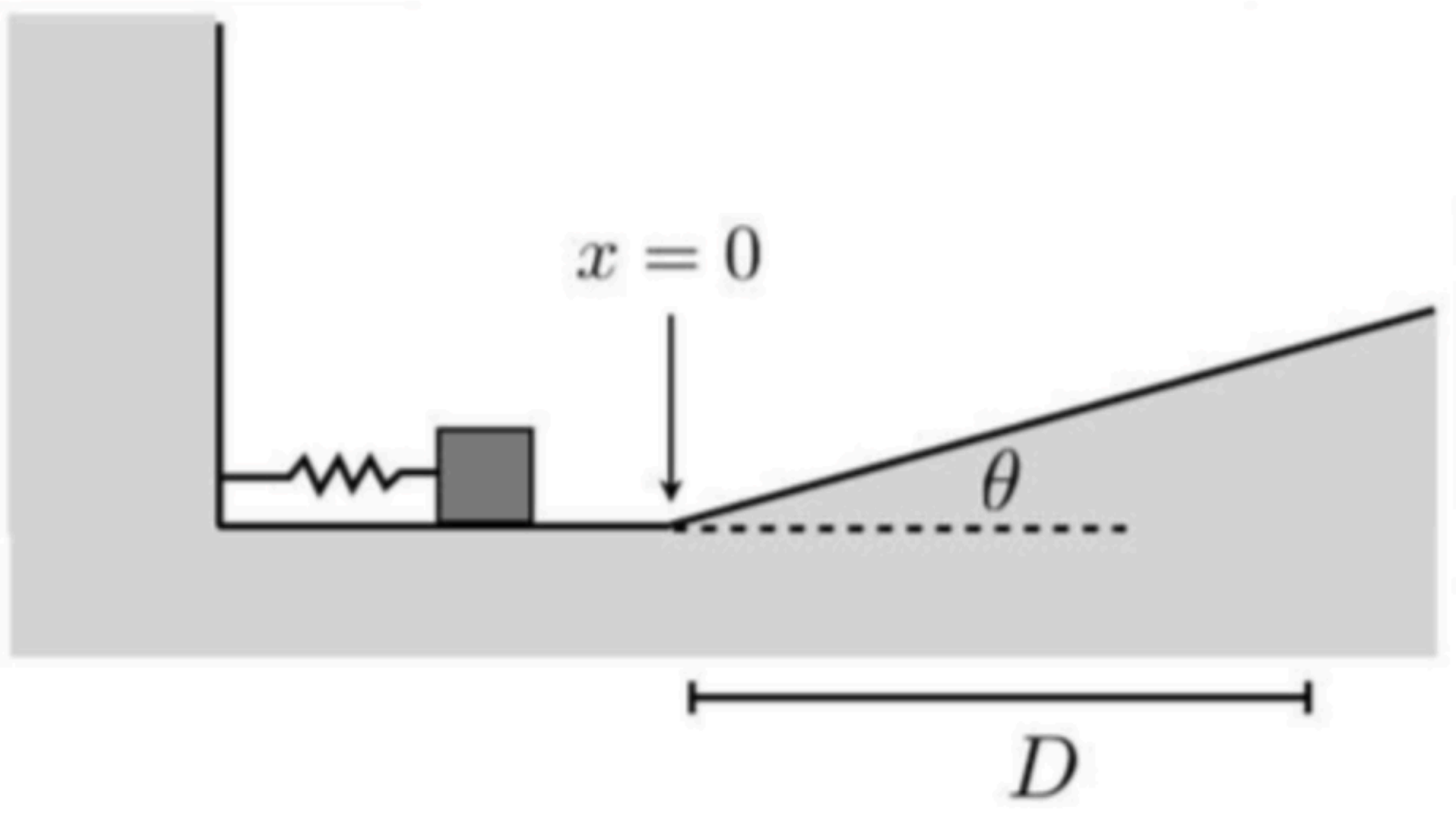
The mechanical energy E of a particle stays constant unless forces outside the system or non-conservative forces do work on it, in which case, the change in the mechanical energy is equal to the work done by the non-conservative forces:

$$W_{\mathrm{nc},AB} = \Delta(K + U)_{AB} = \Delta E_{AB}. \tag{8.12}$$

Hints for HW 8.10

Spring on an Incline

A small 5 kg block is accelerated from rest on a flat surface by a compressed spring (k = 658 N/m) along a frictionless, horizontal surface. The block leaves the spring at the spring's equilibrium position (x = 0) and travels on an incline (θ = 25°) with a coefficient of kinetic friction μ_k = 0.25. The block moves a horizontal distance D = 8 m before coming to a stop.



Part 1

(a) What is the initial compression of the spring?

$x =$ number (rtol=0.02, atol=1e-08) m

Part 2

(b) What is the maximum kinetic energy of the block?

$K_{max} =$ number (rtol=0.05, atol=1e-08) J

Key Equations

Difference of potential energy	$\Delta U_{AB} = U_B - U_A = -W_{AB}$
Potential energy with respect to zero of potential energy at $\vec{\mathbf{r}}_0$	$\Delta U = U(\vec{\mathbf{r}}) - U(\vec{\mathbf{r}}_0)$
Gravitational potential energy near Earth's surface	$U(y) = mgy + \text{const.}$
Potential energy for an ideal spring	$U(x) = \frac{1}{2}kx^2 + \text{const.}$
Work done by conservative force over a closed path	$W_{\text{closed path}} = \int \vec{\mathbf{F}}_{\text{cons}} \cdot d\vec{\mathbf{r}} = 0$
Condition for conservative force in two dimensions	$\left(\frac{dF_x}{dy}\right) = \left(\frac{dF_y}{dx}\right)$
Conservative force is the negative derivative of potential energy	$F_l = -\frac{dU}{dl}$
Conservation of energy with no non-conservative forces	$0 = W_{nc,AB} = \Delta(K+U)_{AB} = \Delta E_{AB}.$

Words of Advice

& What to do if you're really lost...

How to do well in this course

Tip

Full credit for the original version of this document below goes to Dr. Simon Bates from Physics 117 at UBC-Vancouver.

The material below has been used and adapted with his permission.

Introduction

Your success in this course depends to a large extent how you approach it, and how you engage with the activities, the materials and each other.
Here, we give you some ideas and advice on how to do well in the course that you might find useful as you embark on the course.
But before that, here are some key ideas about learning that we have used in designing this course activities and assessments:

Learning is a contact sport.

It's not like watching a good movie, where you can just let it wash over you.
You have to engage to really learn; you have to struggle to learn.
It's hard, it sometimes won't make sense and it takes time and persistence.
You might have found learning (and passing exams) pretty easy to this point; university might well be very different.

Memorizing is not learning.

We won't emphasize memorizing in this course. Every test you do, you can take in your own notes (we call these 'open note' tests).
So more important than remembering every single equation we will use, is knowing when to use which ones, how to use them to solve problems and evaluating if what you've calculated makes sense.

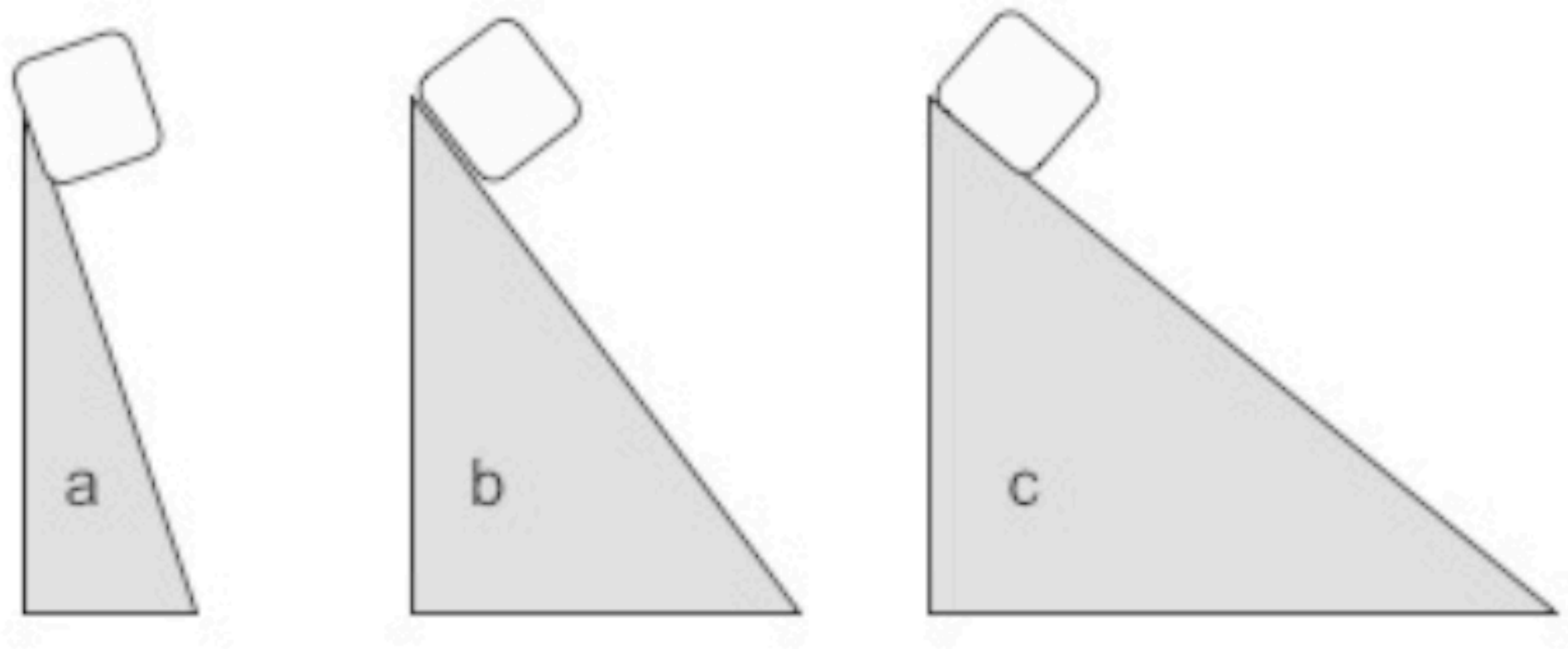
Understanding is learning and understanding should be your goal.

Can you explain an idea or a concept from this course to someone else in a way that they will understand it? And some time after you studied it?
This is the acid test for learning and it is one reason why we place such a lot of value on interaction and communication with your peers in this course.

Clicker Questions

CQ.9.4

Consider this figure. Three blocks of mass m slide down different inclined planes, each beginning at a height h. All of the planes are frictionless. Which block has the most energy at the bottom of the inclined plane?



a) a

b) b

c) c

d) All have the same energy.

A B C D E

CQ.9.5

A boulder rolls from the top of a mountain, travels across a valley below, and rolls part way up the ridge on the opposite side. Describe all the energy transformations taking place during these events and identify when they happen.

a) As the boulder rolls down the mountainside, KE is converted to PE. As the boulder rolls up the opposite slope, PE is converted to KE. The boulder rolls only partway up the ridge because some of the PE has been converted to thermal energy due to friction.

b) As the boulder rolls down the mountainside, KE is converted to PE. As the boulder rolls up the opposite slope, KE is converted to PE. The boulder rolls only partway up the ridge because some of the PE has been converted to thermal energy due to friction.

c) As the boulder rolls down the mountainside, PE is converted to KE. As the boulder rolls up the opposite slope, PE is converted to KE. The boulder rolls only partway up the ridge because some of the PE has been converted to thermal energy due to friction.

d) As the boulder rolls down the mountainside, PE is converted to KE. As the boulder rolls up the opposite slope, KE is converted to PE. The boulder rolls only partway up the ridge because some of the PE has been converted to thermal energy due to friction.

A B C D E

CQ.9.6

A marble rolling across a flat, hard surface at $2\ \mathrm{m/s}$ rolls up a ramp. Assuming that $g = 10\ \mathrm{m/s^2}$ and no energy is lost to friction, what will be the vertical height of the marble when it comes to a stop before rolling back down? Ignore effects due to the rotational kinetic energy.

a) $0.1\ \mathrm{m}$

b) $0.2\ \mathrm{m}$

c) $0.4\ \mathrm{m}$

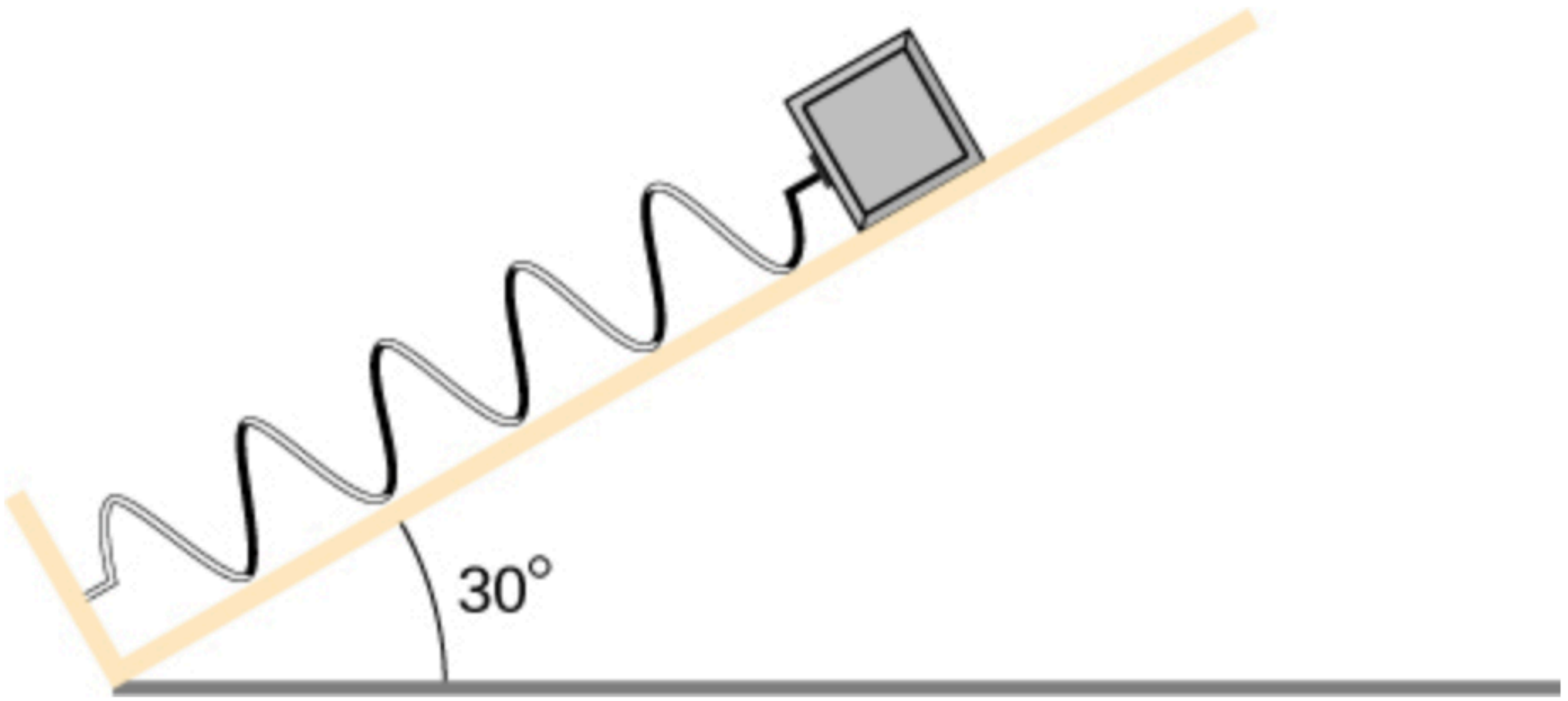
d) $2\ \mathrm{m}$

A B C D E

Activity:
Worked Problems

WP 9.1

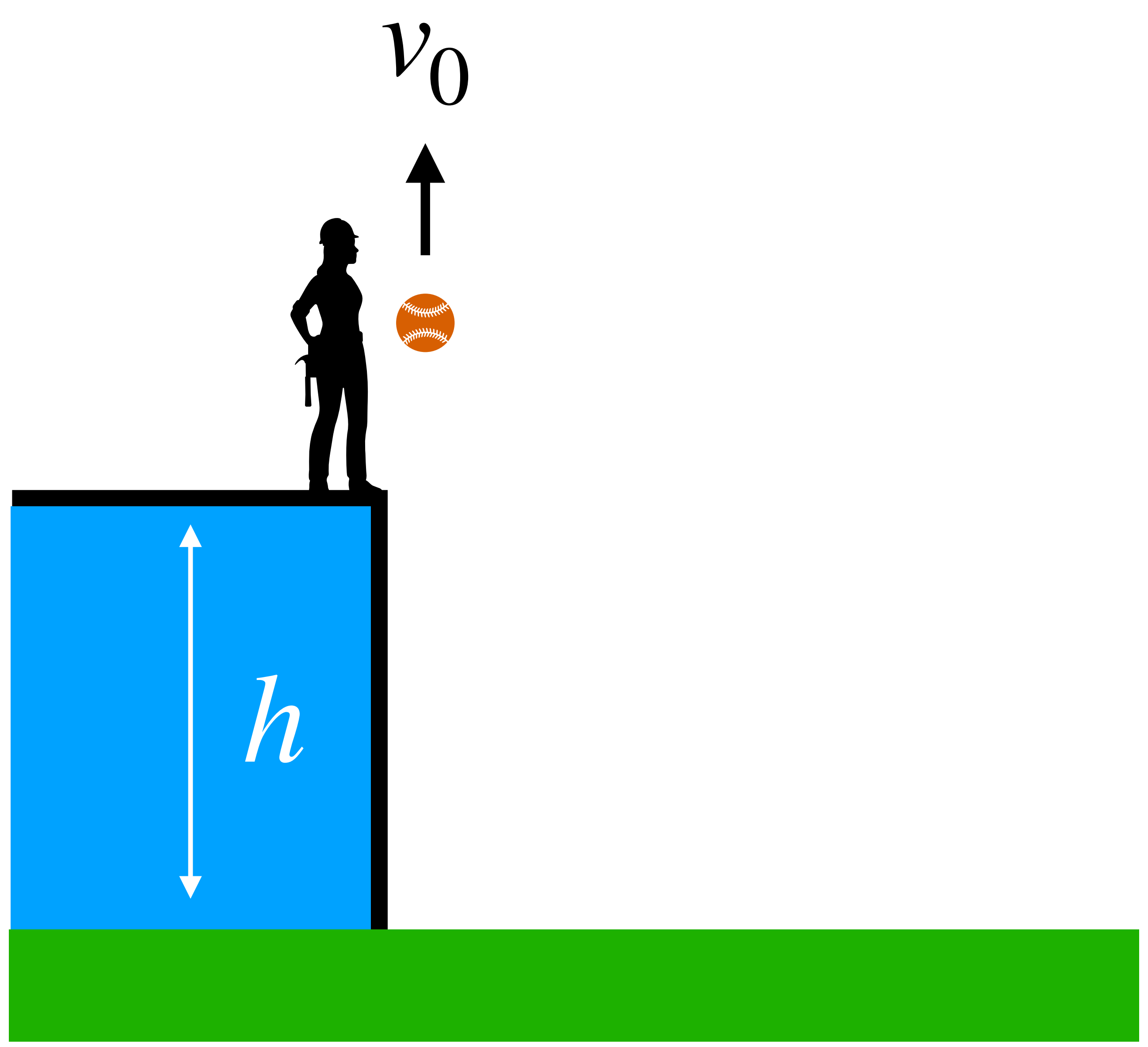
64 . A block of mass 500 g is attached to a spring of spring constant 80 N/m (see the following figure). The other end of the spring is attached to a support while the mass rests on a rough surface with a coefficient of friction of 0.20 that is inclined at angle of $30°$. The block is pushed along the surface till the spring compresses by 10 cm and is then released from rest. (a) How much potential energy was stored in the block-spring-support system when the block was just released? (b) Determine the speed of the block when it crosses the point when the spring is neither compressed nor stretched. (c) Determine the position of the block where it just comes to rest on its way up the incline.



A person standing at the edge of a building of height h tosses a ball straight up with a velocity v_0, and lets it fall to the ground. Find a) the maximum height the ball reaches and b) the velocity of the ball just before it hits the ground. You may ignore air resistance.

WP 9.2

Solve the problem in two ways: using Kinematics, and then Energy.



One more thing...

Preview of what's left

Preview of what's left

Did we just violate Conservation of Energy?

Did we just violate Conservation of Energy?

Find out... after we come back from Reading Break!

See you next class!

Attribution