Energy Part II

Eugenia Etkina and Gorazd Planinsic

Links for the documents for today’s meeting

OALG Chapter 7 file

https://docs.google.com/document/d/1JP_s_gFeEOqQxBKm1DYdFBcUUSV4Gqsj/edit

Folder for the meeting

https://drive.google.com/drive/folders/129fjCuob2w3rN5c5CosMIGWteT7_jmWI

Teachers struggle

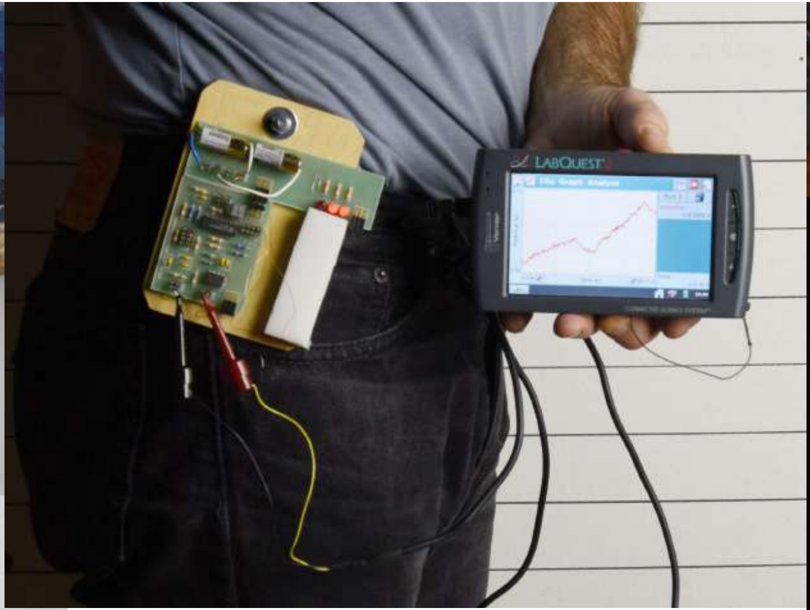
Question asked by one of the participants of a discussion on standards on energy in secondary schools, World conference on Physics Education, 2012

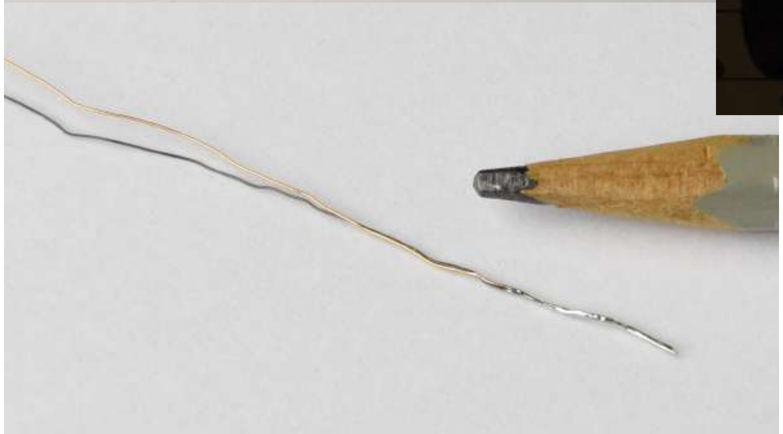
“Why do we have to stress the law of conservation of energy holds only in isolated system?”

How would you respond?

Constant vs Conserved

Testing Experiment (Gorazd Planinsic)

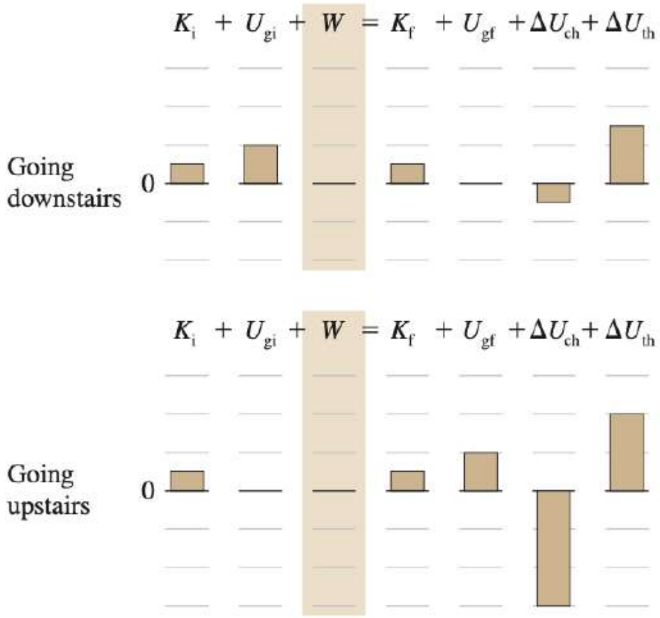


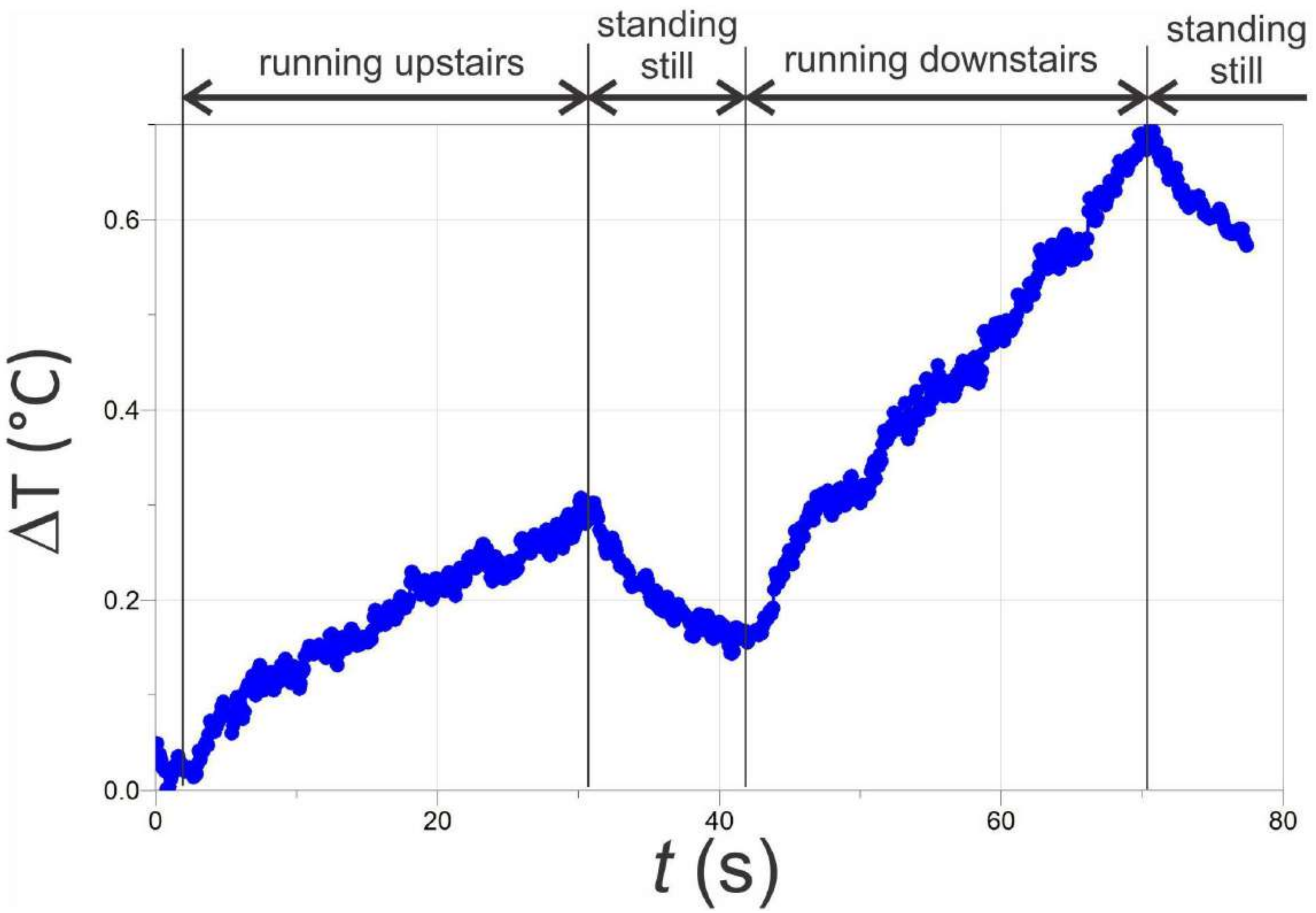


Thermocouple in the shoe, LabQuest and amplifier with batteries

46. * Work-energy bar charts for a person going downstairs and upstairs are shown in **Figure P7.46**. The bar charts show the average energy conversion across several steps. The system is the person, Earth, and the stairs. (a) What are the initial and final states in each case? (b) Describe and explain the similarities in the bar charts. (c) Describe the differences in the bar charts. How do these differences explain why we are less tired going downstairs? (d) How do you explain that when we walk upstairs $|\Delta U_{th}| < |\Delta U_{ch}|$, but when we walk downstairs $|\Delta U_{th}| > |\Delta U_{ch}|$? (Hint: Think about what happens to our shoes and the stairs when we go downstairs.)

FIGURE P7.46





running upstairs
standing still
running downstairs
standing still
ΔT (°C)
0.0
0.2
0.4
0.6
0
20
40
60
80
t (s)

How do we need to change the bar charts now that we have the experimental evidence?

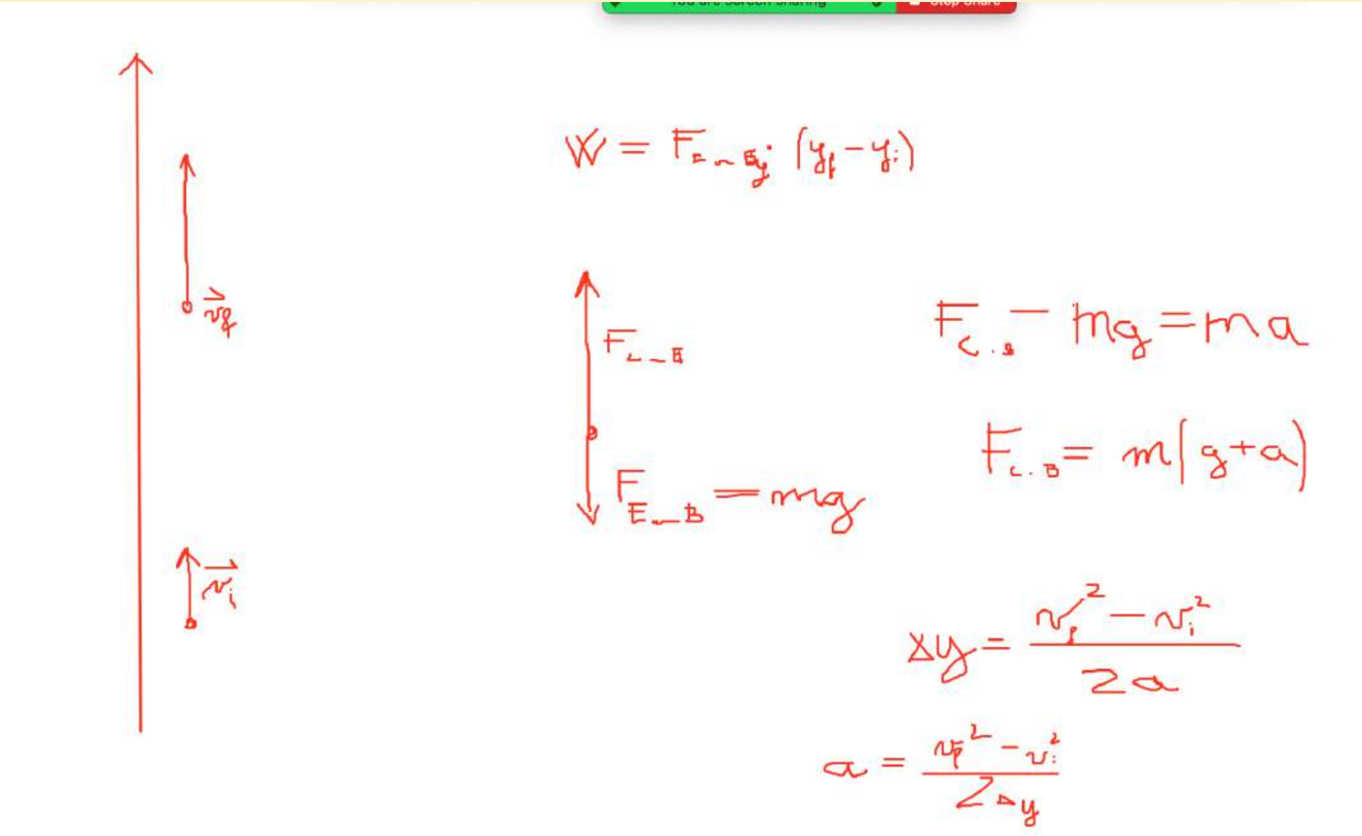
Need to know

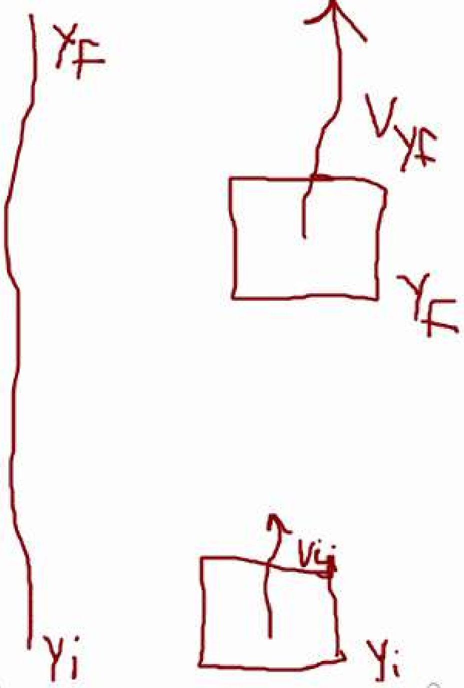
We have done a lot with energy so far but we do not have any mathematical description for different types of energy. And because of this we cannot actually test whether energy is a conserved quantity as we cannot do any quantitative predictions.

We are going to do an activity that involves a derivation. If you are having trouble, you can look up the following document

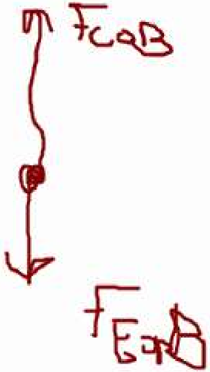
https://docs.google.com/document/d/1E5JTu-sIEjxUbr8clspPDyEG9oV4T9l8/edit

Team 1 7.3.1 [OALG Chapter 7 Final.docx]





$$W = F_{C\,on\,B}(y_f - y_i)$$



Fnet = Fcob - Feonb = ma = Fcob - mg= ma
a = (Vf^2-Vi^2)/2(yf-yi)
Fcob -mg=m((Vf^2-Vi^2)/2(yf-yi))
Fconb = m((Vf^2-Vi^2)/2(yf-yi)) + mg
Fconb = m((Vf^2-Vi^2)/2(yf-yi) + g)
Fconb (yf-yi) = mvf^2/2 - mvfi^2/2 +mg(yf-
yi) = mvf^2/2 - mvfi^2/2 +mg(yf-yi) = mvf^
2/2 - mvfi^2/2 +mgyf - mgyi

Whiteboard - Zoom

Mute | Stop Video | Participants 3 | Chat | New Share | Pause Share | Whiteboard | Remote Control | More

You are screen sharing | Stop Share

a) 

yi, vi

$$W = \left(\frac{m(v_f^2 - v_i^2)}{2(y_f - y_i)} + mg \right)(y_f - y_i)$$

b) $W = \vec{F} \cdot \vec{d} = F_{ros}(y_f - y_i)$ where $\cos(0^\circ) = 1$

$$W = \frac{m(v_f^2 - v_i^2)}{2} + mg(y_f - y_i)$$

c) $W = (ma + mg)(y_f - y_i)$

d) $v_f^2 = v_i^2 + 2a(y_f - y_i)$

$\longrightarrow \quad a = \dfrac{v_f^2 - v_i^2}{2(y_f - y_i)}$

e) $F_{ros} = ma + mg = m\left(\dfrac{v_f^2 - v_i^2}{2(y_f - y_i)} \right.$

Select | Text | Draw | Stamp | Spotlight | Eraser | Format | Undo | Redo

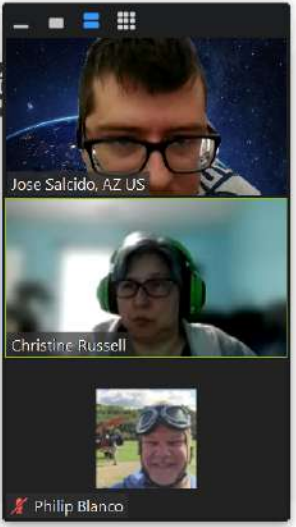
Who can see what you share here?

Breakout Rooms

Breakout Rooms will close in 27 seconds

You will be returned to the main session automatically.

Leave Breakout Room



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$$W = \frac{mv_f^2}{2} - \frac{mv_i^2}{2} + mgh_f - mgh_i$$

$W \to 0$ const

$\frac{mv_f^2}{2} \to K_f$

$\frac{mv_i^2}{2} \to K_i$

$mgh_f \to U_{gf}$

$mgh_i \to U_{gi}$

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

$$U_g = mgh$$

Team 1 7.3.2 Watch the video only AFTER you made the prediction

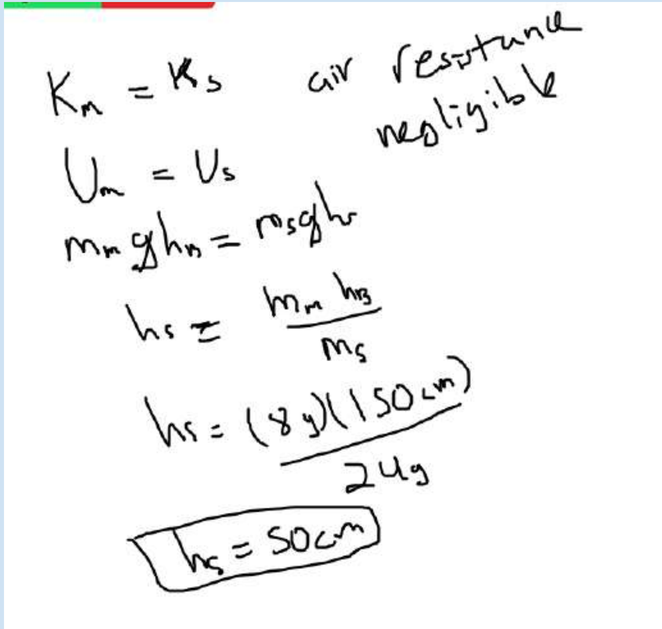
https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-3-2

Team 2 7.3.2 Watch the video only AFTER you made the prediction

The mass of the bearing is 3x the mass of the marble so we would predict that the bearing would be dropped from 50 cm to make the same mark. We assumed that the initial velocity is zero and that gravitational potential energy would be the same in order for there to be the same indentation. We expect that both the marble and the bearing will make the same dent because they have the same amount of energy.

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-3-2

Team 3 7.3.2 Watch the video only AFTER you made the prediction



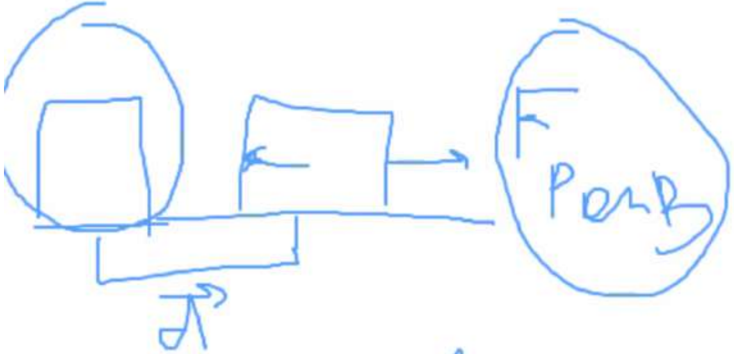
https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-3-2

All together on the whiteboard

You, outside the system, pull on a rope attached to the crate so that it moves slowly at **constant velocity**. At the end of the process, the bottom of the crate and the surface on which it was moving have become warmer.

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-1-5

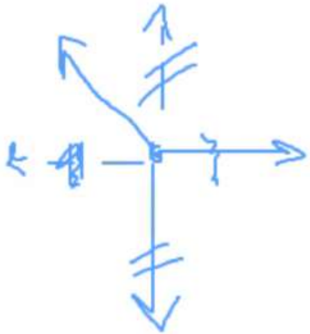
1. What do we choose to be the system?
2. What is the initial and final state?

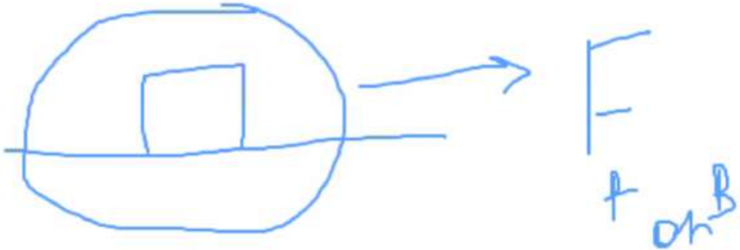


$$W = \Delta E_{total}$$

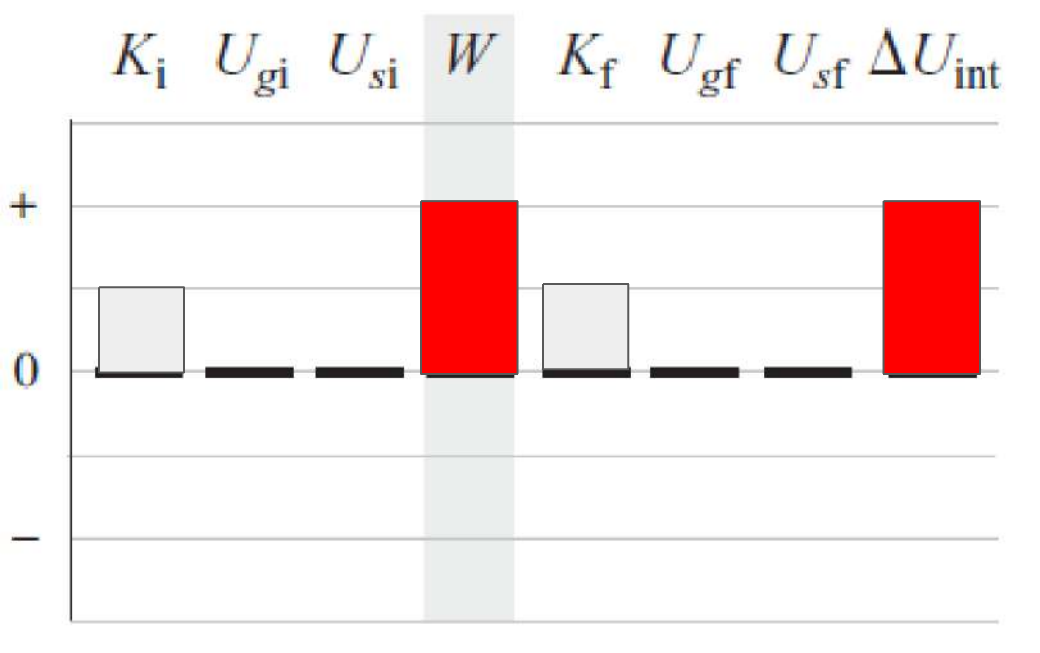
$$\downarrow$$

$$0 \rightarrow \Delta U_{th}$$

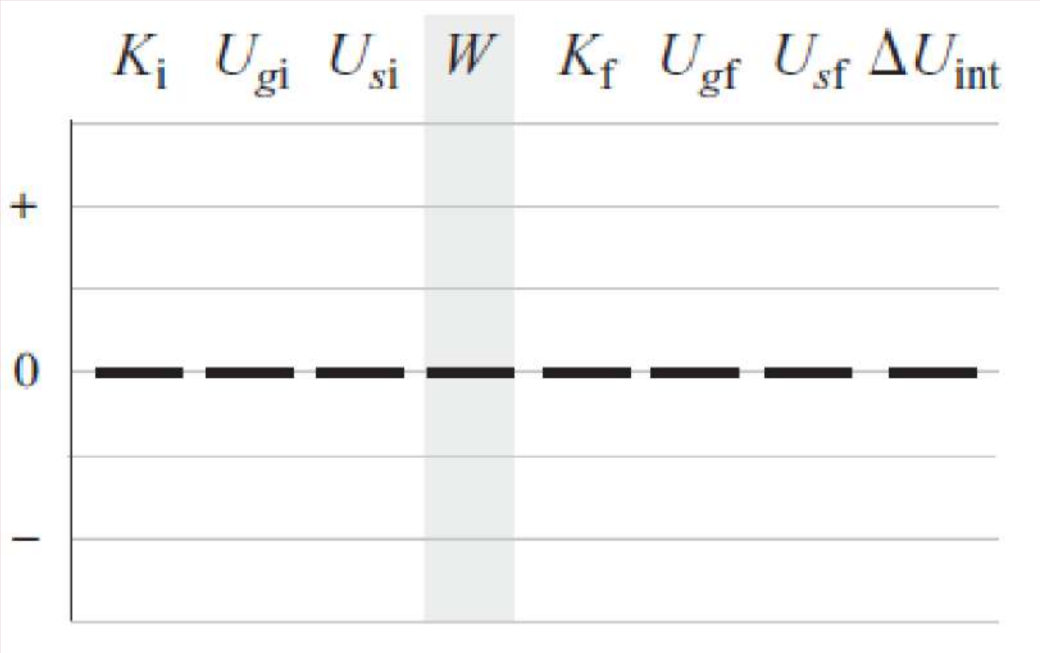




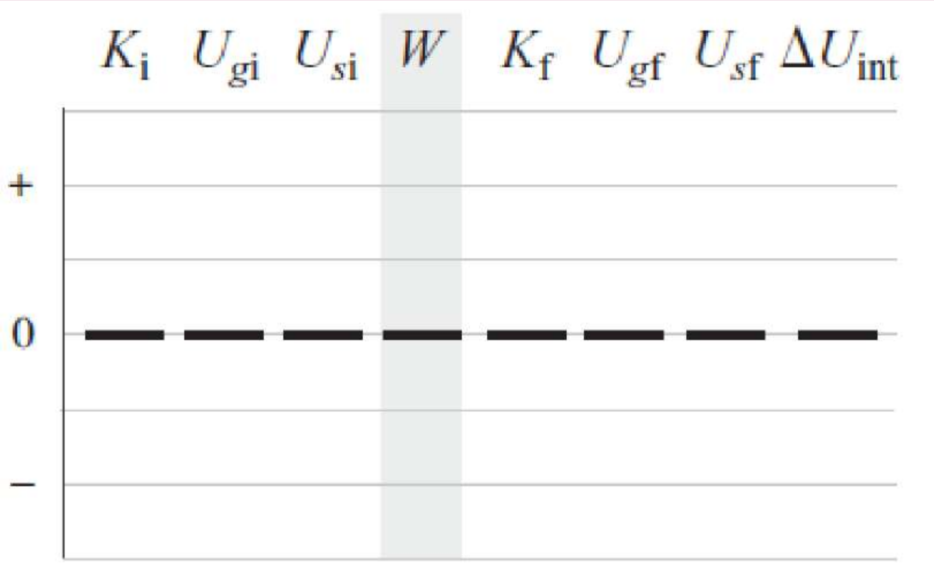
Team 1 OALG 7.5.2



Team 1 OALG 7.5.2

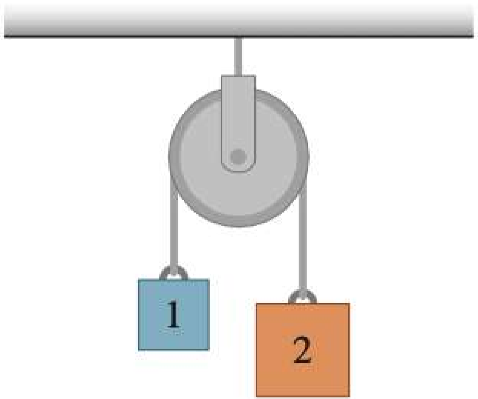


Team 2 OALG 7.5.2



3. An Atwood machine is shown in **Figure Q7.3**. As the blocks are released and block 1 moves downward, the energy of the block 1-Earth system
   (a) increases.
   (b) decreases.
   (c) stays constant.
   (d) It's impossible to say without including block 2 in the system.

FIGURE Q7.3



11.

4. Below you see several statements analyzing the process described in the previous question. Match the energy analysis with the system choice for which the analysis is correct.
   I. The total energy of the system decreases.
   II. The total energy of the system increases.
   III. The total energy of the system stays constant.
   Systems:
   (a) Block 2 and Earth
   (b) Block 1 and Earth
   (c) Both blocks, the string, and Earth
   (d) Both blocks and the string

Team 1 Questions 3 and 4

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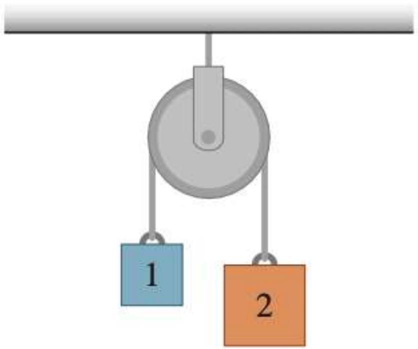

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   (d) Both blocks and the string

Team 2 Questions 3 and 4

3. An Atwood machine is shown in Figure Q7.3. As the blocks are released and block 1 moves downward, the energy of the block 1-Earth system
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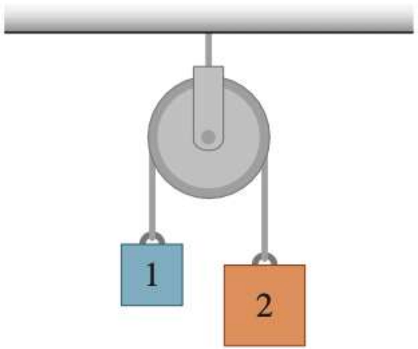

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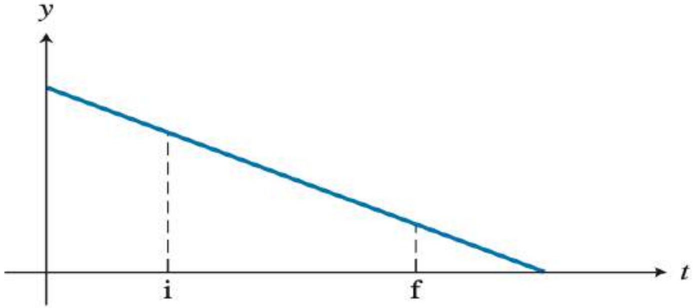
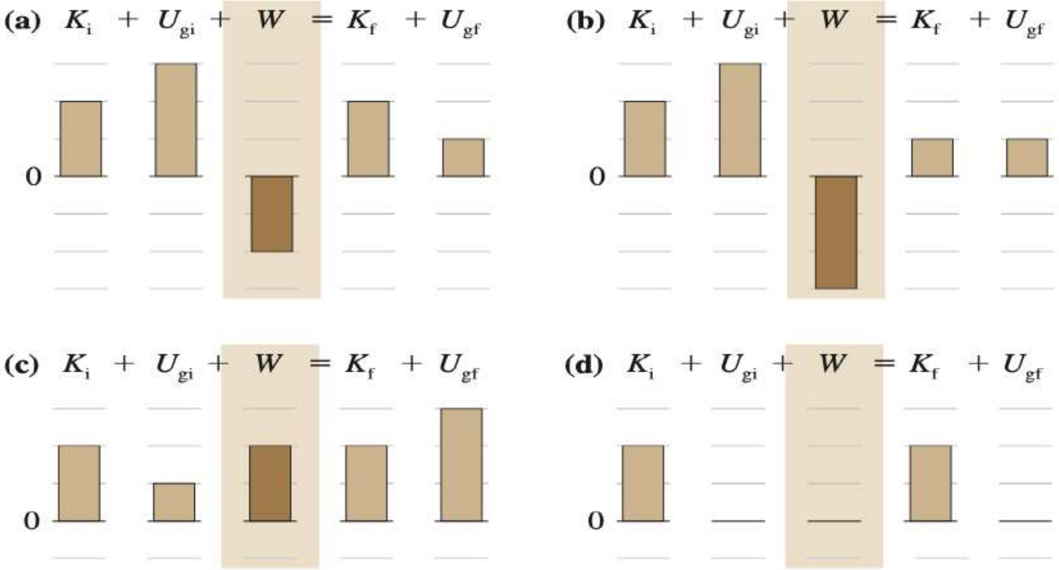
11. The graph in **Figure Q7.11** shows the time dependence of the vertical displacement of a lead ball with marked initial and final states. Choose all the work-energy bar charts (a) to (d) that can represent this process (multiple answers may be correct). Note that the y-axis can point either up or down.

FIGURE Q7.11





Team 1 Question 11

Team 2 Question 11

An example of a 2-3 hour lab 7.7.3 - after students learned about elastic and inelastic collisions.

Read the instructions before the video, think of how you would do it, then read instructions after the video. How is this lab different from a traditional lab?

What are the most important ideas that you learned today?

When work =0 then the total energy of the system is constant

Whenever it is possible test with experiments the results/predictions of a physics problem -important for students

Constant versus conserved - difference

A conserved quantity is a quantity that you can always find at least one system where it is constant

It is helpful to use different bar charts to help students with understanding systems

(1) The importance of choosing your system to help solve your problem into something you can easily calculate.
(2) Solving physics problems is essentially making predictions for an experiment.

Use different systems to help students get a better conceptual understanding to distinguish between constant and conserved.

Gradually building process in learning sequence