Energy and Work

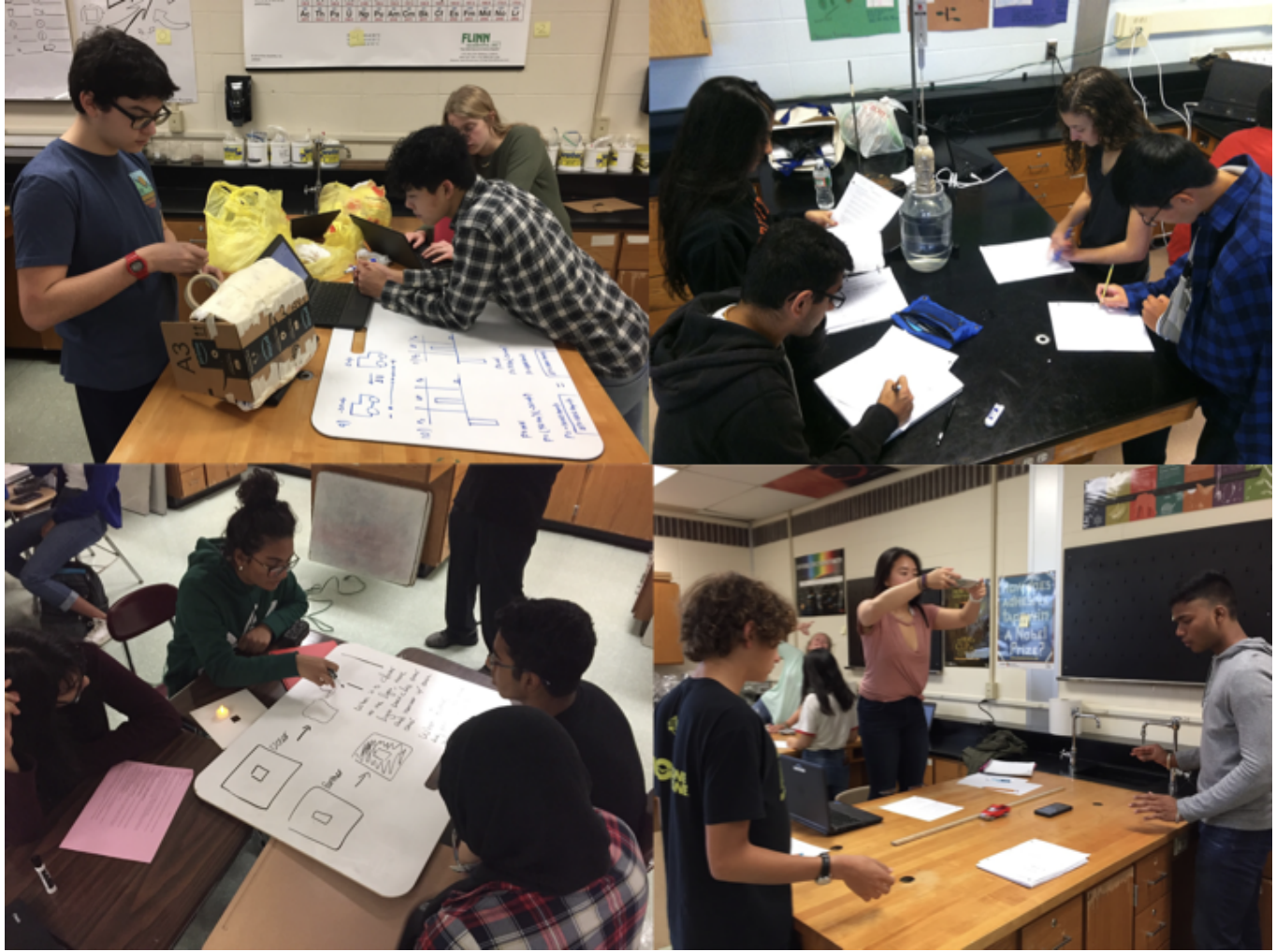
Eugenia Etkina

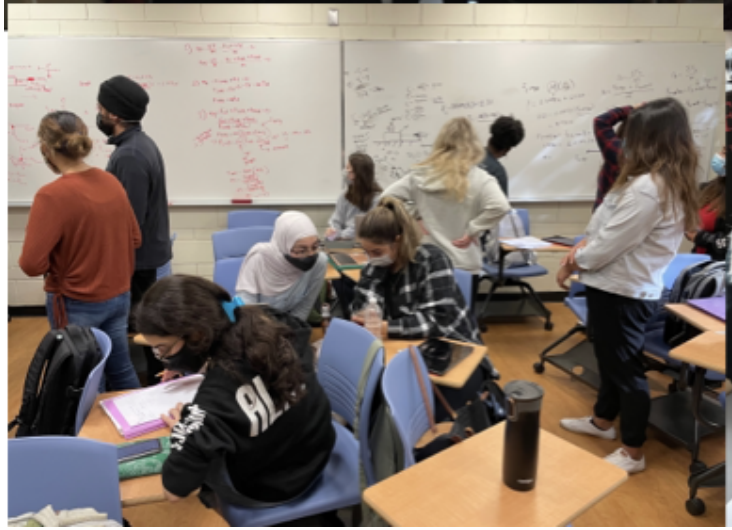
Please rename yourself with your First name, High School or college, and the Country

Eugenia

University

USA


A3



Materials for today's meeting

Please rename yourself with your First name, High School or college, and the Country

Activities for today

OALG Chapter 7 Final.docx click on this link and make sure that the document is open during the whole meeting

Version for teaching in person:

https://docs.google.com/document/d/1_Sd6MWLbqs3Jfcmj25ggnQGOYR_GGHn2/edit

Folder with all resources for the meeting, including papers
https://drive.google.com/drive/folders/1SuyazPT_viM-x9Mx_BWfXP5FK23JI5vB

What did you observe?

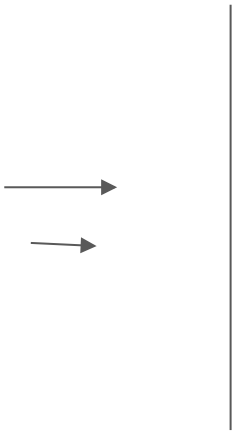
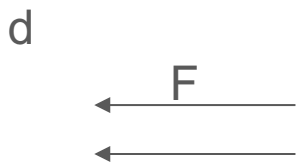
The difference between going up and down stairs?

What toys did you find?

All together OALG 7.1.1. a, b, c OALG Chapter 7 Final.docx

https://mediaplayer.pearsoncmg.com/assets/_frames.true/secs-experiment-video-13

Pay attention to what we include in the system and what the external objects are.

Experiment	a	b	c
Draw arrows indicating the direction of the force you exerted on the system and the displacement of the object in the system while you were exerting the force.			

Team 1 OALG 7.1.1 d OALG Chapter 7 Final.docx

Force times distance Nxm

Team 2 OALG 7.1.1 d OALG Chapter 7 Final.docx

Ability to break the chalk:

Force and distance in the same direction.

Either you increase the force or the distance

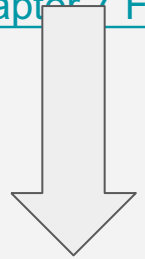
Team 3 OALG 7.1.1 d OALG Chapter 7 Final.docx

New physical quantity is force time distance. The pattern is that a force is applied over a distance, both the applied force and the distance are in the same direction. Force and distance in the same direction increases the CCA (chalk crushing ability) of the system.

Team 4 OALG 7.1.1 d OALG Chapter 7 Final.docx

Force and displacement together

In the same direction



All together OALG 7.1.2 experiments 1 and 2 in the video

OALG Chapter 7 Final.docx

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F x d leads to the increase in CCA

- F x d leads to the decrease in CCA

  F is perpendicular to d there is no change in CCA

All together OALG 7.1.3 experiment 3 in the video

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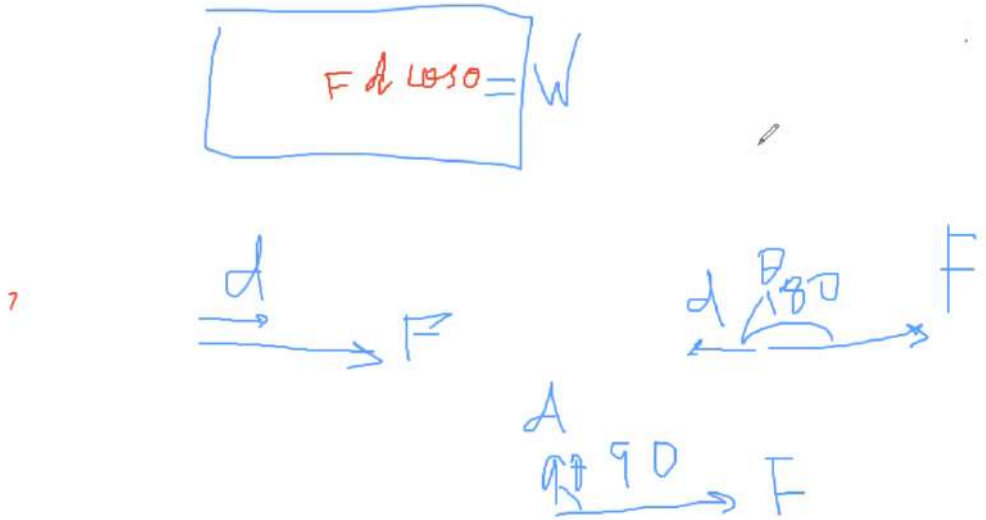

Team 1 OALG 7.1.4 OALG Chapter 7 Final.docx

The change in CCA = Fdcos theta (final) + Fd cos theta (initial)

Team 2 OALG 7.1.4 OALG Chapter 7 Final.docx

A group of students in your class came up with the following equation: $W = \Delta CCA$. Does it seem reasonable? Explain.

Yes, however, need to describe what they are changing like one at a time as there are three factors

Fdcos theta = cca final - cca intial

- \- => Final is bigger
- \+ => Final is smaller

Team 3 OALG 7.1.4 OALG Chapter 7 Final.docx

W = delta CCA

Change in chalk crushing ability

Yes, it seems reasonable, because when work increases CCA increases, when work decreases CCA decreases

Team 4 OALG 7.1.4 OALG Chapter 7 Final.docx

Yes, for us it could be reasonable

Mathematical nature of physical quantities

All together OALG 7.1.5 OALG Chapter 7 Final.docx

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Team 1 OALG 7.1.6 OALG Chapter 7 Final.docx

a) Holding of the board
b) Pulling of the board
c) Elastic material
d) (Friction) Change in Internal energy

Team 2 OALG 7.1.6 OALG Chapter 7 Final.docx

Change in height

Change

Change in energy

Team 3 OALG 7.1.6 OALG Chapter 7 Final.docx

a) **a.** The external force caused the block to move higher above Earth's surface. Gravitational Potential Energy (earth-block system)

b) **b.** The external force caused the cart to move faster and faster. Kinetic Energy

c) **c.** The external force caused the slingshot to stretch. Elastic Potential Energy

d) **d.** The external force caused the surfaces of the touching objects to warm. Thermal Energy

Team 4 OALG 7.1.6 OALG Chapter 7 Final.docx

a. Gravitational
b. Kinetical
c. Elastic
d. internal

Gravitational potential energy

Kinetic energy

Elastic energy

Internal energy

Team 1 OALG 7.1.7 OALG Chapter 7 Final.docx

Team 2 OALG 7.1.7 OALG Chapter 7 Final.docx

Team 3 OALG 7.1.7 OALG Chapter 7 Final.docx

Team 4 OALG 7.1.7 OALG Chapter 7 Final.docx

All together OALG 7.1.8 or use your toys

Use your toys to describe the work-energy processes that occurs. Specify the system and initial and final states.

Alternatively, if you did not prepare your own toys watch the video.

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-1-8.

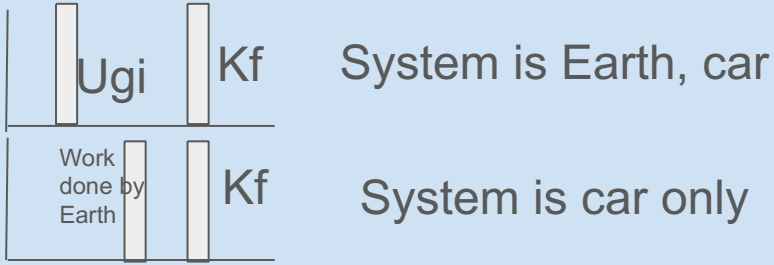
Team 1 OALG 7.2.1 for d use the link provided in the text of the activity OALG Chapter 7 Final.docx

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-2-1.

Energy change is the same because the car lands in the bucket no matter what angle it is launched at (the height of launch is the same).

Hand has to do the work to lift it up

If the system is the carth -



Team 2 OALG 7.2.1 for d use the link provided in the text of the activity OALG Chapter 7 Final.docx

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-2-1.

Team 3 OALG 7.2.1 for d use the link provided in the text of the activity OALG Chapter 7 Final.docx

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-2-1.

Team 4 OALG 7.2.1 for d use the link provided in the text of the activity OALG Chapter 7 Final.docx

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-2-1.

a. **The final position is the same, so the kinetic energy is the same.**

b.Conservation of energy

Can we think of total energy as a conserved quantity?

How can we write the energy conservation relation similar to the one we wrote for momentum?

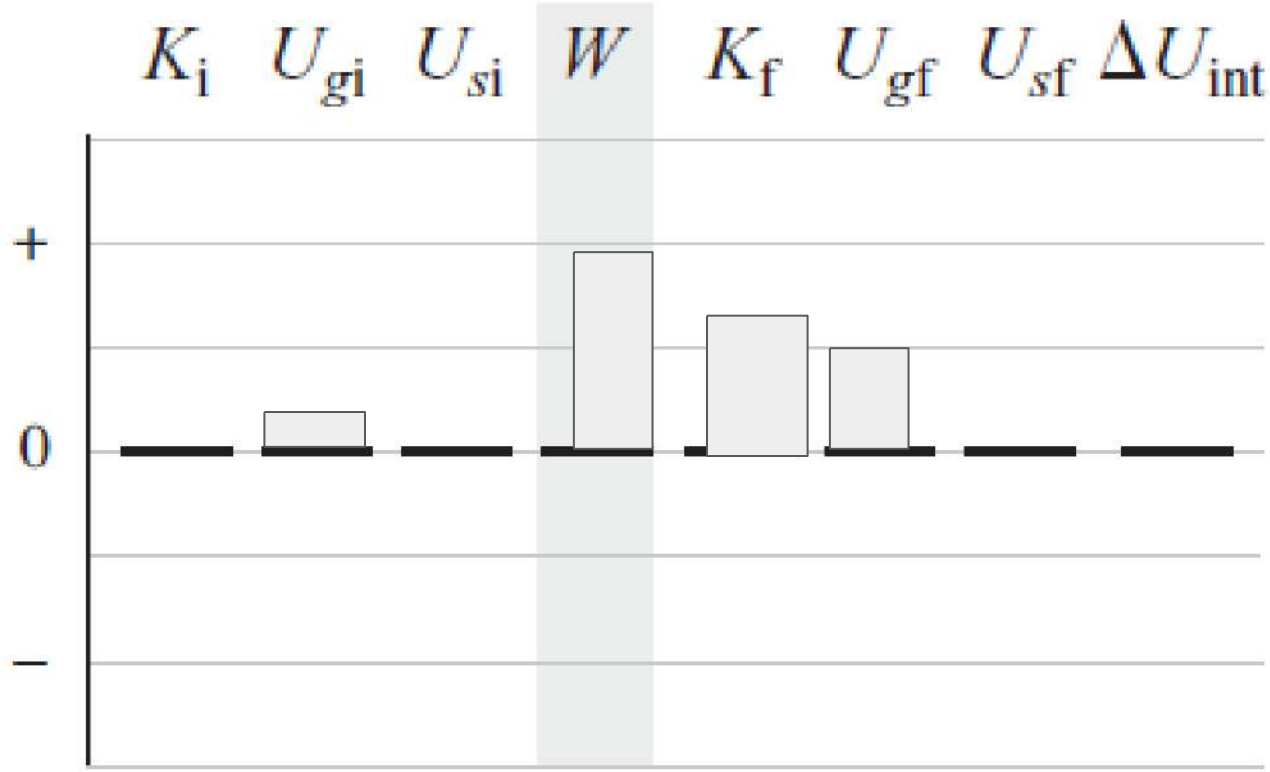
Work = change in the total energy of the system

When is the total energy of a system constant?

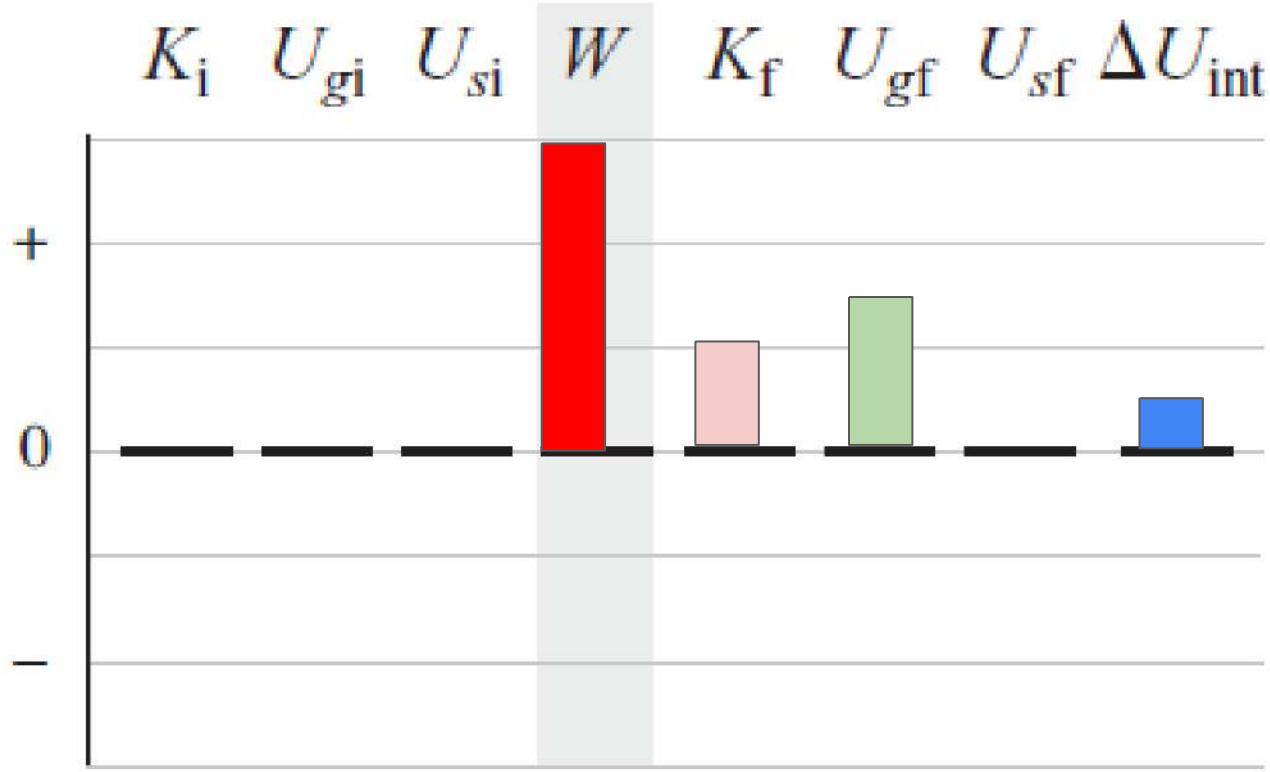
When no work is done: W=0

When is the total energy conserved? When it is converted to work

All together 7.2.2



All together 7.2.2



Team 1 Modified 7.2.3

7.2.3 Represent and reason

Below you read the descriptions of two experiments.

a. Draw a sketch showing initial and final states.

b. Construct a qualitative work-energy bar chart for each of the systems listed below.

Experiment 1: You are lifting a heavy suitcase at constant speed. Initial state: The suitcase is right above the ground. Final state: The suitcase is moving at a distance y above the ground.

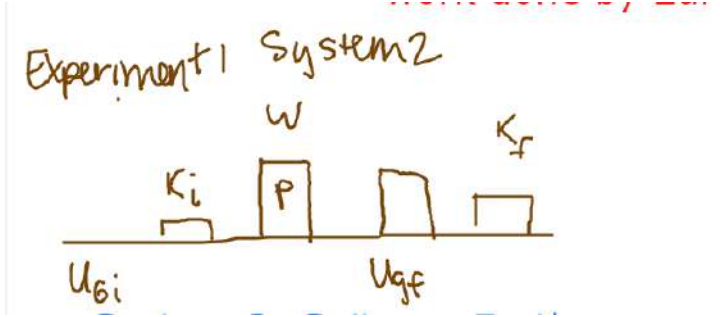
Experiment 2: You are lowering a heavy suitcase at constant speed. Initial state: The suitcase is above ground. Final state: the suitcase is near the ground.

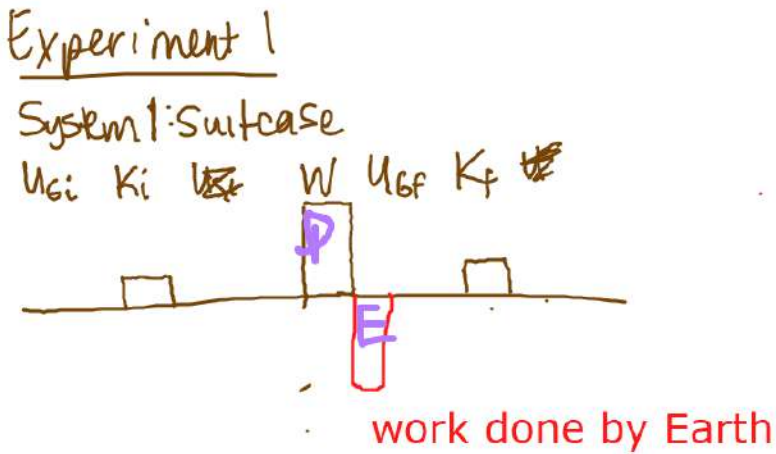
S**ystem 1: The suitcase (Earth does work on the suitcase here).**

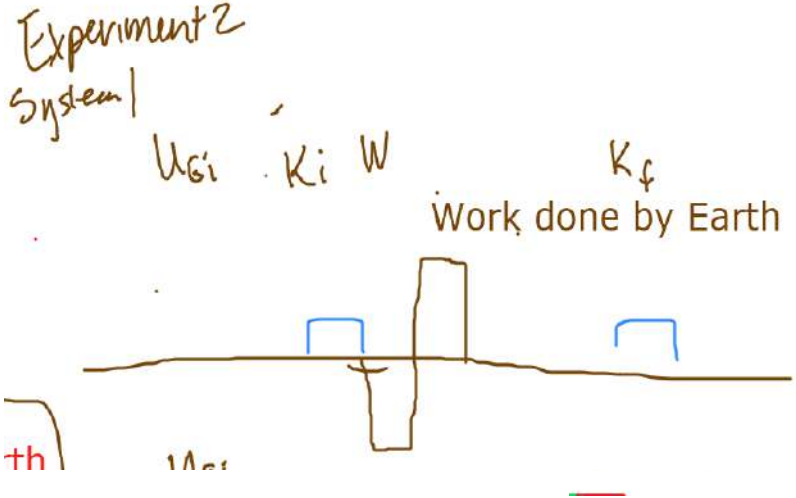
System 2: The suitcase and Earth.

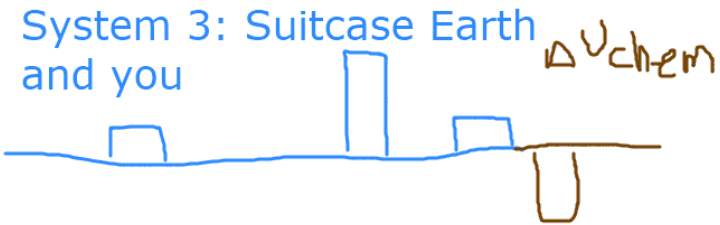
System 3: The suitcase, Earth and you.

Team 1 Modified 7.2.3









Team 2 Modified 7.2.3

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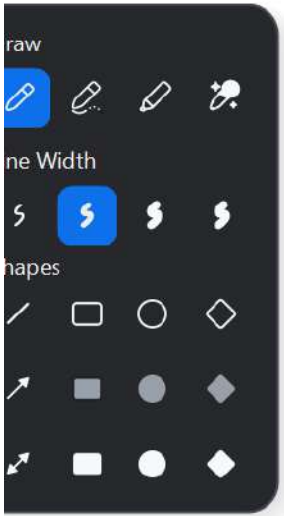
System 1: The suitcase (Earth does work on the suitcase here).

System 2: The suitcase and Earth.

System 3: The suitcase, Earth and you.

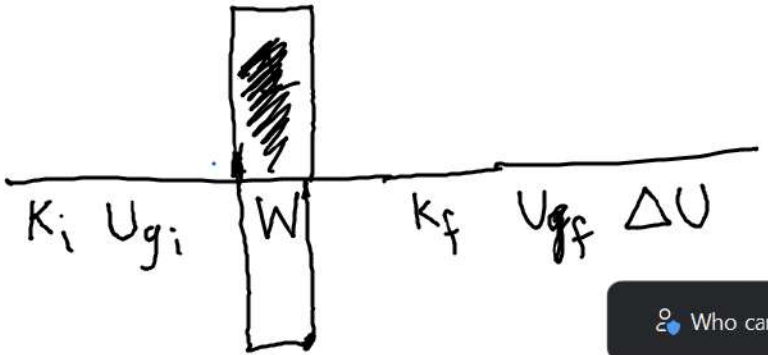
(2)



(1) only suitcase

(2) suitcase + Earth

(3) suitcase + Earth + Person



Team 3 Modified 7.2.3

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b. Construct a qualitative work-energy bar chart for each of the systems listed below.

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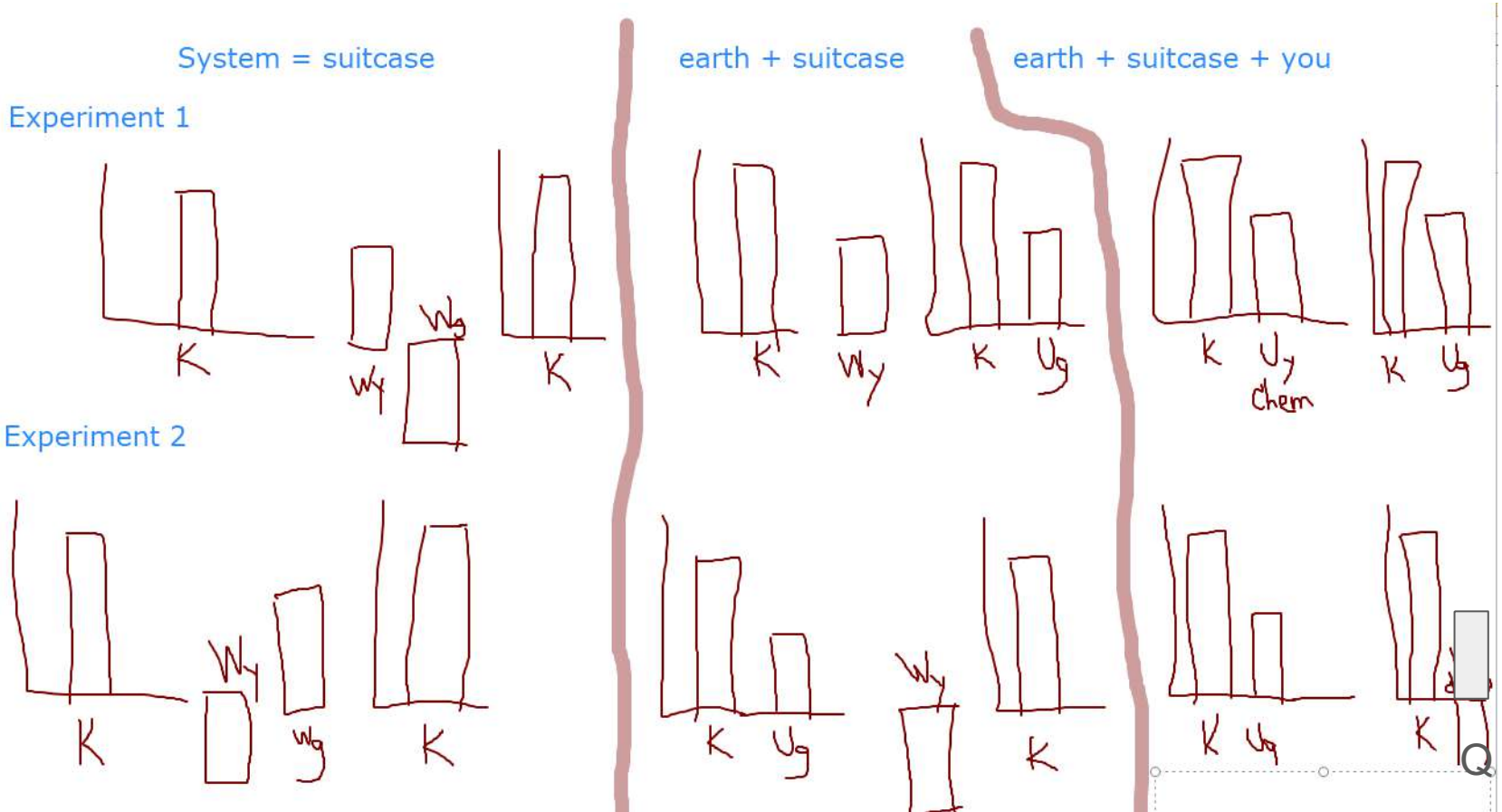
Team 3 Modified 7.2.3



Team 4 Modified 7.2.3

7.2.3 Represent and reason

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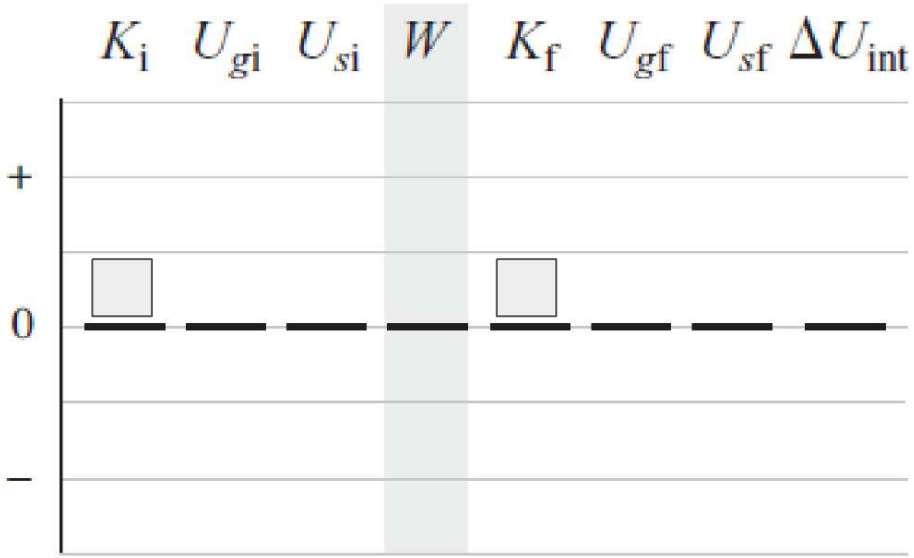
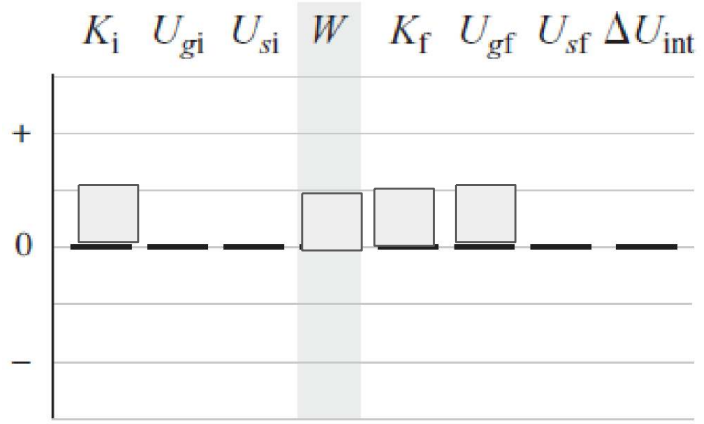
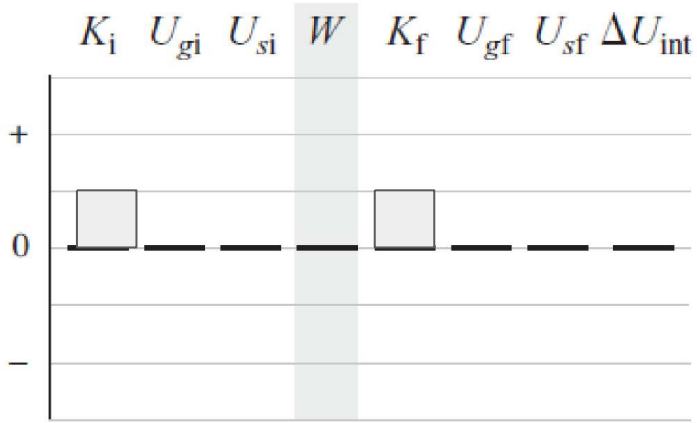
Team 4



suitcase

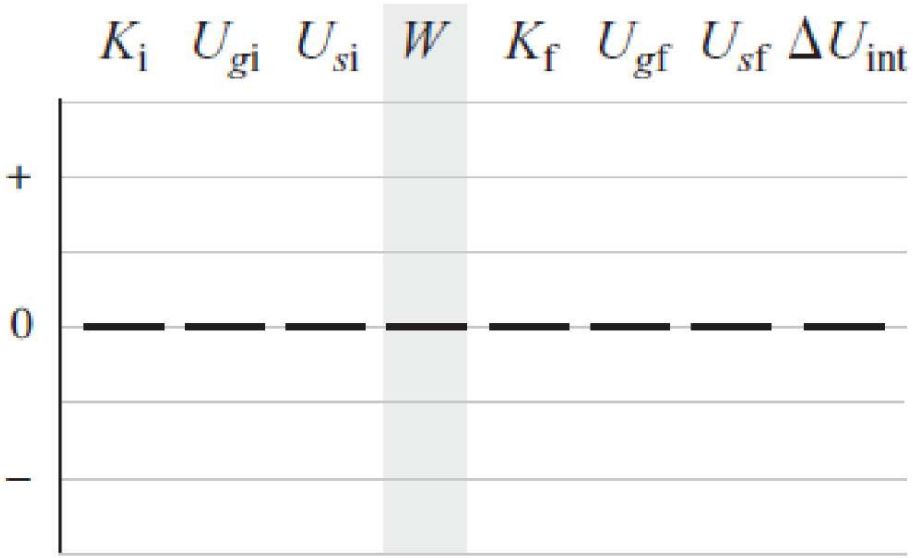


Suitcase+ earth

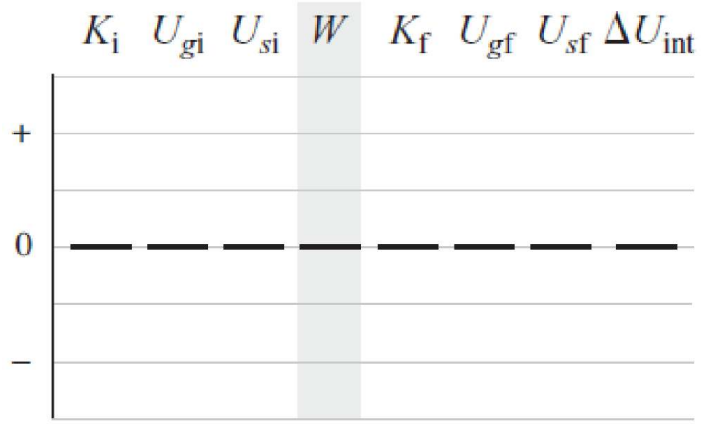


suitcase+earth+me

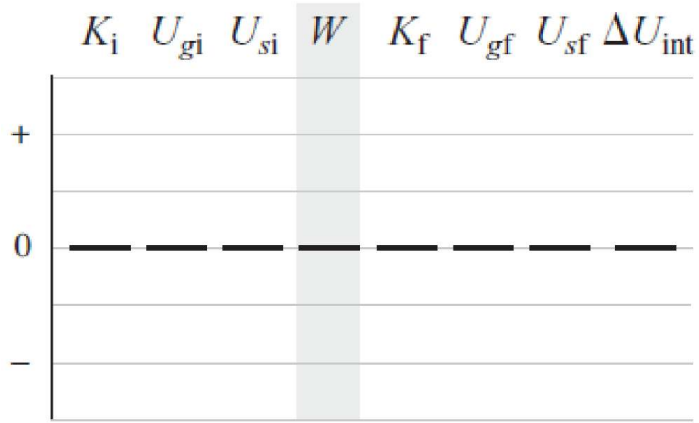
Team 4



suitcase



Suitcase+ earth



suitcase+earth+me

Remember to use chemical energy to balance the bars in the the energy bar chart

List the most important things that you learned today

- Understanding the system and converting the energy from one form to the other
- Thinking the different systems is very important.
- II learned not to skip any parts and jump ahead because you need it for the next part. You heat up when lowering objects-slowly.

1) Energy is not the ability to do work. That work is 1 way to change the energy of a system.
2) Look up James Joyce story (seems fun and engaging for students).
3) To explain the math operation of multiplication, we have to consider the units. We can't add apples and oranges, so when we combine different things we multiply.
4) Try to have students think about the phenomena in words they know before we define their thinking in physics terms. "Lets's not use the word we don't yet understand."

AA: Keep the sequence about discovery the need to know of Work, then describe it as changes in Energy. Then describe different types of change by discovering its chances. Show the relationship between Fdcos(theta), and the

I will have to practice explaining the difference between systems with Earth and without Earth

1. Work changes the energy of the system.
2. It's important to understand what is in the system before doing the scenario.

Define all work features before naming it as work. Work as quantity that modifies system
Linking work to the ability to 'change in energy' using videos is such a great way to establish the concept plus the way to get to the formula just amazing.
James Joules story was great. More stories linked to the topics will be great.

Work - Energy workshop Part II

Annitsa Spanos - Barbara Ingram School for the Arts/Washington County, USA

Eugenia, University, USA

Hisashi, Japan

Gopa,Highschool-USA

Jody

Andres, USA

Christina,

Amin, University, USA

Dorota, HS, USA

Roberta

Valentina

Manupriya

Rudra

Activities for today

OALG Chapter 7 Final.docx click on this link and make sure that the document is open during the whole meeting

Version for teaching in person:

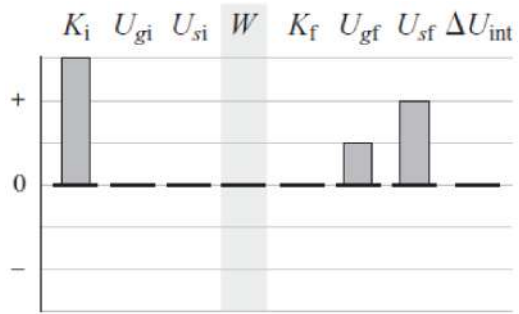
https://docs.google.com/document/d/1_Sd6MWLbqs3Jfcmj25ggnQGOYR_GGHn2/edit

Folder with all resources for the meeting, including papers
https://drive.google.com/drive/folders/1SuyazPT_viM-x9Mx_BWfXP5FK23JI5vB

All together OALG 7.2.4 Bar chart jeopardy

a. Describe in words, and then

b. sketch a process (the system, its initial and final states, and any work done on the system) that is consistent with the qualitative work–energy bar chart shown below. There are many possible choices.



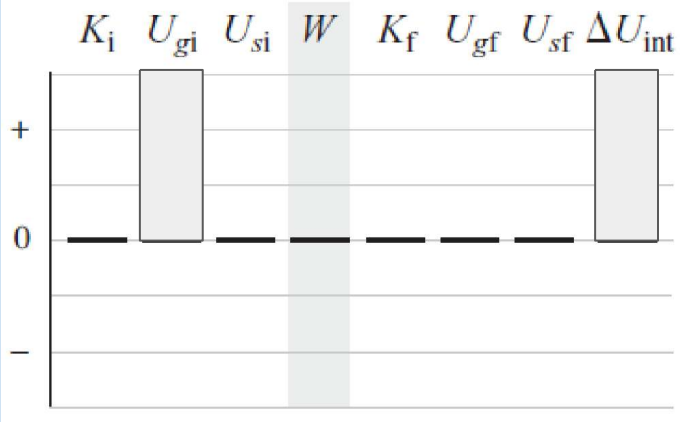
Observe the videos Lead Sphere and Joule's Experiment, choose a system for analysis, initial and final states and draw barch charts.

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-5-4

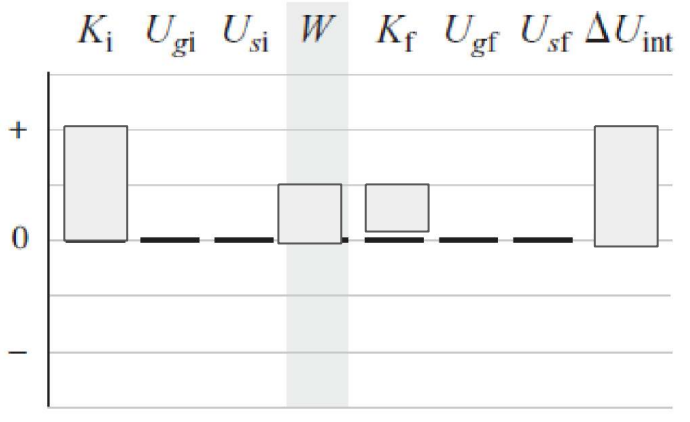
https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-15-3-1

Team 1 Observe the videos choose a system for analysis, initial and final states, and draw barch charts.

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-5-4
https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-15-3-1



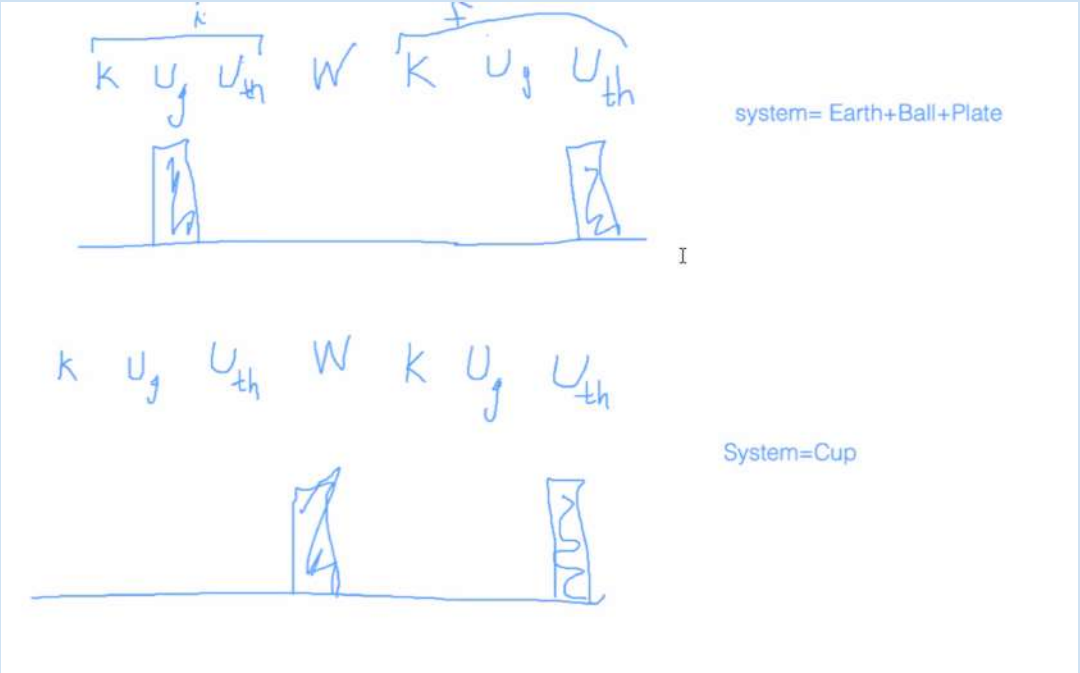
System:
Ball, Earth and surface



System:
Stirrer, liquid

Team 2 Observe the videos choose a system for analysis, initial and final states, and draw barch charts.

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-5-4
https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-15-3-1



Team 3 Observe the videos choose a system for analysis, initial and final states, and draw barch charts.

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https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-15-3-1

Team 4 Observe the videos choose a system for analysis, initial and final states, and draw barch charts.

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https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-15-3-1

Back to the stairs experiment.

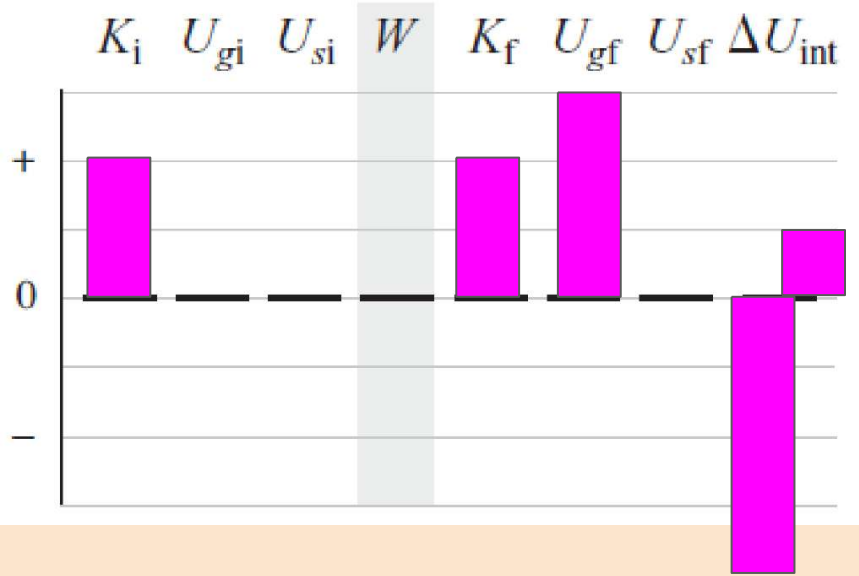
Do stairs do work on a person going up or down?

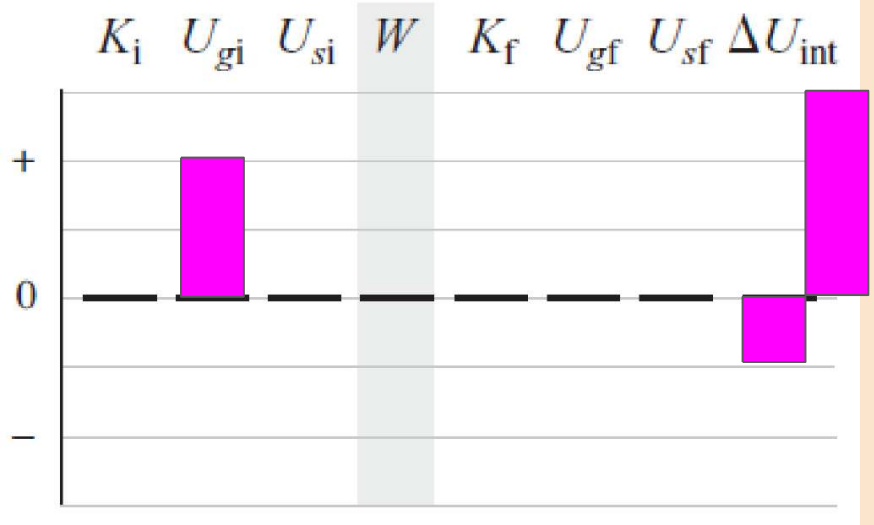
What should be in the system if you wish to describe what is going on using energy framework?

What should we take as initial and final states to draw a bar chart?

Team 1

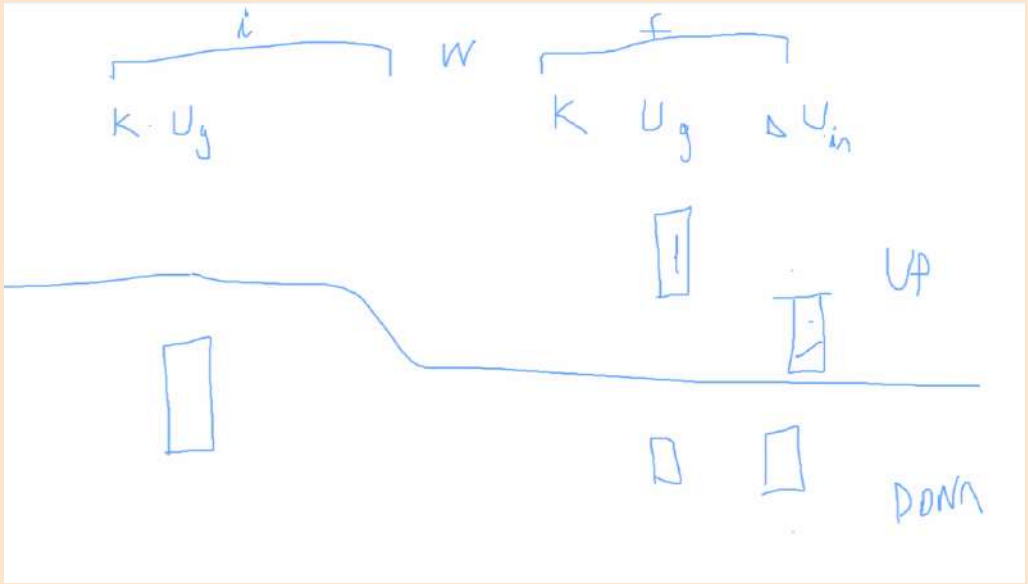
Represent the processes of going up and down the stairs with a bar chart. The system is the person, stairs, Earth. Assume the speed to be constant.





Team 2

Represent the processes of going up and down the stairs with a bar chart. The system is the person, stairs, Earth. Assume the speed to be constant.



Team 3

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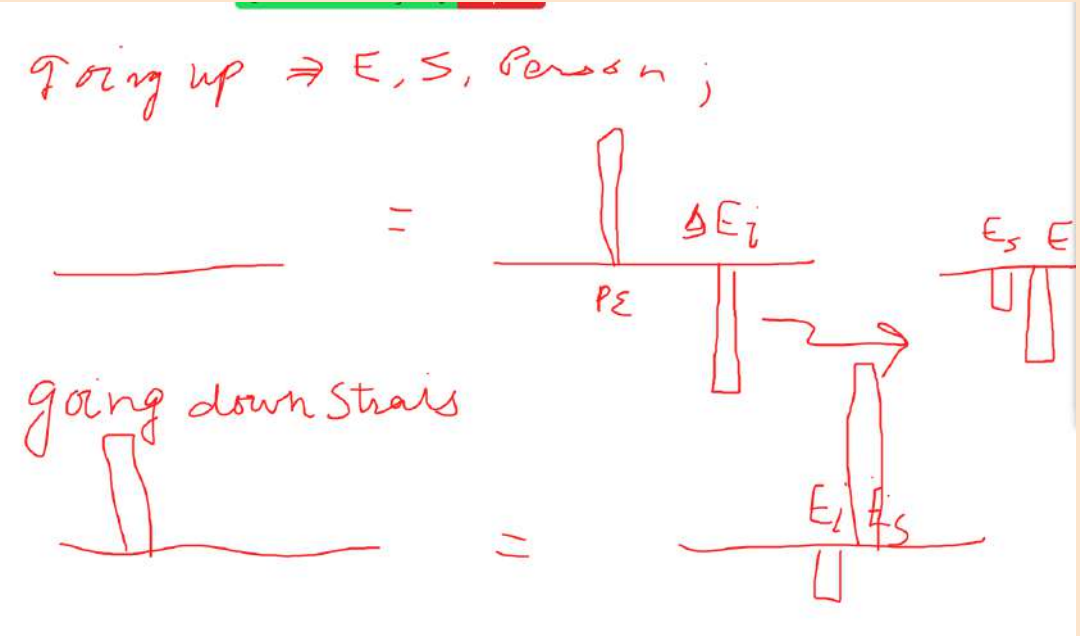
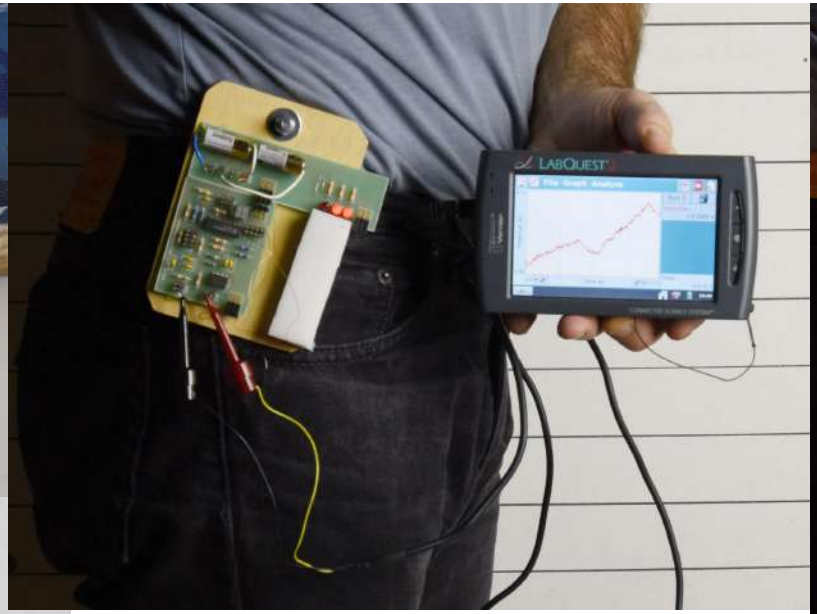
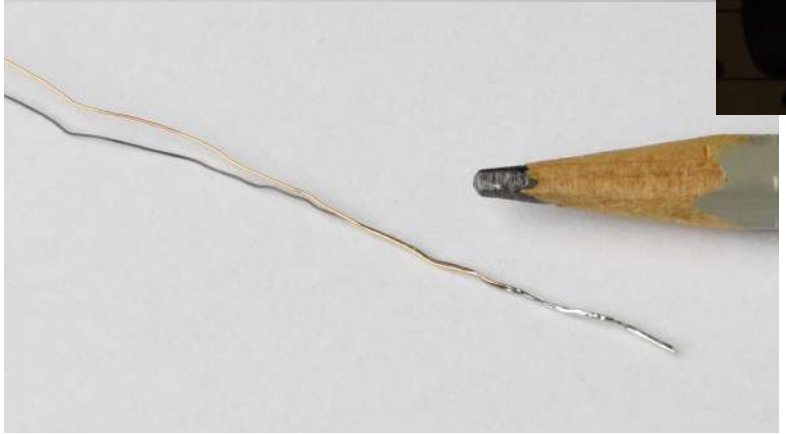


Team 4

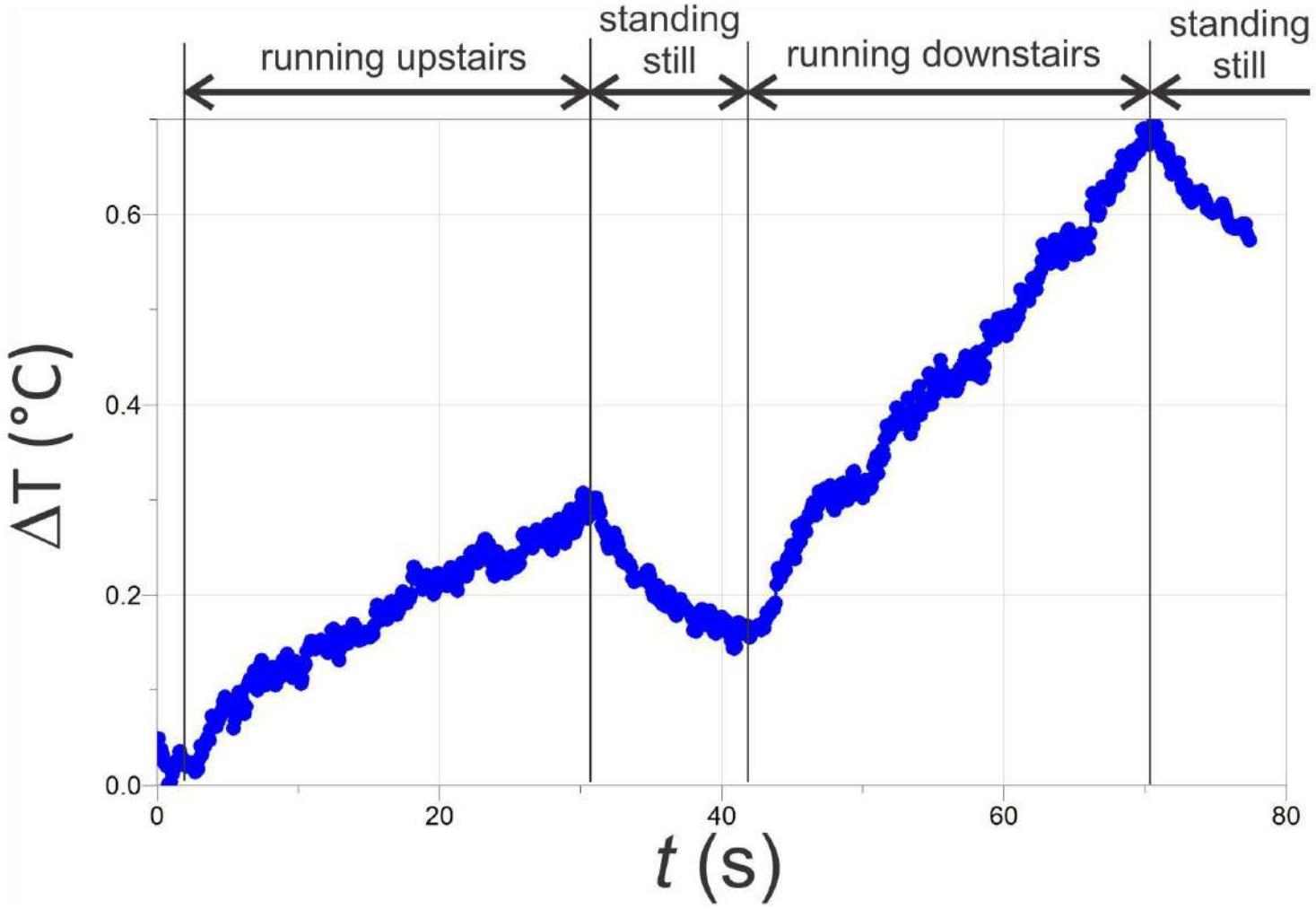
Represent the processes of going up and down the stairs with a bar chart. The system is the person, stairs, Earth. Assume the speed to be constant.

Testing Experiment (Gorazd Planinsic)

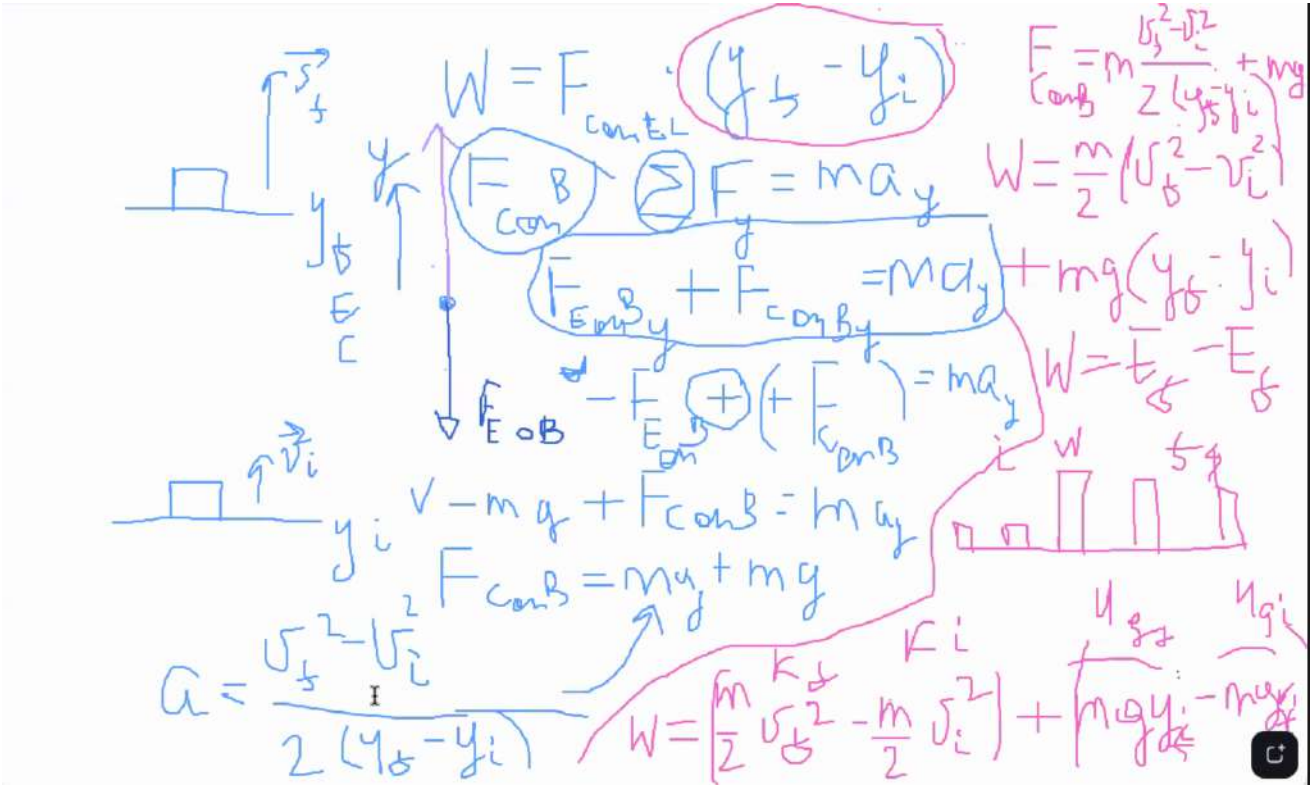




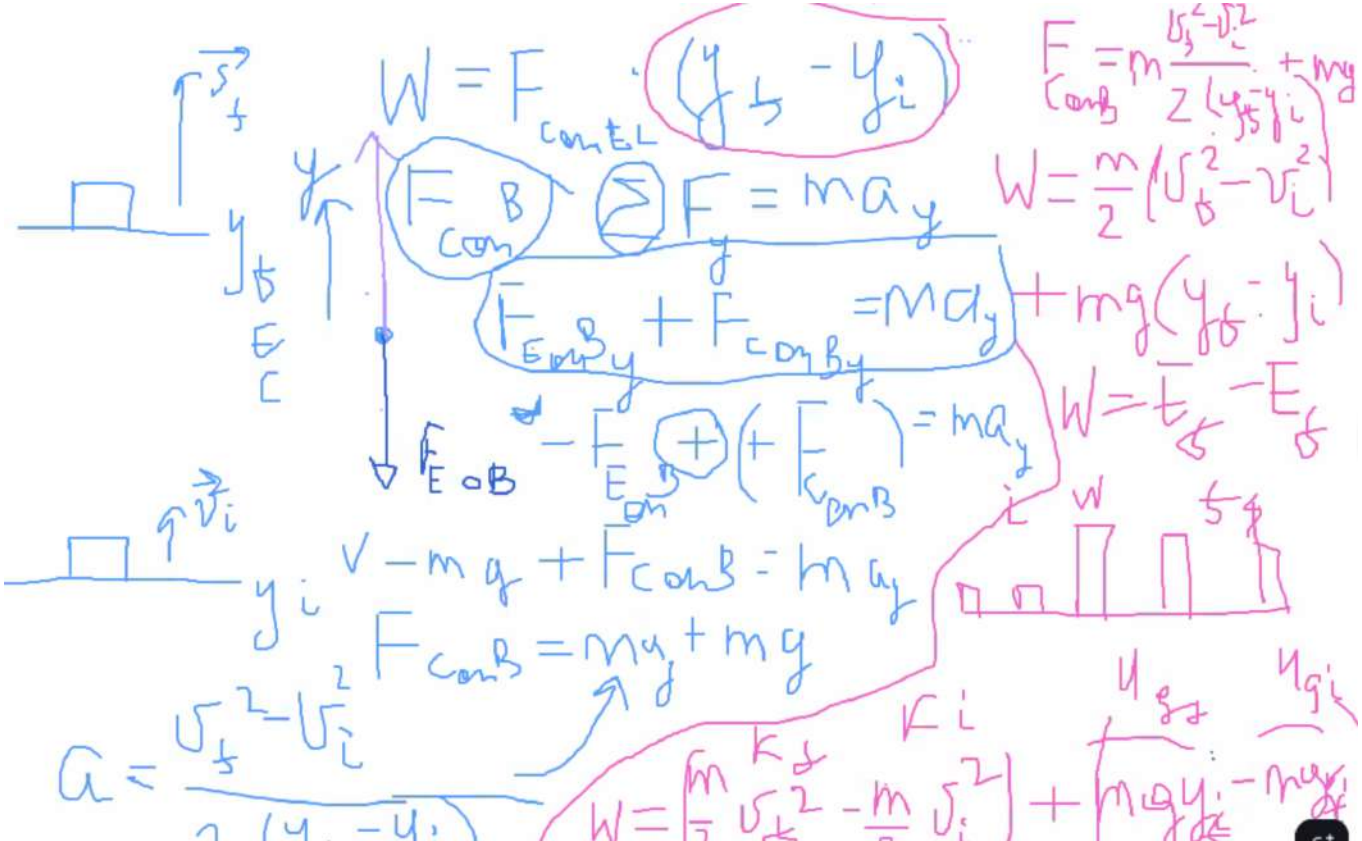
Thermocouple in the shoe, LabQuest and amplifier with batteries


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)

All together OALG 7.3.1 [OALG Chapter 7 Final.docx]

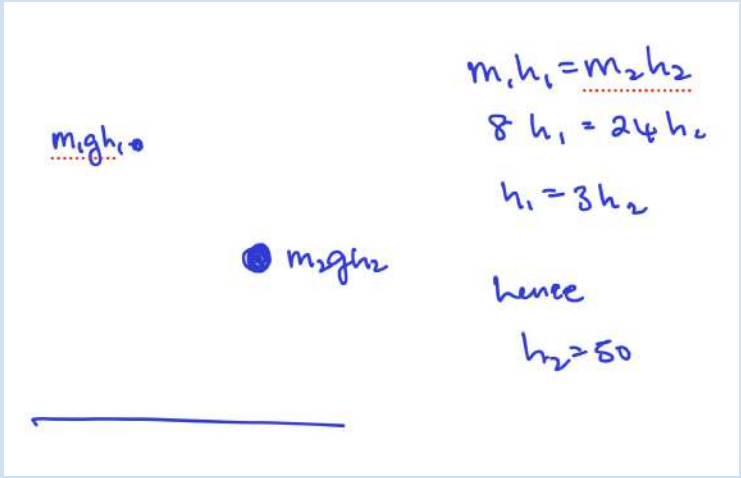


Screenshot of solved 7.3.1



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

$h_{marble} = 3 * h_{steel}$

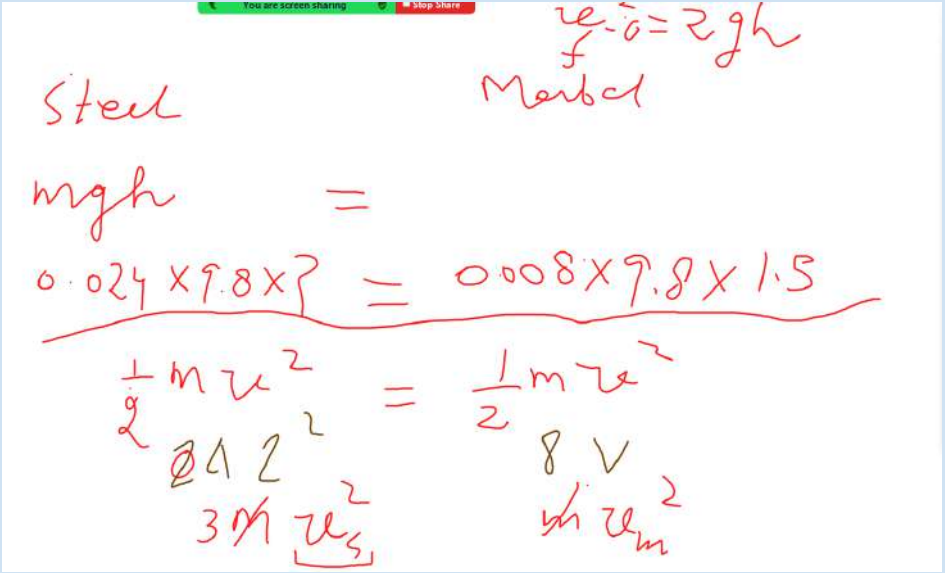


https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-3-2

Team 2 OALG 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 3 OALG 7.3.2 Watch the video only AFTER you made the prediction



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

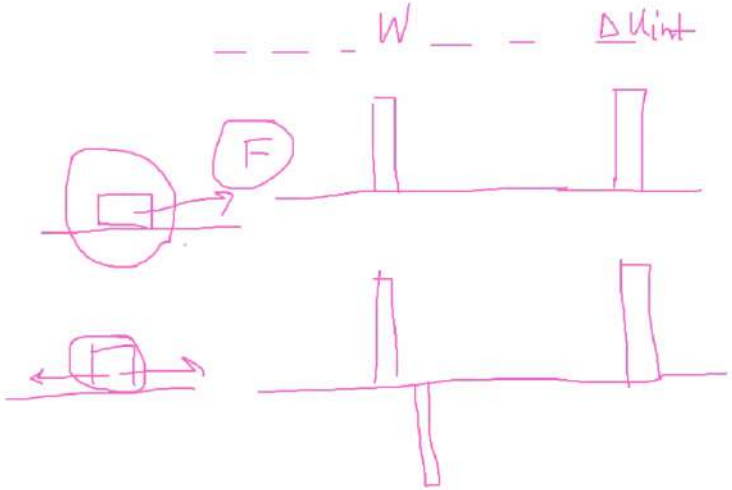
Team 4 OALG 7.3.2 Watch the video only AFTER you made the prediction

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

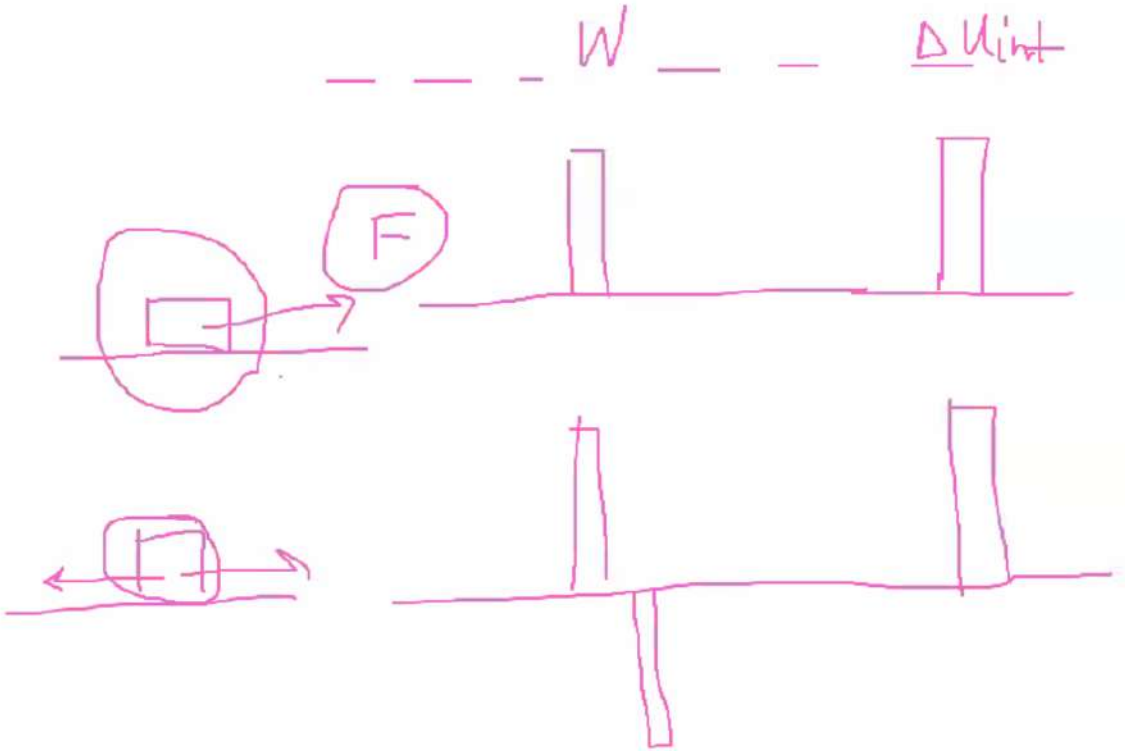
What to do with friction in the energy approach

Watch the video and draw a bar chart. Think of what you will include in the system

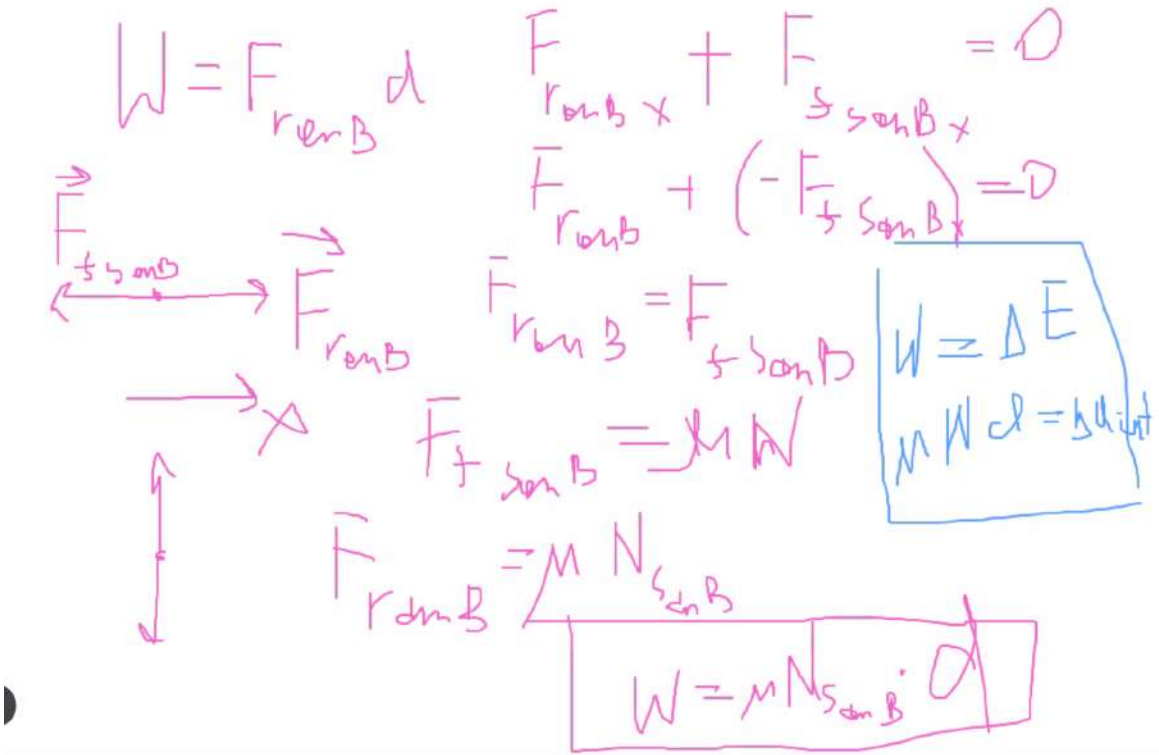
https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-1-5



Screenshot of the whiteboard

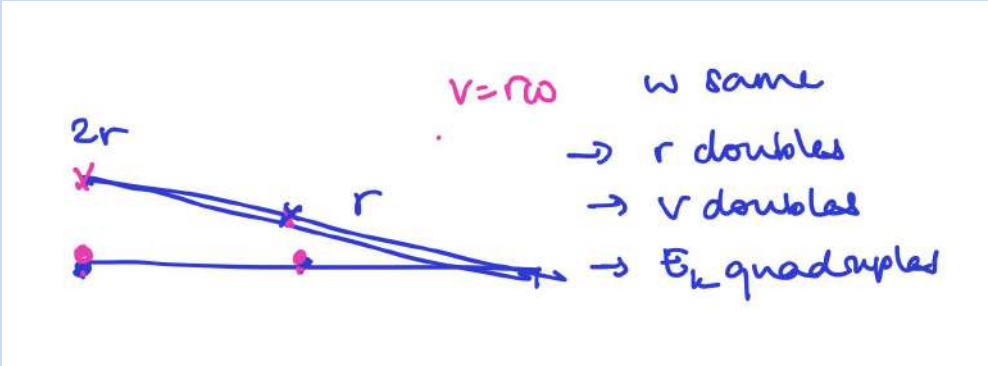


Quantitative aspect OALG 7.5.2 Read and discuss



Team 1 OALG 7.5.3

The ruler has the same angular velocity, but the linear velocity at 12 and 24 cm, will be different (doubled). When you double the linear velocity, the ruler had quadruple the kinetic energy at the 24cm point on the ruler. That quadrupled energy is transferred to the 2nd coin (the further coin), which then moves 4 times as far on the surface.



Team 2 OALG 7.5.3

Team 3 OALG 7.5.3

Team 4 OALG 7.5.3

What did you learn today?

I appreciate the discussion on sum of the forces and distinguishing between the operation of summing, and then thinking about and assigning direction (signs) to forces. Many of my students have difficulty with net force, and summing forces. I think if I introduce it this way, and separating the sets “add the forces” then “assign direction to the forces” more students will develop a better understanding of net force.

Absolutely Amazing workshop!

I understand better what the point of bringing up the the block dilemma

Internal forces convert energy and external forces add energy

Change in internal energy = friction force over displacement which the block moves

Friction is a key component in the understanding of Physics, because most of the world we live on has friction and interactions. In fact, it is quite the opposite for studying kinematics where friction is considered 0 or negligible. Also, explain the algebra as a component a bit different than what is to add and subtract in a Sum of Forces equation. It is important to review the problems as students work out to understand the relationship of the concepts.

Force diagrams ever for starting

How the concept of internal energy and divided it to chemical, sound, and thermal energy is important