ISLE, energy, reading, and assessment

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August 2024

All materials for the workshop are at

[August 2024 Intro, energy, reading, and assessment]

2 files that we will use today:

[OALG Chapter 7 Final.docx]

[ALG Chapter 7.docx]

What is the difference between the ALG and the OALG? When to use each?

ALG vs OALG

What is the difference?

ALG is designed for classroom group work. Students do the experiments in groups and share their findings with the rest of the class. The language for group work is embedded in the activities.

OALG was designed for online individual learning during the pandemic with class discussions AFTER students have worked on the activities. The students perform some simple experiments at home but complicated experiments are videoed and students need to analyze them. Also, the sections have advice for practice problems and reading assignments. Finally, some activities are different.

We will use both in the workshop.

Part I Intro to ISLE

First day for your students

Have you ever seen what happens to wet clothes left to dry on a cold (below 0C) winter day?

The purpose of the question that is not answered?

It i called “The NEED TO KNOW” - the question that will be answered at some point in the unit by the students.

The NEED TO KNOW can be for a big unit or for one lesson or even for one activity.

OALG 12.1.1 Observe and explain

Equipment: 90% isopropyl alcohol, strips of paper.

Dip a piece of paper in rubbing alcohol (or rub the paper with alcohol) and place it on a table. Observe what happens. Describe your observations in simple words. Note that you should observe the paper with rubbing alcohol for several minutes. Alternatively, you may view the experiment by watching the following video.

[https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-12-1-1]

Describe what **you** observed in simple words that a 5 year old can understand. Put your ideas on the slide.

Patterns that we **all** found

How can we explain the **“GRADUAL”** aspect of disappearance?

What are possible mechanisms that can explain **HOW** little parts disappeared?

Propose testing experiments to test those explanations

Testing experiments and predictions based on each explanation

Experiment	Prediction based on Explanation 1	Prediction based on Explanation 2	Prediction based on Explanation 3	Prediction based on Explanation 4

Testing experiments and their outcomes

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https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-12-1-3b

https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-phys-egv2e-alg-12-1-3c

What can we say about the mechanisms responsible for the disappearance of the alcohol parts?

Imagine that somebody sprayed air freshener in a corner of the room. What do you think would happen next?

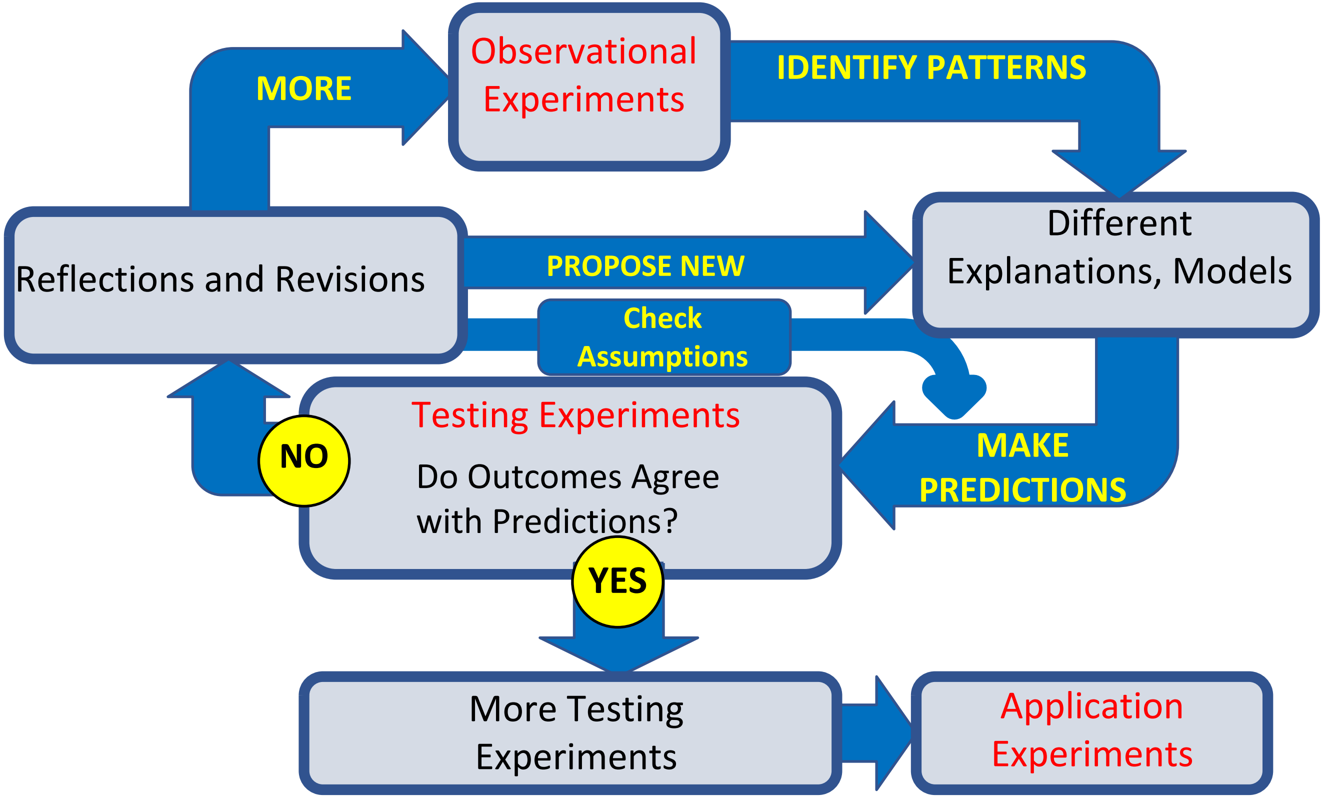
Graphical representations

Imagine that you have eyes that can see the particles of air in the room. Draw a picture representing the behavior of several particles as they move through the room. Think of their possible collisions and how the collisions will affect the directions of their motion and the magnitudes of their speeds.

What other questions can we ask about this phenomenon?

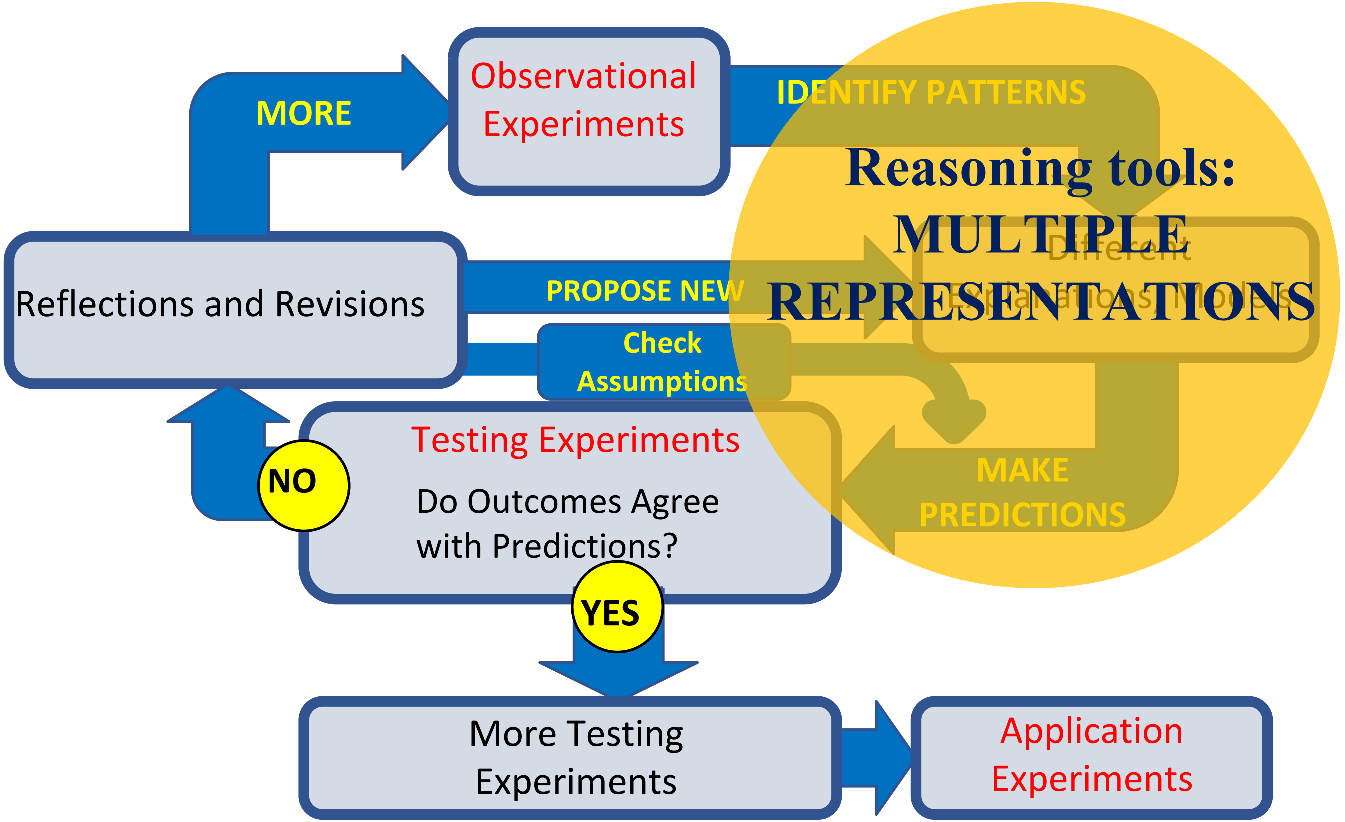
Returning to the need to know

The Investigative Science Learning Environment (ISLE) approach



Etkina and Van Heuvelen, 2001, 2007; Etkina, 2015

The Investigative Science Learning Environment (ISLE) approach



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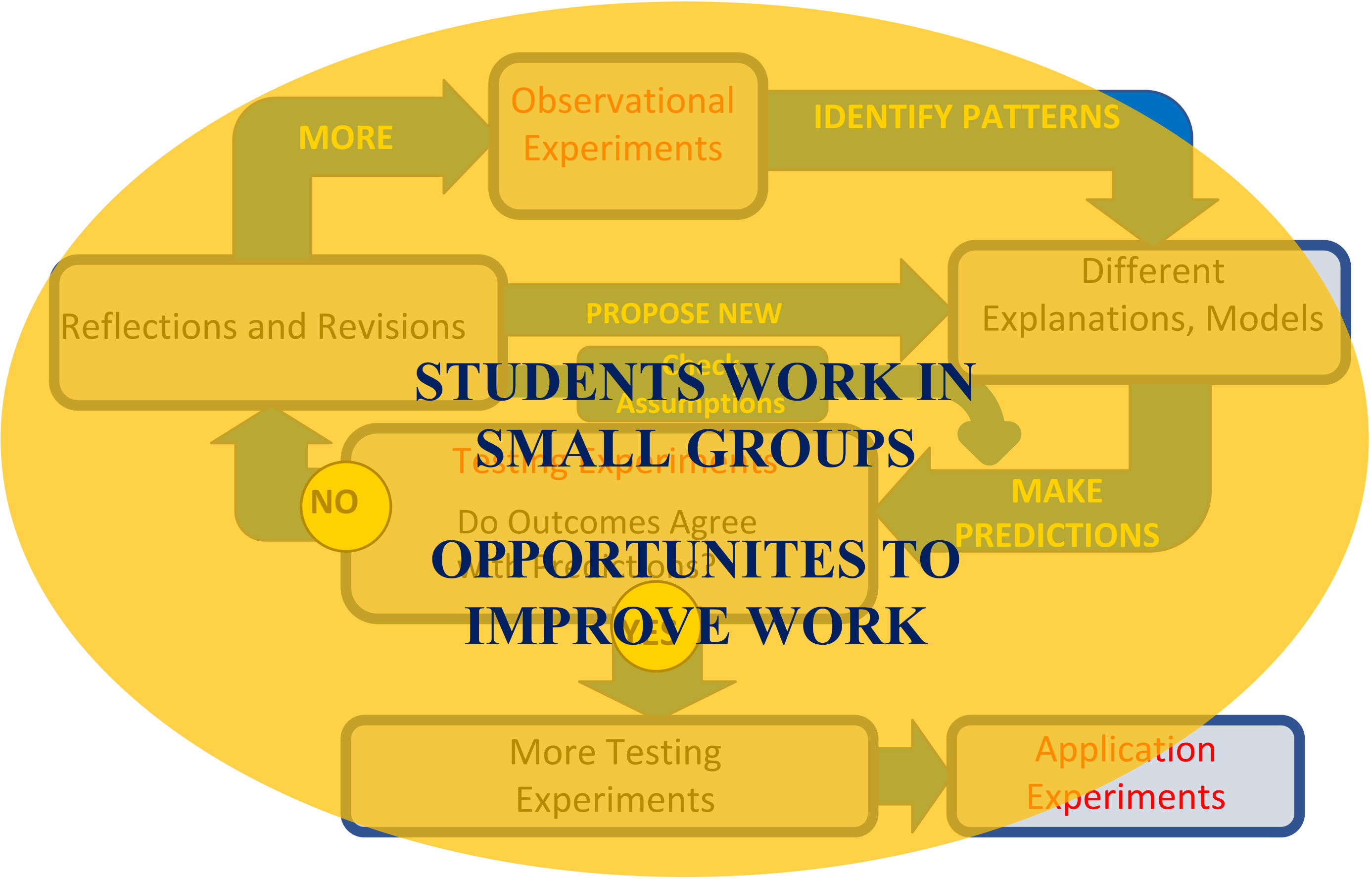

Etkina and Van Heuvelen, 2001, 2007; Etkina, 2015;
https://docs.google.com/document/d/1EGJAPCHBIJGLLt7NS0B0WkimPbbFyf5225vFss1567s/edit?usp=sharing

Let’s go back to your homework

Article in Physics Today - what did you learn? Why was it assigned?

Chapters 1,2,3 in the textbook - what did you learn? Why was it assigned?

Part II: Energy and Work

All together, use whiteboard to draw the bar charts

Imagine that you have 10 plums in a bowl. You give 3 to your friend Marta and 2 to your friend Beth. What happened to the number of the plums when considering just the plums in the bowl as the system? Then, repeat the same analysis for the system that contains the bowl, Marta, and Beth. Can you say that the number of plums in the system is constant in both cases? Can the plums disappear?

Tepresent the process with a bar chart for two systems:

(1) plums in your bowl only and
(2) plums in the bowl and in Marta’s and Beth’s hands.

Choose initial state before you see Marta and Beth and the final after they both got their plums..

Conserved vs constant

A quantity is **constant** if it is the same for different clock readings: constant velocity, constant acceleration, constant number of apples in the second system in our previous activity.

What does it mean when we say “the quantity is **conserved**”? What are examples of conserved quantities?

Does it mean that a conserved quantity is always constant?

Materials for today’s meeting

What did you observe?

The difference between going up and down stairs?

What toys did you find?

Do you see any similarity in the operation of the toys in the video?
https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-1-8

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.

Team 1 OALG 7.1.1 d

Team 2 OALG 7.1.1 d

All together OALG 7.1.2 experiments 1 and 2

[Experiment Video 14]

All together 7.1.3 experiment 3

Experiment Video 14

Team 1 ALG 7.1.4 ALG Chapter 7.docx

Team 2 ALG 7.1.4 [ALG Chapter 7.docx]

All together OALG 7.1.5 [OALG Chapter 7 Final.docx]

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

All together ALG 7.1.6

Team 1 ALG 7.1.7

Team 2 ALG 7.1.7

All together ALG/OALG 7.1.8

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Team 1 OALG 7.2.1

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

Team 2 OALG 7.2.1

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

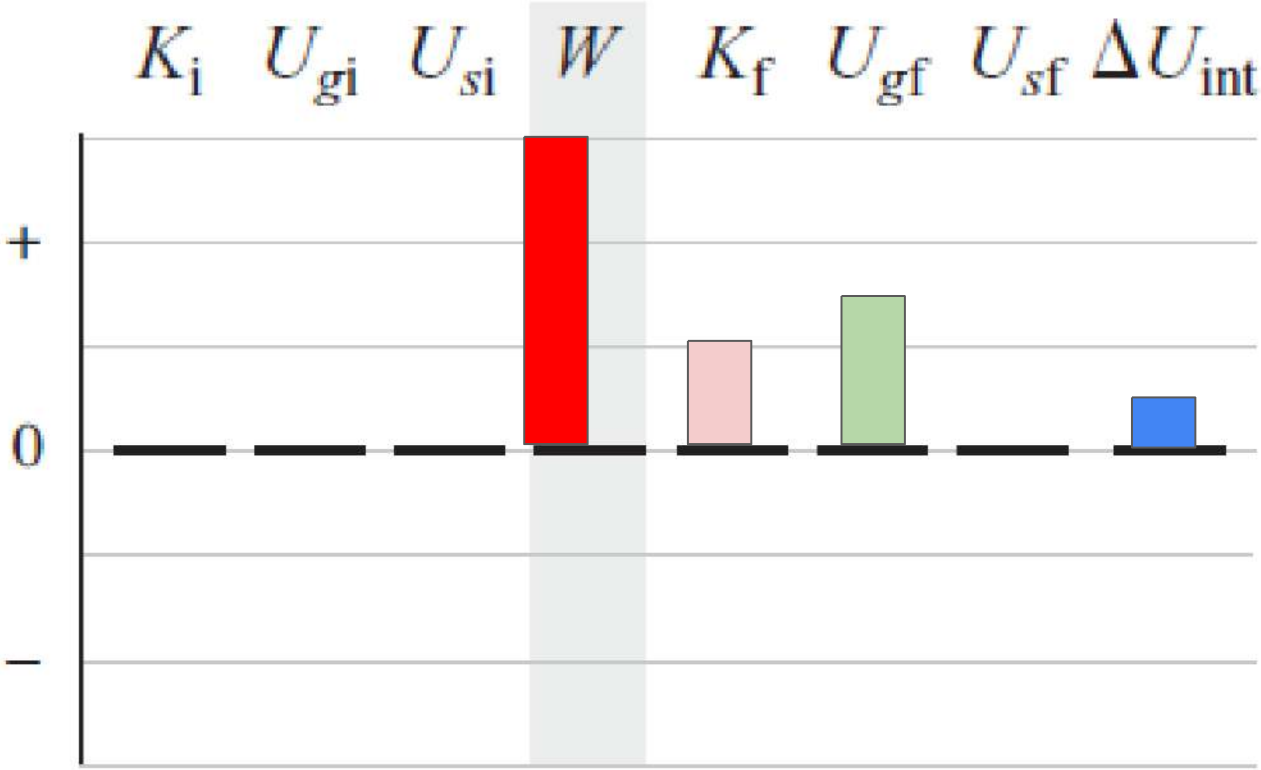
Can we think of total energy as a conserved quantity?

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

When is the total energy of a system constant?

When is the total energy conserved?

All together ALG 7.2.2



Team 1 Modified ALG 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.

System 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 ALG 7.2.3

Team 2 Modified ALG 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.

Team 2 Modified ALG 7.2.3

All together ALG 7.2.4

All together: 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

Back to the stairs experiment.

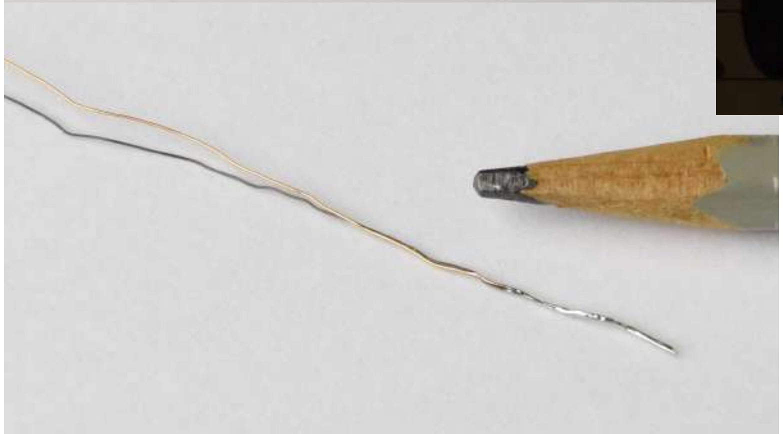
Do stairs do work on you when you go up? Down?

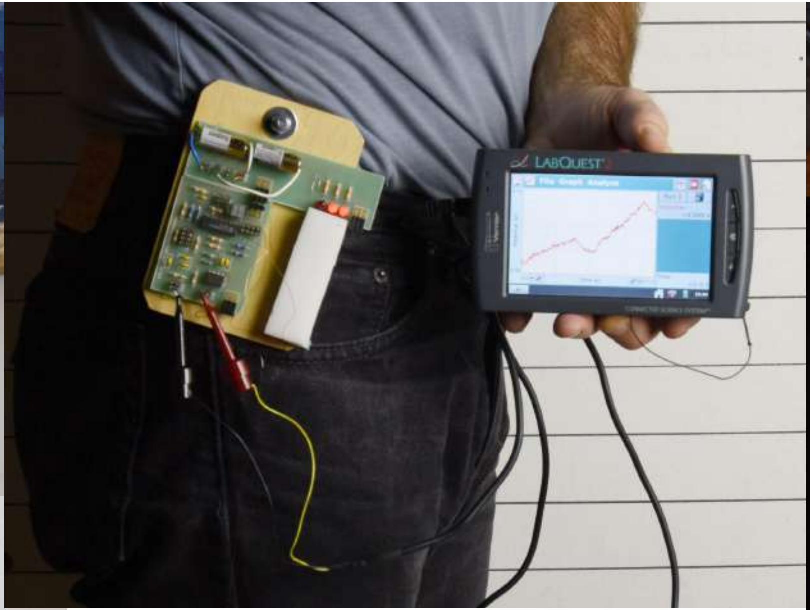
How do we draw a bar chart representing the process? What should be in the system?

Up:

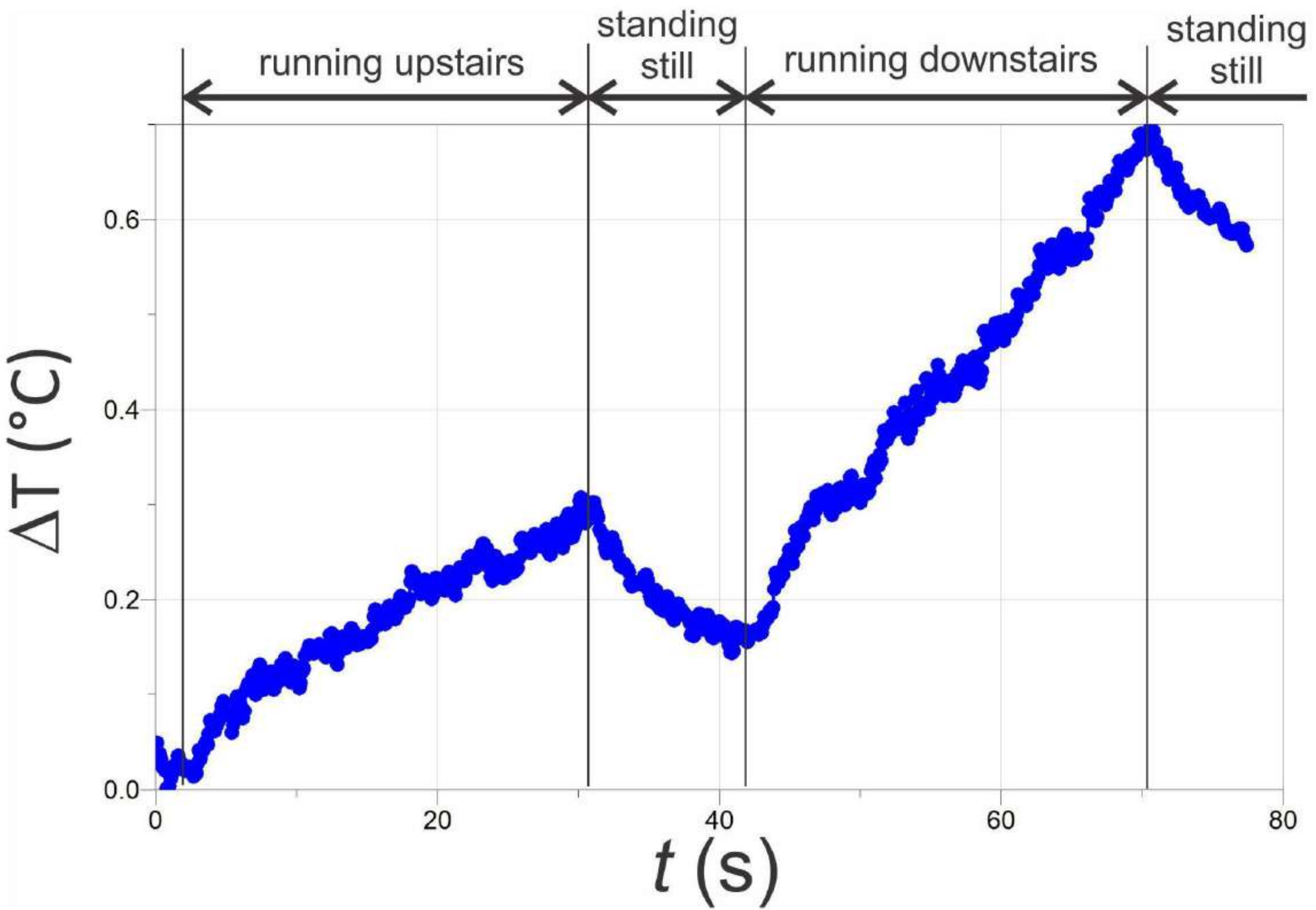
down:

Testing Experiment (Gorazd Planinsic)





Thermocouple in the shoe, LabQuest and amplifier with batteries



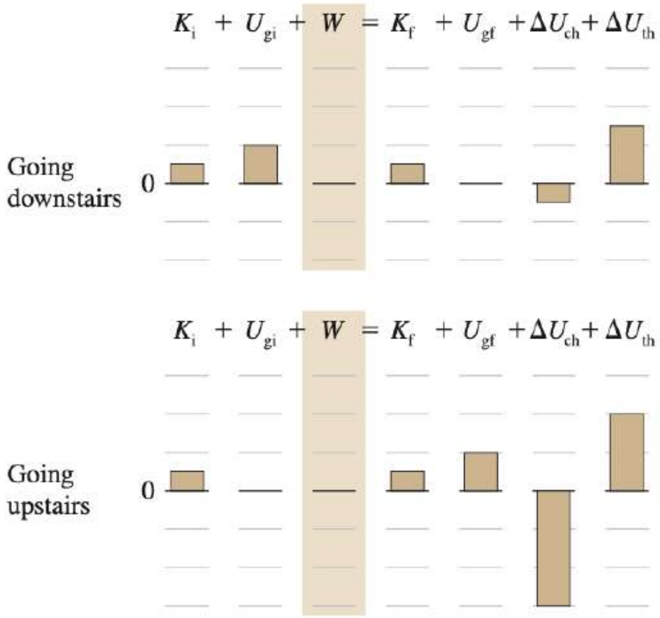
running upstairs
standing still
running downstairs
standing still
ΔT (°C)
0.0
0.2
0.4
0.6
0
20
40
60
80
t (s)

Team 1 Use bar charts to represent the process of us going upstairs at constant speed. Earth, the stairs, and the person are in the system.

Team 2 Use bar charts to represent the process of us going upstairs at constant speed. Earth, the stairs, and the person are in the system.

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



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

All together ALG 7.3.1

Team 1 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 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

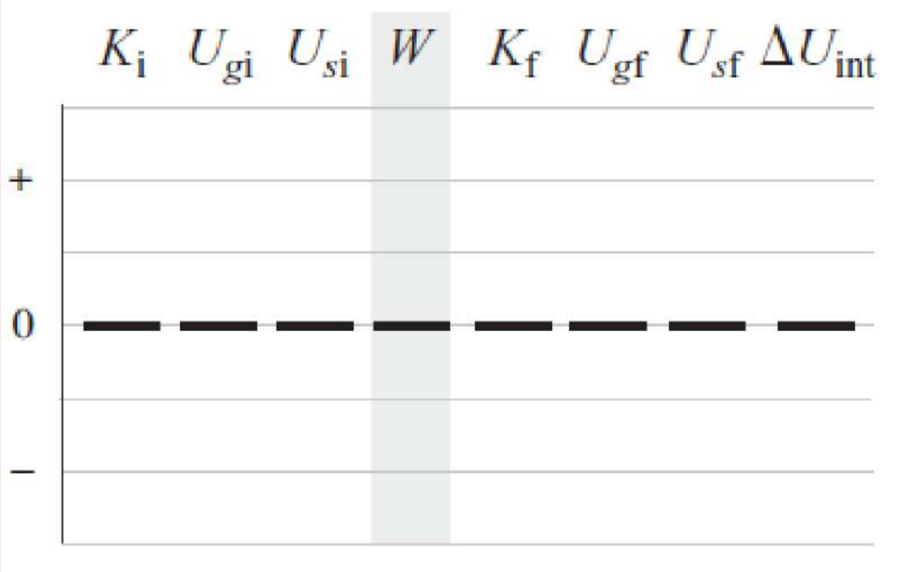
All together on the whiteboard

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.

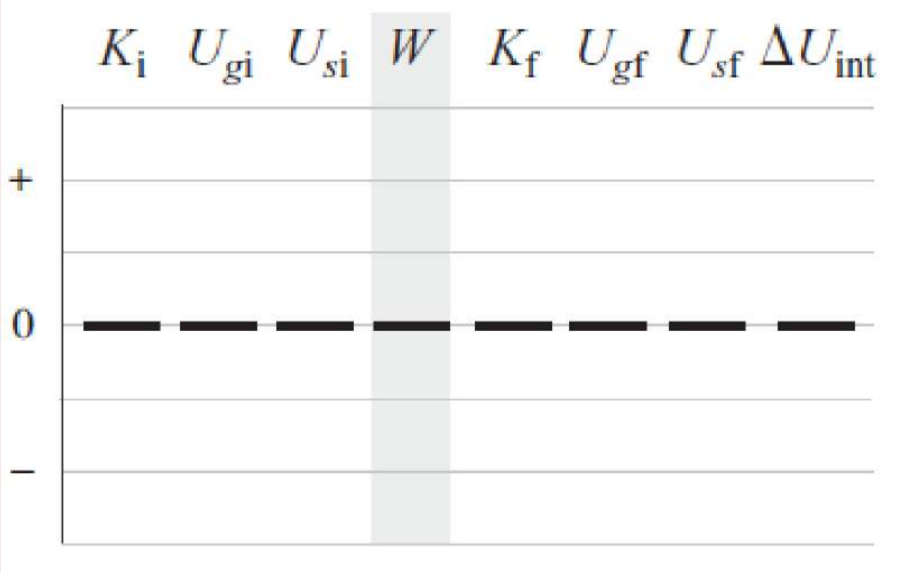
https://mediaplayer.pearsoncmg.com/assets/_frames.true/sci-OALG-7-1-5

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

Team 1 OALG 7.5.2



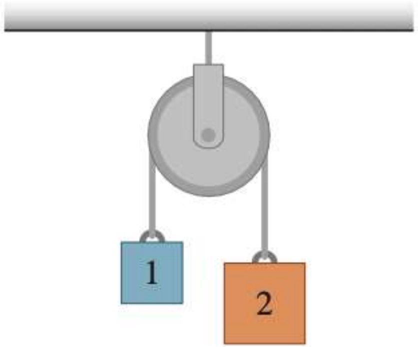
Team 2 OALG 7.5.2



Team 1 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
   (a) increases.
   (b) decreases.
   (c) stays constant.
   (d) It's impossible to say without including block 2 in the system.

FIGURE Q7.3



11.

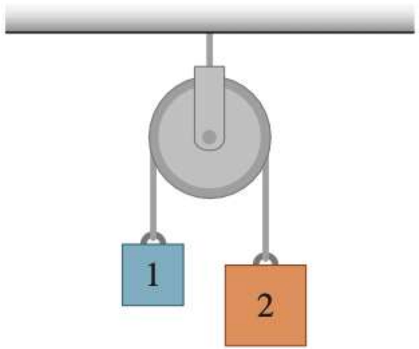
4. Below you see several statements analyzing the process described in the previous question. Match the energy analysis with the system choice for which the analysis is correct.
   I. The total energy of the system decreases.
   II. The total energy of the system increases.
   III. The total energy of 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 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
   (a) increases.
   (b) decreases.
   (c) stays constant.
   (d) It's impossible to say without including block 2 in the system.

FIGURE Q7.3



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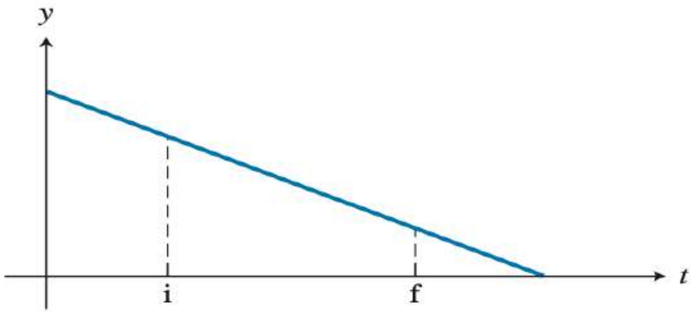
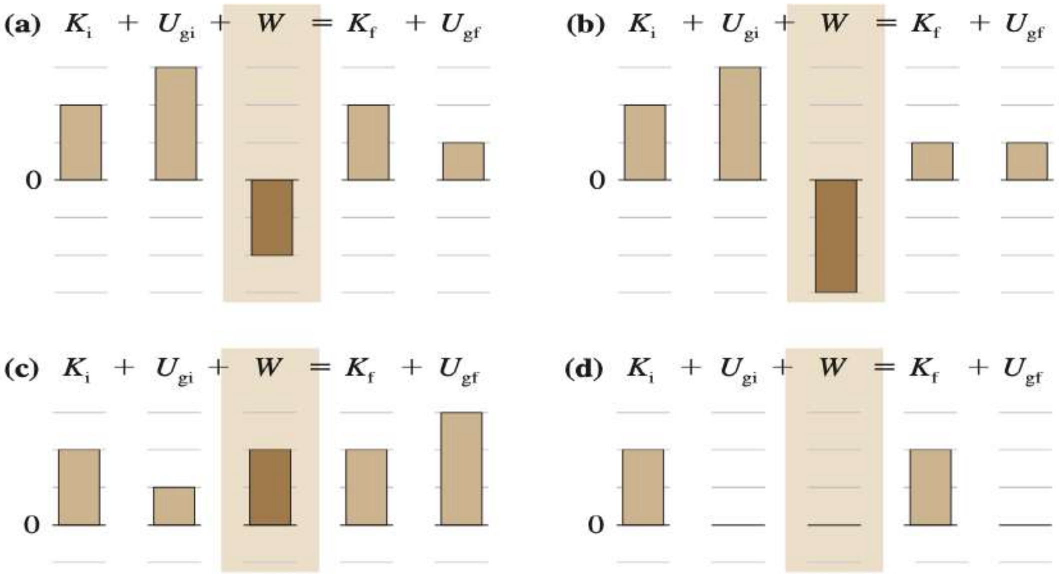
11.

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

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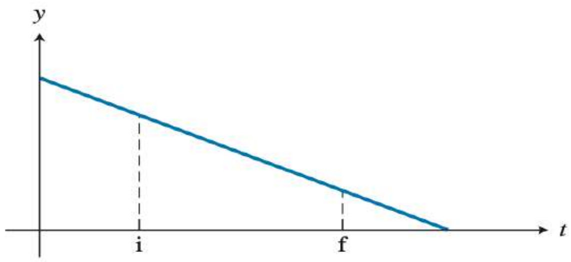
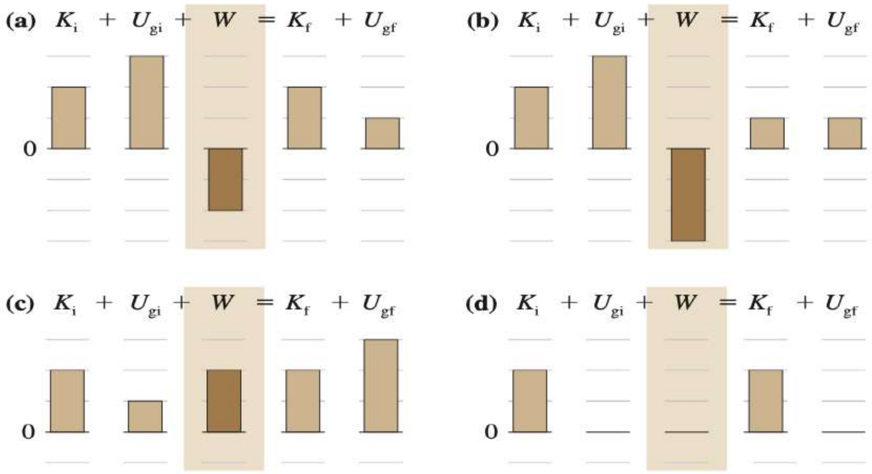
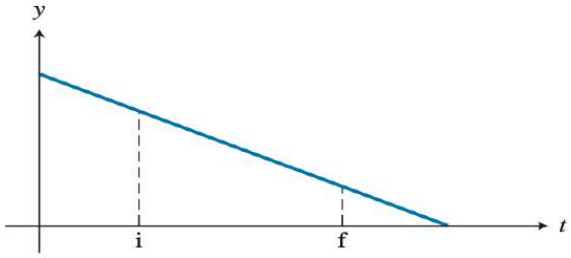


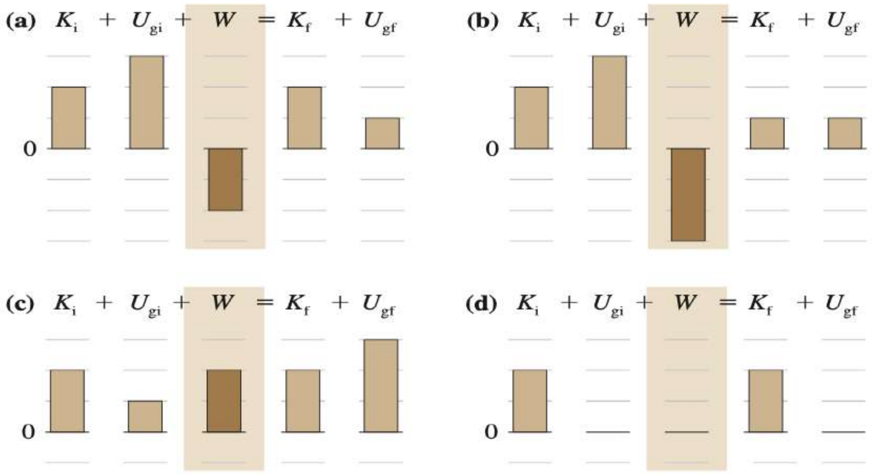


Team 2 Question 11

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





An example of a 2-3 hour lab ALG 7.6.6 and 7.7.3 - after students learned about elastic and inelastic collisions.

Elaborative interrogation - learning to read scientific text Page 184

The generalized work-energy principle

We found experimentally that the energy of an isolated system is constant. We also defined work as a mechanism for energy transfer. Therefore, we can summarize what we have learned about work and energy with the **generalized work-energy principle**.

Generalized work-energy principle The sum of the initial energies of a system plus the work done on the system by external forces equals the sum of the final energies of the system:

$$E_i + W = E_f \tag{7.3}$$

or

$$(K_i + U_{gi} + U_{si}) + W = (K_f + U_{gf} + U_{sf} + \Delta U_{int}) \tag{7.3}$$

Note that we have moved $U_{int\,i}$ to the right hand side ($\Delta U_{int} = U_{int\,f} - U_{int\,i}$) since values of internal energy are rarely known, while internal energy changes are. We will also call Eq. (7.3) the *work-energy equation*.

The generalized work-energy principle allows us to define the total energy of a system as the sum of the different types of energy in the system. Total energy is measured in the same units as work and changes when work is done on the system. In Eq. (7.3), kinetic energy and gravitational and elastic potential energy are forms of **mechanical energy**. Mechanical energy is associated with motion and interactions of macroscopic objects—objects that we can see with our eyes. Internal energy is associated with motion and interactions of microscopic objects—objects that we cannot see with our eyes. Unlike such physical quantities as position or force, energy is not directly observed, and there are no instruments that measure energy. We can only infer the amount of any type of energy if we can express it through measurable quantities.

The work in Eq. (7.3) can be positive or negative. Unlike velocity and acceleration, for which plus and minus signs signify direction, in the case of work the sign signifies another operation—addition or subtraction.

Formative and summative assessment in ISLE

What are the most important things that you learned in the workshop