Physics Education Laboratory
Lecture 08 - p2
PCK for Dynamics / Energy

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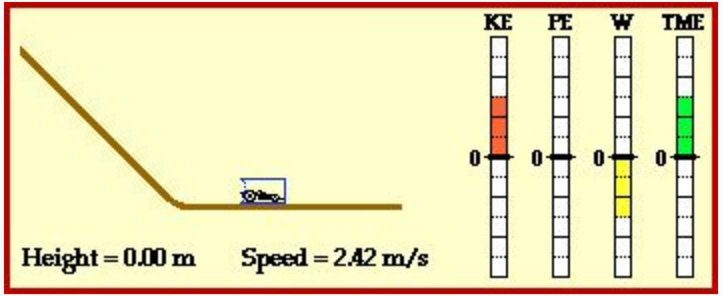
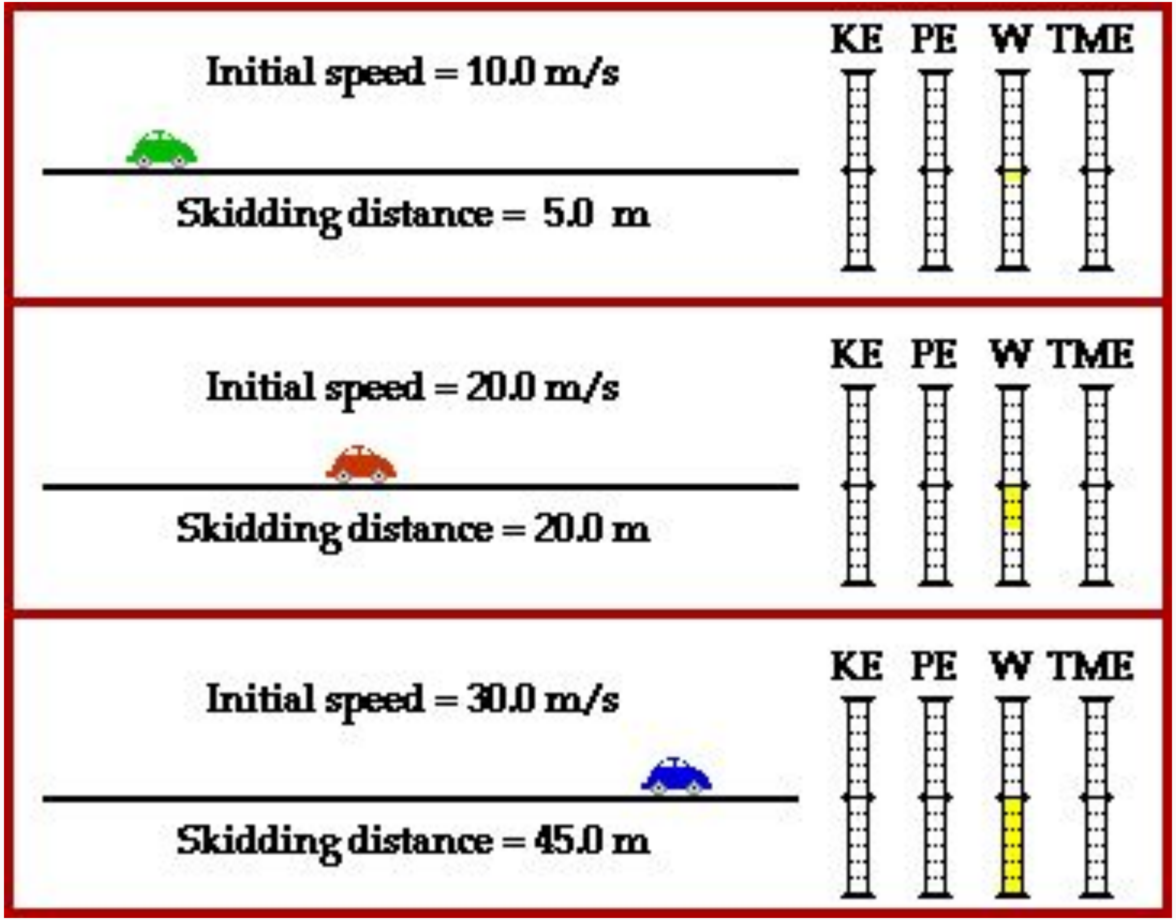
Qualitative work – energy bar charts that serve the same role for analyzing work – energy processes as motion diagrams and force diagrams serve when analyzing kinematics and dynamics problems.

The use of these bar charts helps students think more about the physics of a work – energy process rather than relying on formula-centered techniques that lack qualitative understanding.



View animation: https://www.physicsclassroom.com/mmedia/energy/hw.cfm



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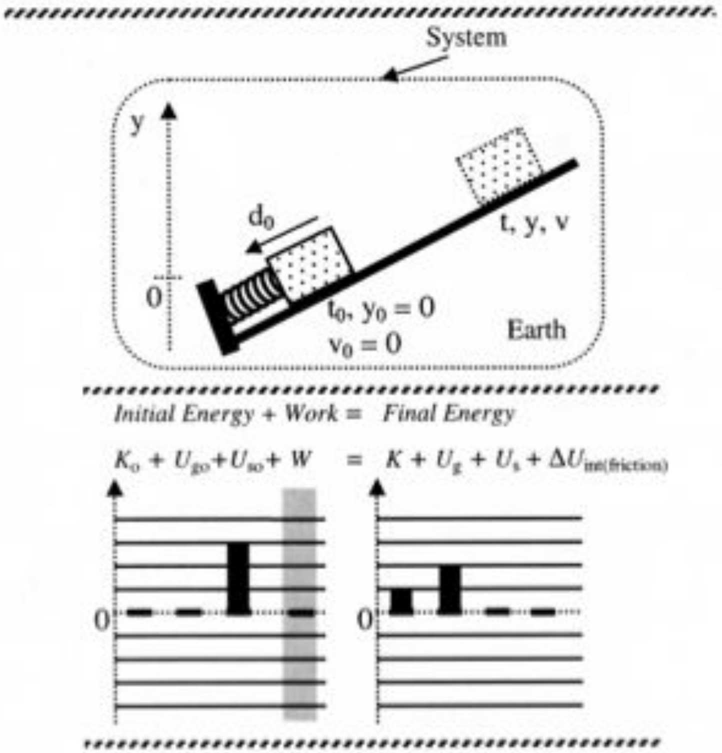
Conceptual ideas and skills about work-energy process that students have to know/possess

- Choosing a system—the object or objects of interest for the process being considered;
- Characterizing the initial state and the final state of the process;
- Identifying the types of energy that change as the system moves from its initial state to its final state and the signs of the initial and final energies of each type;
- Deciding if work is done on the system by one or more objects outside the system as the system changes states;
- Developing the idea that the initial energy of the system plus the work done on the system leads to the final energy of the system—the energy of the universe remains constant;
- Constructing an energy bar chart—a qualitative representation of the work – energy process;
- Converting the bar chart to a mathematical representation that leads to a problem solution.

The work–energy problem is originally described in the detailed sketch. Students are asked to convert the sketch into a qualitative bar chart —a bar is placed in the chart for each type of energy that is not zero, and the sum of the bars on the left is the same as that of the bars on the right.

Then the generalized mathematical work–energy equation without any numbers is set up with one energy expression for each bar on the chart.

Notice that the work part in the bar chart is shaded so as to distinguish conceptually between work and energy, that is, work is a process quantity, but energy is a state quantity.



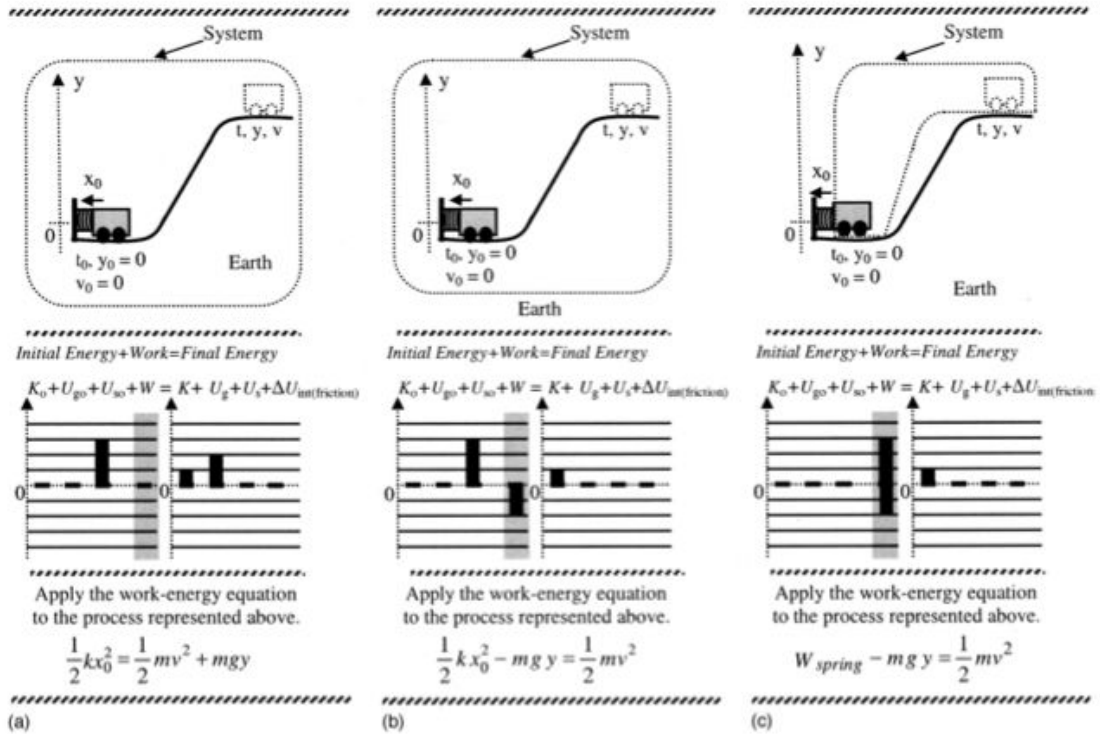
Apply the work-energy equation to the process represented above.

$$\frac{1}{2}kd_0^2 = \frac{1}{2}mv^2 + mgy$$

The different systems are chosen for the same physical process.

(a) The cart, the spring, and Earth are in the system.
(b) The cart and the spring are in the system, but not Earth.
(c) The system includes only the cart.
For each chosen system there is one work–energy bar chart and the corresponding generalized work–energy equation.

In practice, it would be easy for students to use a system that includes Earth and the spring, although the choice of the system does not affect the physical results.

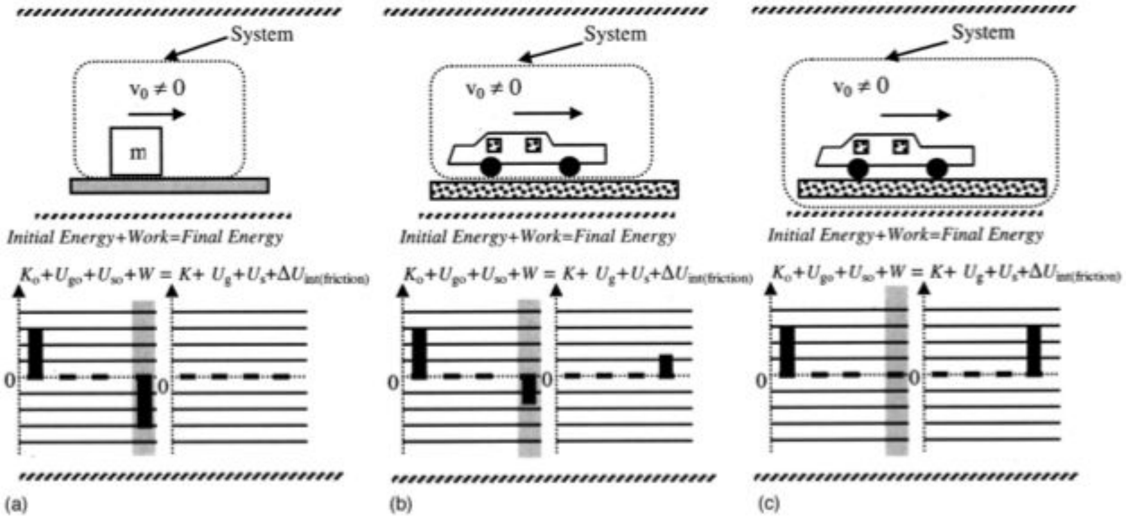


The physical processes involve friction.

(a) A point-particle block slides to a stop on a floor with friction. The system includes only the point-particle block. So the floor exerts an external frictional force on the point-particle block, and this frictional force does a negative amount of work, which has the same magnitude as the block's initial kinetic energy.

(b) A real car skids to a stop on a rough road. The car is the only object in the system. Thus the road that touches the car causes an external frictional force and a difficult work calculation

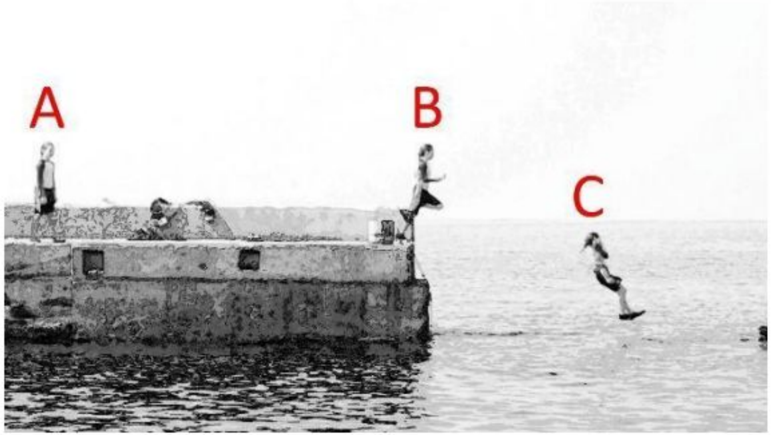
(c) And now? ..



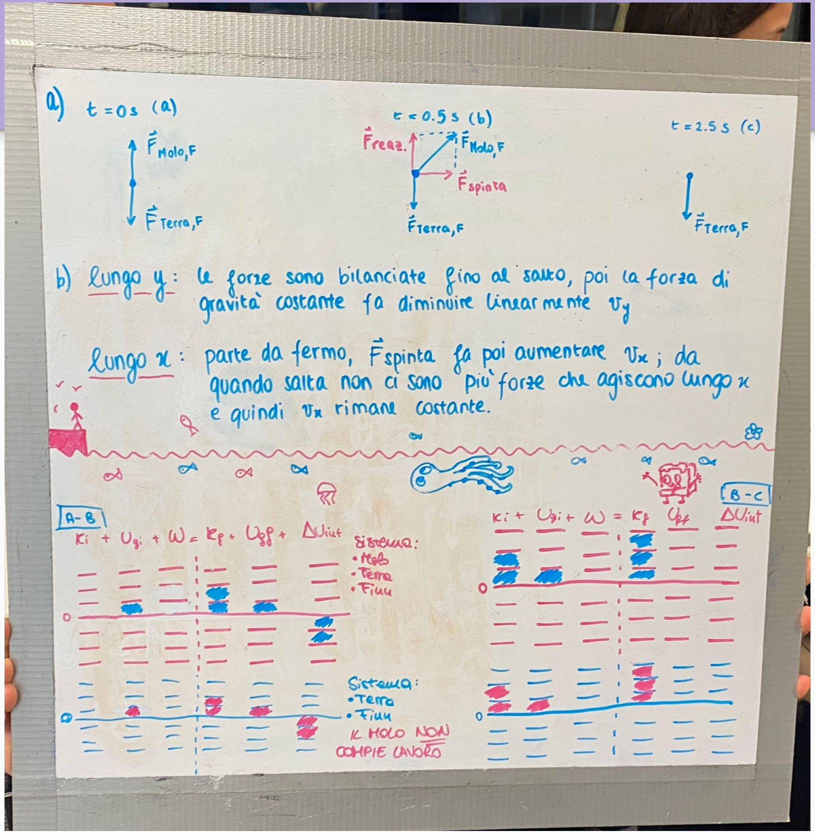
Laboratory – 01

ENERGY AND MOMENTUM

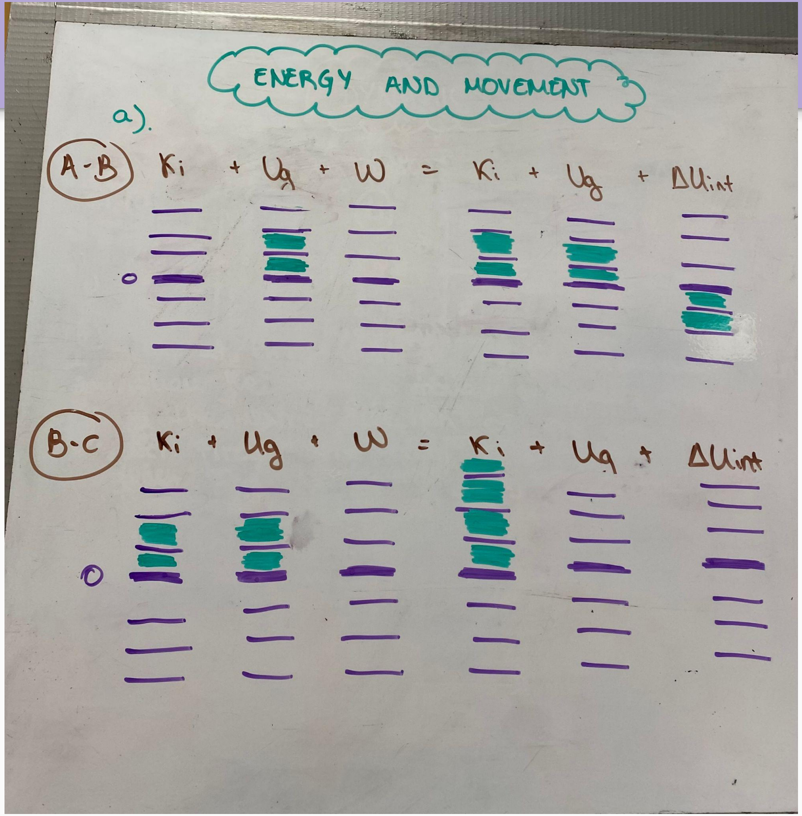
Let the system consist of Finn, pier, and Earth and let's choose the three states A, B and C as shown in the figure below.

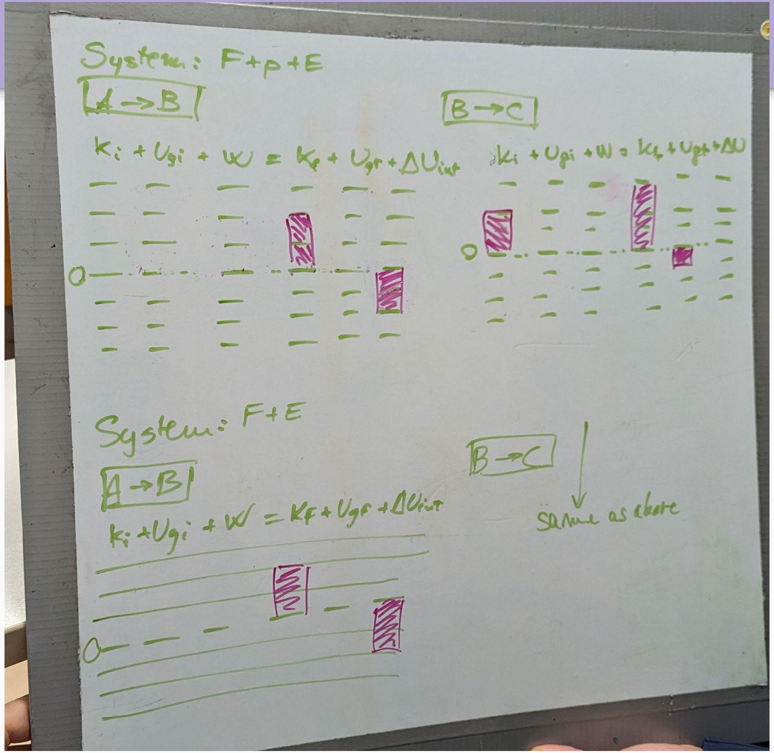


Laboratory – 01

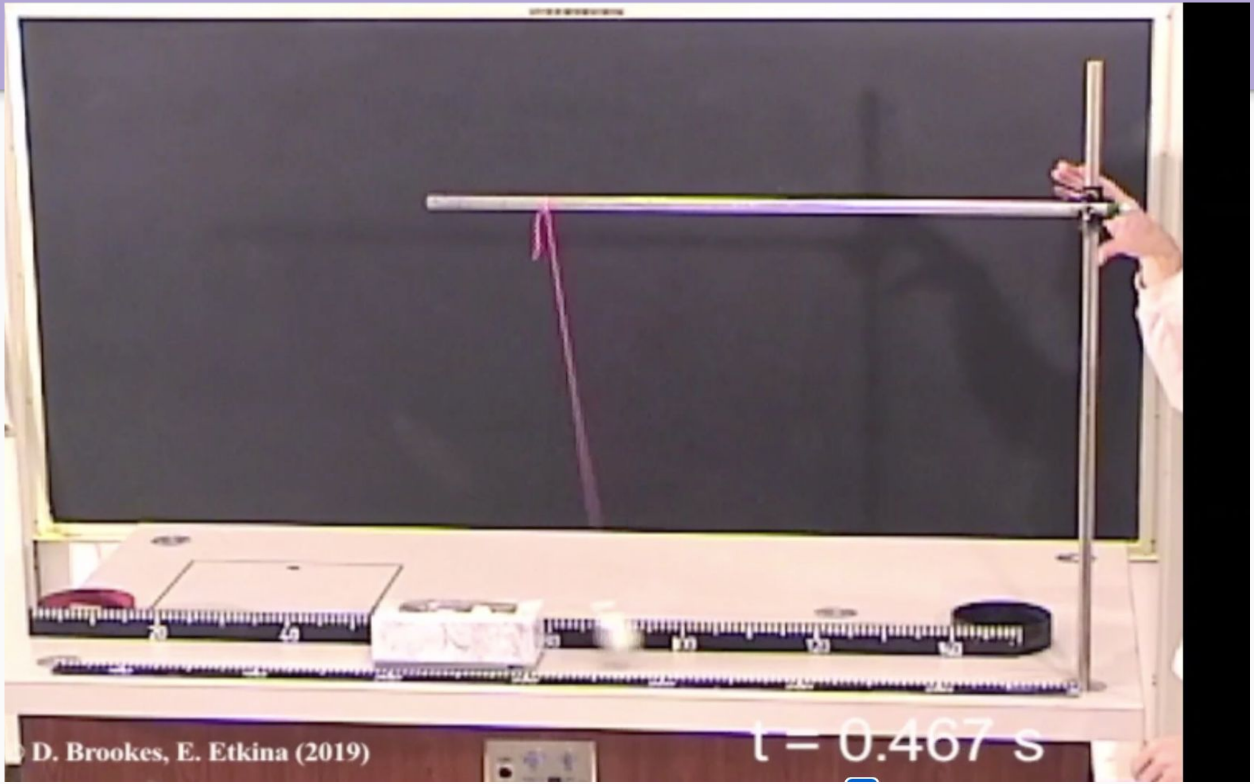


Laboratory – 01





Laboratory – 02



Laboratory – 02