Designing Interactive Problem-Solving Tutorials

Leon Hsu, Ken Heller, Aaron Hasnudeen
University of Minnesota

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Outline

- Status of tutorials
- Helping students to use multiple representations

Personal Assistant for Learning

Goal:

To provide students in introductory physics with a readily accessible coach to help them practice making the decisions necessary for solving problems competently.

Computer coaching functions:

- Available at students' convenience
- Ensure that students engage in productive practice
- Help students make appropriate decisions
- Provide students with varying amount of individualized guidance and feedback

Present status

- One tutorial roughly 70% complete
- Tested partial tutorial with 7 students from an introductory physics class.
  - Interface usability
  - Amount of guidance
  - Length

Multiple representations

The ability to construct and interpret multiple representations of a problem situation is critical to problem-solving.

- Experts use a variety of representations (diagrams, graphs, equations) while solving problems.

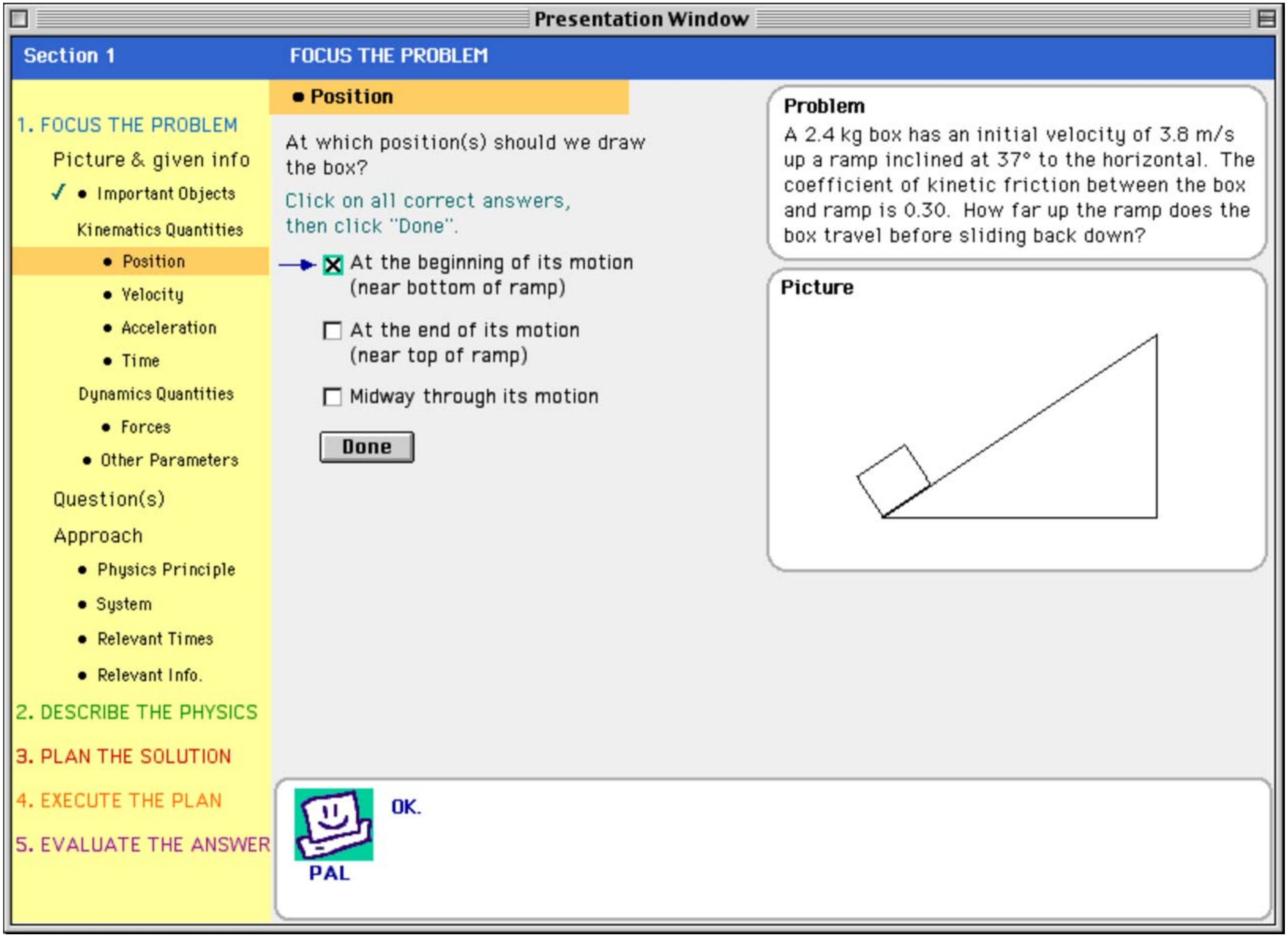
- All instruction aimed at helping students to improve their problem-solving abilities encourages students to use multiple representations in solving the problem.
  (e.g., Overview Case Study Physics)

Helping students to use MRs

- Students must construct a picture of the situation.

<u>Decisions:</u>

– What objects should be included?
– At what times/positions should the objects be drawn?
– What other information should included in the picture?


Presentation Window
Section 1
FOCUS THE PROBLEM
• Position
1. FOCUS THE PROBLEM
Picture & given info
✓ • Important Objects
Kinematics Quantities
• Position
• Velocity
• Acceleration
• Time
Dynamics Quantities
• Forces
• Other Parameters
Question(s)
Approach
• Physics Principle
• System
• Relevant Times
• Relevant Info.
2. DESCRIBE THE PHYSICS
3. PLAN THE SOLUTION
4. EXECUTE THE PLAN
5. EVALUATE THE ANSWER
At which position(s) should we draw the box?
Click on all correct answers, then click "Done".
At the beginning of its motion (near bottom of ramp)
At the end of its motion (near top of ramp)
Midway through its motion
Done
Problem
A 2.4 kg box has an initial velocity of 3.8 m/s up a ramp inclined at 37° to the horizontal. The coefficient of kinetic friction between the box and ramp is 0.30. How far up the ramp does the box travel before sliding back down?
Picture
OK.
PAL

Presentation Window

Section 1 FOCUS THE PROBLEM

1. FOCUS THE PROBLEM
   - Picture & given info
     - ✓ • Important Objects
     - Kinematics Quantities
       - ✓ • Position
       - ✓ • Velocity
       - 1 • Acceleration
       - ✓ • Time
     - Dynamics Quantities
       - ✓ • Forces
     - • Other Parameters
   - Question(s)
   - Approach
     - • Physics Principle
     - • System
     - • Relevant Times
     - • Relevant Info.
2. DESCRIBE THE PHYSICS
3. PLAN THE SOLUTION
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5. EVALUATE THE ANSWER

• Other Parameters

What is the angle between the ramp and the horizontal?

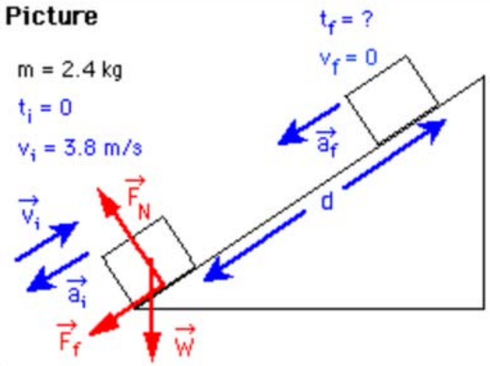
Answer: [ ] degrees

Enter the number from the keyboard, then press "Return".

Problem

A 2.4 kg box has an initial velocity of 3.8 m/s up a ramp inclined at 37° to the horizontal. The coefficient of kinetic friction between the box and ramp is 0.30. How far up the ramp does the box travel before sliding back down?

Picture



PAL

Helping students to use MRs

- Students must construct a picture of the situation.

- Students must construct a physics diagram of the situation.

Decisions:

– What should be included in the diagram?

Presentation Window

Section 2 — **DESCRIBE THE PHYSICS**

1. FOCUS THE PROBLEM
2. DESCRIBE THE PHYSICS
   - Diagrams & Define Quantity(ies)
   - Target Quantity(ies)
   - Quant. Relationships
3. PLAN THE SOLUTION
4. EXECUTE THE PLAN
5. EVALUATE THE ANSWER

• Diagrams & Define Quantity(ies)

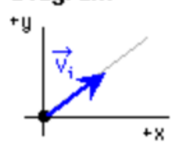
A diagram should include all the necessary quantities for applying the approach you specified.

In the picture at right, click on a quantity to be added to the **final state** diagram below.

Click "Diagram Complete" when finished.

Diagram Complete

Diagram

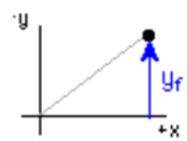


initial state

$KE = \frac{1}{2}mv_i^2$

$m = 2.4$ kg

$v_i = 3.8$ m/s

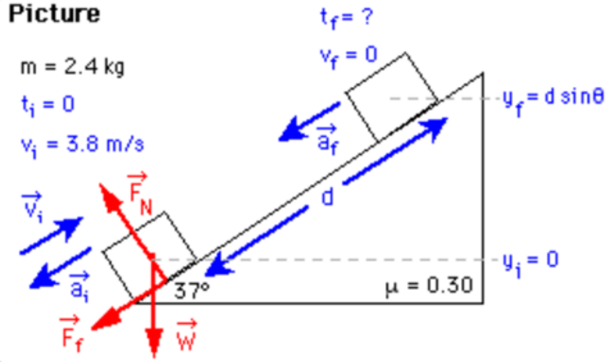


final state

$PE_g = mgy_f$

$y_f = d \sin\theta$

Picture



Question

How far up the ramp does the box travel?

Approach

Use conservation of energy.

System: box and Earth

Times: t_i – box at bottom of ramp

t_f – box at highest point

Energies: $E_i = KE$

$E_f = PE_g$

E_{in} : none

E_{out} : Friction

PAL

OK.

Helping students to use MRs

- Students must construct a picture of the situation.
- Students must construct a physics diagram of the situation.
- Students construct an equation corresponding the approach they choose to solve the problem.

Decisions:

– Which equations are applicable to the specified approach?
– What is the physical meaning of the terms in the applicable equations?

Presentation Window

Section 2 **DESCRIBE THE PHYSICS**

1. FOCUS THE PROBLEM
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   - Diagrams & Define Quantity(ies)
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   - 1 Quant. Relationships
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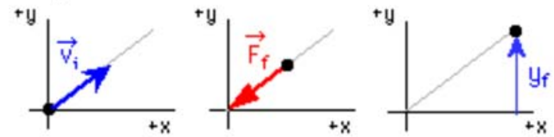
• Quantitative Relationships

Click on every quantity in the diagram at right which corresponds to E_{out}.

Click Done when all quantities have been selected.

Done

Diagram



initial state — $KE = \frac{1}{2}mv_i^2$, $m = 2.4$ kg, $v_i = 3.8$ m/s

Energy xfer — $E_{out} = F_f d$

final state — $PE_g = mgy_f$, $y_f = d \sin\theta$, $\theta = 37°$

Target Quantity: d

Quantitative Relationships
(Conservation of Energy)

$$mgd\sin\theta - \frac{1}{2}mv_i^2 = 0$$

$$E_f - E_i = E_{in} - E_{out}$$

$m = 2.4$ kg $\quad v_i = 3.8$ m/s
$\theta = 37°$

Approach
Use conservation of energy.
System: box and Earth
Times: t_i – box at bottom of ramp
t_f – box at highest point
Energies: E_i = KE
$E_f = PE_g$
E_{in}: none
E_{out}: Friction

PAL

Assessment

Examine students performance on exam questions for:

- Presence of pictures and diagrams
- Correctness of pictures, diagrams, and equations
- Consistency between pictures, diagrams, and equations