You can draw here

GET READY: Go here and make sure you see the “Are you Ready” Sli.do Q
Canvas -> Course Content -> Lecture (under Week 9 - Chapter 8)

Physics 111 - Lecture 11

November 17, 2020

Do not draw in/on this box!

You can draw here

You can draw here

Reminders/Announcements

- Test 4 marks are released
  - There may be some sig-fig related issues, TAs are working through them as we speak
  - The priority is to fix these before the bonus test is opened so we don't have to fix them again next week.

- Bonus Test 4 window will be opening later today
  - Warning: May be delayed by a couple of hours while the sig-fig issues are being fixed

Reminders/Announcements

	Homework (due Thurs 6 pm)	Test/Bonus Test (Thurs 6pm - Sat 6pm)	Learning Log (Sat 6pm)
Week 1	-	-	-
Week 2	HW01 - Intro to Mastering Physics	Test 0 **(not for marks)**	Learning Log 1
Week 3	HW02 - Chapter 2 HW03 - Chapter 3	Test 1 (on Chapters 2 & 3)	Learning Log 2
Week 4	HW04 - Chapter 4	Bonus Test 1	Learning Log 3
Week 5	HW05 - Chapter 5	Test 2 (on Chapters 4 and 5)	Learning Log 4
Week 6	N/A	N/A	N/A
Week 7	HW06 - Chapter 6	Bonus Test 2	Learning Log 5
Week 8	HW07 - Chapter 7	Test 3	Learning Log 6
Week 9	HW08 - Chapter 8	Bonus Test 3	Learning Log 7
Week 10	HW09 - Chapter 9 (deadline extended)	Test 4 (window moved to Sun Nov 15 - Tues Nov 17 due to Fall mini-break)	No Learning Log
Week 11	HW10	Bonus Test 4	Learning Log 8
Week 12	HW 11	Test 5	Learning Log 9
Week 13	HW 12	Bonus Test 5	Learning Log 10

Final Exam Information

Final Exam Info

The moment you've all been waiting for. Here is what I can tell you now.

The final exam will:

- be conducted on Canvas (most likely).
- be scheduled and a sit-down exam
- have the same rules as Tests (but no test window)
- include multiple choice questions (similar to Tests).
- include short answer questions (similar to Test & Practice Qs).
- require you to solve some problems with symbols/algebra.
- NOT include questions on deriving formulas.
- have some choice in which problems you choose

Final Exam Practice Qs

Jake Bobowski	SCI 261
~Home~	jake.bobowski@ubc.ca
PHYS 111	**Introductory Physics for the Physical Sciences I**
MWF 08:30-09:30	Room: COM 201
My Schedule	**Term 1**

UBC
Okanagan

UBC Canvas Login

MasteringPhysics Login

https://people.ok.ubc.ca/jbobowsk/phys111.html

Final Exam Practice Qs

2012 PHYS 111-002 Midterm 1
2012 PHYS 111-002 Midterm 1 Solns

2012 PHYS 111-002 Midterm 2
2012 PHYS 111-002 Midterm 2 Solns

2012 PHYS 111 Practice Final
2012 PHYS 111 Practice Final Solns

2012 PHYS 111 Final
2012 PHYS 111 Final Solns

2013 PHYS 111-001 Midterm 1
2013 PHYS 111-001 Midterm 1 Solns

2013 PHYS 111-002 Midterm 1
2013 PHYS 111-002 Midterm 1 Solns

2013 PHYS 111-001 Midterm 2
2013 PHYS 111-001 Midterm 2 Solns

2013 PHYS 111-002 Midterm 2
2013 PHYS 111-002 Midterm 2 Solns

2013 PHYS 111 Practice Final
2013 PHYS 111 Practice Final Solns

2013 PHYS 111 Final
2013 PHYS 111 Final Solns

2014 PHYS 111-001 Midterm 1
2014 PHYS 111-001 Midterm 1 Solns

2014 PHYS 111-001 Midterm 2
2014 PHYS 111-001 Midterm 2 Solns

2014 PHYS 111 Final
2014 PHYS 111 Final Solns

2015 PHYS 111 Practice Midterm 1
2015 PHYS 111 Practice Midterm 1 Solns

2015 PHYS 111-001 Midterm 1
2015 PHYS 111-001 Midterm 1 Solns

2015 PHYS 111 Practice Midterm 2
2015 PHYS 111 Practice Midterm 2 Solns

2015 PHYS 111-001 Midterm 2
2015 PHYS 111-001 Midterm 2 Solns

2015 PHYS 111 Final
2015 PHYS 111 Final Solns

2016 PHYS 111 Final
2016 PHYS 111 Final Solns

2017 PHYS 111-002 Midterm 1
2017 PHYS 111-002 Midterm 1 Solns

2017 PHYS 111-002 Midterm 2
2017 PHYS 111-002 Midterm 2 Solns

2017 PHYS 111 Final
2017 PHYS 111 Final Solns

Chapter 10
Important Concepts

Where are we now in our study of energy?

Energy is a big topic, not one that can be presented in a single chapter. Chapters 9 and 10 are primarily about mechanical energy and the mechanical transfer of energy via work. And we've touched on thermal energy because it's unavoidable in realistic mechanical systems with friction. These are related by the energy principle:

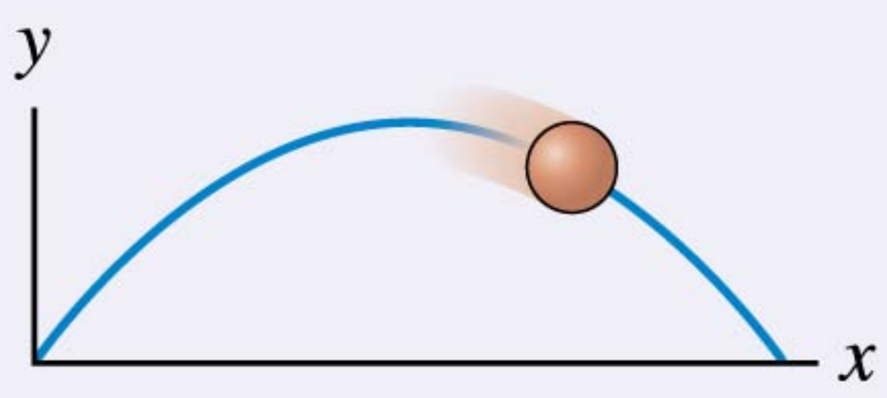
$$\Delta E_{\mathrm{sys}} = \Delta K + \Delta U + \Delta E_{\mathrm{th}} = W_{\mathrm{ext}}$$

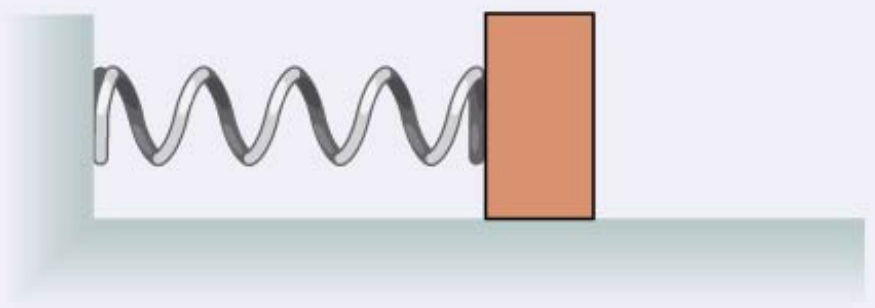
Part V of this book, Thermodynamics, will expand our energy ideas to include heat and a deeper understanding of thermal energy. Then we'll add another form of energy—electric energy—in Part VI.

What is potential energy?

Interaction energy is usually called potential energy. There are many kinds of potential energy, each associated with *position*.

- Gravitational potential energy changes with height.
- Elastic potential energy changes with stretching.

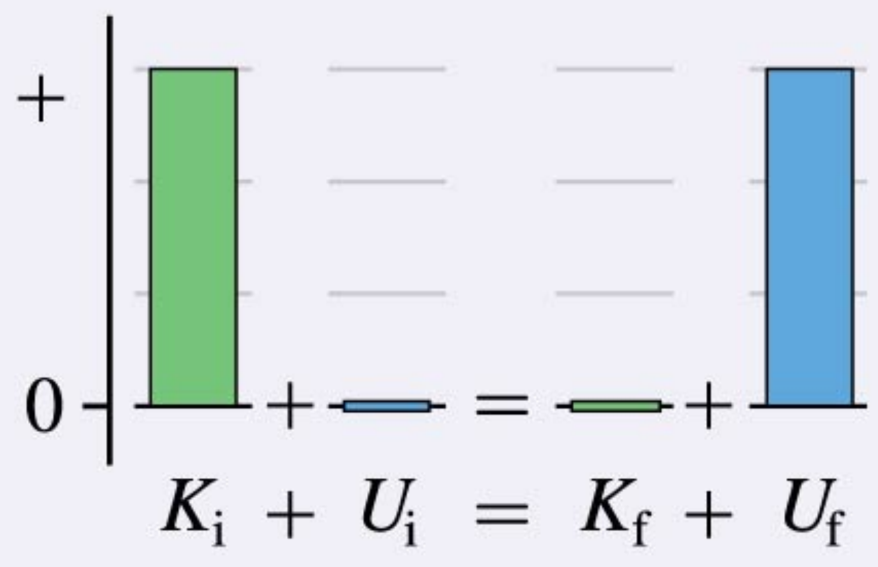




When is energy conserved?

- If a system is isolated, its total energy is conserved.
- If a system both is isolated and has *no dissipative forces*, its mechanical energy, $K + U$, is conserved.

Energy bar charts are a tool for visualizing energy conservation.



Law of Conservation of Energy

- **Isolated system:** $W_{ext} = 0$. The total system energy $E_{sys} = K + U + E_{th}$ is conserved. $\Delta E_{sys} = 0$.
- **Isolated, nondissipative system:** $W_{ext} = 0$ and $W_{diss} = 0$. The **mechanical energy** $E_{mech} = K + U$ is conserved: $K_i + U_i = K_f + U_f$.

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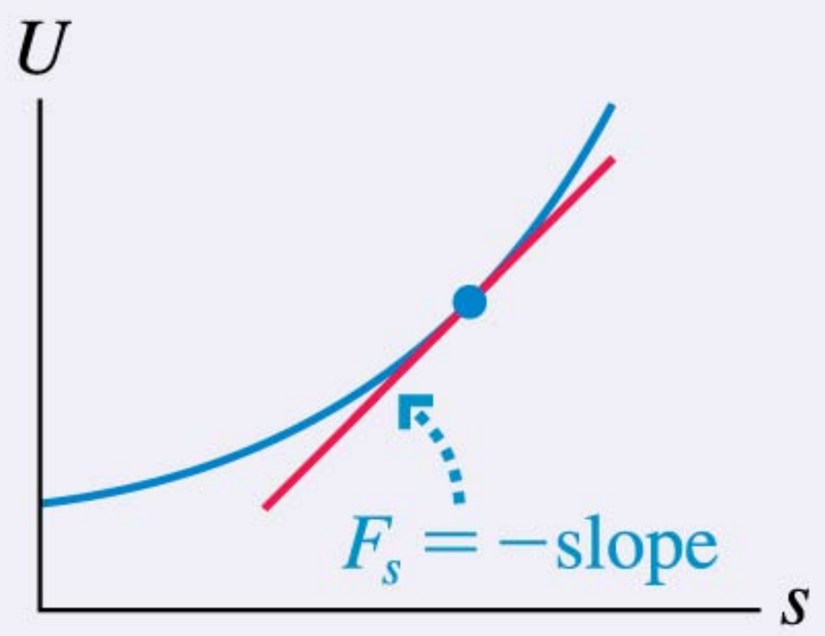
How is force related to potential energy?

Only certain types of forces, called conservative forces, are associated with a potential energy. For these forces,

- The work done changes the potential energy by $\Delta U = -W$.
- Force is the negative of the slope of the potential-energy curve.



Potential energy, or *interaction energy*, is energy stored inside a system via interaction forces. The energy is stored in *fields*.

- Potential energy is associated only with **conservative forces** for which the work done is independent of the path.
- Work W_{int} by the interaction forces causes $\Delta U = -W_{int}$.
- Force $F_s = -dU/ds = -$(slope of the potential energy curve).
- Potential energy is an energy of the system, not an energy of a specific object.

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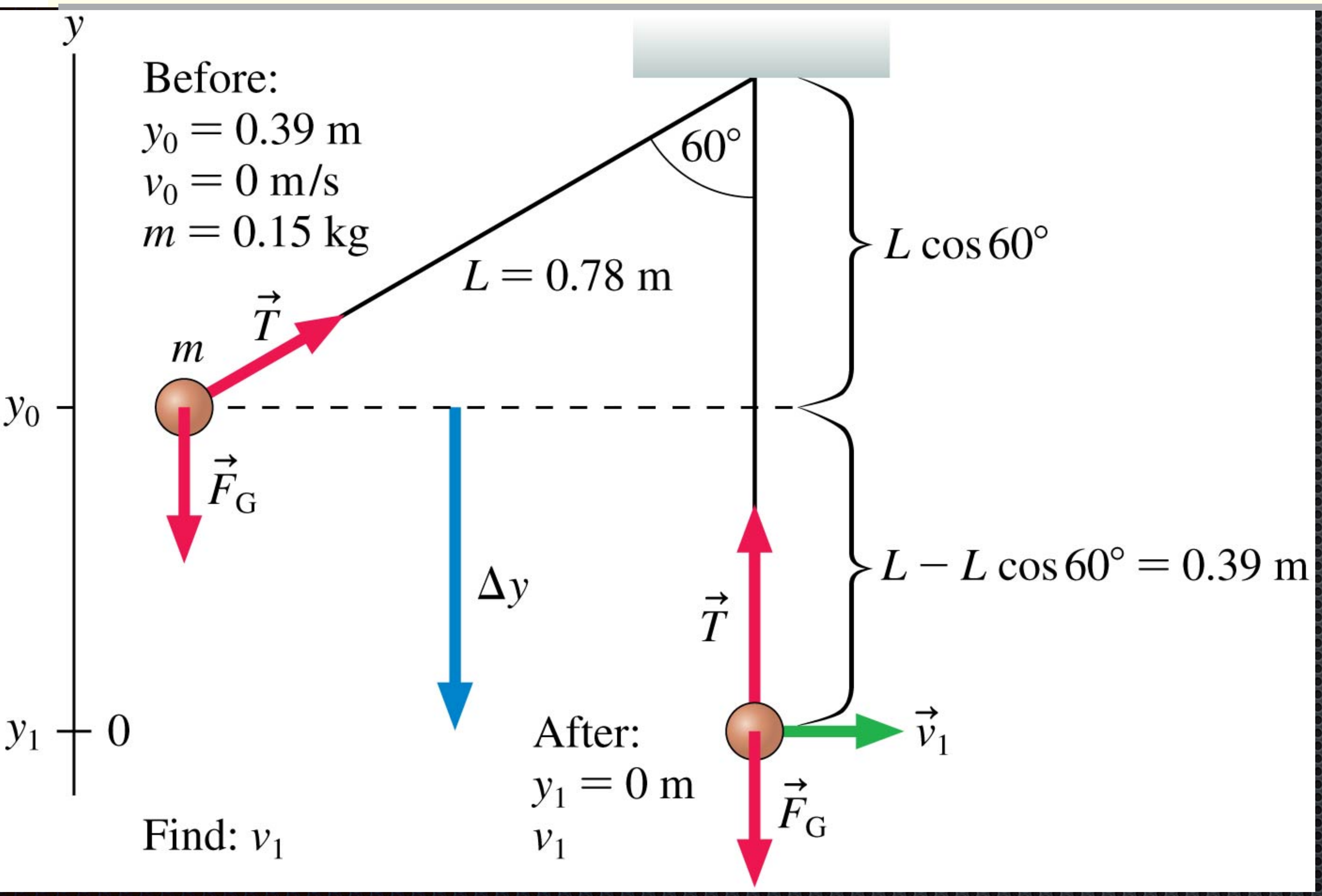
EXAMPLE 10.7 | The speed of a pendulum

VISUALIZE **FIGURE 10.16** shows a before-and-after pictorial representation, where we've placed the zero of potential energy at the lowest point of the ball's swing. Trigonometry is needed to determine the ball's initial height.

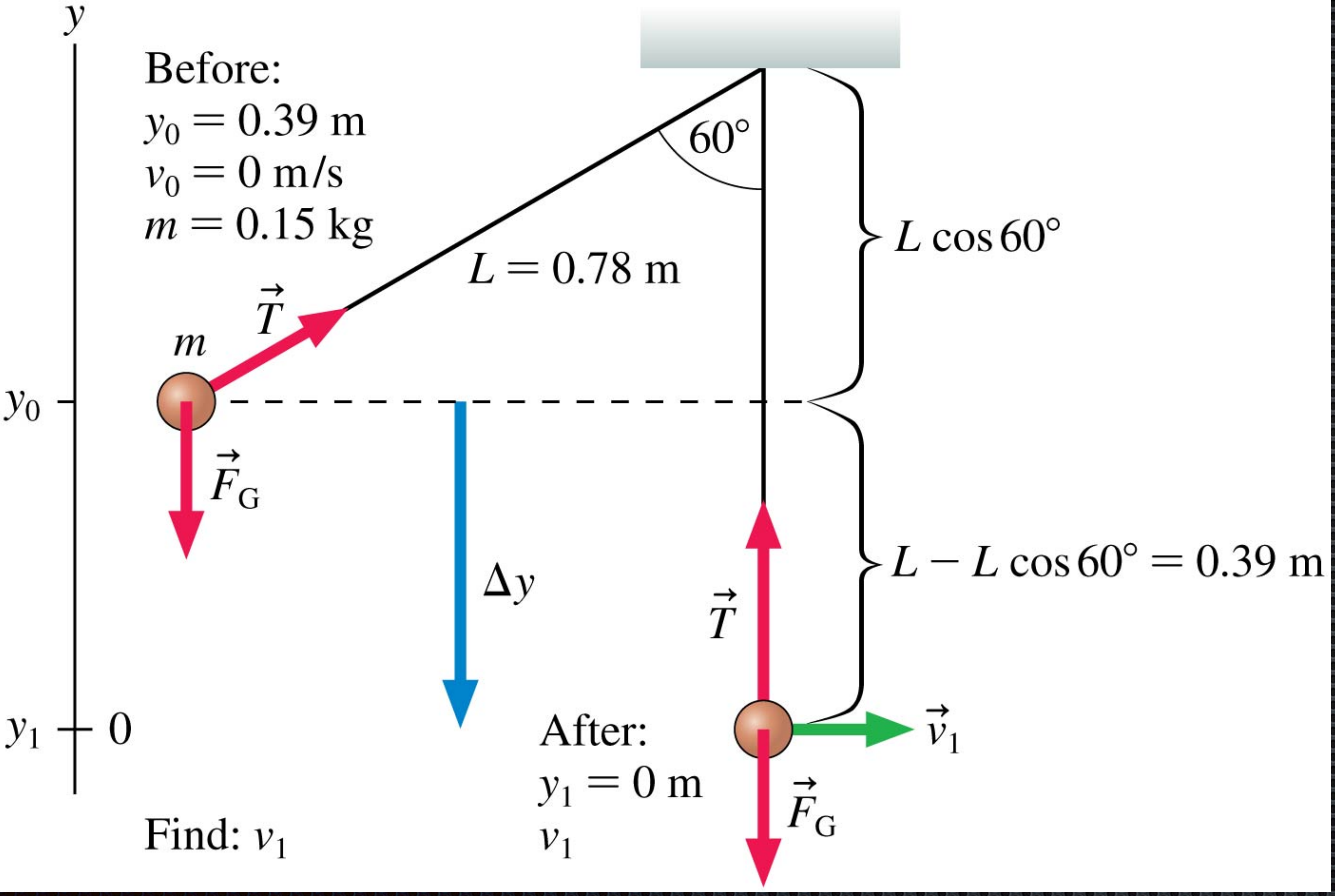
EXAMPLE 10.7 The speed of a pendulum

VISUALIZE **FIGURE 10.16** shows a before-and-after pictorial representation, where we've placed the zero of potential energy at the lowest point of the ball's swing. Trigonometry is needed to determine the ball's initial height.



EXAMPLE 10.7 The speed of a pendulum

VISUALIZE **FIGURE 10.16** shows a before-and-after pictorial representation, where we've placed the zero of potential energy at the lowest point of the ball's swing. Trigonometry is needed to determine the ball's initial height.



EXAMPLE 10.7 The speed of a pendulum

SOLVE Conservation of mechanical energy is

$$K_i + U_{Gi} = 0 + mgy_0 = K_f + U_{Gf} = \tfrac{1}{2}mv_1^2 + 0$$

Thus the ball's speed at the bottom is

$$v_1 = \sqrt{2gy_0} = \sqrt{2(9.80 \text{ m/s}^2)(0.39 \text{ m})} = 2.8 \text{ m/s}$$

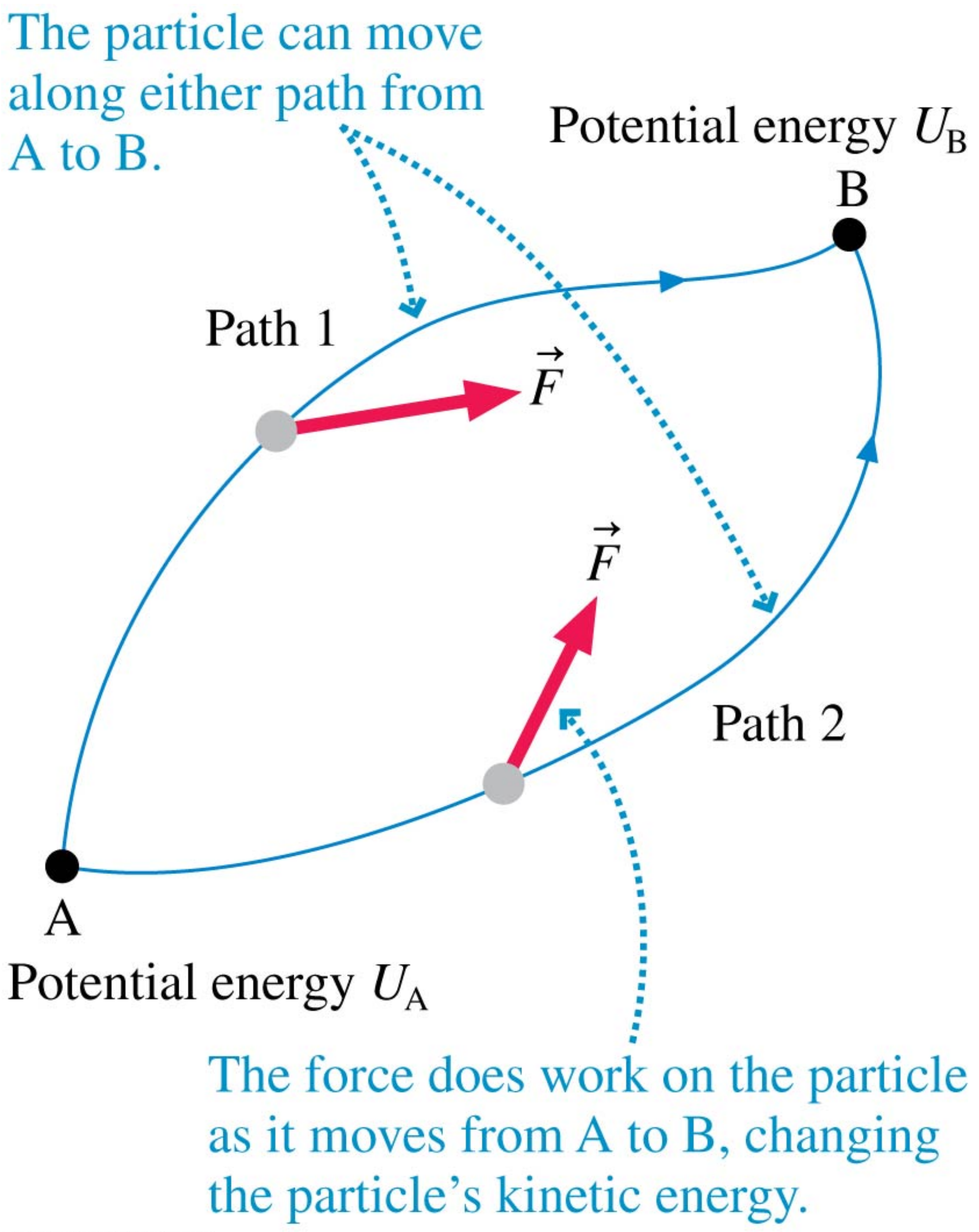
The speed is exactly the same as if the ball had simply fallen 0.39 m.

ASSESS To solve this problem directly from Newton's laws of motion requires advanced mathematics because of the complex way the net force changes with angle. But we can solve it in one line with an energy analysis!

Conservative Forces

- The figure shows a particle that can move from A to B along either path 1 or path 2 while a force $\vec{F}$ is exerted on it.
- If there is a potential energy associated with the force, this is a conservative force.
- The work done by $\vec{F}$ as the particle moves from A to B is independent of the path followed:

$$\Delta U = -W_c(\mathrm{i} \rightarrow \mathrm{f})$$



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Nonconservative Forces

- If an object slides up and down a slope with friction, then it returns to the same position with *less* kinetic energy.
- Part of its kinetic energy is transformed into gravitational potential energy as it slides up, but part is transformed into thermal energy that lacks the "potential" to be transformed back into kinetic energy.
- A force for which we cannot define a potential energy is called a **nonconservative force**.
- Friction and drag, which transform mechanical energy into thermal energy, are nonconservative forces, so there is no "friction potential energy."
- Similarly, forces like tension and thrust are nonconservative.

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Chapter 10
Clicker Questions

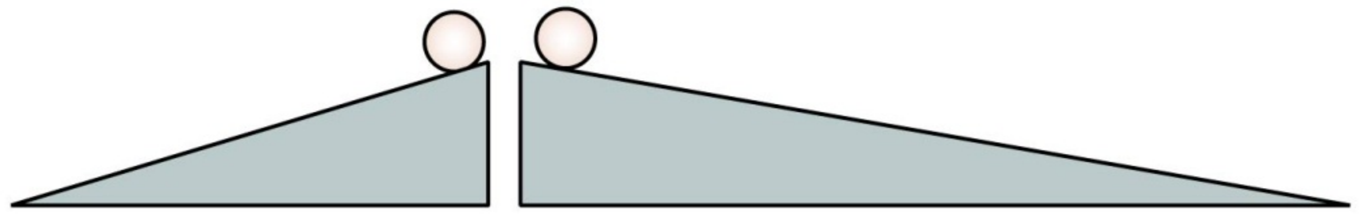
Chapter 10
Clicker Questions

A B C D

New: Put a Zoom stamp in the box
to lock in your choice
(trying this rather than Slido)

QuickCheck 10.2

Starting from rest, a marble first rolls down a steeper hill, then down a less steep hill of the same height. For which is it going faster at the bottom?



A. Faster at the bottom of the steeper hill.

B. Faster at the bottom of the less steep hill.

C. Same speed at the bottom of both hills.

D. Can't say without knowing the mass of the marble.

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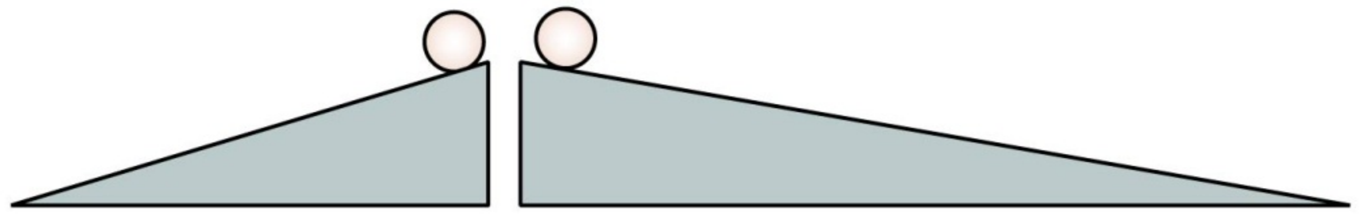
A B C D

QuickCheck 10.2

Starting from rest, a marble first rolls down a steeper hill, then down a less steep hill of the same height. For which is it going faster at the bottom?



A. Faster at the bottom of the steeper hill.

B. Faster at the bottom of the less steep hill.

✔ **C. Same speed at the bottom of both hills.**

D. Can't say without knowing the mass of the marble.

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A

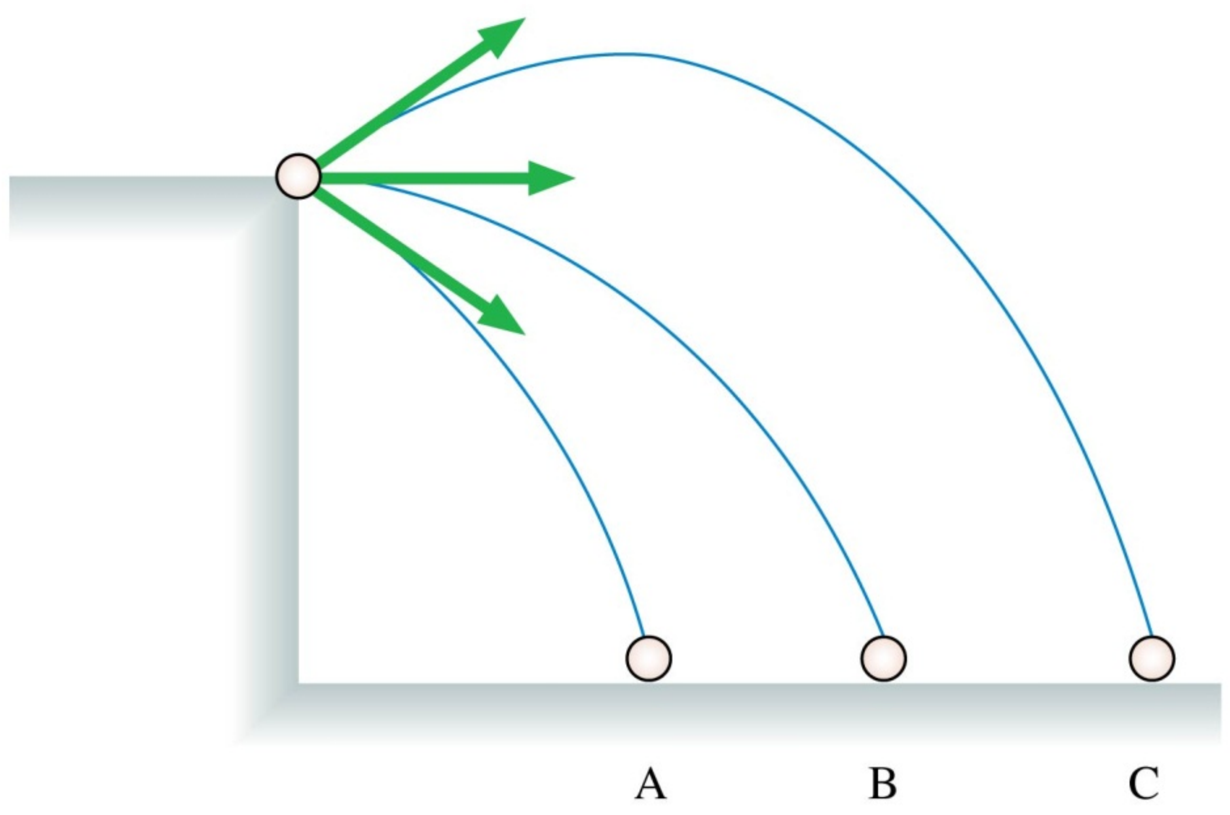
B

C

D

QuickCheck 10.8

Three balls are thrown from a cliff with the same speed but at different angles. Which ball has the greatest speed just before it hits the ground?



A. Ball A

B. Ball B

C. Ball C

D. All balls have the same speed.

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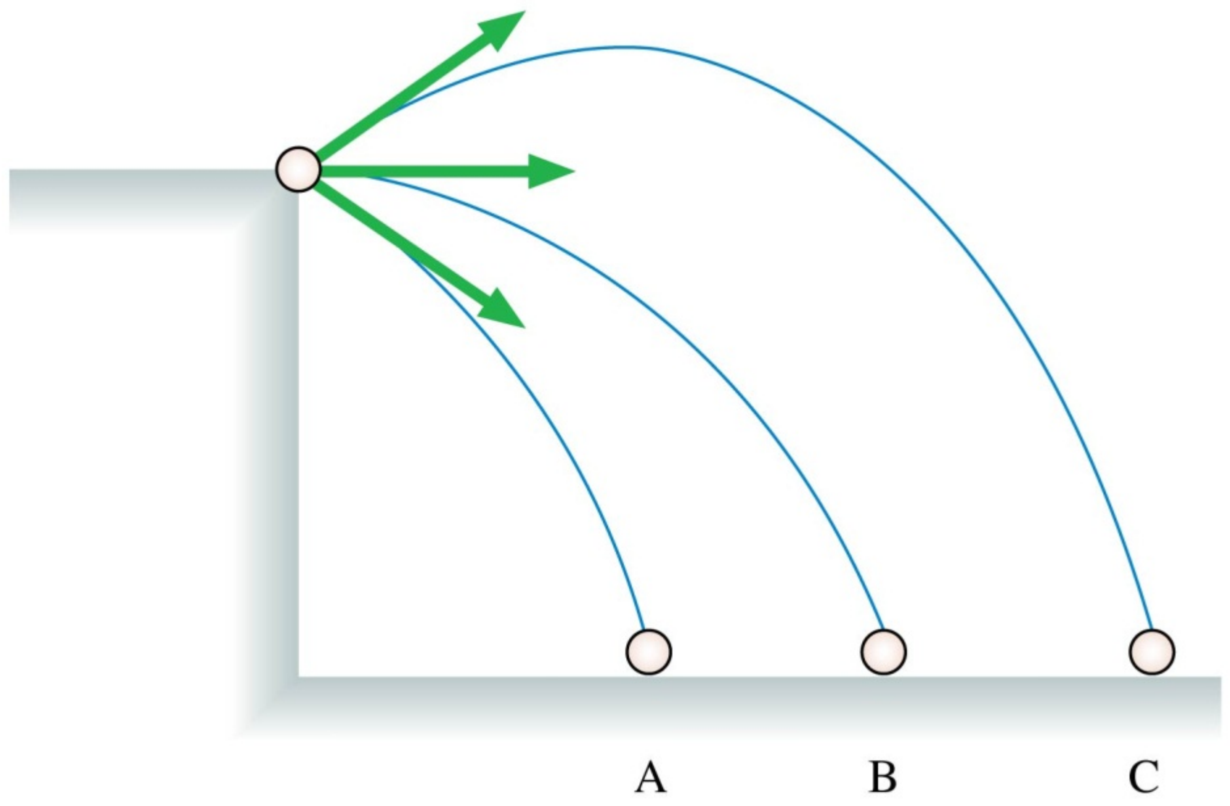
A B C D

QuickCheck 10.8

Three balls are thrown from a cliff with the same speed but at different angles. Which ball has the greatest speed just before it hits the ground?



A. Ball A

B. Ball B

C. Ball C

✔ **D. All balls have the same speed.**

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A B C D

QuickCheck 10.9

A hockey puck sliding on smooth ice at $4\ \text{m/s}$ comes to a 1-m-high hill. Will it make it to the top of the hill?

A. Yes
B. No
C. Can’t answer without knowing the mass of the puck.
D. Can’t say without knowing the angle of the hill.

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A B C D

QuickCheck 10.9

A hockey puck sliding on smooth ice at 4 m/s comes to a 1-m-high hill. Will it make it to the top of the hill?

A. Yes

B. No

$$\frac{1}{2}mv^2 = mgy \text{ requires } v^2 = 2gy \approx 20\ \mathrm{m^2/s^2}$$

C. Can't answer without knowing the mass of the puck.

D. Can't say without knowing the angle of the hill.

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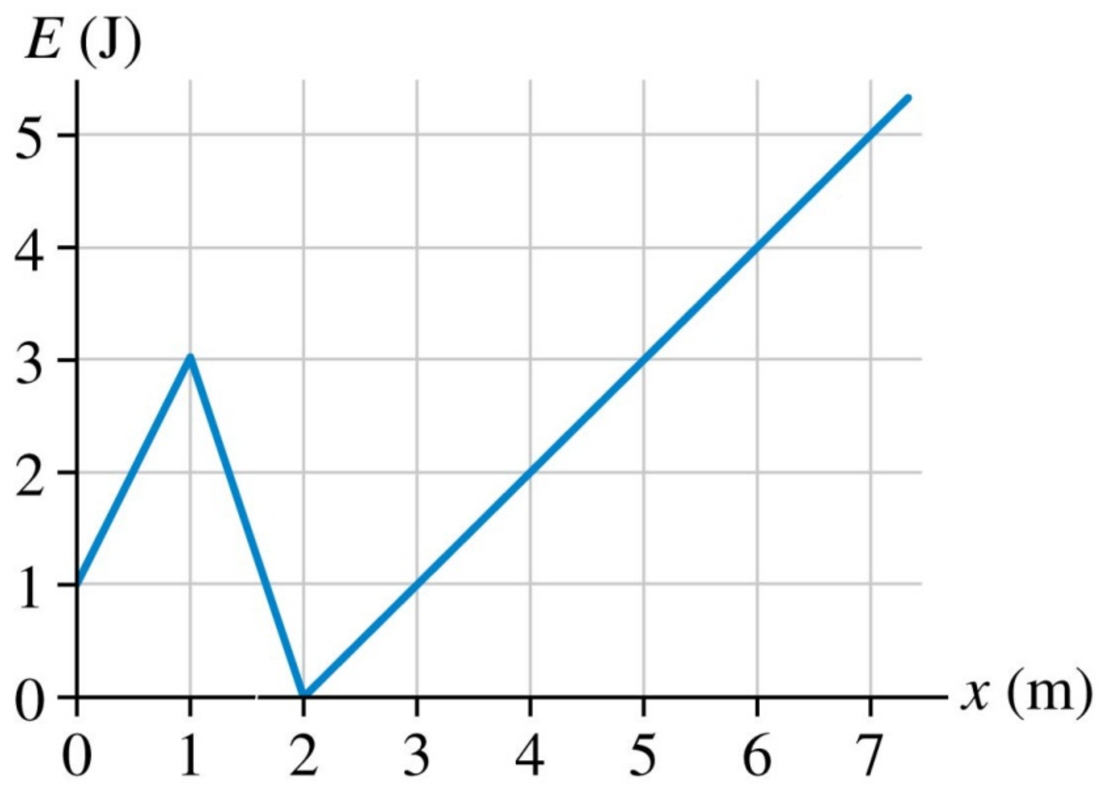
A B C D

QuickCheck 10.10

A particle with the potential energy shown is moving to the right. It has 1.0 J of kinetic energy at $x = 1.0$ m. In the region $1.0 \text{ m} < x < 2.0 \text{ m}$, the particle is



A. Speeding up.

B. Slowing down.

C. Moving at constant speed.

D. I have no idea.

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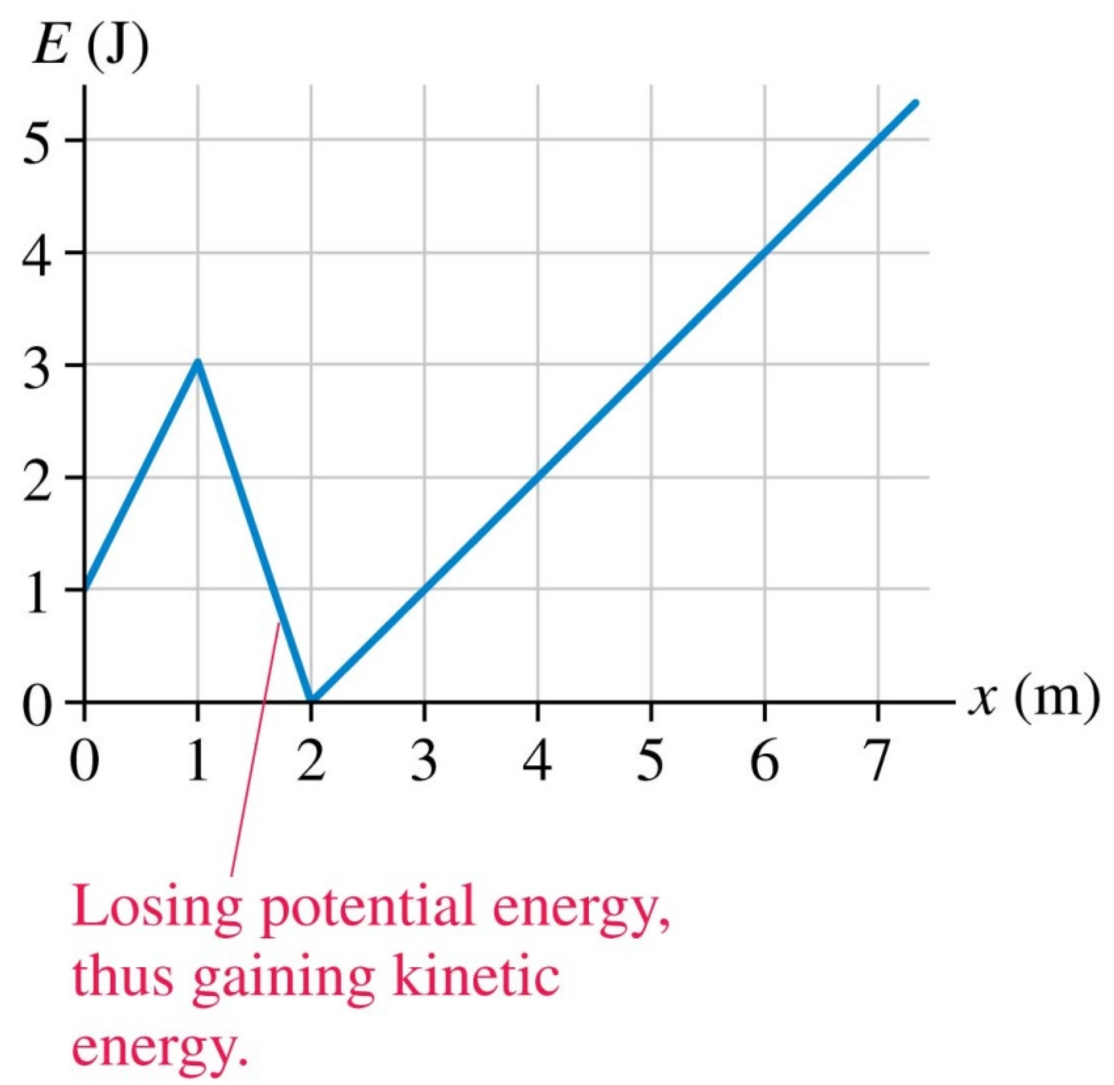
A B C D

QuickCheck 10.10

A particle with the potential energy shown is moving to the right. It has 1.0 J of kinetic energy at $x = 1.0$ m. In the region $1.0\text{ m} < x < 2.0\text{ m}$, the particle is



✔ A. **Speeding up.**

B. Slowing down.

C. Moving at constant speed.

D. I have no idea.

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A

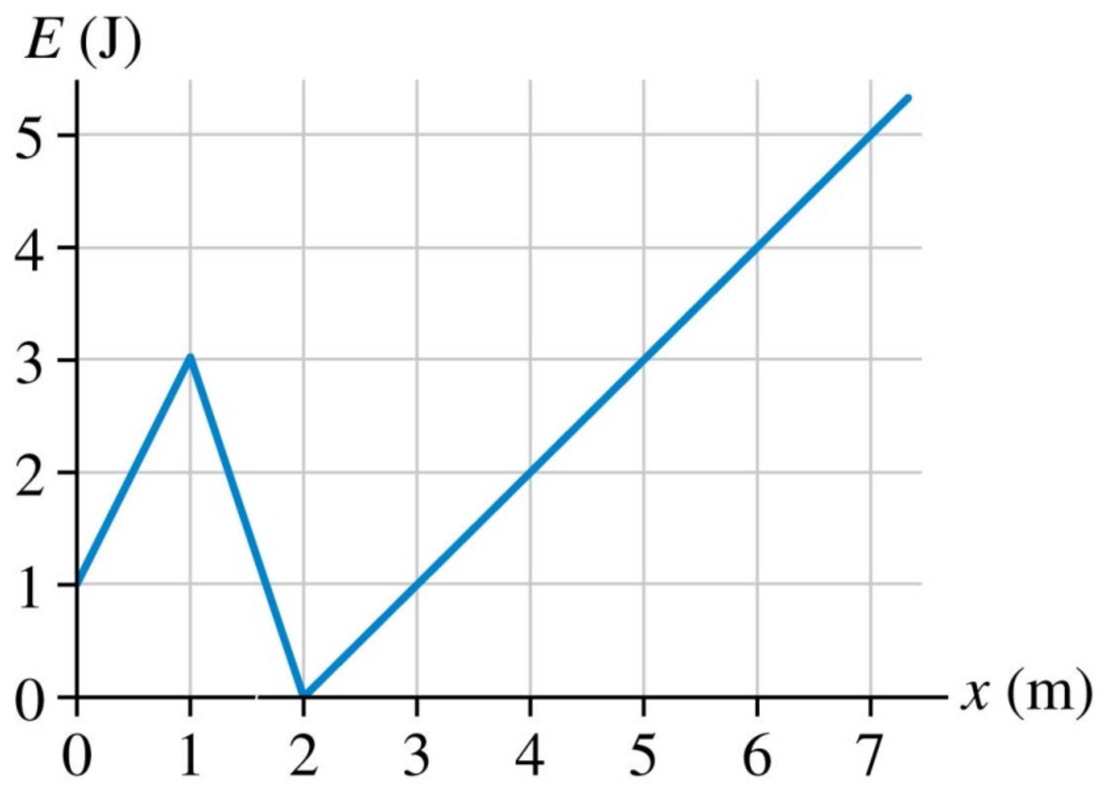
B

C

D

QuickCheck 10.11

A particle with the potential energy shown is moving to the right. It has $1.0\ \mathrm{J}$ of kinetic energy at $x = 1.0\ \mathrm{m}$. Where is the particle's turning point?



A. $1.0\ \mathrm{m}$

B. $2.0\ \mathrm{m}$

C. $5.0\ \mathrm{m}$

D. $6.0\ \mathrm{m}$

E. It doesn't have a turning point.

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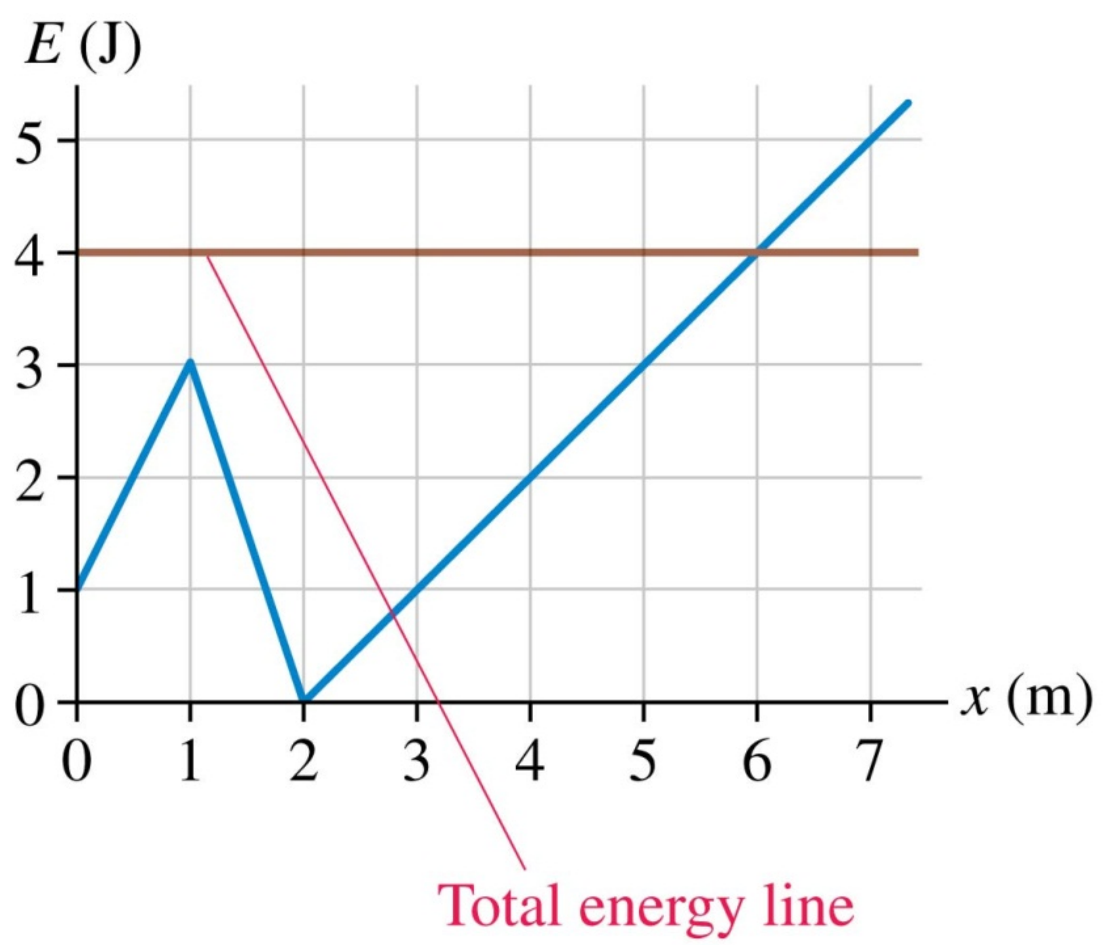
A B C D

QuickCheck 10.11

A particle with the potential energy shown is moving to the right. It has $1.0\ \text{J}$ of kinetic energy at $x = 1.0\ \text{m}$. Where is the particle's turning point?



A. $1.0\ \text{m}$

B. $2.0\ \text{m}$

C. $5.0\ \text{m}$

✔ **D.** $\mathbf{6.0\ m}$

E. It doesn't have a turning point.

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A

B

C

D

QuickCheck 10.6

A spring-loaded gun shoots a plastic ball with a launch speed of 2.0 m/s. If the spring is compressed twice as far, the ball's launch speed will be

A. 1.0 m/s
B. 2.0 m/s
C. 2.8 m/s
D. 4.0 m/s
E. 16.0 m/s

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A B C D

QuickCheck 10.6

A spring-loaded gun shoots a plastic ball with a launch speed of $2.0\ \text{m/s}$. If the spring is compressed twice as far, the ball's launch speed will be

A. $1.0\ \text{m/s}$

B. $2.0\ \text{m/s}$

C. $2.8\ \text{m/s}$

✔ **D. $\mathbf{4.0\ m/s}$**

E. $16.0\ \text{m/s}$

Conservation of energy: $\frac{1}{2}mv^2 = \frac{1}{2}k(\Delta x)^2$

Double $\Delta x \rightarrow$ double v

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A

B

C

D

QuickCheck 10.7

A spring-loaded gun shoots a plastic ball with a launch speed of $2.0\ \mathrm{m/s}$. If the spring is replaced with a new spring having twice the spring constant (but still compressed the same distance), the ball's launch speed will be

A. $1.0\ \mathrm{m/s}$

B. $2.0\ \mathrm{m/s}$

C. $2.8\ \mathrm{m/s}$

D. $4.0\ \mathrm{m/s}$

E. $16.0\ \mathrm{m/s}$

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A B C D

QuickCheck 10.7

A spring-loaded gun shoots a plastic ball with a launch speed of 2.0 m/s. If the spring is replaced with a new spring having twice the spring constant (but still compressed the same distance), the ball's launch speed will be

A. 1.0 m/s
B. 2.0 m/s
✔ **C. 2.8 m/s**
D. 4.0 m/s
E. 16.0 m/s

Conservation of energy: $\frac{1}{2}mv^2 = \frac{1}{2}k(\Delta x)^2$
Double $k \rightarrow$ increase
v by square root of 2

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A B C D

Example 10.3 The Speed of a Sled

EXAMPLE 10.3 | **The speed of a sled**

Christine runs forward with her sled at 2.0 m/s. She hops onto the sled at the top of a 5.0-m-high, very slippery slope. What is her speed at the bottom?

MODEL Let the system consist of the earth and the sled, which we model as a particle. Because the slope is "very slippery," we'll assume that friction is negligible. The slope exerts a normal force on the sled, but it is always perpendicular to the motion and does not affect the energy.

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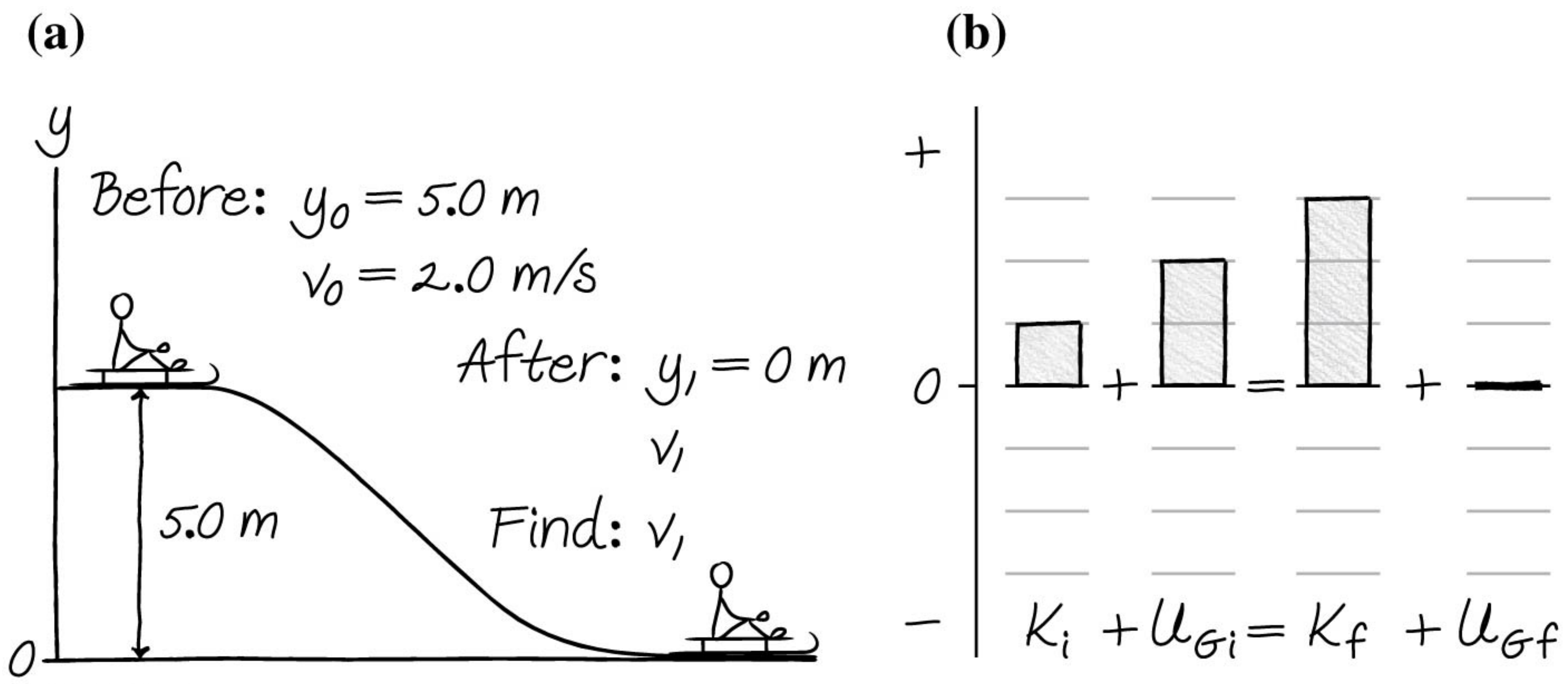
Example 10.3 The Speed of a Sled

EXAMPLE 10.3 | **The speed of a sled**

VISUALIZE **FIGURE 10.9a** shows a before-and-after pictorial representation. We are not told the angle of the slope, or even if it is a straight slope, but the change in potential energy depends only on the vertical distance Christine descends and *not* on the shape of the hill. **FIGURE 10.9b** is an energy bar chart in which we see an initial kinetic *and* potential energy being transformed into entirely kinetic energy as Christine goes down the slope.



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Example 10.3 The Speed of a Sled

EXAMPLE 10.3 | **The speed of a sled**

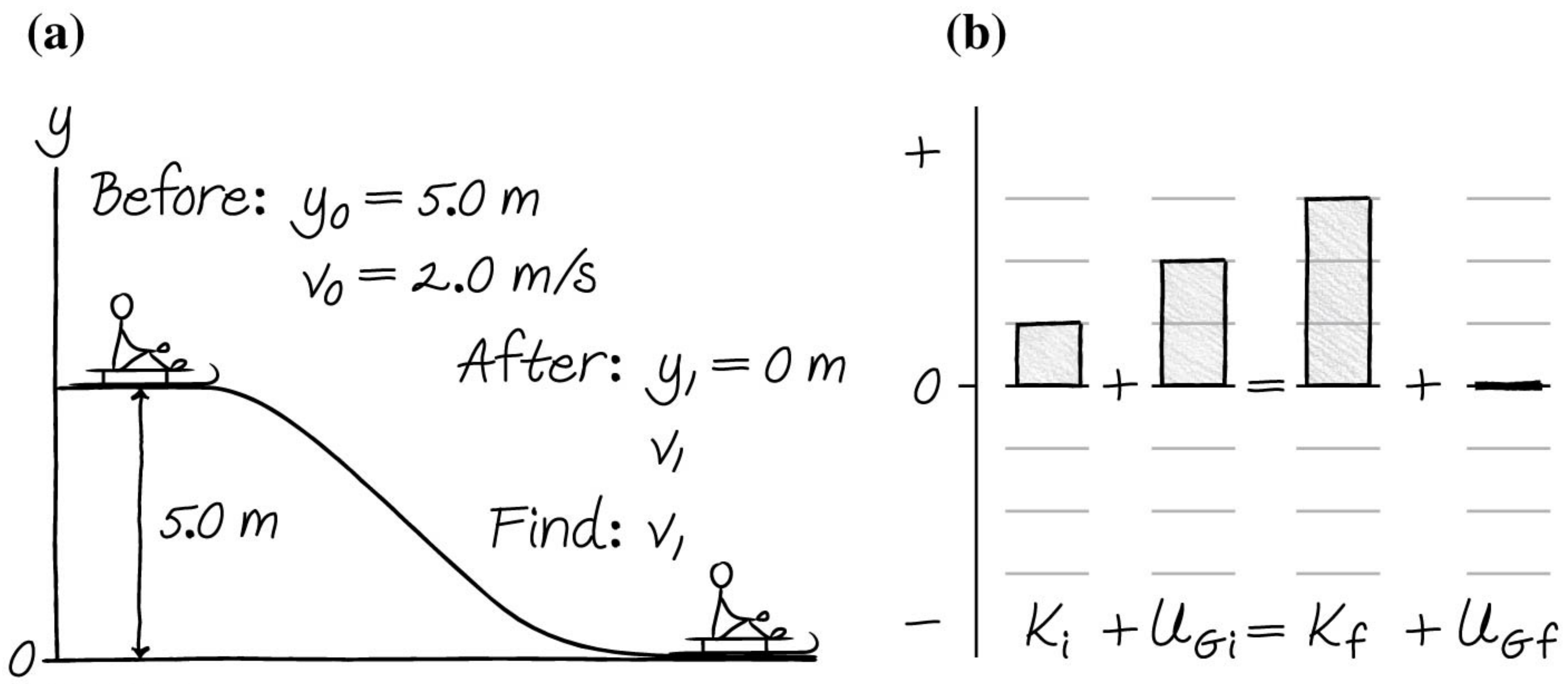
SOLVE The energy analysis is just like in Example 10.2; the fact that the object is moving on a curved surface hasn't changed anything. The energy principle, written as a conservation statement, is

$$K_i + U_{Gi} = \tfrac{1}{2}mv_0^2 + mgy_0$$
$$= K_f + U_{Gf} = \tfrac{1}{2}mv_1^2 + 0$$

Her speed at the bottom is

$$v_1 = \sqrt{v_0^2 + 2gy_0}$$
$$= \sqrt{(2.0\ \text{m/s})^2 + 2(9.80\ \text{m/s}^2)(5.0\ \text{m})}$$
$$= 10\ \text{m/s}$$

ASSESS 10 m/s ≈ 20 mph is fast but believable for a 5 m ≈ 15 ft descent.



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