Physics 211

Sections 1 & 70
Dr. Geoffrey Lovelace
Fall 2012
Lecture 15 (10/16/12)

Lecture 15 outline

- Announcements
- Conservation of energy
  - Demo & example: pendulum
  - Example: colliding black holes & coaster
  - Conceptual questions
- Power
  - Examples: light bulbs, humans, horses, computers
  - Conceptual questions

Announcements

- Homework
  - Homework #7: due today 11:59PM
  - Bonus: No homework due next week
- Tuesday, October 23 (next class!): Exam #2
  - Bring: #2 pencils, eraser, sci. calculator, **CWID**
  - I provide: scantron form, formula sheet
  - Cumulative but emphasis on new material (projectiles and onward)
- Reading: For Thursday: start chapter 6
- Office hours: 10AM-11AM, 4PM-5PM today

Exam advice

- What to study
  - Examples in text (work, then check)
  - Clicker questions from class
  - Learning path review: summarize materials
  - Homework problems
  - Odd-# problems (conceptual and quant.)
- Exam format
  - Same as last time: conceptual and quantitative problems, mostly multiple choice
- Questions?

Sep 20	Force, laws of motion *HW #3 due*
Sep 25	**Exam 1**
Sep 27	Laws of motion, *HW #4 due*
Oct 2	Free body diagrams
Oct 4	Free body diagrams, friction, *HW #5 due*
Oct 9	Free body diagram practice & wrap-up
Oct 11	Work, energy, kinetic & potential energy *HW #6 due*
Oct 16	Kinetic & potential energy, conservation of energy
Oct 18	Conservation of energy, power, *HW #7 due*
Oct 23	**Exam 2**
Oct 25	Linear momentum, conservation of linear momentum, *HW #8 due*
Oct 30	Conservation of linear momentum, collisions
Nov 1	Center of mass, rockets, *HW #9 due*
Nov 6	Circular motion, gravitation
Nov 8	Gravitation, Kepler's laws
Nov 13	Special feature: temperature, heat, entropy *HW #10 due*
Nov 15	**Exam 3**
Nov 20	*Fall Recess — No class*

Today

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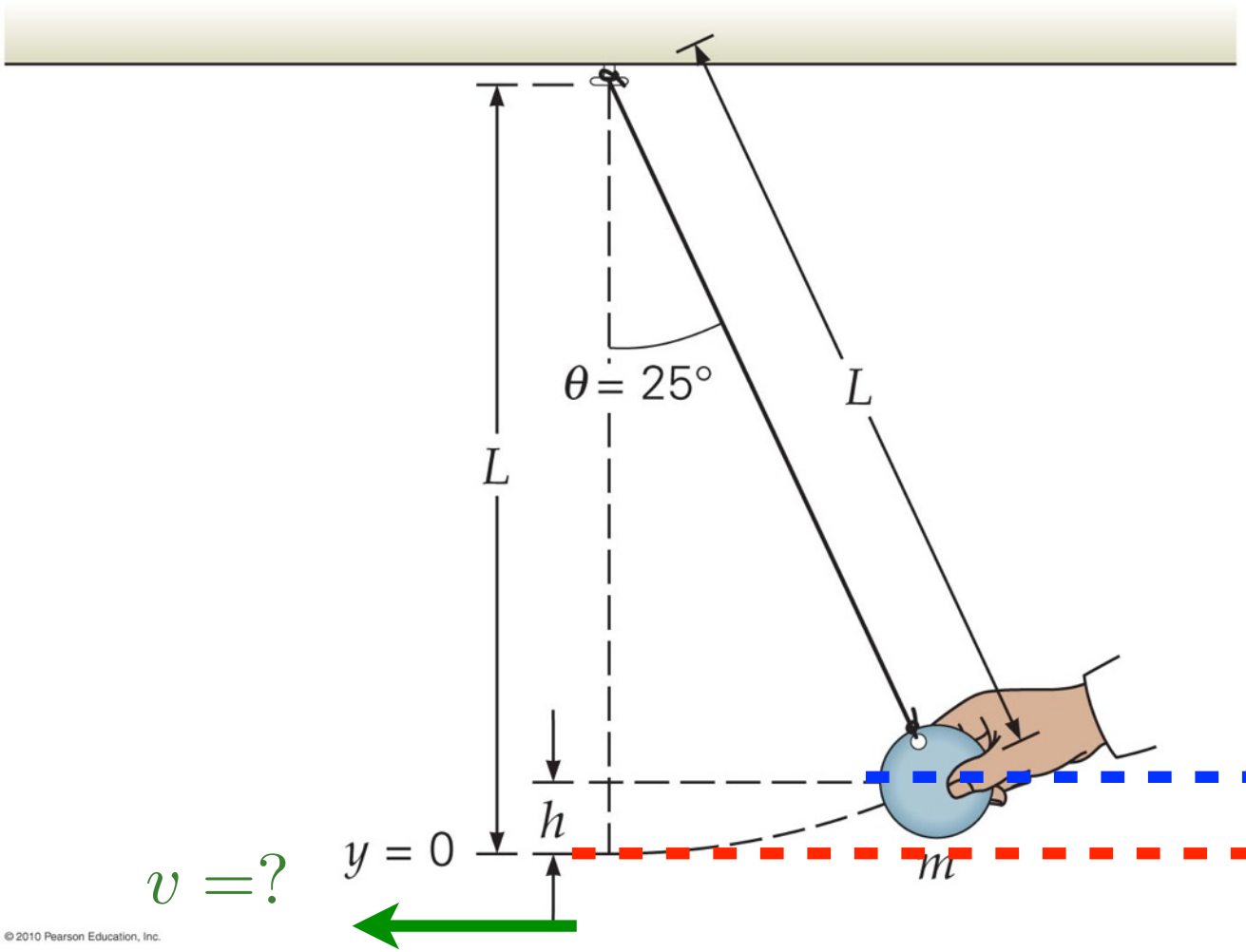
Conservation of energy

- Example: pendulum



$$\frac{1}{2}\cancel{m}v^2 = \cancel{m}gh$$

$$v^2 = 2gh$$

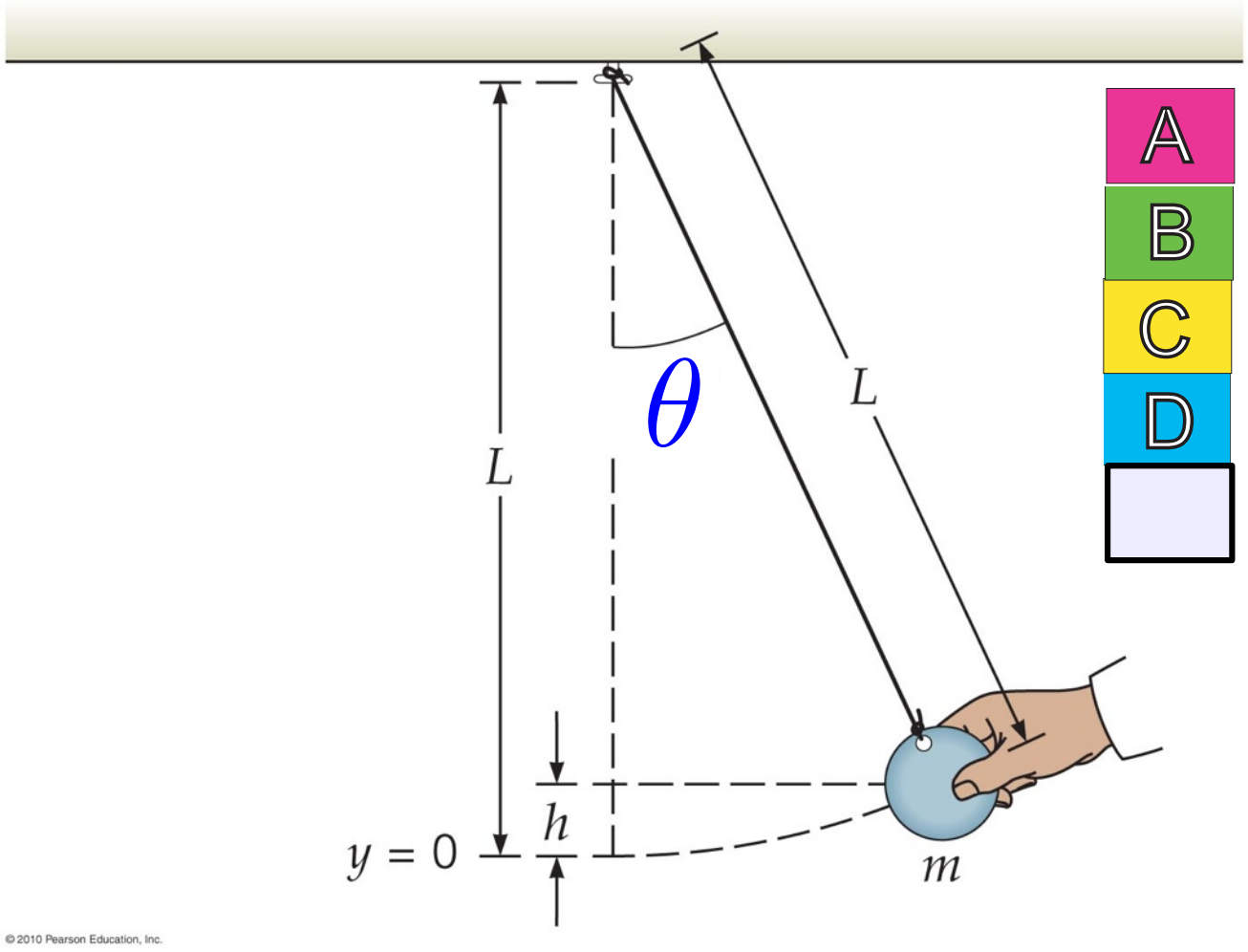
$$v = \sqrt{2gh}$$

$$U = mgh$$

$$U = 0$$

Clicker question #62

- Where is the potential energy the **smallest**?



A $\theta = 90°$

B $\theta = 45°$

C $\theta = 30°$

D $\theta = 0°$

U=const

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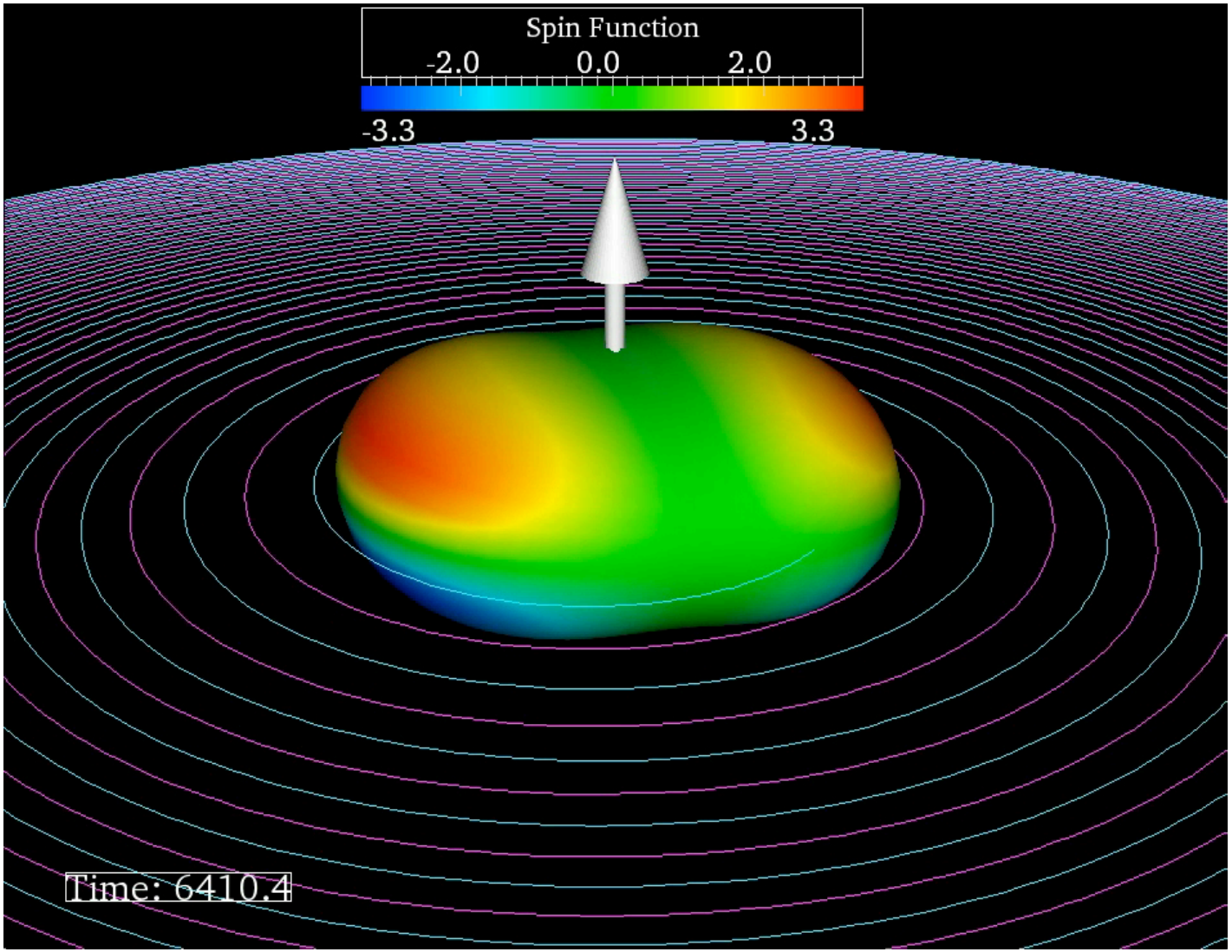
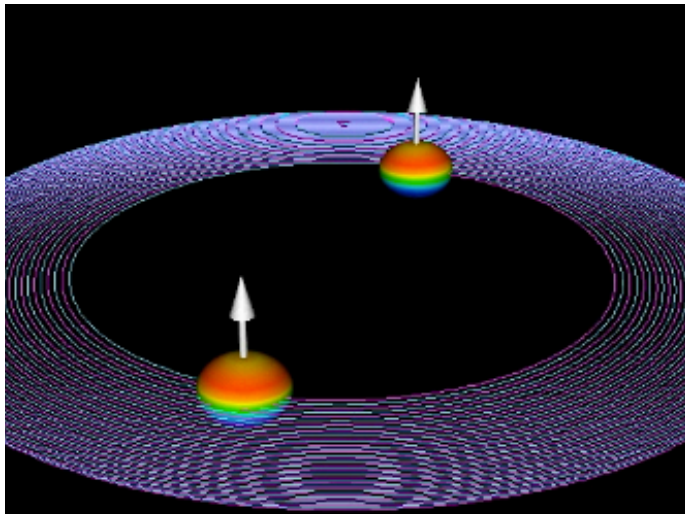
Conservation of energy

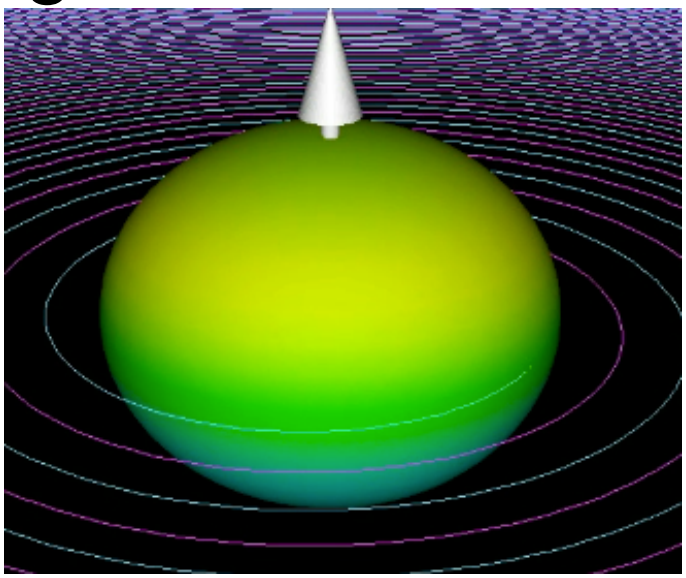
- Example: two colliding black holes



Conservation of energy

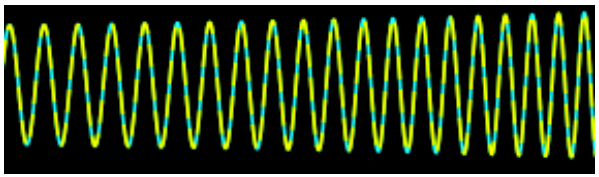
- Example: two colliding black holes $E = mc^2$ $c = 3 \times 10^8 \text{ m/s}$





Mass of each hole: 10 solar masses

Mass of final black hole: 17.8 solar masses



2.2 solar masses emitted $(= 4 \times 10^{47} J)$ as **gravitational waves**

Conservation of energy

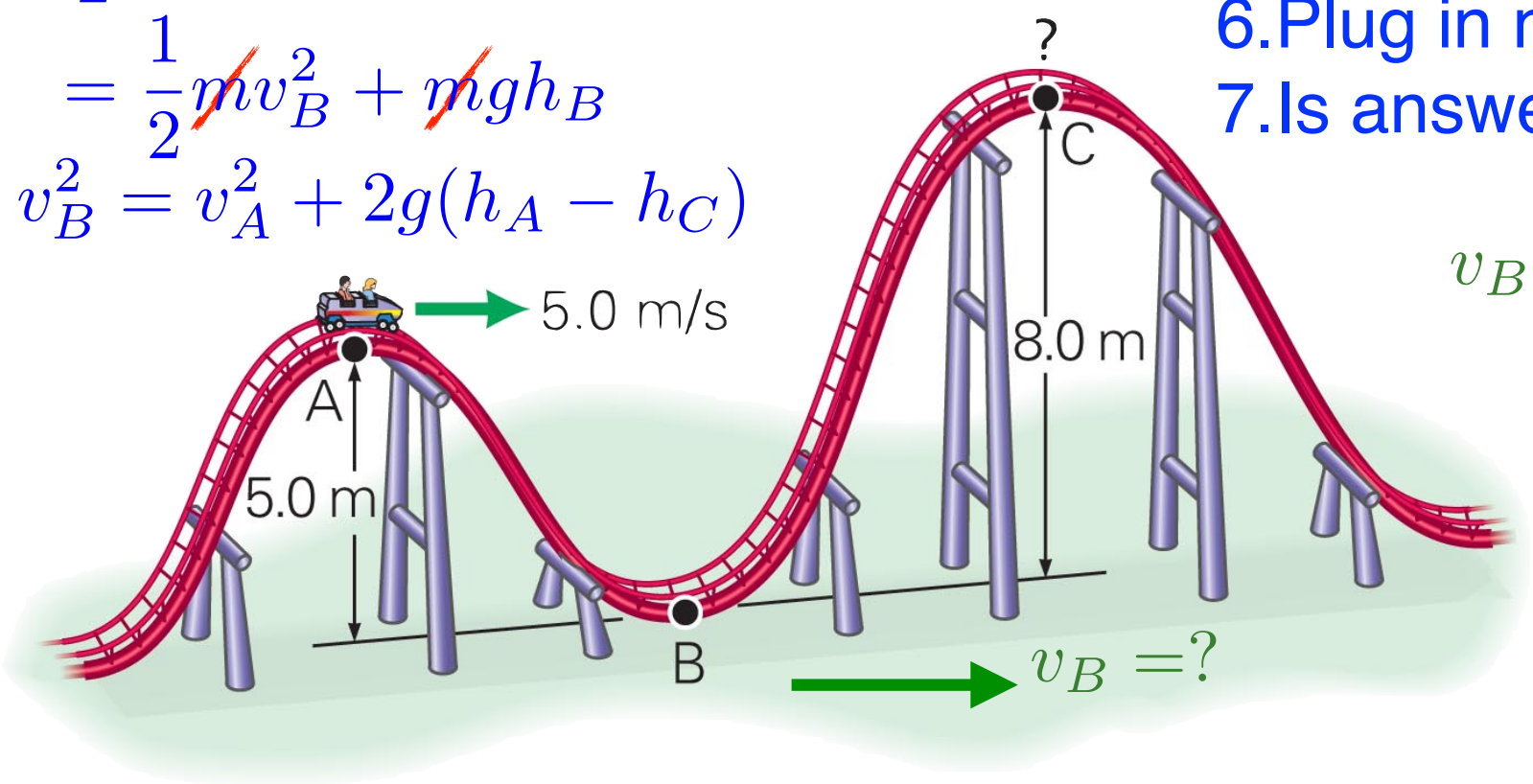
- Example: roller coaster

Given: $v_A = 5.0$ m/s
Goal: v_B

$$\frac{1}{2}mv_A^2 + mgh_A$$
$$= \frac{1}{2}mv_B^2 + mgh_B$$
$$v_B^2 = v_A^2 + 2g(h_A - h_C)$$

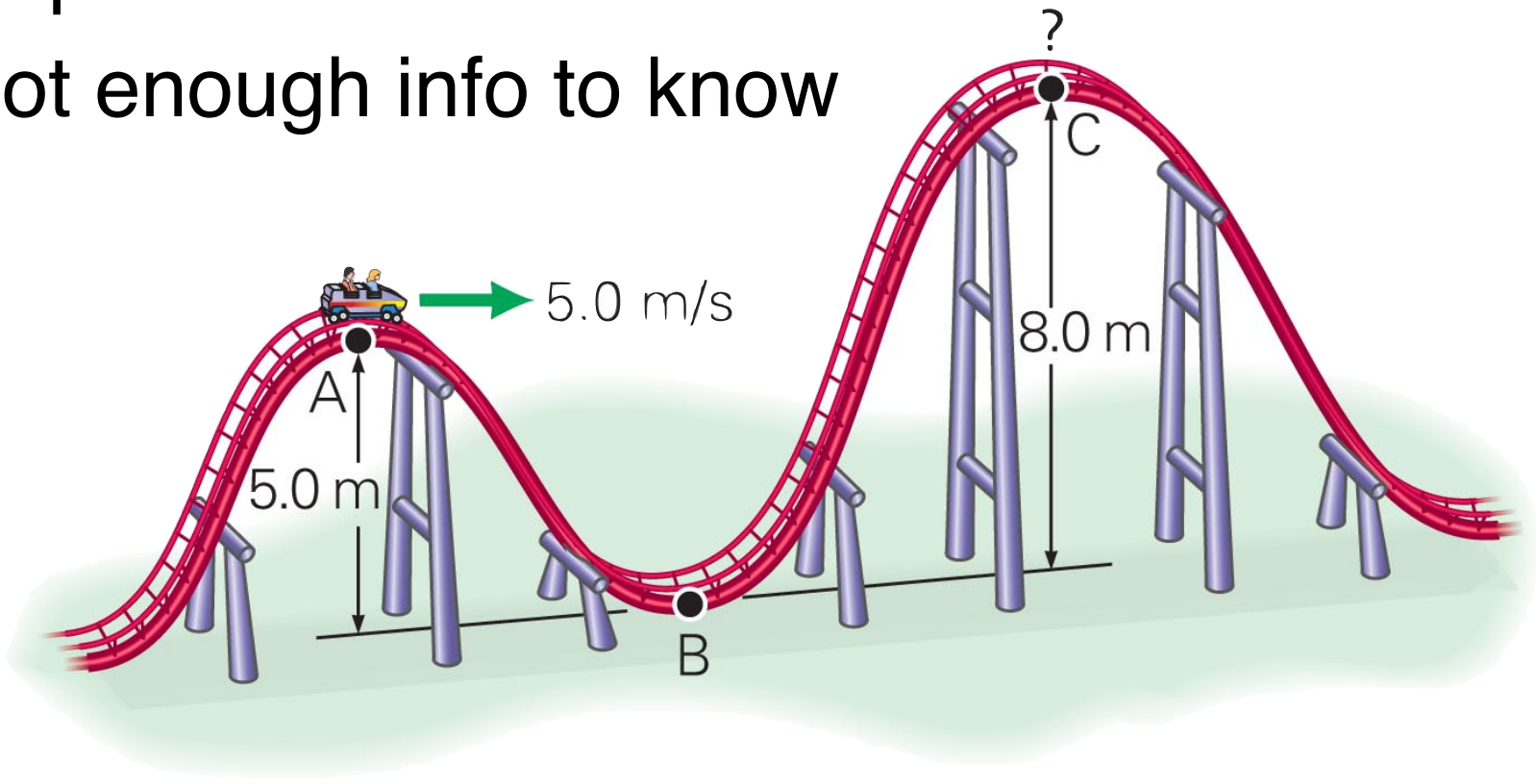
1. Read carefully
2. (Draw a sketch)
3. Given? Goal?
4. Principles & equations? $v_B =$
5. Calculate
6. Plug in numbers
7. Is answer reasonable?

$$v_B = 11 \text{ m/s}$$



Clicker question #63

- Does the car reach point C?
  - A Yes
  - B No
  - C Depends on mass of cart
  - D Not enough info to know



Conservation of energy

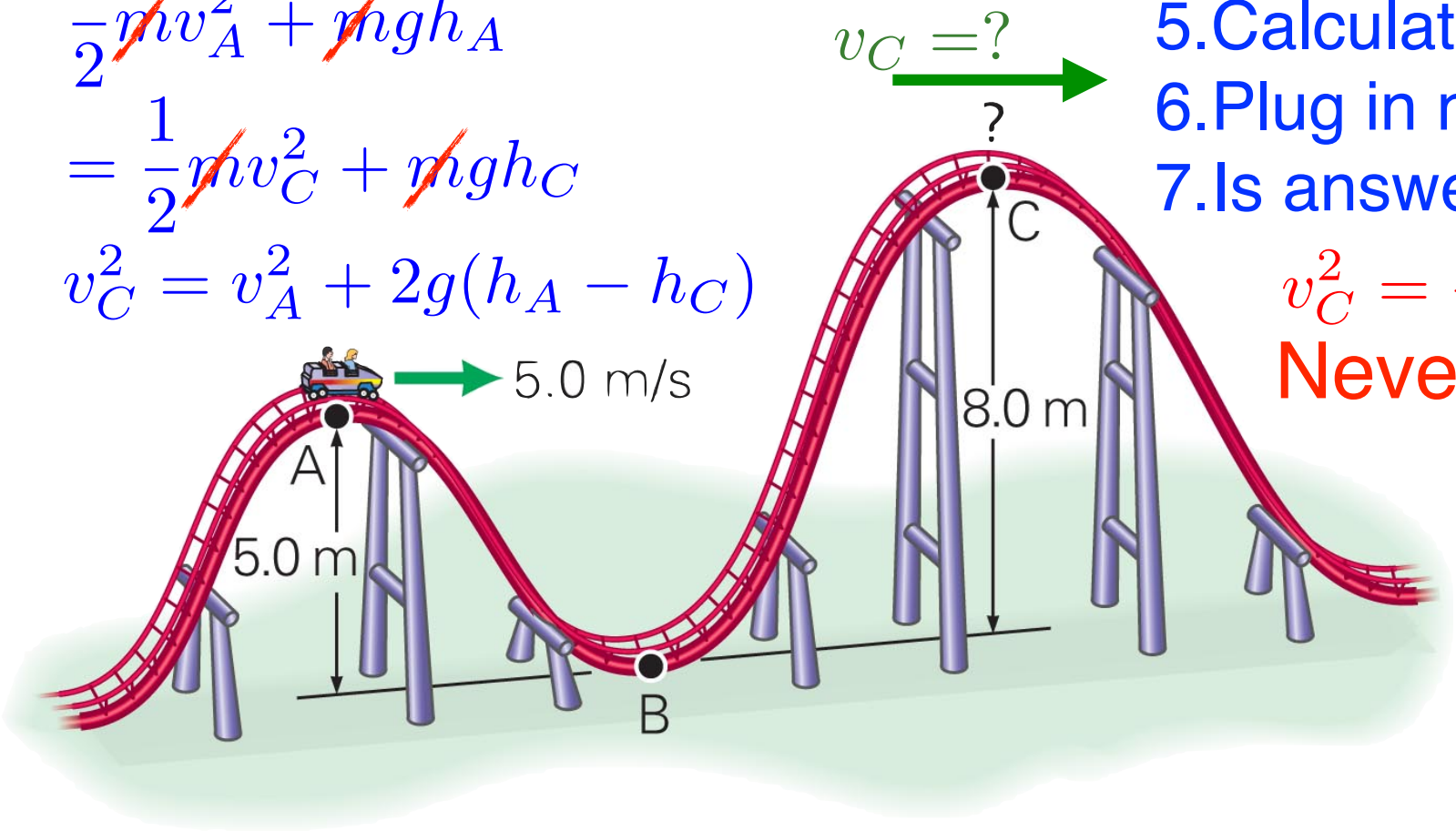
- Example: roller coaster

Given: $v_A = 5.0\ \mathrm{m/s}$
Goal: v_C

$$\frac{1}{2}mv_A^2 + mgh_A$$
$$= \frac{1}{2}mv_C^2 + mgh_C$$
$$v_C^2 = v_A^2 + 2g(h_A - h_C)$$

1. Read carefully
2. (Draw a sketch)
3. Given? Goal?
4. Principles & equations?
5. Calculate
6. Plug in numbers
7. Is answer reasonable?

$v_C^2 = -34\ \mathrm{m/s}$
Never reaches C



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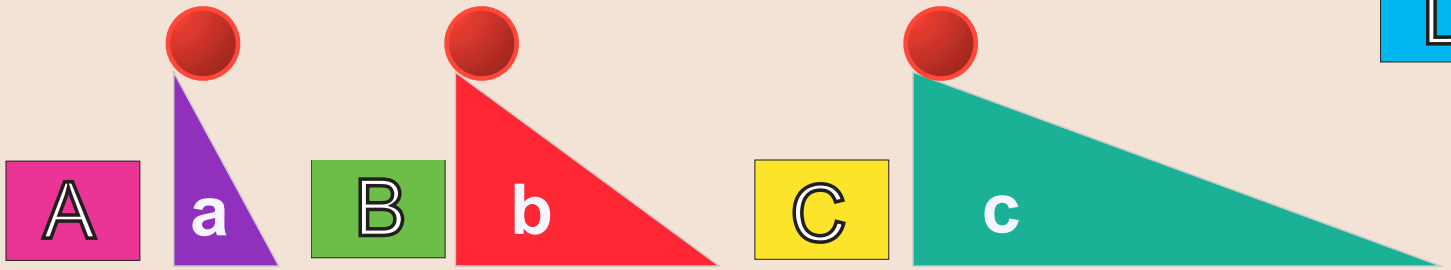
Clicker question #58

Question 5.16 Down the Hill

Three balls of equal mass start from rest and roll down different ramps. All ramps have the same height. Which ball has the greater speed at the bottom of its ramp?

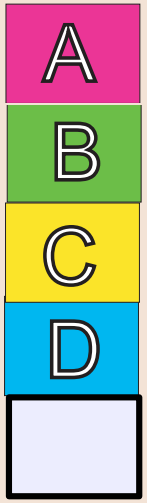


D same speed for all balls

Clicker question #59

Question 5.13 Up the Hill

Two paths lead to the top of a big hill. One is steep and direct, while the other is twice as long but less steep. How much more potential energy would you gain if you take the longer path?



A. the same

B. twice as much

C. four times as much

D. half as much

E. you gain no PE in either case

Clicker question #60

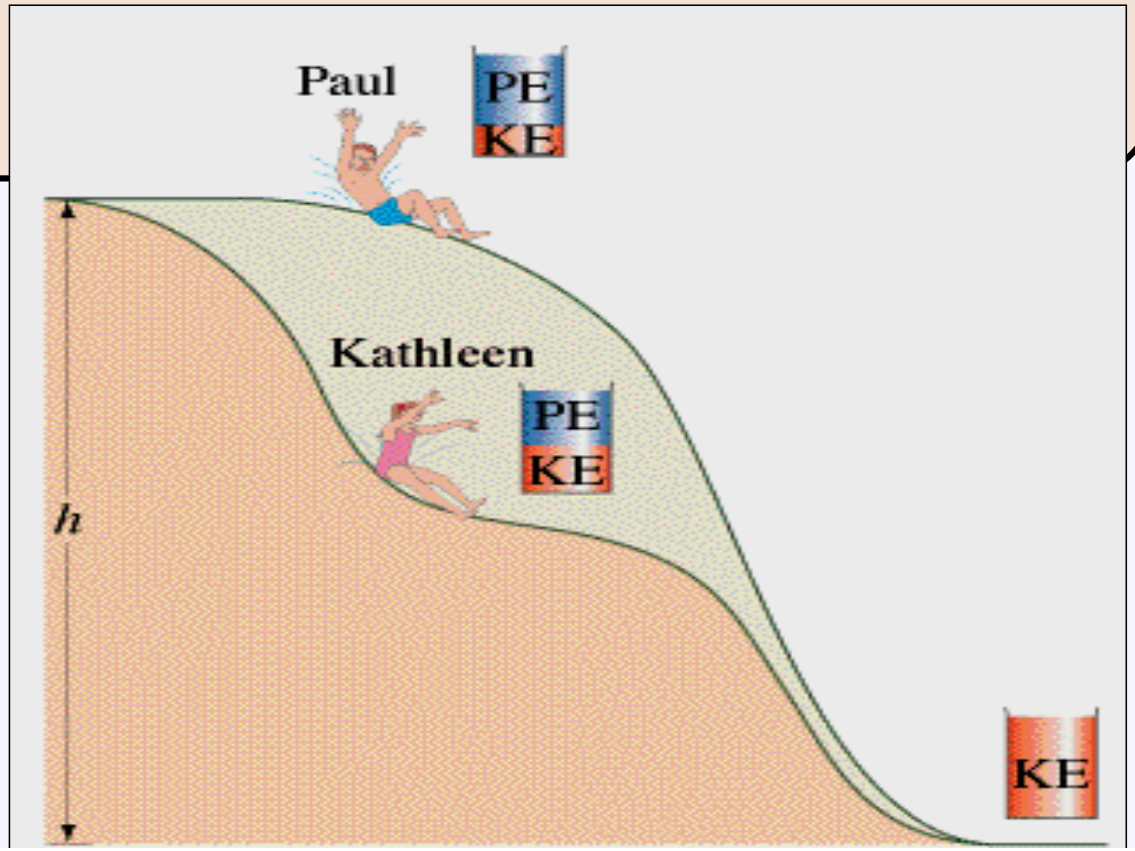
Question 5.18a Water Slide I

Paul and Kathleen start from rest at the same time on frictionless water slides with different shapes. At the bottom, whose velocity is greater?

A Paul

B Kathleen

C both the same



Clicker question #61

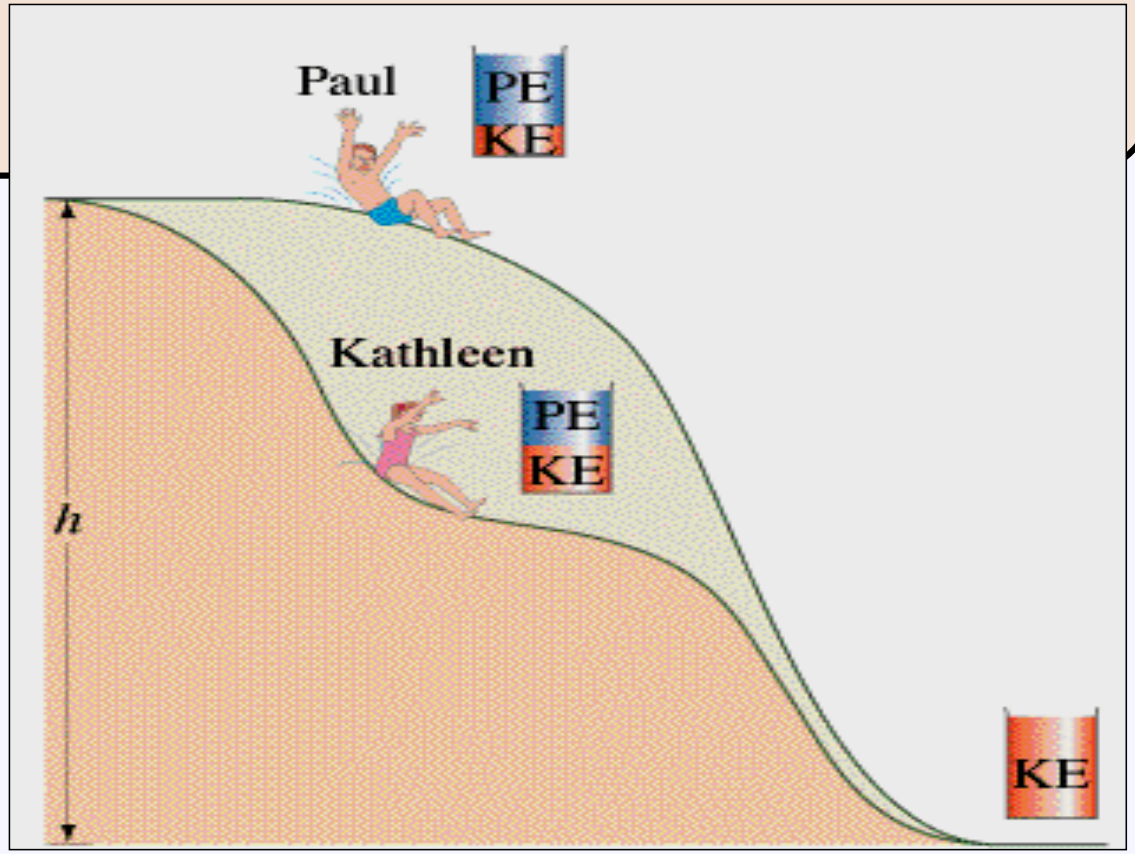
Question 5.18b Water Slide II

Paul and Kathleen start from rest at the same time on frictionless water slides with different shapes. Who makes it to the bottom first?

A Paul

B Kathleen

C both the same



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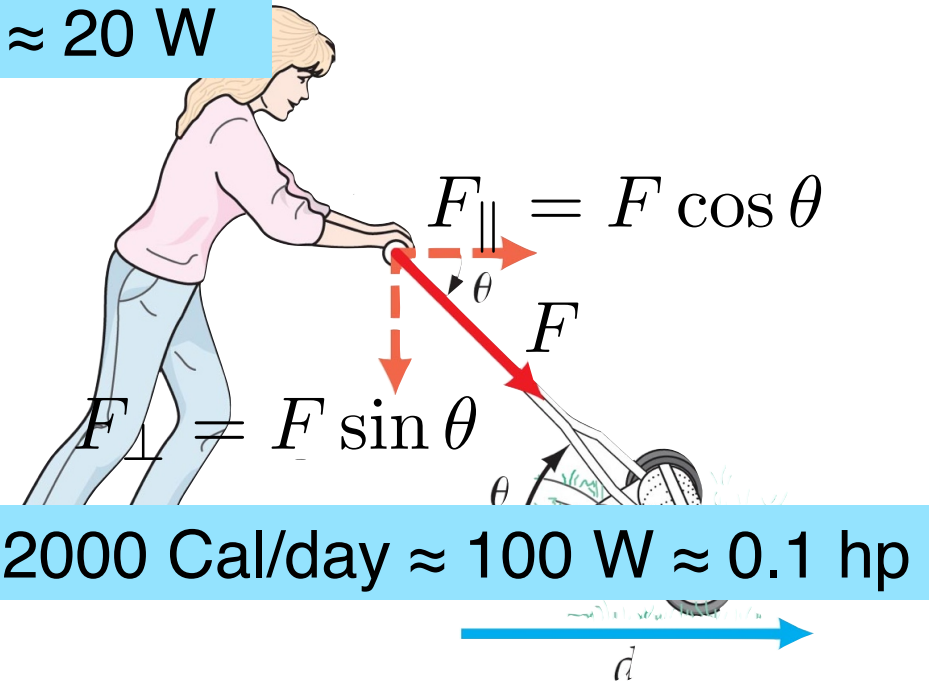
Power

Brain: 400 Cal/day ≈ 20 W

- Average power = work / time

$$\bar{P} = \frac{W}{t} = F\frac{d}{t}\cos\theta = F\bar{v}\cos\theta$$

  - Or: rate of energy transfer
  - Units: Watt (1 W = 1 J/s)
    - Or: 1 hp = 746 W



2000 Cal/day ≈ 100 W ≈ 0.1 hp

$$W = F_{\parallel}d = Fd\cos\theta$$

100 W

27 W

Power example

≈ 100 W ≈ 180000 W ≈ 100 W

http://www.youtube.com/watch?v=seNkjYyG3gI

Clicker question #64

Question 5.21a Time for Work I

Mike applied 10 N of force over 3 m in 10 seconds. Joe applied the same force over the same distance in 1 minute. Who did more work?

a) Mike

b) Joe

c) both did the same work

Clicker question #65

Question 5.21b Time for Work II

Mike performed 5 J of work in 10 secs. Joe did 3 J of work in 5 secs. Who produced the greater power?

a) Mike produced more power

b) Joe produced more power

c) both produced the same amount of power

Clicker question #66

Question 5.22a Electric Bill

When you pay the electric company by the kilowatt-hour, what are you actually paying for?

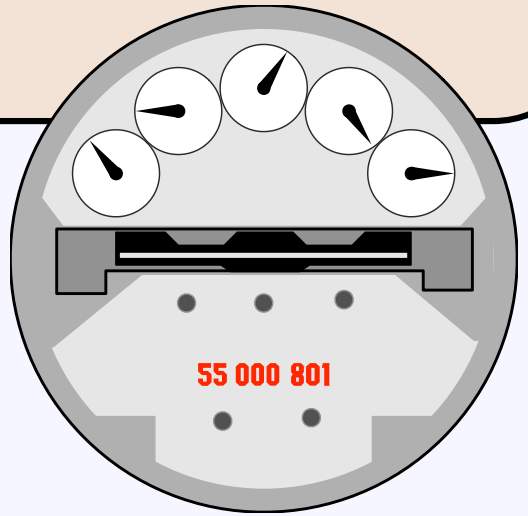
a) energy

b) power

c) current

d) voltage

e) none of the above



Clicker question #67

Question 5.22b Energy Consumption

Which contributes more to the cost of your electric bill each month, a 1500-Watt hair dryer or a 600-Watt microwave oven?

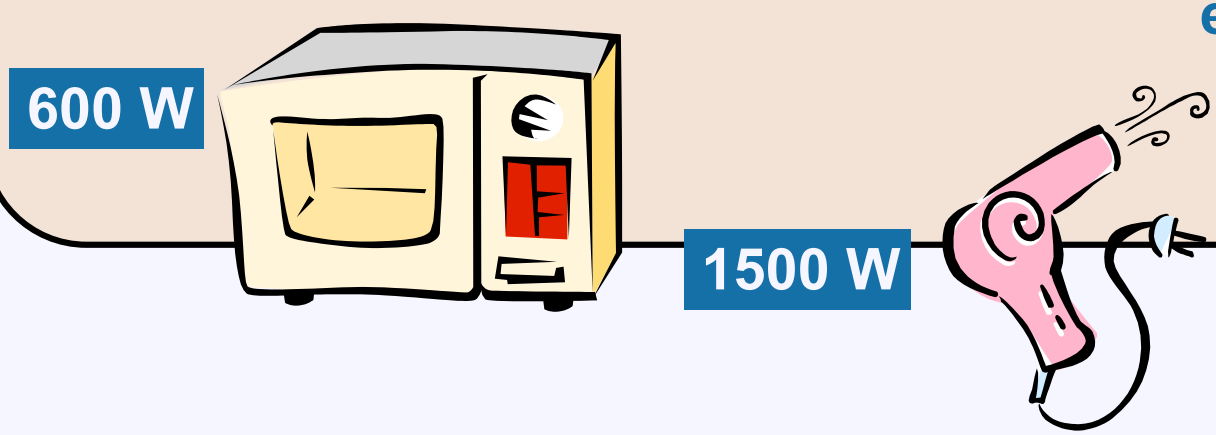
a) hair dryer

b) microwave oven

c) both contribute equally

d) depends upon what you cook in the oven

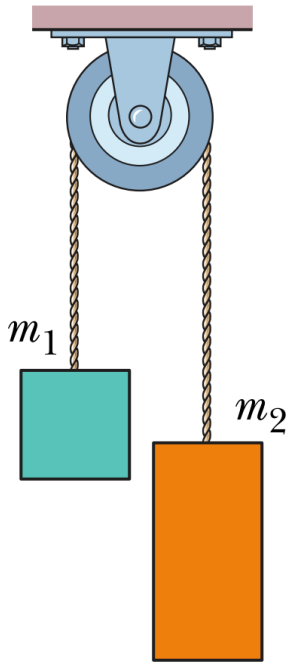
e) depends upon how long each one is on



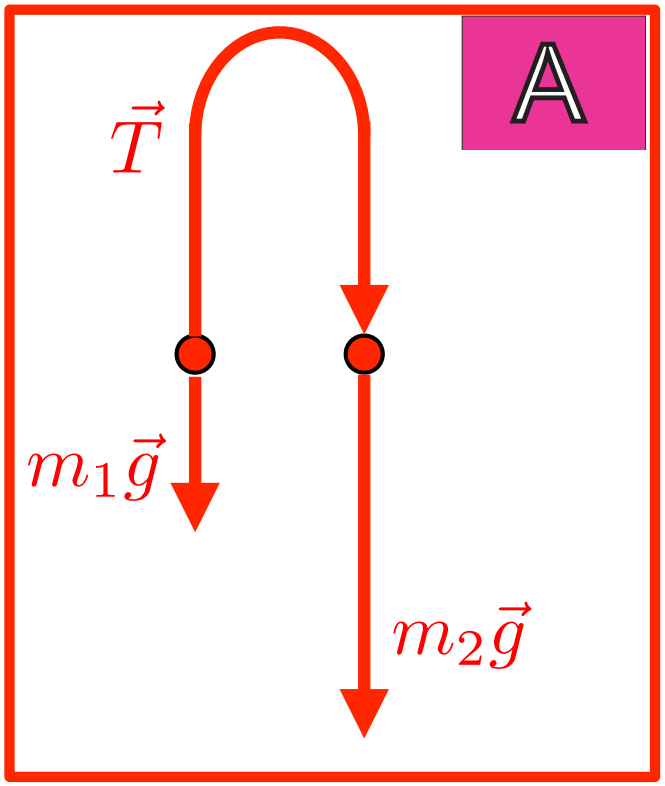
Class participation #14

- 0. Name
- 1. Clicker question answer

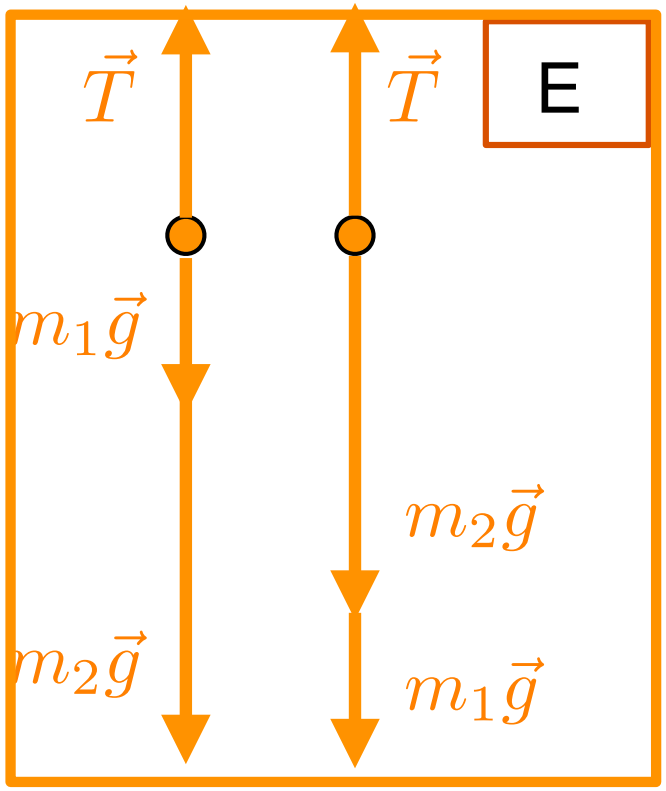
Which is the correct pair of free-body diagrams for Atwood's machine?



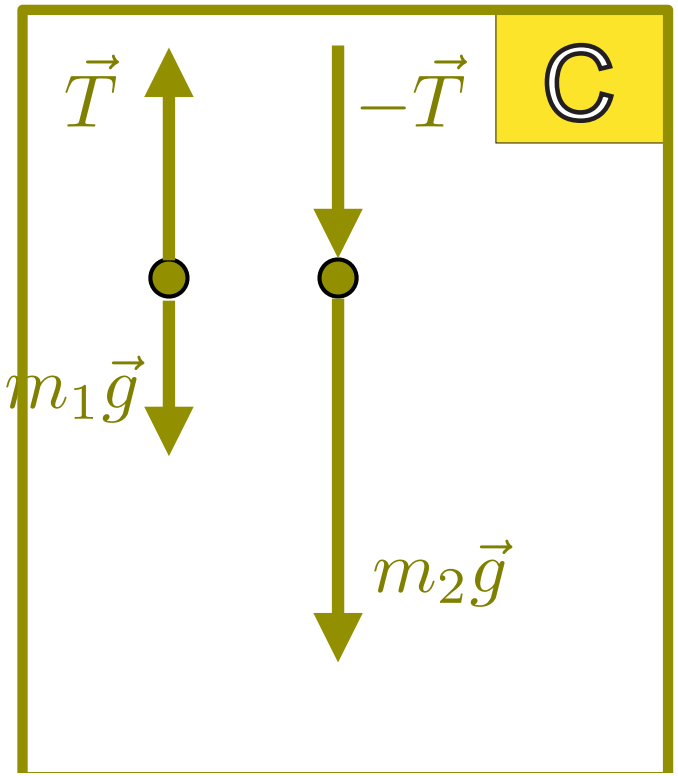
A



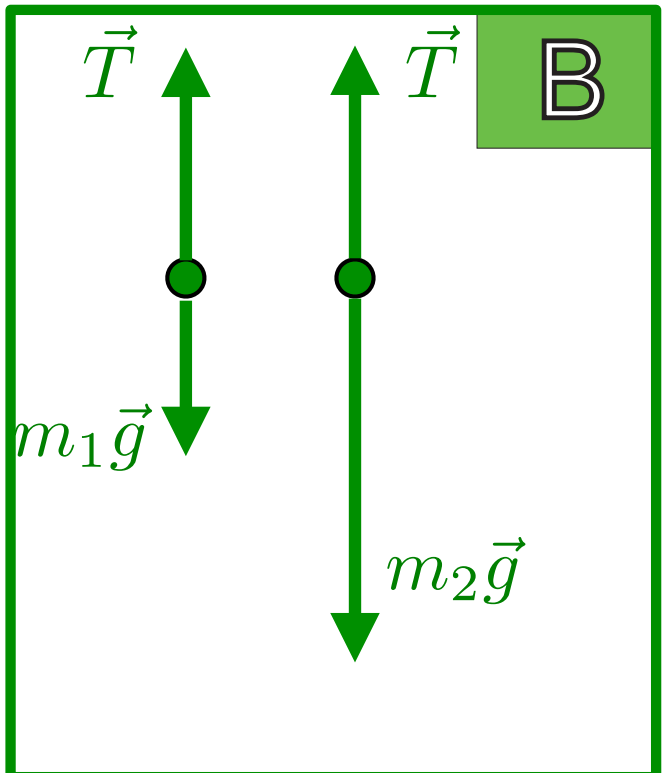
E



C



B



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