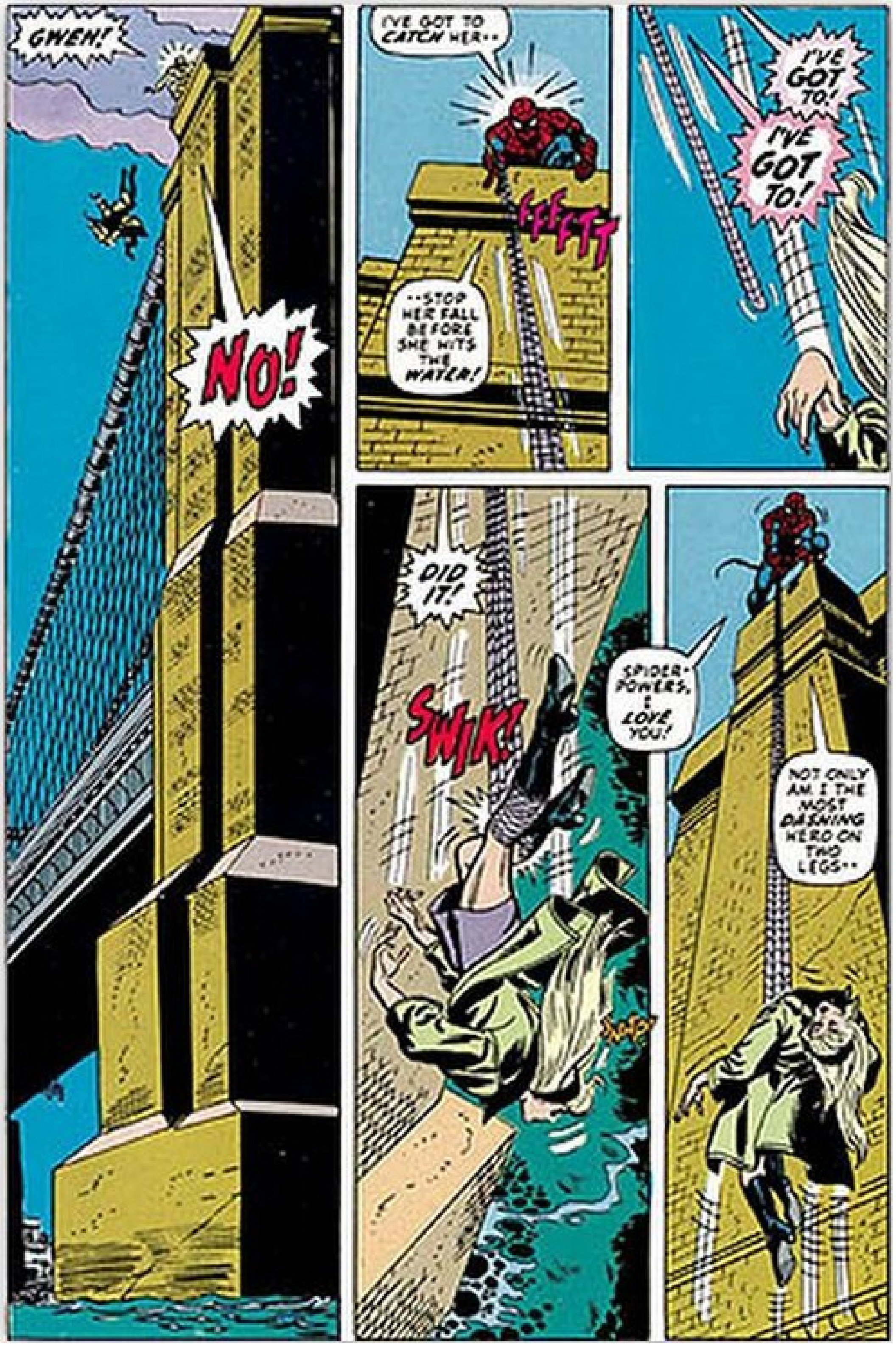
# Problem Solving Day

I have energy and momentum problems that I can cover today. But given I have a ton of extra practice problems on the class website and Cengage, today would be a great day to catch up with any remaining questions that you might still have.




# Spiderman's Gwen Stacy

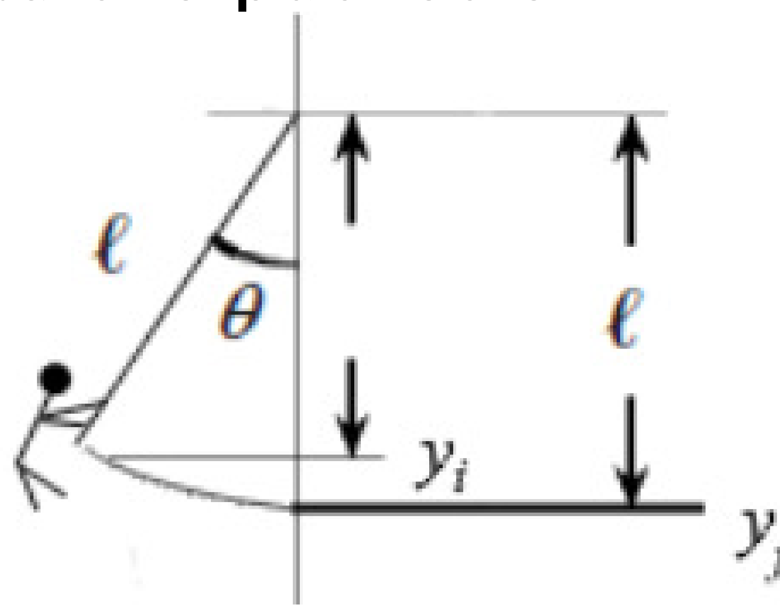
Gwen who weighs 50 kg falls 300 feet and is then brought to rest by Spiderman's webbing in 0.5 s. What is the impulse and force on Gwen? Ignore air resistance.

What does Spiderman do to stop this in the future?

An acrobat swings on a 26.0 m long cable initially inclined at an angle of 39.0° with the vertical. (Assume the cable has negligible mass.)

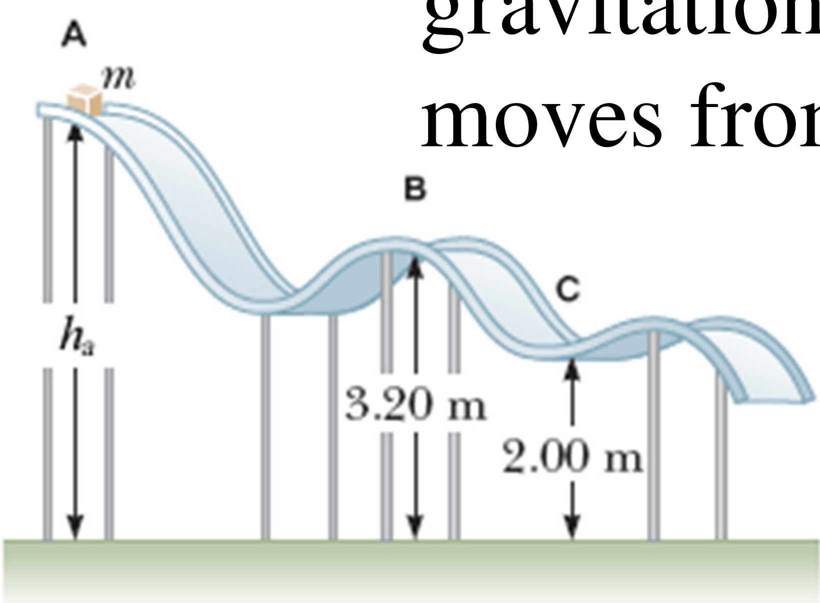
(a) What is the acrobat's speed (in m/s) at the bottom of the swing if she starts from rest?

(b) What is the acrobat's speed (in m/s) at the bottom of the swing if instead she pushes off with a speed of 4.80 m/s?

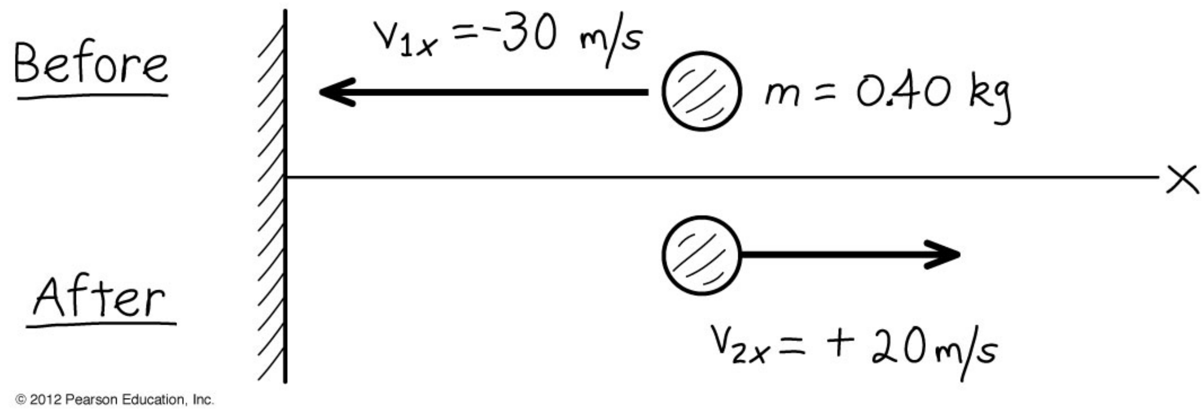


The figure below shows an object with a mass of $m = 3.10$ kg that starts from rest at point A and slides on a track with negligible friction. Point A is at a height of $h_a = 6.10$ m.

1. What is the object's speed at point B?
2. What is the object's speed at point C?
3. What is the net work (in J) done by the gravitational force on the object as it moves from point A to point C?



A child in a sled with combined mass of 50 kg slide down a frictionless hill. If the sled starts from rest and has a speed of 3.0 m/s at the bottom, what is the height of the hill?




A 0.40 kg ball is initially moving to the left at 30 m/s. After hitting the wall, the ball is moving to the right at 20 m/s. What is the impulse of the net force on the ball during its collision with the wall?

A. 20 kg • m/s to the right

B. 20 kg • m/s to the left

C. 4.0 kg • m/s to the right

D. 4.0 kg • m/s to the left

E. none of the above

**Q70**

# More examples for impulse: Another baseball example

A baseball player of mass 84.0 kg running at 6.70 m/s slides into home plate and comes to a stop.

- What magnitude of impulse is delivered to the player by friction?
- If the slide lasts 0.750 s, what is the average friction force exerted on the player?

A 75.0 kg ice skater moving at 10.0 m/s crashes into a stationary skater of equal mass. After the collision, the two skaters move as a unit at 5.00 m/s. Suppose for this problem the average force a skater can experience without breaking a bone is 4500 N. If the impact time is 0.100 s, does a bone break for either skater?

For each skater:

$$|F_{av}| = |\Delta p| / \Delta t$$

Mass of each skater does not change

$$|F_{av}| = |\Delta p| / \Delta t = m\,|\Delta v| / \Delta t$$

A piece of fruit falls straight down. As it falls,

A. the gravitational force does positive work on it and the gravitational potential energy increases.

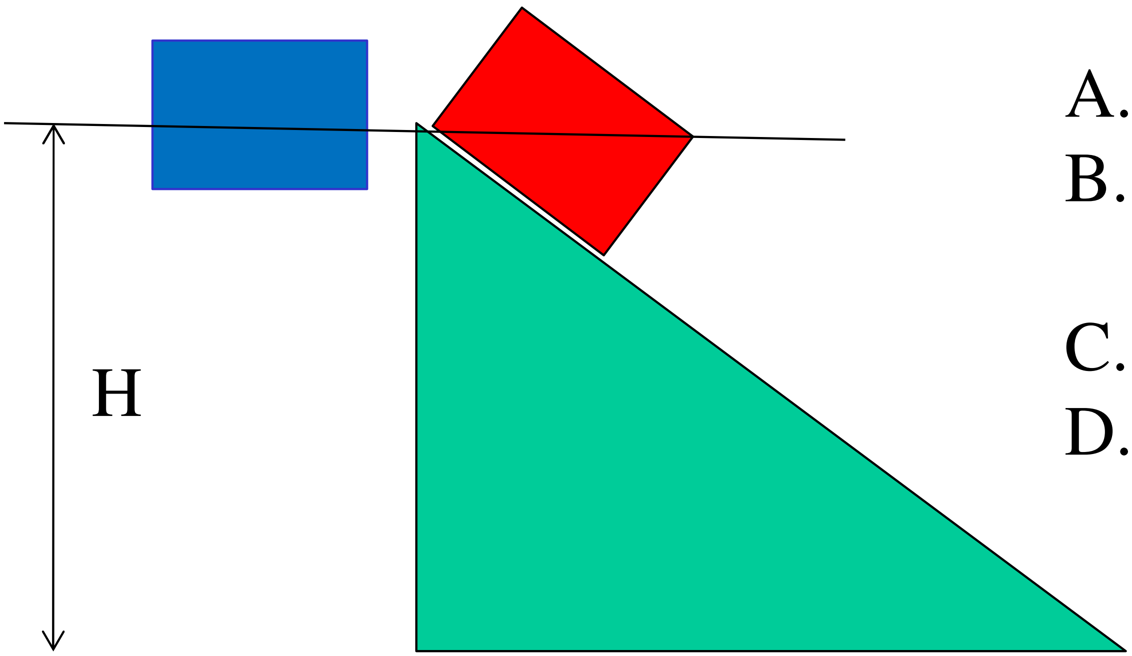
B. the gravitational force does positive work on it and the gravitational potential energy decreases.

C. the gravitational force does negative work on it and the gravitational potential energy increases.

D. the gravitational force does negative work on it and the gravitational potential energy decreases.

Q62

Two identical boxes fall a distance H. One falls directly down; the other slides down a frictionless incline. Which has the larger speed at the bottom?




A. The one falling vertically
B. The one sliding down the incline
C. Impossible to determine
D. It's the same

**Q63**

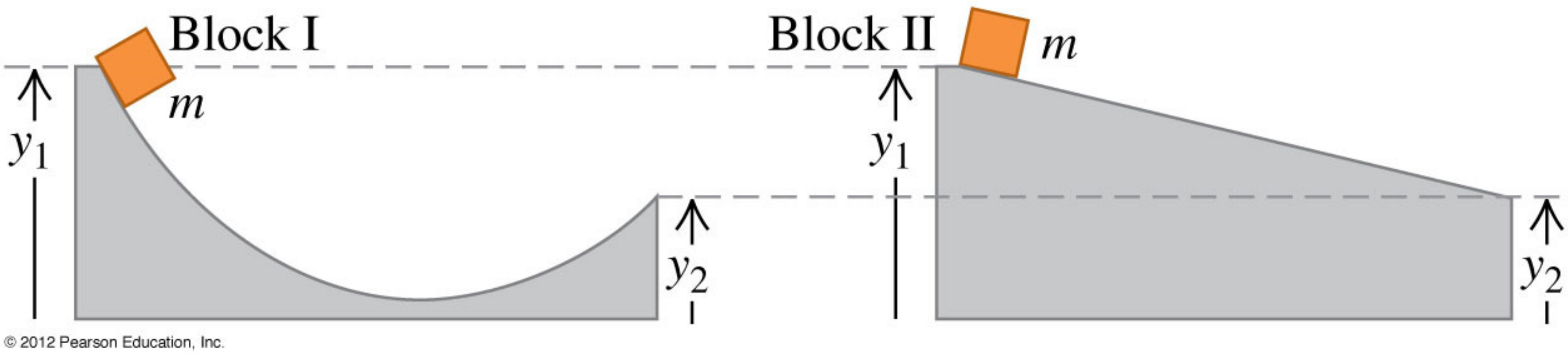
$W_c = -\Delta PE$ and Total Work $= W_c + W_{nc} = \Delta KE$ $(KE = \frac{1}{2} mv^2)$

What if we turn friction back on? (**Q64**)

If frictionless, which takes the shortest time to travel that distance? (**Q65**)

Work and energy ideas are powerful for forces, distances, speeds, but not times.

The two ramps shown are both frictionless. The heights $y_1$ and $y_2$ are the same for each ramp. A block of mass $m$ is released from rest at the left-hand end of each ramp. Which block arrives at the right-hand end with the greater speed?




A. the block on the curved track

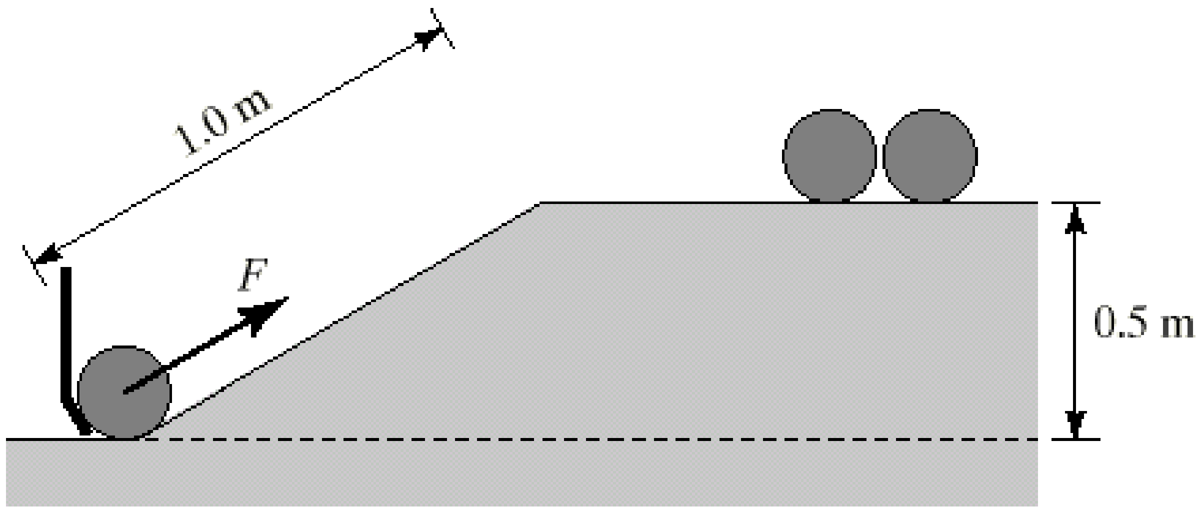
B. the block on the straight track

C. Both blocks arrive at the right-hand end with the same speed.

D. The answer depends on the shape of the curved track.

**Q66**

At the bowling alley, the ball-feeder mechanism must exert a force to push the bowling balls up a 1.0-m long ramp. The ramp leads the balls to a chute 0.5 m above the base of the ramp. Approximately how much force must be exerted on a 5.0-kg bowling ball?




A. 200 N
B. 50 N
C. 25 N
D. 5.0 N
E. impossible to determine

Q68

A satellite is moving around the Earth in a circular orbit. Over the course of an orbit, the Earth's gravitational force

A. does positive work on the satellite.

B. does negative work on the satellite.

C. does positive work on the satellite during part of the orbit and negative work on the satellite during the other part.

D. does zero work on the satellite at all points in the orbit.

Q67

# More conservative examples:

Springs (ignoring friction)
Any example in Chapter 2-4 (ignoring friction)

In this class, friction and air resistance are the main nonconservative forces we will use. In general, it is defined as nonconservative if you cannot get that energy back (like if you push something).

# Power not tested

- Due to lack of time, power is not tested. However, it’s a pretty easy topic (just work divided by time) and it can help you understand how your electricity bill works.
- It’s ease is why I drop it. You can figure it out on your own. The other material we cover needs a little more guidance.
- I include some stuff on it below in case you want to see what I would teach if I had time.

# Understanding Your Electricity Bill

Power is rate at which energy is transformed:

Average power:

$$\overline{P} = \frac{\text{Work}}{\text{time}} = \frac{W}{\Delta t}$$

Units: J/s = Watt (W)

Also: since $W = F_{||}\Delta x$,

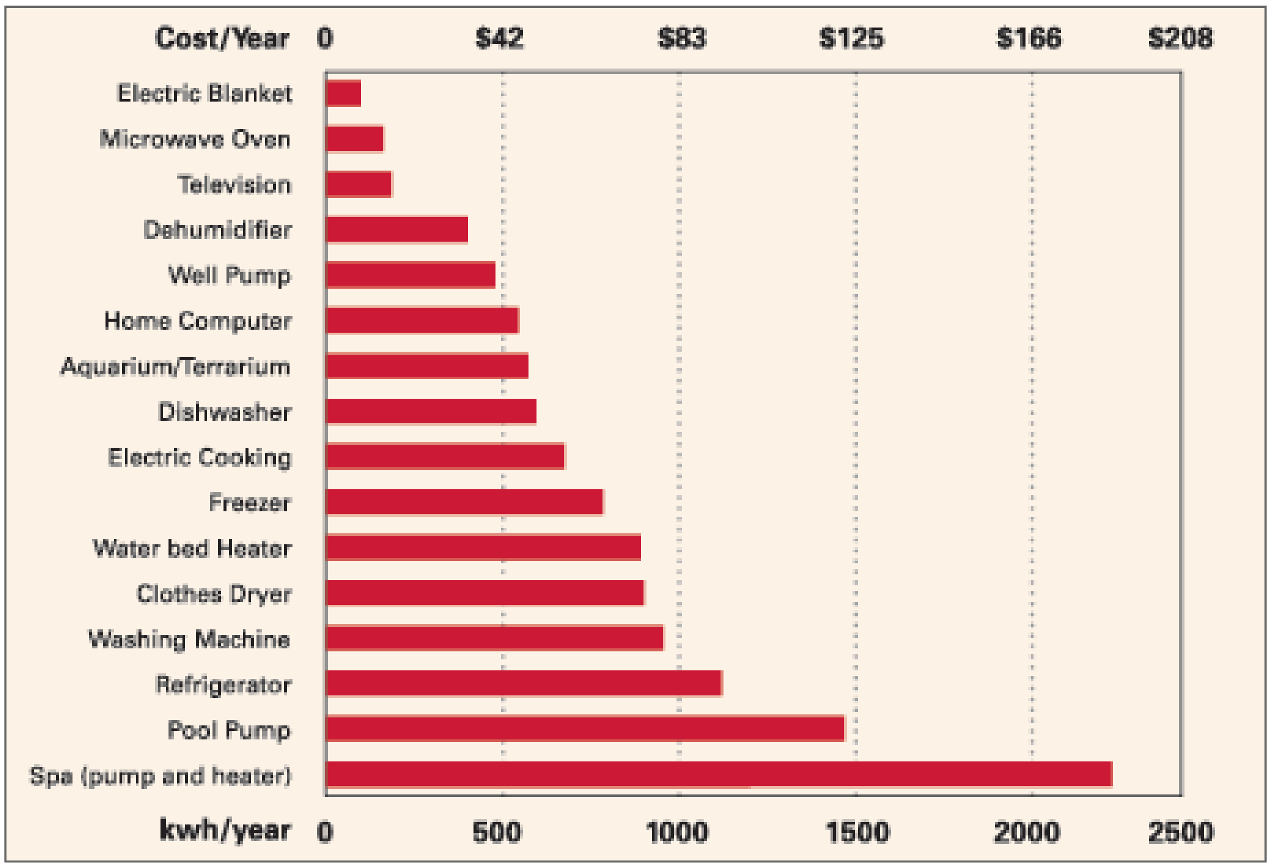
$$\overline{P} = \frac{F_{||}\Delta x}{\Delta t} = F_{||}\overline{v}$$

Note: Power is **not** energy. Power is the **rate** at which energy is transformed/used.

An advertisement claims that a certain 1200 kg car can accelerate from rest to a speed of 25 m/s in a time of 8.0 s. What power (in units of horsepower) must the motor produce in order to cause this acceleration?

Ignore losses due to friction. (1 hp=746 W)

About how much does it cost to run a 1.8 kW heater for 1 month if it is used 3 hours each day. Electricity costs about $0.10 per kWh.

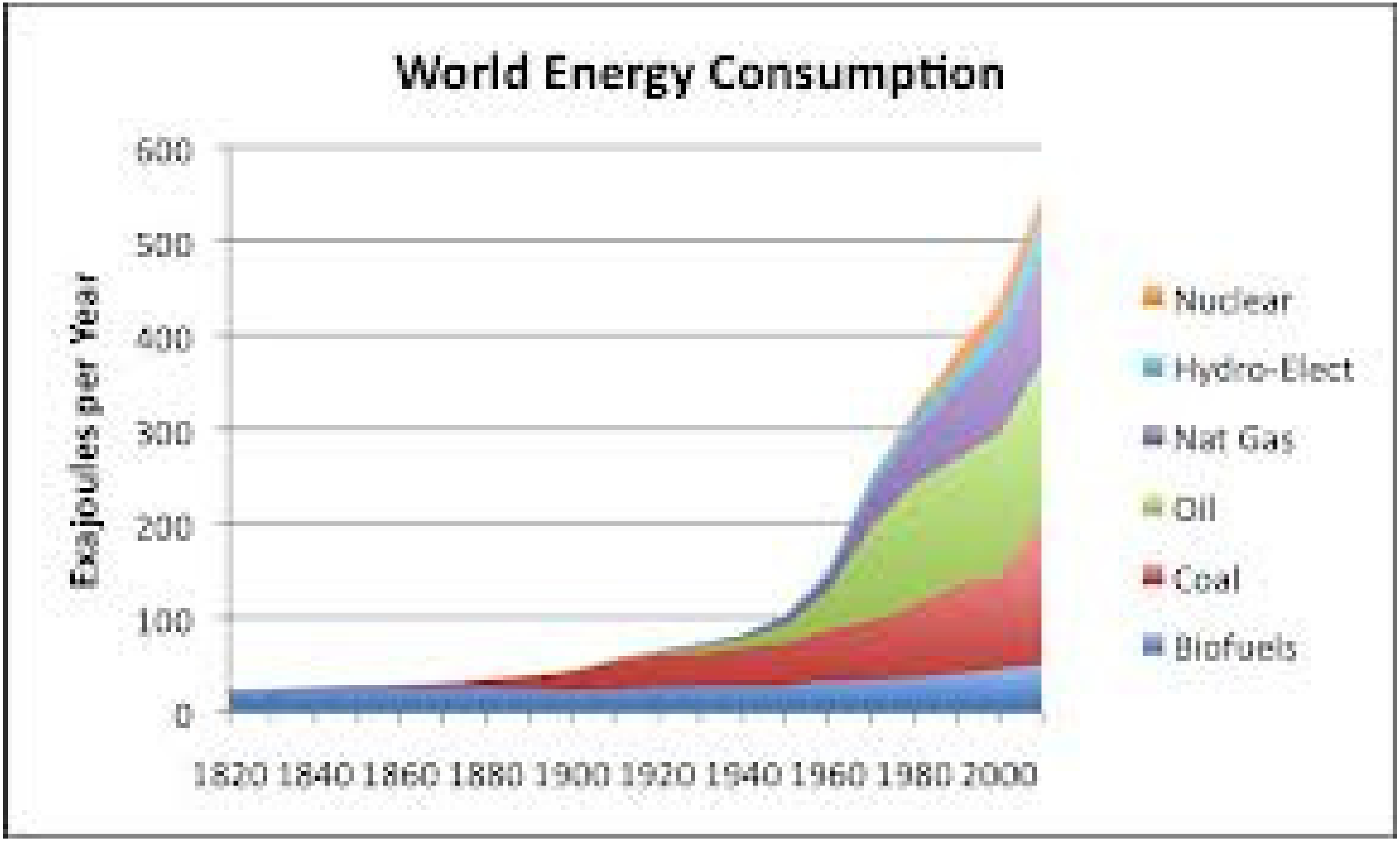



Yearly cost of powering household items.

Multiply the item's power times the time it is used.

Cost of forgetting to turn off your bathroom light for the day. Let's say you have three 75W bulbs in this light and you are gone for 12 hours. Again, electricity costs about $0.10 per kWh.

# 1 Exajoule (EJ) = $10^{18}$ J




The “All of the Above” Policy: We need to increase our energy production from all sources!

**How many hamsters running on wheels would it take to provide enough power for a house?**

Let's assume a hamster weighing 50 grams can run up a 30-degree slope at 2 m/s.

120 hamsters to keep a 60-watt bulb lit

Average hamster probably spends ~5 % of its life running, so we would need 2,400 hamsters just for lightbulb

The average household needs a constant power consumption of about ~2.5 kW. Each house would need ~100,000 hamsters.

Weightlifter A lifts a 100-kg weight to a height of 2.5 m above the ground in 1.0 s. Weightlifter B lifts a 75-kg weight to a height 2.5 m above the ground in 0.5 s. Which of the two weightlifters uses more power to lift the weights?


$$\overline{P} = \frac{\text{Work}}{\text{time}} = \frac{W}{\Delta t}$$

A. A

B. B

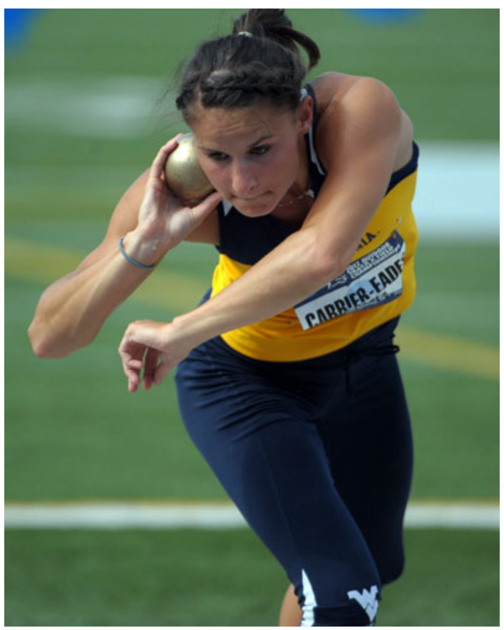
C. They both use the same amount of power.

D. Impossible to determine.

Q61

# Average Power

A shot-putter accelerates a 7.3-kg shot from rest to 14 m/s. If this motion takes 2.0 s, what average power was produced?



# Clicker Answers

Clicker #=Answer

60=A, 61=B, 62=B, 63=D, 64=A, 65=A, 66=C, 67=D, 68=C, 70=A