What's a Joule?

Overview: Energy shows up in all kinds of ways. We'll see how today through a simple lesson.

What to Learn: Energy is the ability to do work. You'll get practice playing with units and learning about how we measure energy and the forms it take.

Materials

- Something that weighs around 100 grams or 4 ounces, about the same as an apple
- A meter or yard stick

Lab Time

1. Grab your 100-gram object, put it on a table.
2. Now lift it off the table straight up until you lift it one meter (one yard).
3. Lift it up and down 20 times.
4. Record your observations in the worksheet.

Joule Observations

1. Describe the energy in your object before you do anything to it. Is there more than one way to say this, in terms of units?
2. When you move the object over one meter, what are you doing?
3. When you do this 20 times, use math to say how many Joules of work you are doing.
4. How many Joules of work do you do if you lift the apple 50 times?

Reading

If we wish to talk about energy further, we need to have a unit of measurement. For energy, a couple of units are the *Joule* and the *calorie*. A Joule is the energy needed to lift one Newton one meter. A Newton is a unit of force. One Newton is about the amount of force it takes to lift 100 grams or 4 ounces or an apple.

It takes about 66 Newtons to lift a 15-pound bowling ball and it would take a 250-pound linebacker about 1000 Newtons to lift himself up the stairs! So, if you lifted an apple one meter (about 3 feet) into the air you would have exerted one Joule of energy to do it.

The calorie is generally used to talk about heat energy, and you may be a bit more familiar with it due to food and exercise. A calorie is the amount of energy it takes to heat one gram of water one degree Celsius. Four Joules are about one calorie.

A 100-gram object takes about one Newton of force to lift. Since it took one Newton of force to lift that object, how much work did we do? Remember work = force x distance so in this case work = 1 Newton x 20 meters or work = 20 Joules.

You may ask, “But didn’t we move it 40 meters, 20 meters up and 20 down?” That’s true, but work is moving something against a force. When you moved the object down you were moving the object with a force, the force of gravity. Only in lifting it up are you actually moving it against a force and doing work. Four Joules are about 1 calorie, so we did 5 calories of work.

“Wow, I can lift an apple 20 times and burn 5 calories! Helloooo weight loss!” Well… not so fast there Richard Simmons. When we talk about calories in nutrition we are really talking about kilo calories. In other words, every calorie in that potato chip is really 1000 calories in physics. So as far as diet and exercise goes, lifting that apple actually only burned .005 calories of energy … rats.

It is interesting to think of calories as the unit of energy for humans or as the fuel we use. The average human uses about 2000 calories (food calories that is, 2,000,000 actual calories) a day of energy. Running, jumping, sleeping, and eating all use calories/energy. Running 15 minutes uses 225 calories. Playing soccer for 15 minutes uses 140 calories. (Remember those are food calories, multiply by 1000 to get physics calories). This web site has a nice chart for more information: Calories used in exercise.

Everything we eat refuels that energy tank. All food has calories in it and our body takes those calories and converts them to calories/energy for us to use. How did the food get the energy in it? From the sun! The sun’s energy gives energy to the plants, and when the animals eat the plants they get the energy from the sun as well.

So, if you eat a carrot or a burger you are getting energy from the sun! Eating broccoli gives you about 50 calories. Eating a hamburger gives you about 450 calories! We use energy to do things and we get energy from food. The problem comes when we eat more energy than we can use. When we do that, our body converts the energy to fat, our body’s reserve fuel tank. If you use more energy then you’ve taken in, then your body converts fat to energy. That’s why exercise and diet can help reduce your weight.

Exercises Answer the questions below:

1. If something has a weight of 2 Newtons and is moved half a meter, how many Joules of energy are used? Show your work.

2. What is the source of all this energy we’re working with here?

3. It doesn’t count as work when you move the apple back down. Why not?

Answers to Exercises: What's a Joule?

1. If something has a weight of 2 Newtons and is moved half a meter, how many Joules of energy are expended? (1 Joule)
2. What is the source of all this energy we're working with here? (the sun)
3. It doesn't count as work when you move the apple back down. Why not? (The force of gravity does the work, not your arm.)