

Quantifying the Energy Associated with Everyday Things and Events

Teacher's Guide to Accompany the BLOSSOMS Video

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The topic of this video is energy in general, and specifically the ways we can quantify it. In order to make the concepts accessible to a broad audience, this video focuses on everyday things and events. How is it that energy plays a part in a child riding a scooter? How is the energy we consume in playing related to the energy on the food we eat? This video poses these questions to the class and challenges them to put a list of five such items into an ordering from most energy to least.

The first segment of this video focuses on a key concept throughout the lesson -- the units of measure for energy. Whenever we quantify a physical parameter, we need both a number (indicating the amount) and a unit of measure which indicates what quantity we are counting. For energy, a standard unit of measure is the Joule, defined as a Newton meter. A Newton is a unit of force. I find it easy to remember that a Newton is about the weight of a medium sized. If you lift an apple by one meter, you just did one Joule on work -- you gave the apple one Joule more potential energy than it had previously. And your muscles must have consumed at least one Joule of energy supply (such as glucose). Actually, your muscles will need to consume more like 5 Joules to lift the apple since our metabolism of food energy in our bodies is only about 20% efficient.



At the end of the first segment, pose a challenge to the students. I suggest that you, as the teacher, work with the students to develop a few more examples of a concrete instances of energy associated with common every-day things and events. I would suggest you to make your examples include a variety of domains like: mechanical kinetic energy, chemical energy, electricity, heat, air pressure, etc. One of the challenges in this is ensuring that the examples are sufficiently detailed to specify an amount of energy. For example, a student may say that “climbing stairs” is an example of an event related to energy. That is true. But the amount of energy depends on how many stairs and the size of the person climbing them. I would suggest that “a 5th grader climbing a flight of 14 stairs” is better than just “climbing stairs”. So please help your students to think through their examples and make them complete.

For the rest of the video, the challenge is to rank a set of common, every-day things and events in terms of the amount of energy associated with them. Here are the things we ask the students to ponder during this session:

The energy needed to propel a scooter for a distance of 1 kilometer at a speed of 5 meters per second. Something has to do work to keep a scooter going. Usually the rider does the work with his or her foot pushing backward on the ground. To travel one kilometre, you need to consume some energy. We want to consider how that energy relates to that related to some other every-day events.

Another item we are asking the students to rank is the gravitational potential energy of a Canada Goose flying at 1,000 meters above the ground. We introduced in the first segment that an apple raised by one meter is a Joule. Well, it will take more energy to raise a goose by a thousand meters. But how much more?

Food energy in an ear of corn. We know the rider of the scooter (or the goose for that matter) will eat food to get energy. How much energy is there in the food we eat? How do we quantify that and compare it to other kinds of energy?

Energy needed to pump up a 2 liter bottle to 60psi gauge pressure. Air and other gases are often used in engines and other devices to store or convert energy. It turns out that common soda bottles can hold quite a lot of pressure. How much energy is involved in that?

Energy needed to compress a suspension spring of a Honda Accord by 2 cm. We know that cars manage energy in lots of different ways – accelerating, braking, climbing hills. But what about the energy related to going over bumps? That’s what an automotive suspension manages. How does that energy compare with other kinds of energy?

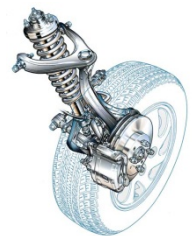


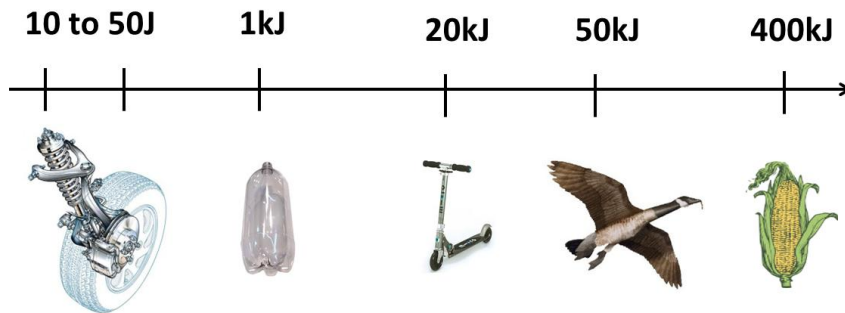
The list of five things above is somewhat arbitrary, but the list nicely covered a range from a few Joules to about a Mega Joule. So this will help people appreciate a wide range of quantities. The main challenge we pose to the class is to take this list and put them in the right order. This can be done by taking any pair from the list of five above and deciding what order they should be in. You could do this in any sequence you want, but the video starts off with the Canada goose and the suspension spring. Which has more energy? How do you justify your answer? The reason that the goose and car suspension are a good place to start is that:



1) the estimates can be made by just comparing forces and distances, and 2) the amount of energy is very different so you don’t need too much refined calculation to get the right answer.

After doing the first two items, I find it is helpful to have a visual aid to organize the work. I suggest you use a chalk board or other visual media to make a number line and place the five items on that line. In the video, we go through a process of placing all five items on a line and we end up with the figure below.





Your use of this video can be flexible. You may find that just doing three of the items is enough to get the basic lesson across. Some of the items like the two-liter soda bottle are fairly advanced. You might find a simple way to make a rough estimate, but an actual calculation of the energy is fairly hard work. If you decide to attempt this with your class, I suggest you try reviewing the supplementary materials provided on the BLOSSOMS web site.

However you choose to make use of the video, it is helpful to keep in mind the key learning opportunities:

- Energy is an important concept. Understanding energy in its many forms is a key to solving the future problems of humanity.
- Understanding energy requires quantification. We need to know how much energy there is and where it is going.
- To develop understanding of energy, it's helpful to quantify energy in things all around us -- the food we eat, the work we do, the machines we operate.

I hope this video can provide some structure for an interesting set of activities and discussions for you and your students.