Energy Part 1: Work

Energy is an idea that is important in our daily lives. We get **energy** from the food we eat. Too much high-energy food, and the energy is stored in our bodies as fat; too little and we lose weight. In the north country, we build our houses to conserve energy. In the tropics, we build houses to keep the heat out. Not long ago, California had an energy crisis that cost the state and its citizens a tremendous amount of money. Currently, a lot of energy is being put into mounting a recall election to challenge the governor of that state…

Energy is an idea essential to understanding every life and physical science unit we teach.

The scientific definition of **energy** is deceptively easy:

Energy is the ability to do work.

So what is work?

Of course, everybody knows what it means to do **work**. We do work every day. As we sit at our computers thinking, or struggle to solve a mathematics problem, we are doing work--- right? When we strain our muscles to lift a heavy object, we are doing work—right? When we run up stairs, we are doing work---right? As we labor to push a stalled car out of traffic, we are doing work---right? But, has work been done?

For some of the examples of work in the paragraph above, you might be surprised to know that physicists would not agree that **work** is being done. So, the difficult part of defining **energy** as scientists define it is defining **work** as scientists define it.

Examples of Work (as scientists define work)	Non-Examples of Work (as scientists define work)
• Using a lever to lift a rock • Carrying a box up stairs • Pushing a stalled car	• Writing a term paper • Unsuccessfully attempting to lift a heavy box • Pulling on the reins of a donkey that will not move

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What distinguishes the examples of **work** as scientists define it from our everyday examples of work?

Let's look at each example of **work being done**, starting with those that are scientifically approved:

- When you use a lever to lift a rock, the lever is pushing up on the rock *as* the rock moves up.
- When you carry a box up the stairs, you are exerting an upward force on the box *as* the box moves up.
- *As* you push the car, it moves in the direction you are pushing.

What about everyday ideas of work that scientists don't accept?

- When you compose a writing sample, you call the mental processes occurring (e.g., sorting through information, structuring paragraphs, editing) *work*. A scientist would not call thinking **work**. However, a scientist would agree that when you push down on the computer keys you are doing **work** because work has been done on the keys. As you push down on the keys, the keys move downward.
- When you just can't lift that heavy box, despite strain and sweat, your muscles are straining, but to no avail, that's not work because no work was done on the box.
- When you try to budge that stubborn donkey, both of you are pulling against each other, but it's a stalemate with no motion in either direction.

So what makes the first set of examples fit the scientific concept of **work**? What's missing from the second set?

In each example, three things are present:

1. There is a force (a physical push or pull).
2. There is movement.
3. An object moves in the direction of the force as the force is being exerted.

These three pieces together lead to the definition of **work**:

Work is done when:
- a force is applied on an object, *and*
- the object moves in the direction of that force, *and*
- the force and motion occur simultaneously.

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Only when all elements are present is **work** done.

Energy and work

So… how does this fit with our definition of **energy**?

Energy is the ability to do work.

This means that energy is present when something or someone is <u>*capable*</u> of doing work. **Work** doesn't actually have to be done in order for **energy** to be present; the <u>*ability*</u> to do so must be there. Sound confusing?

Next week we will go into this in more detail when we look at different types of energy: <u>potential</u> and <u>kinetic</u>.

Meanwhile, think about these questions:

What are some examples of **potential energy?**

In other words, under what circumstances is the *ability* to work present, but <u>no work</u> is being done?

What do the New York State Standards say?

In the <u>Elementary</u> and <u>Intermediate</u> Core Curricula, Standard 4, The Physical Setting, Key Idea 4 states:

- *Energy exists in many forms, and when these forms change energy is conserved.*

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