УДК 620.9=111

Voitovich S., Govrov A., Matusevich O.

Work and Energy

Belarusian National Technical University
Minsk, Belarus

We hear and use the word “work” many times each day. People go to *work*. We do our math home*work*. You *work* on your bicycle. A sculpture is a *work* of art. In each case the word “work” has a different meaning.

In physical science, however, work has only one meaning. When we do work, we exert a force through a distance. For example, the people who are walking are doing work. They are using a force to move a certain distance. You do work when you try to fix a part on your bicycle. The sculpture itself is not doing work. But the person applying the chisel certainly is. In this article we will find out more about work in its scientific sense.

Energy is a word we have heard and used many times. People already have a good idea of what energy is. For instance, we know that a blasting off rocket has a lot of energy. It means that a high-speed truck has plenty of energy. A basketball player needs a lot of energy to play the entire game. We need energy to do work. That is why we must eat a good breakfast each day. Machines also need energy to do work. Whenever work is done, energy is used.

Work. How can we tell when work is being done? For work to be done, a force must be applied to an object. The force must cause a change. Look at the people in Figure 1. Are either of them doing work?

Figure 1A shows a girl trying to lift a 500-N barbell off the floor. Although she exerts a force, the barbell does not move. Since there is no change, she is not doing work. The girl in Figure 1B, however, does do work in lifting the 100-N barbell to her knees. She does more work as she lifts the barbell to her chest and as she presses it over her head. She did work because in each case the force exerted on the barbell made it move a certain distance.

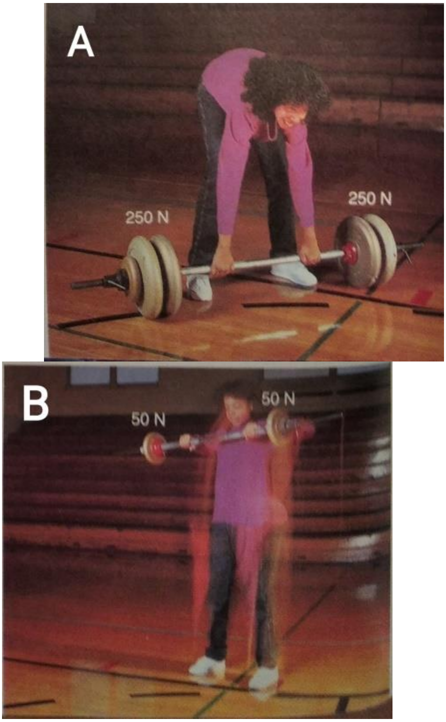

Figure 1. People Try to Do Work

It is worth mentioning that to do work we have to apply a force. We must make the object move in the same direction as our force. In fact, work is defined in these terms. Work is the amount of force exerted on an object times the distance the object moves [1]. As the boy lifts the barbell, he does work on the barbell. But is he doing work if he simply carries the barbell across the room? See Figure 2. In the scientific sense, he is not doing work. The direction of the applied force (up) is not the same as the direction of motion (to the right).

Notice that work does not involve time. All that matters is what force is exerted on the object and what distance the object moves. Once the boy presses the barbell over his head, he does no further work on the barbell. He does no work even if he holds it there for an hour.

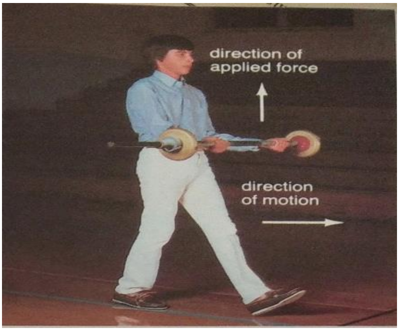

Figure 2. The Boy Does Work

Energy. Suppose we lift a super-hard ball a distance of one meter. When we release the ball, it falls. It gains speed until it hits the floor. After the ball hits the floor, it bounces back up.

The ball's motion is complex. The height and speed of the ball keep changing. These changes occur because the ball has energy. Energy is the ability to cause changes in matter. These changes are possible because you did work on the ball by lifting it. The more work you put into lifting the ball, the more energy the ball gets. Energy comes in many forms. Some of the many forms of energy are chemical energy, mechanical energy, and light energy. See Table 1 for other forms of energy.

Form of Energy	Source
Atomic	radioactive materials
Chemical	batteries
Light	the sun
Mechanica	machines
Sound	vibrations

Table 1. Forms of Energy and Their Sources

All the different forms of energy can be divided into two basic kinds. These kinds are potential energy and kinetic energy. Potential energy is stored energy. The energy in a wound-up rubber band is potential energy. So is the energy of a person on a high-dive platform. All these objects have potential energy because work was done on them to put them in their present state. Kinetic energy is the energy of motion. When the rubber band is released, the plane's propeller spins and the toy flies. The toy has kinetic energy. When the swimmer dives off the platform, she has kinetic energy. Potential energy and kinetic energy are related. As one decreases, the other increases. This relationship is the basis of a very important law about energy.

We observe changes all the time. Balls bounce, bicycles roll down hills, batters hit baseballs high into the air, and children swing on swings. Energy changes from one kind into another. As the swimmer dived, she lost potential energy. At the same time, she gained kinetic energy. The total energy of the diver is her potential energy plus her kinetic energy. But the total energy of an object does not change! The total energy remains the same. This is an important pattern in nature called the conservation of energy. The Law of Conservation of Energy states that the total energy of an object, or of a group of objects, stays the same [2].

References:
1. Work and Energy [Electronic resource]. – Mode of access: https://www.toppr.com/guides/physics/work-and-energy/work-and-energy. – Date of access: 13.03.2021.
2. Law of Conservation of Energy [Electronic resource]. – Mode of access: https://www.nuclear-power.net/laws-of-conservation/law-of-conservation-of-energy. – Date of access: 11.01.2021.