2.8: Looking Back and Ahead

> This page is a draft and is under active development.

We now have quite a few different forms of energy: thermal, bond, kinetic, gravitational potential, and spring (or elastic) potential energy. A given physical situation could involve any number of these. Energy can be transferred among physical systems either as heat (when there is a temperature difference between two objects) or as work (when one object exerts a force on another object that acts through a distance). There are yet other forms of energy that involve electrical interactions, magnetic interactions, and a more general form of the gravitational energy.

It turns out that gravitational potential and spring potential energies we discussed in this Chapter are examples of one of the two fundamental *types* of energy, the type that depends on the *positions* of objects. An energy that depends only on the relative positions of objects, and not on their past history (the path they took) or on their speeds, is called a potential energy. “Positional energy” is a more descriptive word, but for historical reasons, these are labeled *potential energy*. The second fundamental type of energy depends only on the speeds of particles (objects). This kind of energy is called energy of motion or *kinetic energy*.

All of the various kinds of energy fit into one of the two fundamental types. For example, chemical bonds involve the electric potential energies that depend on the locations of the electrons of the atoms as well as their kinetic energies as they whirl around the nucleus. Thermal energy is a combination of the kinetic and potential energies of individual atoms due to their random motions. Bond energy is a potential energy due to the force individual atoms exert on each other. The elastic energy of a spring is a potential energy because it depends only on the positions of the elements of the spring, not on their speeds. When an object rotates, it has energy due to its rotational motion, rotational kinetic energy.

One energy is as good as any other, almost. On a ***microscopic*** scale, energy is energy and any kind can be turned into any other kind. But on a ***macroscopic*** scale, where lots of particles (atoms and molecules) are involved, it turns out that all kinds of energy can be turned into thermal energy, but there are restrictions on turning thermal energy back into other kinds. We can convert some, but not all thermal energy to other forms. (We delve into the mysteries of entropy and the second law of thermodynamics in Chapter 4.)

By treating thermal interactions and mechanical interactions on an equal footing, we can approach realistic situations without having to automatically assume friction or air resistance is negligible. By now you should be very comfortable with the Energy-Interaction model. When we encounter new “kinds” of energy, it won’t be a “big deal”. We simply add them to our repertoire of energies that might change in any particular interaction.

Now we are in a position to delve into particle models of matter. Our goal is to be able to understand, in a general or universal way, as many of the properties of matter as we can. As we do this, we will also make a much more direct connection to thermodynamic concepts you have worked with in chemistry courses.

Even as we extend and perfect our Energy-Interaction model, we recognize that many questions are beyond its reach. For example, our before-and-after approach cannot tell us, “How long did it take an object to fall?”. Questions like this involve the dynamics (the details) of interactions. We will spend more time in Physics 7B and accompanying courses understanding the dynamics of rigid objects. This is fundamentally the relation of force to motion known as Newton’s Laws. Using Newton’s laws and kinematics to describe the details of interactions, we can answer questions that are unanswerable using the before-and-after approach. But for right now, we stick to an energy approach and avoid, as much as possible, the details of interactions.

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