About Energy

What is Energy?

The formal definition of energy as given by all physics text books is the ability of an entity to do work. Then one may ask.

What is work?

To answer this question, and subsequently, what is energy, one needs only to look at what happens in the physical world regarding all entities that requires these entities to do something other than do nothing. Entities require something to make them move, change their shape or form, or from one state of matter to another. Eg from a solid to a liquid to a gas.

This is what a physicist means by doing work.

A better definition of energy that can be better understood is to say that energy is

Definition E1

Energy is the “substrate” that causes the change of the physical state of an entity from one physical state A to another physical state B.

That is fundamentally what is happening in any physical process that causes a change in the physical state of an entity. One example of a body or elementary particle will not move or change its direction of movement unless a “something” interacts with it. One case is that of another colliding particle or body, or a field such as an electric or gravitational field.

Thus the colliding body or field is the “substrate” given in definition E1 that causes a change in the physical state of the body given in the example above. However, as any physicist or student of physics knows, any interacting entities or bodies do not have the interaction occurring in a one way direction. Any interaction of one body on another also has an interaction upon itself caused by the body it is interacting on.(Newtons 3rd Law)

To go back to the above example, If body B changes its physical state of motion by having body A interact with it by a collision, then body A also interacts with body B to change its physical state of motion. In the case of a field such as gravity, for both bodies to interact with each other, they both must possess the same field. Taking gravity as an example, the gravitational field of Body A interacts with the gravitational field of body B as “seen” by body A perspective, and the reverse from body B perspective.

Thus it is not body A or body B, or any field they may have that causes any change in either of their physical states, it is the interaction itself that causes these changes.

Therefore the “substrate” of definition E1 is not a physical property that makes up energy, but it is the interaction of one physical property of an entity A with that of another entity B that can be defined as the source of the energy. It can be considered that the interacting property that is the source of energy is of a common like type. Eg. electromagnetic fields interact with other electromagnetic fields. A more precise definition of E1 can be better defined as

Definition E2

Energy is the interaction of physical properties of one entity, or a system of entities with another entity or system of entities that causes the change in the physical state of all entities involved from one physical state A to another physical state B.

When speaking of energy, many a physicist will coin the term “Energy can be transferred from one form of energy into another”

What does this mean?

The are many terms for energy. Electrical, chemical, nuclear, gravitational, thermal, mechanical and kinetic energy to name some of the most common. Do they all have something that is fundamentally in common to all of them that complies with definition E2, and facilitates the term for the transference of one energy into another?

To answer this, it is best to consider the fundamental entities in the universe, the electron and proton. Each possess an electric and gravitational field which can interact with each other forming much of known matter in the universe. Even more fundamental is electromagnetic radiation in the form of photons, of which the interaction of two like photons with the right properties of what is termed wavelength or frequency, can create an electron-positron pair. This is a reverse process where combining an electron-positron pair will result in two photons of the same wavelength that created the electron-positron pair.

This satisfies definition E2, and thus electromagnetic radiation is one of the most fundamental forms of energy that

is common to all forms of matter. This fundamental form of energy can defined by what is measured as the wavelength or frequency of this EM radiation or photons, also called light. When examined, the forms of energy mentioned can be broken down to the interaction of photons with the matter that interacting photons had created, or the interaction of the electric and gravitational fields matter possess, with each other.

A really simple definition of energy could be stated as thus.

Definition E3

Energy is what causes a change in an entity or system of entities to change form an initial physical state A to another physical state B.

Energy and forces

When considering energy as defined by Definition E3, it is defined commonly in physics that to change the physical state of an entity, such as the direction of motion or velocity, a force is exerted on the entity. Gravity, or an electric force for example. Thus energy can be considered as another expression or definition of a force, and from Definition E2, a force can be defined as the simple interaction of energy fields, where those energy fields on the most basic level are gravitational, electromagnetic or nuclear.

If all there is a unification of these fields into one grand unified field theory that is sought by physicists, then a fundamental process of thinking to unify these fields would be to consider that they all interact with each other in a fundamental way, and that they are all manifestations of a single field, and hence energy source.