SCI – ENERGY

Unlike matter, energy (e.g. light, heat, electricity, etc.) do not have mass, nor do they occupy space; rather, they affect matter, causing changes to their position or state. For example, heating causes water to boil and change state; explosion causes things to go flying, changing their position.

On molecular levels, changes of state are actually movements of atoms or molecules. For instance, the degree of heat energy contained in a substance is a measure of the relative vibrational motion of the atoms and molecules of the substance. Therefore we can define energy as the ability to move matter. Additionally, energy generates force in the direction of the force. As such, we can also say that energy is the capacity to do work.

Forms of Energy

There are many forms of energy. These include: mechanical energy, heat (or thermal) energy, light energy, chemical energy, electrical energy, atomic energy, solar energy, etc.

Kinds of Energy

Energy can be categorized as either kinetic or potential energy.

- Kinetic energy: is the energy in action or motion. Light shining, heat pressing a cloth, physical motion and electric current are all forms of kinetic energy.
- Potential energy: is energy in storage. A system or substance with potential energy is not doing work at the time but could do work if a very little force acts on it. In other words, potential energy is a stored energy that could release one or more forms of kinetic energy. For instance, a stretched rubber band has potential energy, it can send a paper clip flying. Numerous chemicals, such as gasoline and other fuels, release kinetic energy when ignited. The potential energy contained in such chemicals and fuels is called chemical energy.

Measuring Energy

As energy does not occupy space or have mass, it cannot be measured in units of weight or volume, but it can be measured in other kinds of units. One of the most common units is the calorie, which is defined as the amount of heat required to raise the temperature of 1gram of substance or 1millilitre of water

by 1 degree Celsius. This is a very small unit, so it is frequently more convenient to use kilocalories. Many forms of chemical energy can be measured in calories by converting a substance to heat energy in a device called bomb calorimeter and measuring the heat released by the corresponding rise in temperature. Temperature measures the molecular motion in a substance caused by the kinetic energy present in it.

Energy Laws: Laws of Thermodynamics

The first law of thermodynamics can be expressed as follows: Energy is neither created nor destroyed, but may be converted from one form to another.

The second law of thermodynamics can be expressed as follows: In any energy conversion, some of the usable energy is always lost. The conversion of energy and the loss of usable energy to heat are both aspects of increasing entropy. (Entropy is the measure of the degree of disorder in a system.) Heat energy is the result of the random vibrational motion of atoms and molecules. It is the most disordered (lowest) form of energy, and its spontaneous flow to cooler surroundings is a way for that disorder to spread. Therefore, the second law of thermodynamics may be more generally stated as follows: *Systems will go spontaneously in one direction only*—toward increasing entropy. The second law also says that all systems will go spontaneously only toward lower potential energy, a direction that releases heat from the systems.

Note: The word "spontaneously" is very important in this statement of the second law. It is possible to pump water uphill, charge a battery stretch a rubber band, compress air, or otherwise increase potential energy of a system. The verbs, "pump", "charge", "stretch" and "compress", tell us, however, that energy is being put into the system. In contrast, flow in the opposite direction, which release energy occurs spontaneously.