Homework 11

Energy

Energy is a scalar physical quantity which expresses the ability of an object to do work. It means that an object which possesses some energy can interact with other objects and cause changes in their positions and velocities. An object with higher energy can do more work. There are many forms of energy – kinetic, potential, thermal, chemical, nuclear etc.

Energy conserves. It means that energy can not be created or destroyed – it can only be transferred from one form into another. For example, a power plant does not create electrical energy. A power plant converts kinetic energy of water flow or chemical energy of fuel into electrical energy. When a battery of, say, a flashlight is depleted, it does not mean that the energy previously stored in battery just disappeared. The energy was just converted into thermal energy and energy of light.

We start with ***kinetic energy***. The ***kinetic energy*** of an object is the extra energy which it possesses due to its motion. Any moving object possesses kinetic energy. If two objects have same mass, the one with higher speed has higher energy. (I used the word "speed" instead of "velocity" because only the magnitude of velocity is important for the kinetic energy). If the speeds of two moving objects are equal, the object with higher mass will have higher kinetic energy. Kinetic energy can be calculated using the formula:

$$E_{kinetic} = \frac{m \cdot V^2}{2},$$

where ***m*** is mass, ***V*** is speed. The International System unit to measure energy is Joule (J).

$$1J = 1\frac{kg \cdot m^2}{s^2}$$

It is named after James Prescott Joule (1818-1889) – English physicist and brewer. Many scientists contributed to discovery and understanding of the energy conservation law. Among these were James Joule, Hermann Helmholtz and Julius Meyer.

James Prescott Joule

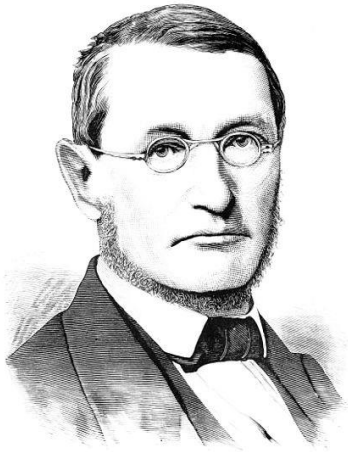
(1818-1889)

Hermann Ludwig Ferdinand

von Helmholtz

(1821-1894)

Julius Robert von Meyer (1814 – 1878), German physician and physicist whose name is associated with the first formulation of the energy conservation law. Famous Japanese physicist, Ryogo Kubo describes the discovery of Julius Meyer as follows:



Julius Rober von Mayer

(1814-1878)

Julius Robert Mayer (1814–1878) was really a genius who was born in this world only with the errand to make this great declaration. Hermann Ludwig Ferdinand von Helmholtz (1821–1894) gave this law the name "Erhaltung der Kraft" or "the conservation of energy". Like Mayer, he started his career as a medical doctor but lived a glorious life as the greatest physiologist and physicist of the day. James Prescott Joule (1818–1889) worked over forty years to establish the experimental verification of the equivalence of work and heat.

Among the three, Mayer was the first who arrived at this law and the last whose work was recognized. His life was most dramatic. A lightening stroke of genius overtook him, a German doctor of the age of twenty six, one day on the sea near Java when he noticed that venous blood of a patient under surgical operation appeared an unusually fresh red. He considered that this might be connected with Lavoisier's theory of oxidation in animals, which process becomes slower in tropical zones because the rate of heat loss by animals will be slower there. A great generalization of this observation lead him to the idea of the equivalence of heat and mechanical work. For three years after his voyage, while he was working as a medical doctor at home, he devoted himself to complete the first work on the conservation of energy "Bemerkungen über die Kräfte der unbelebten Natur" which was sent to the Poggendorf Annalen and was never published by it. In 1842 Liebig published this paper in his journal (Annalen der Chemie und Pharmacie) but it was ignored for many years.

Mayer wrote four papers before 1851. During these years of unusual activity he cared for nothing other than his theory. In 1852 he became mentally deranged and was hospitalized. He recovered after two years but never returned to science. "

Ryogo Kubo, "Thermodymamics"

Problems:

1. Calculate kinetic energy of a falling stone with a mass of 10kg after 3 second of falling.
2. Imagine that both the mass and the speed of a moving object increased 2 times. How did its kinetic energy change?
3. Calculate kinetic energy of a 2000kg car moving at a speed of 100km/h.
4. It is possible to use the energy of tidal waves to produce electricity. For a first glance this is an eternal (well, almost eternal – as long as the Earth and Moon exist) energy source. Is it true? Explain your answer.