



Ministry of Higher Education and Scientific Research
University of Al-Mustaqbal
College of Health and Medical Technologies



General Physics

Frist Stage

A Lecture Two Title / Theoretical

Energy

By

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Energy

Energy is the ability to do work

The law of conservation of energy states that energy may be transformed from one form to another, but it cannot be created or destroyed; the total amount of energy is constant. For example, electrical energy is converted into light energy and heat energy in an electric light bulb. The unit of energy and work is the same, the Joule

There are many forms of energy. Two forms of mechanical energy often are used in radiologic science: kinetic energy and potential energy.

1. Kinetic energy is the energy associated with the motion of an object as expressed by the following:



Kinetic Energy

$$KE = \frac{1}{2}mv^2$$

What is the Kinetic Energy of a 150 kg object that is moving with a speed of 15 m/s?

$$KE = \frac{1}{2} mv^2$$

$$KE = ?$$

$$m = 150\text{kg}$$

$$v = 15\text{m/s}$$

$$KE = \frac{1}{2} (150\text{kg}) (15 \text{ m/s})^2$$

$$KE = \frac{1}{2} (150\text{kg}) (225)$$

$$KE = 16875\text{J}$$

An object moving with a speed of 35 m/s and has a kinetic energy of 1500 J, what is the mass of the object.

$$KE = \frac{1}{2} mv^2$$

$$KE = 1500\text{J}$$

$$m = ?$$

$$v = 35\text{m/s}$$

$$2KE/v^2 = m \quad \text{OR} \quad m = 2KE/v^2 \quad (\text{rearrange equation})$$

$$m = 2(1500\text{J})/(35)^2$$

$$m = 3,000/1225$$

$$m = 2.45\text{kg}$$

2. Potential energy is the stored energy of position or configuration. Four common examples of potential energy include a skydiver waiting to jump from an airplane, a rubber band that has been stretched out between two fingers, water sitting behind a dam, and the energy in a battery. All four examples are examples of stored energy that has the potential to do work upon its release.



Potential Energy

$$PE = mgh$$

where h is the distance above the Earth's surface.

Question: A radiographer holds a 6-kg x-ray tube 1.5 m above the ground. What is its potential energy?

Answer: Potential energy = mgh
 $= 6 \text{ kg} \times 9.8 \text{ m/s}^2 \times 1.5 \text{ m}$
 $= 88 \text{ kg m}^2/\text{s}^2$
 $= 88 \text{ J}$

3. **Chemical energy** is the **energy stored** within chemical bonds of a substance. These chemical bonds link atoms with other atoms and molecules with other molecules. **Since chemical energy is stored**, it's a form of **potential energy** that comes from electrons' arrangement in atoms and ions.

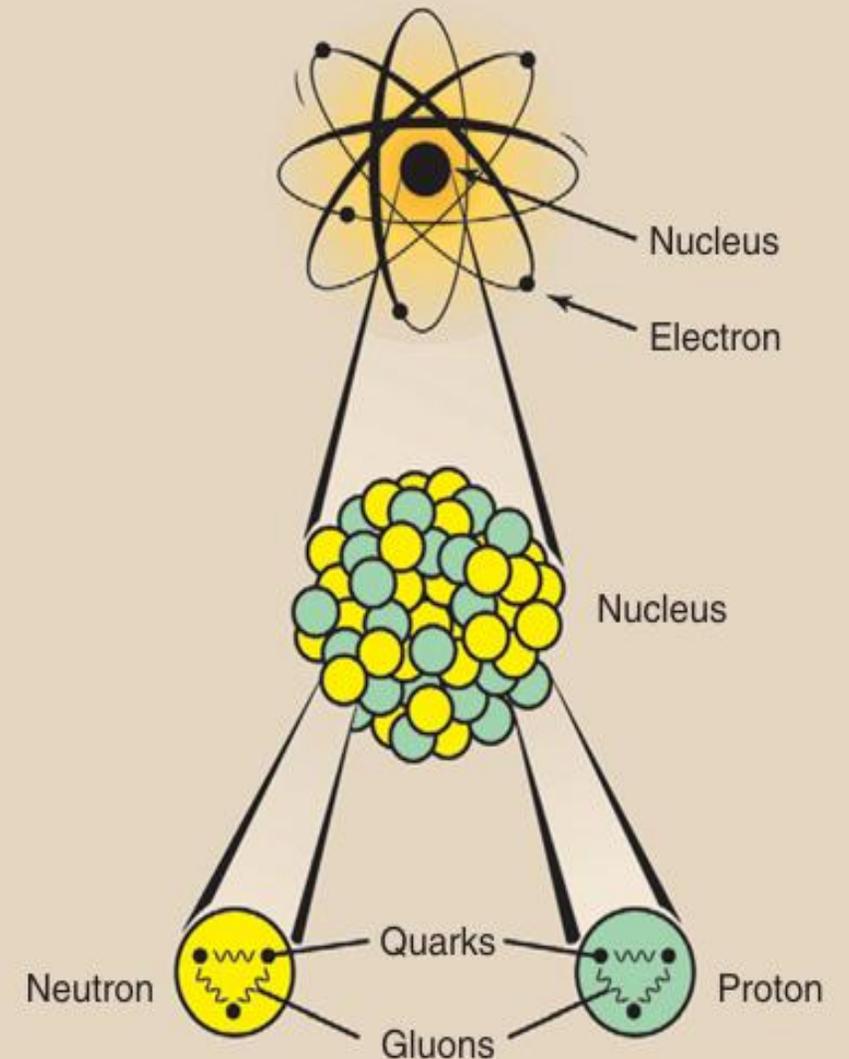
4. **Electrical energy** is caused by the **movements** of electrons in one direction. The faster they move, the more electrical energy they carry. Although any charged particle such as protons, electrons, cations, anions, positrons can produce electrical energy, the most common current carrier are electrons. Alternating current (AC) is a prominent example of electrical energy. It is generated by almost all power plants and used by most power distribution systems. It is considered a form of **kinetic energy** that comes from the flow of electric charge.

5. **Thermal energy** comes from the **heated up** objects. As the temperature of an object increases, its atoms and molecules move faster and collide with each other at higher rates. Example: When you place a pot of water on the stove, the internal energy of the heated element (in the stove) is transferred to the water within the pot. This ultimately raises the temperature of the water, causing water molecules to move faster. A form of **Kinetic Energy** due to the motion of atoms and molecules.

Every object in the universe is made of atoms. Each atom contains electrons, protons, neutrons, and a nucleus. Unlike normal chemical reactions that form molecules, nuclear reactions involve changes in the atom's nucleus, which ultimately causes a change in the atom itself. When a heavy nucleus splits into lighter nuclei (fission) or nuclei combine to form a bigger and heavier nucleus (fusion), a massive amount of energy is released. This energy is called **6. nuclear energy**.

Example: Existing **nuclear power plants** use nuclear fission of uranium and plutonium to produce electricity. They are cheaper, more efficient, and environment-friendly than traditional plants that use coal and gas to generate electricity.

A form of **Potential Energy** stored in the nucleus (core) of the atom.



7. **Electromagnetic energy** is perhaps the least familiar form of energy. It is the most important for our purposes, however, because it is the type of energy that is used in **x-ray imaging**. In addition to X-rays, electromagnetic energy includes radio waves; microwaves; and ultraviolet, infrared, and visible light.

Frequently, **matter** and **energy** exist side by side a moving automobile has mass and kinetic energy; boiling water has mass and thermal energy.

Perhaps the **strangest property** associated with **matter** and **energy** is that they are **interchangeable**, a characteristic first described by **Albert Einstein** in his **famous theory of relativity**.

Einstein's mass-energy equivalence equation is a cornerstone of that theory.

This **mass-energy equivalence** serves as the basis for the atomic bomb, nuclear power

$$E = mc^2$$

where E is energy, m is mass, and c is the velocity (speed) of electromagnetic radiation (light) in a vacuum.

Energy emitted and transferred through space is called **radiation**.

Electromagnetic energy is usually referred to as **electromagnetic radiation** or, simply, **radiation**

Many types of radiation are harmless, but ionizing radiation can injure humans. We are exposed to many sources of ionizing radiation. These sources can be divided into two main categories: natural environmental radiation and man-made radiation.

Natural environmental radiation results in an annual dose of approximately 3 millisieverts (mSv). Man-made radiation results in 3.2 mSv annually. An mSv is the unit of effective dose.

Natural environmental radiation consists of four components: cosmic rays, terrestrial radiation, internally deposited radionuclides, and radon.

Cosmic rays are particulate and electromagnetic radiation emitted by the sun and stars.

Terrestrial radiation results from deposits of uranium, thorium, and other radionuclides in the Earth.

The largest source of natural environmental radiation is radon. Radon is a radioactive gas that is produced by the natural radioactive decay of uranium.

Diagnostic X-rays constitute the largest man-made source of ionizing radiation (3.2mSv/yr).

Other sources of man-made radiation include nuclear power generation, research applications, industrial sources, and consumer items.