Lecture 2.3

Al-Mustaqbal University College

Medical Physics Department

First Stage

ميكانيك – مرحلة اولى

محاضرة ثانية- ثالثة

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Lecture 2

What is Energy

There are different forms of energy on this planet. The Sun is considered as the elemental form of energy on the Earth. In Physics, energy is considered a quantitative property which can be transferred from an object in order for it to perform work. Hence, we can define energy as the strength to do any kind of physical activity. Thus, they say,

Energy is the ability to do work

According to the laws of conservation of energy it states that "the energy can neither be created nor destroyed but can only be converted from one form to another". The SI unit of energy is Joule.

Units of Energy

The International System of Units of measurement of energy is **Joule**. The unit of energy is named after James Prescott Joule. Joule is a derived unit and it is equal to the energy expended in applying a force of **one newton through a distance of one meter**. However, energy is also expressed in many other units not part of the SI, such as ergs, calories, British Thermal Units, kilowatt-hours, and kilocalories, which require a conversion factor when expressed in SI units.

Energy Conversion: Transfer and Transform

We know the energy can be transferred from one form to another, the movement of energy from one location to another is known as energy transfer. We notice various energy transformations happening around us.

Following are the four ways through which energy can be transferred:

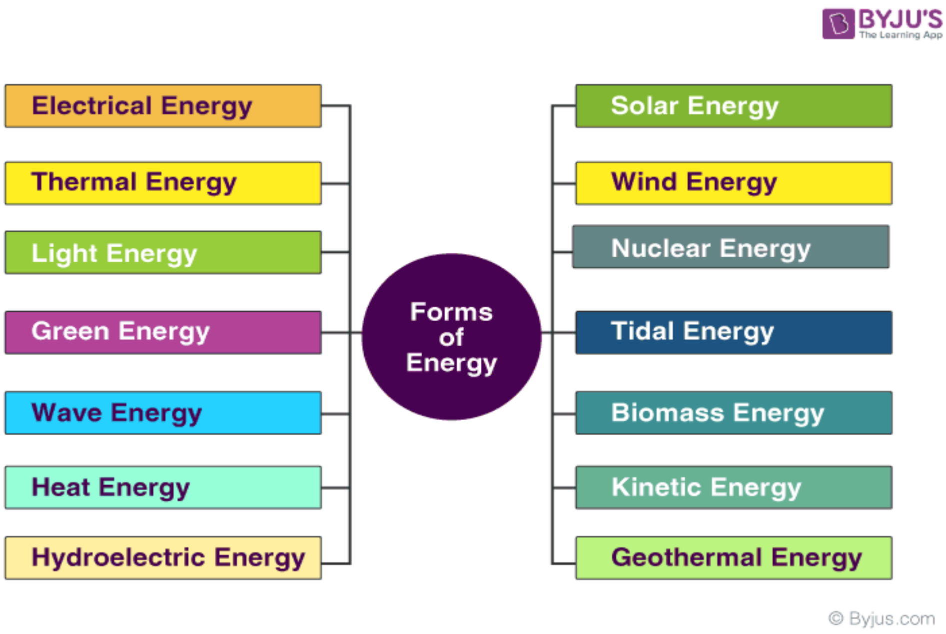
- **Mechanically – By the action of force**
- **Electrically – Electrically**
- **By Radiation – By Light waves or Sound waves**
- **By Heating – By conduction, convection, or radiation**

The process which results in the energy changing from one form to another is known as energy transformation. While energy can be transformed or transferred, the total amount of energy does not change – this is called energy conservation.

Law of Conservation of Energy

The law of conservation of energy is one of the basic laws in physics. It governs the microscopic motion of individual atoms in a chemical reaction. The law of conservation of energy states that "*In a closed system, i.e., a system that is isolated from its surroundings, the total energy of the system is conserved*." According to the law, the total energy in a system is conserved even though the transformation of energy occurs. Energy can neither be created nor destroyed, it can only be converted from one form to another.

Different Types of Energy



Although there are many forms of energy, it is broadly categorized into:

1. Kinetic Energy
2. Potential Energy

Kinetic Energy

Kinetic energy is the energy associated with the object's motion. Objects in motion are capable of causing a change or are capable of doing work. To better understand, let us think of a wrecking ball. A wrecking ball in motion is used to do work such as demolition of buildings, stones, etc. Even a slow-moving wrecking ball is capable of causing a lot of damage to another object such as an empty house. However, a wrecking ball that is not in motion, does not do any work. Another example of kinetic energy is the energy associated with the constant, random bouncing of atoms or molecules. This is also known as thermal energy. The average thermal energy of a group of molecules is what we call temperature, and when thermal energy is being transferred between two objects, it's known as heat.

Kinetic energy is determined by the given formula

$k.E = 1/2\ mv^2$

Different Types of Kinetic Energy:

Radiant energy

Thermal Energy

Sound Energy

Electrical Energy

Mechanical Energy

Potential Energy

Potential energy is the energy stored in an object or system of objects. Potential energy has the ability to transform into a more obvious form of kinetic energy.

Potential energy is determined by the given formula

P.E = m *g * h

Both potential energy and kinetic energy form mechanical energy.

Mechanical energy is determined by the following formula

Mechanical energy = 1/2 mv^2 + mgh

Different Types Of Potential Energy

Gravitational Potential Energy

Elastic Potential Energy

Chemical Potential Energy

ElectricPotentialEnergy

Some of the examples of electric potential energy include:

- An incandescent light bulb that is turned off
- A radio tower that is not working
- A black-light turned off
- A television before it is turned on

Frequently Asked Questions – FAQs

What happens to the total energy of the object falling freely towards the ground?

The energy remains constant.

What happens to the energy of a body on which work is done?

The body gains more energy.

What is the commercial unit of energy?

The commercial unit of energy is Kilowatt-hour.

Can energy be stored?

Yes, energy can be stored. One efficient way to store energy is in the form of chemical energy in a battery. When connected in a circuit, energy stored in the battery is released to produce electricity.
Energy can also be stored in many other ways. Batteries, gasoline, natural gas, food, water towers, a wound-up alarm clock, a Thermos flask with hot water all stores of energy.

Which of the following is the energy possessed by its position?

- Kinetic Energy
- Potential Energy
- Mechanical Energy
- Electrical Energy

Lecture 3

What is Work?

For work to be done, a force must be exerted and there must be motion or displacement in the direction of the force. The work done by a force acting on an object is equal to the magnitude of the force multiplied by the distance moved in the direction of the force. Work has only magnitude and no direction. Hence, work is a scalar quantity.

Formula of Work

The work done by a force is defined to be the product of component of the force in the direction of the displacement and the magnitude of this displacement.

$$W = (F \cos \theta)d = F.d$$

We understand from the work equation that if there is no displacement, there is no work done, irrespective of how large the force is. To summarize, we can say that no work is done if:

- the displacement is zero
- the force is zero
- the force and displacement are mutually perpendicular to each other.

What is Power?

Power is a physical concept with several different meanings, depending on the context and the available information. We can define power as the rate of doing work, and it is the amount of energy consumed per unit of time.

Formula of Power

As discussed, power is the rate of doing work. Therefore, it can be calculated by dividing work done by time. The formula for power is given below.

P = W/t

Where, P is the power, W is the work done and T is the time taken.

$$P = \frac{W}{t}$$

W = Work done | t = Time taken | P = Power

Example of Power

A garage hoist lifts a truck up 2 meters above the ground in 15 seconds. Find the power delivered to the truck. [Given: 1000 kg as the mass of the truck]

First we need to calculate the work done, which requires the force necessary to lift the truck against gravity:

F = mg = 1000 x 9.81 = 9810 N.

W = Fd = 9810N x 2m = 19620 Nm = 19620 J.

The power is P = W/t = 19620J / 15s = 1308 J/s = 1308 W.

Example of Work

An object is horizontally dragged across the surface by a 100 N force acting parallel to the surface. Find out the amount of work done by the force in moving the object through a distance of 8 m.

Solution:

Given:

F = 100 N, d = 8 m

Since F and d are in the same direction, θ = 0, [θ is the angle of the force to the direction of movement], therefore

W = FdCos θ

W = 100 x 8 x Cos 0

W = 800 J [Since Cos 0 = 1]

Work	
Definition	The work done by a force is defined to be the product of component of the force in the direction of the displacement and the magnitude of this displacement.
Formula	Work can be calculated by multiplying Force and Distance as follows $W = F \times d$
Unit	The SI unit of work is the Joule (J)

Energy	
Definition	Energy is defined as the capacity to do work.
Formula	The energy stored in an object due to its position and height is known as potential energy and is given by the formula: P.E. = mgh
Unit	The SI unit of energy is Joules (J).

Power	
Definition	Power is defined as the rate at which work is done.
Formula	The formula for power is $P = W/t$
Unit	The SI unit of power is Watt (W).