UNIT 5 WORK, POWER AND ENERGY.

KEY CONCEPTS

- Work is a kind of energy produced by forces.
- Power is the rate at which work is done.
- Simple machines change the forces needed to do the work.
- Energy is the capacity of objects to do work.
- Energy can transfer from one system to another, but always remains constant.

1. FORCES AND WORK

For a body to change speed, increase altitude or deform, a force must always act on it. The energy of the body changes in all these situations. In order to measure these changes in energy, we use the concept of work.

> **Work** is a kind of energy that we can measure when an object is displaced because a force acts on it, either partially or completely in the same direction and as the motion.

$$\boldsymbol{W = F \cdot d}$$

W represents the amount of work done, ***F*** is the force that acts in the same direction as the motion, and ***d*** is the distance travelled under the action of the force.

For work to be done, displacement must take place; the object must move. Also the force must act on the object constantly. When an object moves, it doesn't always do work. In physics, no work is done if a force acts for only a moment and then stops acting (creates an *impulse*).

The SI unit used to measure work is the **joule (J)**, which is equal to the newton metre (N·m). One **joule** is the **work done** by an object that, subjected to a force of **1 N**, is **displaced 1 m** in the same direction of the force.

2. WORK AND POWER

Work has nothing to do with the amount of time that the force is acting to cause the displacement. Sometimes, the work is done very quickly and other times the same work is done rather slowly. So we need a quantity to measure the speed of doing work.

Power is the rate at which work is done. It is equivalent to an amount of energy consumed per unit of time. In the SI, the unit of power is the joule per second (J/s), known as the **watt (w)** in honour of James Watt, the eighteenth-century developer of the steam engine.

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

The **same** amount of **work** is done when you carry a rucksack upstairs whether you walk or run, but **more power** is needed for running because the work is done in a **shorter** amount of **time**.

3. WORK AND ENERGY

Energy is defined as the capacity of objects to do **work**. Because it is equivalent to work, energy is also measured in **joules** (J).

3.1. Potential energy

To raise an object up to certain height, we must to overcome its weight. Work done in this process is stored as **gravitational potential energy**, so it is the work stored by an object at a certain height above the ground. Gravitational potential energy (**Ep**) depends on the mass of the object and the height it is at.

$$Ep = m \cdot g \cdot h$$

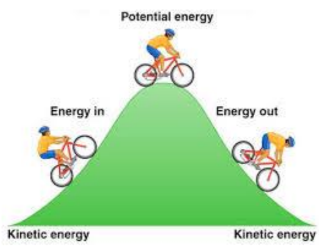
3.2. Kinetic energy

Kinetic energy (Ek) is the energy that an object in motion has. This type of energy depends on the mass of the object and how fast it moves (its **speed**):

$$Ek = \frac{1}{2}\, m \cdot v^2 \qquad Ec = \frac{1}{2}\, m \cdot v^2$$

3.3. Mechanical energy

Mechanical energy includes kinetic energy and potential energy. Objects have **mechanical energy** when they move at a certain speed (kinetic energy), or are at a certain height above the ground (potential energy).



$$E_M = Ek + Ep$$

4. FORMS AND CONSERVATION OF ENERGY

Work and heat are physical agents that produce transformations in matter. Thus, **energy** can be defined as the capacity of bodies and systems to do work or to transfer heat. While they do this, their energy decreases.

Energy can have **different forms** depending on the property that enables it to do work or to transfer heat. **Mechanical, electrical, chemical, electromagnetic, thermal, internal or nuclear** energy are different forms of energy.

Energy can be transformed from one form to another or from one body to another, but as a whole, it **remains constant**. This is one of the most fundamental laws of physics: the **law of conservation of energy**.

When the only type of force acting on an object is gravitational force, the total mechanical energy of that object remains constant. For example, a falling body loses potential energy but gains kinetic energy. It is known as the **Principle of Mechanical Energy conservation.** This principle allows for simple calculations that would be otherwise complex.