MINISTRY OF EDUCATION

SECONDARY ENGAGEMENT PROGRAMME

GRADE 10

PHYSICS

WEEK 12 **LESSON 1**

TOPIC: Work, Energy and Power

OBJECTIVES: At the end of this lesson, students will be able to:

a) Understand why energy is defined as the ability to do work or the capacity for doing work.
b) Define work done by and work done against a force.
c) Distinguish between potential and kinetic energy.
d) State the formulae for kinetic and potential energy.

CONTENT

Work

In Science, we use the word work in a precise way. For example, if you lift a brick from the ground and put it on a wall or if you climb up the stairs you are 'working' in the scientific sense of the word.

Similarly, if you push a pram or a bicycle and it moves you are also working, but if you push a wall and it remains standing, although you may get tired, you are not working. Therefore, for work to be done, a force must produce motion.

Work is the product of a force and the distance moved by its point of application in the direction of the force.

$$Work = Force \times displacement$$

$$W = F \times s$$

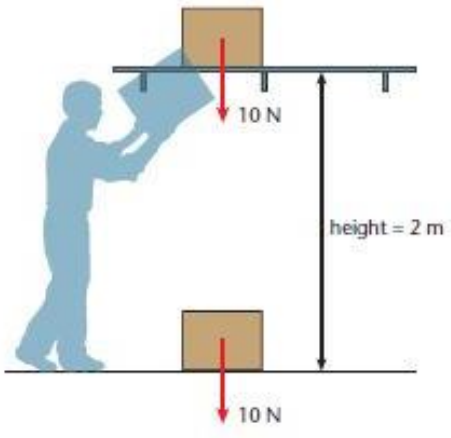

Figure 1 showing a person lifting a box through a particular height

We can similarly express the formula as:

$$Work = Force \times distance\ moved\ in\ the\ direction\ of\ the\ force$$

The unit of work, given by force x distance is the Newton-metre (Nm).

The Newton metre is called the joule.

The SI unit of work is called the joule (J).

A joule is the work done when the point of application of a force of 1 Newton moves through a distance of 1 metre in the direction of the force.

$$1\ Joule = 1\ Newton \times 1\ metre$$

$$1J = 1Nm$$

Question 1

If a force of 50N is used to pull a box along the ground a distance of 8m and the box moves in the same direction as the force, calculate the work done by the force.

W = Fs

W = 50N x 8m

W = 400 Nm

W = 400 J

Energy

Energy is the ability to do work.

The energy that something has is a measure of its ability to do work.

The unit of energy, the Joule (J) is the same as the unit of work.

Thus: Work done = Energy used

Question 2

How much energy was used to pull the box in Question 1 above?

Work done = Energy used

Energy used = 400J

E = 400J

Types of Energy

1. Mechanical Energy
    a. Potential (Gravitational, elastic)
    b. Kinetic

2. Electromagnetic Energy e.g. Ultraviolet waves, infrared waves, micro waves etc.

3. Chemical Energy due to the energy stored in the bonds of chemical compounds

4. Sound Energy due to energy being transferred by vibrating particles of a sound wave

5. Thermal Energy due to the motion of the particles of a body

6. Heat Energy which is thermal energy in the process of being transferred from one point to another due to temperature differences between the points.

7. Electrical Energy which results from charged particles in electric fields

8. Nuclear potential energy due to the energy binding the particles of the nucleus of an atom

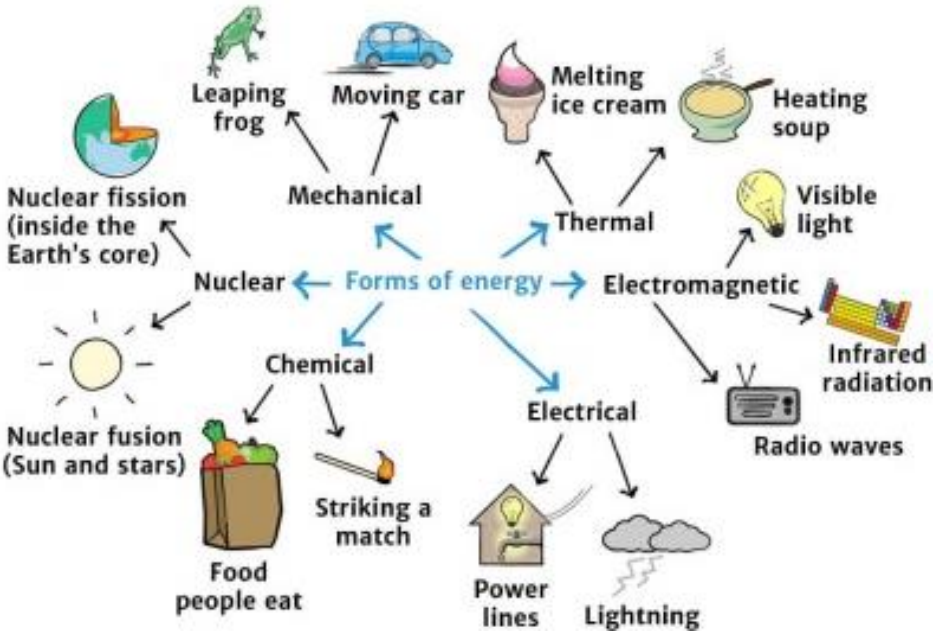

Figure 2 showing different forms of energy

Kinetic Energy

Kinetic Energy is the energy of a body has due to its motion. It is calculated using the formula:

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

Where m is mass of the body and v is its velocity.

Gravitational Potential Energy

Potential energy is the energy a body has due to:

1. Its position in a force field
2. Its state (for example stretched/compressed/chemical)

The change in gravitational potential energy, ΔE_P, of a body of mass m, as it moves through a height Δh, in a gravitational field of strength g is given by:

$$\Delta E_P = mg\Delta h$$

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Power

Power is the rate of doing work or of using energy.

$$power = \frac{work\ done}{time}$$

$$or\ power = \frac{energy\ used}{time}$$

Power is measured standardly in watts (W)

1 watt (1W) is the power used in doing 1 J of work per 1 s.

Thus 1W = 1J/s

Personal power is the power you generate as you run up a stairway, climb a hill, cycle up a slope or lifting a heavy object up and down a measured height for a large number of time.

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