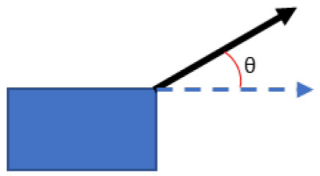
GCE Physics Unit 1.4 Energy concepts

Work:

When a force is applied to an object that moves, work is done by that force.

$W = F\,x\cos\theta$

Where θ is the angle between the force and the direction of movement.



The **work done is equal to the amount of energy transferred**. For example, if 100J of work is done to lift an object at a constant velocity, it will gain 100J of gravitational potential energy.

Gravitational potential energy:

Gravitational potential energy is the energy of an object due to its position above the surface of the Earth.

$$\Delta E = mg\Delta h$$

Kinetic energy:

Kinetic energy is the energy of an object due to its motion.

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

Power:

Power is the rate of transfer of energy, measured in Watts where 1 W = 1 J s^{-1}

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

Conservation of energy:

The law of conservation of energy states that **energy cannot be created or destroyed**, it can only be **transferred** from one form to another.

This means that in any situation the **total energy of the system must remain constant**.

For example,

- A cannonball fired vertically upwards with 1000J of kinetic energy will transfer to 1000J of gravitational potential energy at its highest point.
- A slingshot spring with 50J of elastic potential energy will transfer 50J of kinetic energy to a ball when fired.

In both these examples no energy has been lost as heat due to dissipative forces such as friction.

In reality, **friction and air resistance will cause some losses** during the transfer but the total energy must remain the same. Therefore, if the cannonball only gains 950J of gravitational energy the rest, 50J, must be **lost as heat due to the work done by air resistance**. The frictional forces can be calculated using the work equation,

$$Work = F\,d$$

Elastic potential energy:

Elastic potential energy is the energy of an object due to it being deformed by a force.

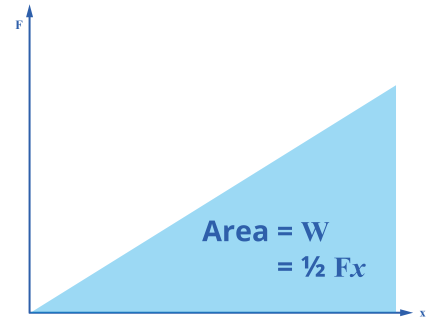
It can be calculated in two ways, either using this equation:

$$E = \frac{1}{2}kx^2$$

Using Hooke's law (see unit 1.5), this equation can be converted to,

$$E = \frac{1}{2}Fx = \frac{F^2}{2k}$$

Or calculated graphically using the area under a F-x graph.



Efficiency:

Friction and other dissipative forces reduce the efficiency of a system as they reduce the useful energy transfer.
The efficiency can be calculated using this equation;

$$efficiency = \frac{useful\ energy\ transfer}{total\ energy\ input} \times 100\%$$

W =Work done in Joules (J)
E = Energy in J
x = extension of a spring in m
v = speed or velocity in m s^{-1}
P = power in Watts (W)
F = Force in N
m = mass in kg
k = spring constant in N m^{-1}
Δh = change in height in m
t = time in s
d = distance travelled in the direction of the force in m