

Meaning of Work, Power, and Energy

Work:

Work is product of force and displacement of a body along the same line as that force is acting.

Work is force multiplied by the distance moved as a result of the force acting, expressed in Joules (J).

The means by which energy is transferred from one object or system to another.

$$W = Fd$$

Where W is work (J), F is the magnitude of force (N), and d is displacement of the body (m).

For example a body builder during a bench press exercise acts against a barbell and his arms with a constant force of 2000 N. The centre of gravity of the barbell – arms system is vertically displaced by 0,6 m. What is the work performed by body builder?

Where $F = 2000 \text{ N}$

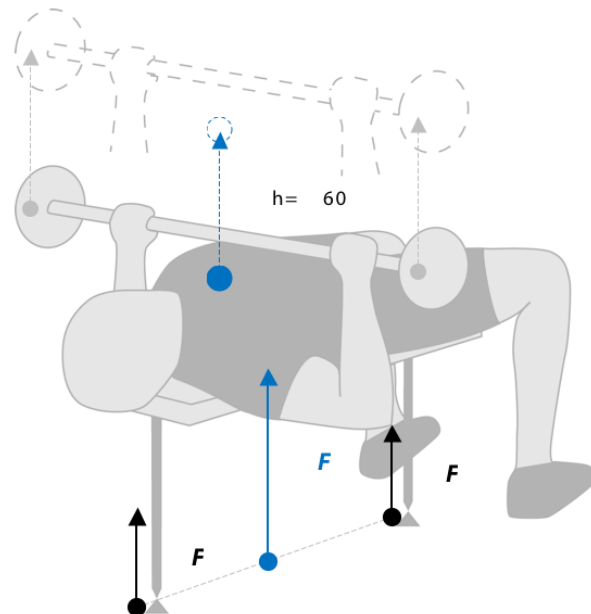
$d = 0.6 \text{ m}$

$W = ?$

$$W = Fd$$

$$W = 2000 \text{ N} \times 0.6 \text{ m}$$

$$W = 1200 \text{ J}$$



To specify work performed when a force is acting on a body we must know three pieces of information:

1. Average force acting on a body.
2. Direction of that force.
3. Displacement of the body in the direction of the acting force during the time when the force is acting on the body.

Power:

Power is the rate at which work is done, and can be calculated either by dividing the work done by the time in which the work was done or by multiplying the force applied by the velocity at which it was applied, expressed in Watts (W).

Power measures speed with which work is performed or How quickly or slowly work is done.

Power is rate at which energy is transferred or the rate at which work done.

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

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

Where P=Power (Watt)

W= work done (J)

ΔE = Energy transferred (J)

t= time (s)

Energy:

In mechanics energy is defined as an ability of a body to perform work.

There are two forms of mechanical energy: kinetic energy, related to motion of a body, and potential energy, related to the position of a body in the Earth's gravitational field.

Kinetic energy

- A body in motion has ability to perform work through its motion.
- Kinetic energy is the energy that objects possess due to their motion.
- Moving objects have the capacity to do work due to motion.

$$KE = \frac{1}{2}mv^2 \quad \text{Or} \quad E_k = \frac{1}{2}mv^2,$$

Where m = mass of the object (kg)

v = velocity (m/s)

KE or E_k = Kinetic energy (J)

Potential energy

- Potential energy is ability of a body to perform work due to its position.
- Capacity to do work due to the object's position.

As we know, an object can store energy as a result of its position. In the case of a bow and an arrow, when the bow is drawn, it stores some amount of energy, which is responsible for the kinetic energy it gains, when released. We can define potential energy as:

The energy held by an object because of its position relative to other objects, stresses within itself, its electric charge, or other factors.

Similarly, in the case of a spring, when it is displaced from its equilibrium position, it gains some amount of energy which we observe in the form of stress we feel in our hand upon stretching it. We can define potential energy as a form of energy that results from the alteration of its position or state.

$$E_p = mgh .$$

Where m = mass of the object (kg)

g = acceleration due to gravity (9.8 m s^{-2})

h = height (m)

E_p = Potential energy