Five ideas about energy

1. Energy can be stored in fuels
2. Energy can exist in various forms
3. Energy can be changed from one form to another and from one place to another.
4. It is only when energy changes occur that "something useful" or "work", can be done.
5. Heat is a form of energy => "internal" energy

Different forms of Energy

Chemical Energy - energy is stored in chemical bonds

Gravitational Potential Energy - energy that a body has because of its elevated position above a certain level where gravity acts.

Kinetic Energy - energy a body has because of its motion.

Electrical Potential Energy - energy that an electric charge has due to an electric force between itself an another charge.

Elastic Potential Energy - energy that a body has when it is stretched or compressed

Nuclear Potential Energy - energy that protons and neutrons have within the nucleus of an atom because of the nuclear force between them

Sound Energy - energy of the movement of particles that are carrying a longitudinal sound wave.

Light Energy - light (electromagnetic waves) is a form of radiant energy

Internal Energy (Heat) - Energy that particles of a medium have because of their random motion or because of the molecular forces between them.

Examples of Energy Transformations

Campfire : chemical → internal (heat) + light

Someone running : chemical → kinetic

light bulb : electrical potential → light + internal

uranium-235 in a nuclear reactor : nuclear potential → kinetic energy (neutrons)

falling ball : gravitational potential → kinetic

pendulum swinging back + forth : gravitational potential ⇄ kinetic

block sliding down an incline with constant speed : gravitational potential → internal

note the difference!!

trolley rolling with no friction down an incline : gravitational potential → kinetic

elevator descending at a constant speed : gravitational potential → internal (brakes)

Conservation of Energy

- In all energy transformations, the total amount of energy remains constant.
- Energy, like momentum, is a conserved quantity.

In any closed system the total energy is constant

OR

"Energy cannot be created or destroyed"

Work ΔW

Whenever something occurs, or something changes, or a job is done, there is an energy transformation. The amount of energy which is transformed is called the work.

$\Delta W \rightarrow$ change in energy

Example

What is the work done when 100 J of chemical energy are converted into electrical energy in a light bulb?

Chemical → electrical

100 J of work is done

(Total energy stays the same)

Work done when a force moves an object through a distance.

When a person applies a force F to move a trolley through a distance Δx chemical energy goes into the work being done

If there is no friction (and the ground is level)

chemical → work → kinetic energy

If you push the trolley over a longer distance, you do more work thereby giving the trolley more kinetic energy.

If there is friction: (+ the ground is level)
(+ the trolley has a constant speed)

Chemical → work → internal
(wheels get hot)

If there is friction: (+ the ground is level)
(+ the trolley speeds up)

chemical → work → internal
→ kinetic

If there is no friction but the trolley is on an incline with a constant speed (going uphill)

chemical → work → gravitational potential

Calculating Work

$$\Delta W = F \Delta x$$

F and Δx must be in the same direction!!

Units: $1\,J = 1\,N\,m$

$1\,J = 1\,kg\,m\,s^{-2}\,m$

$1\,J = 1\,kg\,m^2\,s^{-2}$

A joule is a small unit of energy.

A joule is the energy needed to lift a 1 kg book (weight 10N), through a distance of 10 cm.
(or lifting an apple (1N) a distance of 1 m.)

Typical "power" station might produce 1000 MJ/s

Situations where no work is done:

1. If the object does not move
2. If there is no force acting on the body while in motion
3. If the force is perpendicular to the displacement.

Examples

Calculate the work done:

1. by a force of 50N which moves an object 3.0m along the line of the force.

$\Delta W = F \Delta x$

$\Delta W = (50N)(3.0m)$

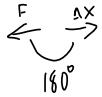
$\Delta W = 150J$

2. by a net force of 10N which slows a moving object from 50 ms^{-1} to rest over a distance of 25m.

$\Delta W = F \Delta x$

$\Delta W = (10N)(25m)$

$\Delta W = 250J$



→ internal

3. by a force of 100N which is applied in a northerly direction onto an object which is moving through a distance of 8.0m east.

no work.