11
AQA Topic P2.3

Work and energy

ThinkAbout:

1. A moving object has movement energy, also called . . . . energy.
2. When an object is lifted to a higher place, it is given . . . . potential . . . .
3. Energy can be . . . . from one form to . . . .
4. A falling object is . . . . energy from . . . . potential energy to . . . . energy.
5. A stretched catapult has . . . . potential . . . .

Work and energy

When a force moves an object, energy is transferred and work is done. In fact:

work done (joules, J) = **energy transferred** (joules, J)

To calculate the work done (energy transferred):

work done (joules, J) = **force applied** (newtons, N) × **distance moved in the direction of the force** (metres, m)

Example 1

How much energy is transferred if a force of 2 N moves through a distance of 10 m?

work done = force × distance moved
= 2 N × 10 m
= 20 joules (20 J)

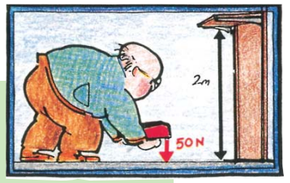
∴ energy transferred = work done = 20 J

Gravitational potential energy

When an object is lifted up, work is done against the force of gravity, its weight.

It follows (from the equations above) that:

change in gravitational potential energy (joules, J) = **weight** (newtons, N) × **change in vertical height** (metre, m)



Example 2

A man lifts up a brick of mass 5 kg from the floor to a shelf 2 metres high.
What is the change in gravitational potential energy of the brick?

Step 1 : Find the weight first (see Topic 10).

weight = mass × gravitational field strength
= 5 kg × 10 N/kg = 50 N

Step 2 :

change in gravitational potential energy = weight × change in vertical height
= 50 N × 2 m = 100 joules

Answers: 1. kinetic 2. gravitational, energy 3. transferred/transformed/changed, another 4. transferring, gravitational, kinetic 5. elastic, energy

Potential energy

Gravitational potential energy is the energy ***stored*** in an object because of the height it has been lifted to, against the force of gravity.

Elastic potential energy is the energy stored in an elastic object, when work has been done on the object to change its shape (eg. a catapult).

Kinetic energy (movement energy)

Kinetic energy can be transformed into other forms of energy, as shown in the table:

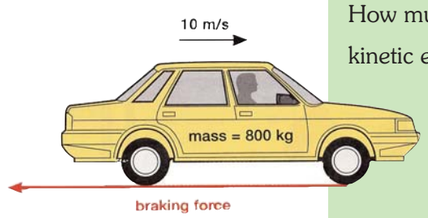
Example:	*Kinetic energy is transformed to:*
a car braking	*heat in brakes + tyres*
a wind turbine	*electricity, heat, sound*
roller-coaster car, going up a ramp	*gravitational potential energy, heat*
bullet fired into wood	*heat*
space-shuttle, re-entering atmosphere	*heat*

An object has more kinetic energy,
- the greater its mass, and
- the greater its speed.

H

The formula for kinetic energy is:

kinetic energy (joules, J) = ½ × **mass** (kilogram, kg) × **speed²** $(m/s)^2$



Example 3

A car of mass 800 kg is travelling at 10 m/s.
How much kinetic energy has it got?

kinetic energy = ½ × mass × speed²
= ½ × 800 kg × $(10\ m/s)^2$
= ½ × 800 kg × 100 m^2/s^2
= 40 000 joules (40 kJ)

Example 4

For the car in Example 3 above,
a) How much work must be done to stop it?
b) When the brakes are applied, it comes to rest in 8 m. What is the average force exerted by the brakes?

a) To stop the car,
work done = energy transferred = 40 000 joules
This energy will be transferred to heat in the brakes/tyres.

b) From the opposite page:
work done = force × distance moved
40 000 J = force × 8 m
∴ force = 5000 newtons

Take care:

- Remember work done against frictional forces is transferred mainly as heat.
- In calculations, always show your working ...so you may then get some marks even if the final answer is wrong.

More details in ***Physics for You***, pages 97–99, 11, 109.