Efficiency

So energy is transferred between different stores. But not all of the energy is transferred to useful stores.

Most Energy Transfers Involve Some Losses, Often by Heating

1) You've already met the principle of conservation of energy on the previous page, but another important principle you need to know is:

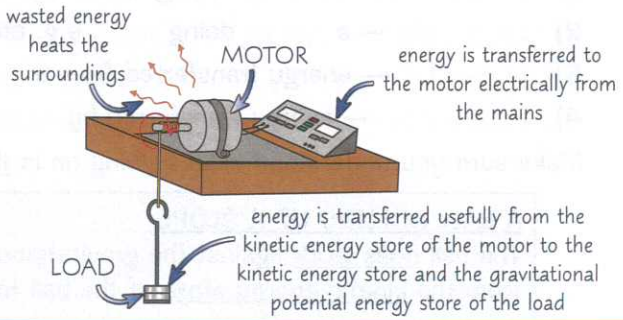
Energy is only useful when it is transferred from one store to a useful store.

2) Useful devices can transfer energy from one store to a useful store.
3) However, some of the input energy is always dissipated or wasted, often to thermal energy stores of the surroundings.

Dissipated is a fancy way of saying the energy is spread out and so is 'lost'.

4) Whenever work is done mechanically (see p.157), frictional forces have to be overcome, including things like moving parts rubbing together, and air resistance. The energy needed to overcome these frictional forces is transferred to the thermal energy stores of whatever's doing the work and the surroundings.
5) This energy usually isn't useful, and is quickly dissipated.

The diagram shows a motor lifting a load.
The motor transfers energy usefully from its kinetic energy store to the kinetic energy store and the gravitational potential energy store of the load, but it also transfers energy mechanically to the thermal energy stores of its moving parts, and electrically to the thermal energy stores of its circuits.
This energy is dissipated, heating the surroundings.



6) The conservation of energy principle means that:
total energy input = useful energy output + wasted energy.
7) The less energy that's wasted, the more efficient the device is said to be.
The amount of energy that's wasted can often be reduced — see next page.

You can Calculate the Efficiency of an Energy Transfer

The efficiency of any device is defined as:

$$\text{efficiency} = \frac{\text{useful energy transferred by device (J)}}{\text{total energy supplied to device (J)}}$$

This will give the efficiency as a decimal. To give it as a percentage, you need to multiply the answer by 100.

EXAMPLE: A toaster transfers 216 000 J of energy electrically from the mains. 84 000 J of energy is transferred to the bread's thermal energy store. Calculate the efficiency of the toaster.

$$\text{efficiency} = \frac{\text{useful energy transferred by device}}{\text{total energy supplied to device}} = \frac{84\,000}{216\,000} = 0.388... = 0.39 \text{ (to 2 s.f.)}$$

This could also be written as 39% (to 2 s.f.).

All devices have an efficiency, but because some energy is always wasted, the efficiency can never be equal to or higher than 1 (or 100%).

Make sure your revising efficiency is high...

One really important thing to take from here — devices that transfer energy from one store to other stores will always transfer energy to stores that aren't useful. And when I say always, I mean always. Always. (Always.)

Q1 An electrical device wastes 420 J of energy when it has an input energy of 500 J.
Calculate the efficiency of the device as a percentage. [3 marks]

Efficiency

1 An electric fan transfers 7250 J of energy. 2030 J of this is wasted energy.

Grade 4-6

a) Suggest **one** way in which energy is wasted by the fan.

.....

[1]

b) Calculate the efficiency of the fan.

Efficiency = ...

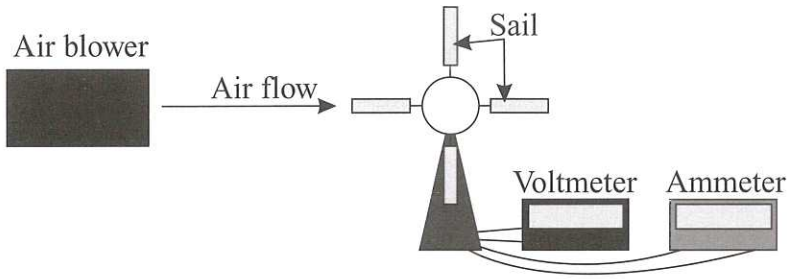
[3]

[Total 4 marks]

2 A student investigates the efficiency of a scale model of an electricity generating wind turbine using the equipment in **Figure 1**. He changes the number of sails on the turbine and calculates the energy transferred by the turbine's generator. The air blower is supplied with 30 kJ of energy and has an efficiency of 0.6.

Grade 6-7

Figure 1



a) When using two sails, the efficiency of the turbine was 12%. Calculate the useful energy transferred out from the turbine.

Energy transferred = ... J

[4]

b) Describe **two** ways the student could increase the efficiency of the turbine.

1. .....

2. .....

[2]

[Total 6 marks]

Exam Practice Tip

Some of the energy input to a device is always dissipated or wasted. If you're asked to suggest ways to improve the efficiency of a device, think about how energy is wasted and then what could be done to reduce that waste.