Efficiency and Power

29 November 2019   15:17

Often, in fact always it seems, when you change energy from one form to another you some some that is wasted. So a kettle heats up the water, which is what you want, but it also heats up the surroundings a bit, which you don't.

It is useful to know how good something is at turning energy into something useful rather than into waste. This is called its 'efficiency' and is worked out like this:

The humble push bike is generally thought to be one of the most efficient machines every made. The petrol engine on cars is not as efficient

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

When you do this you always get a number with no units.

You always get a number that is less than 1 - since energy is always wasted.

Sometimes efficiency is measured in % - just use the formula above, and then times by 100 to get percentage.

Example

An electric motor is supplied with 200J of energy. The motor is used to lift an object. The object gains 60J of GPE. How efficient is the motor?

Useful energy is 60J. Total energy supplied = 200J

Efficiency is 60/200 = 0.3

In percentage this is 0.3 X 100 = 30.0 %

Power
Power tells us how much energy is used in a second. Power is measured in Joules per second, which is also called 'Watts'.

$$\frac{\text{power, } P}{(\text{watts, W})} = \frac{\text{energy transferred to appliance, } E \text{ (joules, J)}}{\text{time take for energy to be transferred, } t \text{ (seconds, s)}}$$

Here are some values:

Appliance	Power rating
A torch	1 W
An electric light bulb	100 W
An electric cooker	10 000 W = 10 kW (where 1 kW = 1000 watts)
A railway engine	1 000 000 W = 1 megawatt (MW) = 1 million watts
A Saturn V space rocket	100 MW
A very large power station	10 000 MW
World demand for power	10 000 000 MW
A star like the Sun	100 000 000 000 000 000 000 MW

Power questions crop up a lot. Often you have to use another question first.

Example

- A builder is lifting 15 small bags of cement one at a time onto a table that is 0.8m above the ground. Each bag has a mass of 7Kg.

How much energy does the builder use to lift all the bags?

- The builder takes 1.5 minutes to lift all the bags. What power is the builder using to lift the bags?