Calculating energy efficiency

Efficient devices are good at transferring energy to useful energy stores. An efficient light bulb, for instance, transfers energy mostly as light rather than wasting it as heat. The efficiency of a device is the percentage of energy transferred usefully.

Key facts

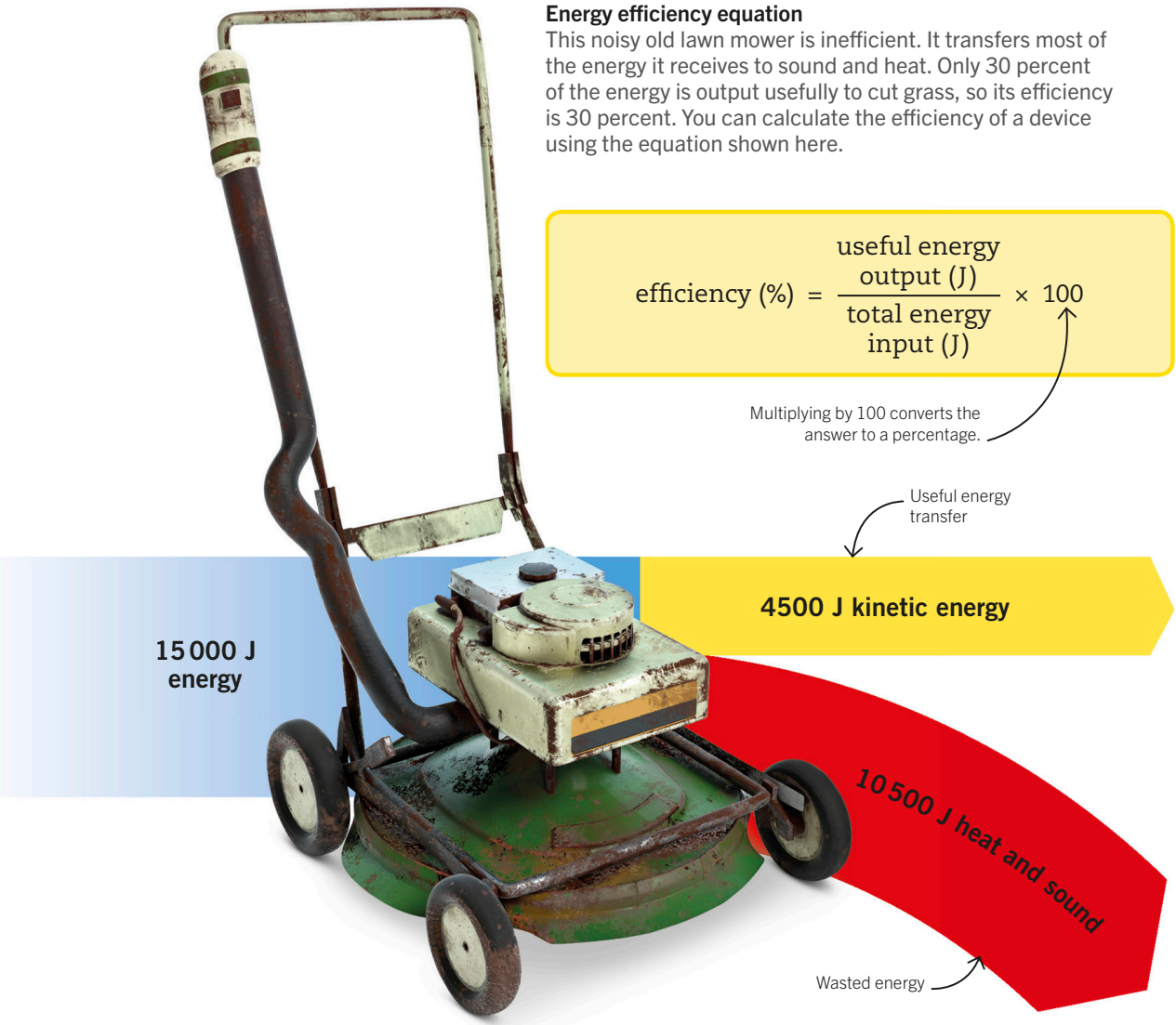
- ✓ **The efficiency of a device is the percentage of energy transferred usefully.**
- ✓ **Efficiency can be calculated from either energy or power.**

Energy efficiency equation

This noisy old lawn mower is inefficient. It transfers most of the energy it receives to sound and heat. Only 30 percent of the energy is output usefully to cut grass, so its efficiency is 30 percent. You can calculate the efficiency of a device using the equation shown here.

$$\text{efficiency (\%)} = \frac{\text{useful energy output (J)}}{\text{total energy input (J)}} \times 100$$

Multiplying by 100 converts the answer to a percentage.

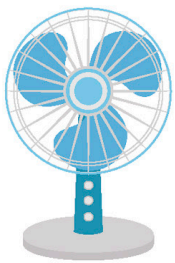


Efficiency and power
You can also calculate efficiency if you know the total power input and useful power output of a device. Use this equation instead.

$$\text{efficiency (\%)} = \frac{\text{useful power output (W)}}{\text{total power input (W)}} \times 100$$

Efficiency calculations

Question 1
A 75-watt fan runs for 1 minute, transferring 4500 joules of energy. 200 joules is transferred to thermal energy stores, 700 joules is transferred through sound waves, and the rest is transferred to useful kinetic energy stores. What is the efficiency of the fan?



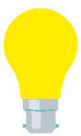
Answer 1
Useful energy transfer = 4500 J – (200 J + 700 J)
= 3600 J
(Wasted energy)

$$\text{Efficiency} = \frac{3600\ \text{J}}{4500\ \text{J}} \times 100$$
$$= 80\%$$

(Total energy transferred)

Check your answer makes sense. Nothing can be more than 100% efficient, so your answer must be less than 100.

Question 2
A 5-watt light bulb has an efficiency rating of 60%. What is its useful power output?



Answer 2
Rearrange the second efficiency equation to make useful power output the subject.
Useful power output = efficiency × total power input

$$= \frac{60}{100} \times 5\ \text{W}$$
$$= 3\ \text{W}$$

Improving efficiency
Machines with moving parts generate frictional forces that transfer energy to useless energy stores, such as sound and heat. Adding lubricants like oil reduces friction and so improves efficiency. No devices are 100 percent efficient, as some energy is always lost through heating, light, sound, or other energy transfers.