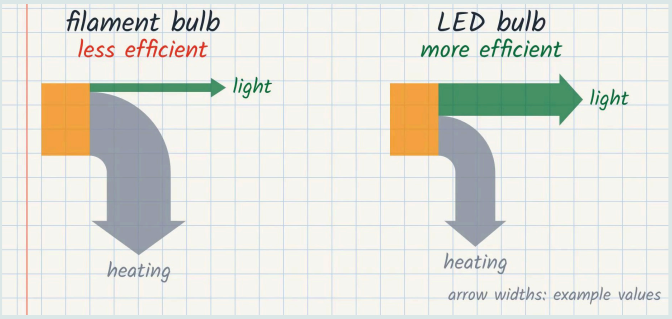
Efficiency

How much of the energy is useful?

1 What efficiency means



- Every device takes in energy. Some of it is **useful** output; the rest is **dissipated**, usually by heating the surroundings.
- **Efficiency** is the fraction of the input that is useful. A filament bulb dissipates more by heating, so it is less efficient than an LED.

2 The equations

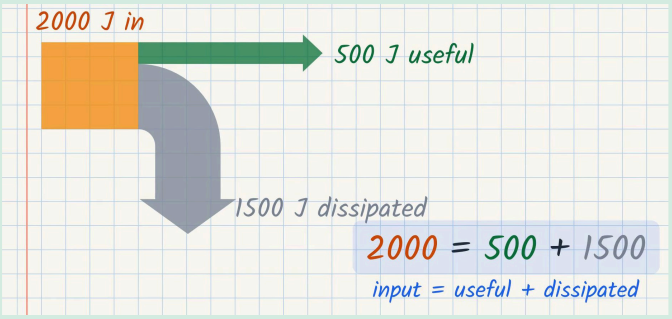
$$\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

no unit

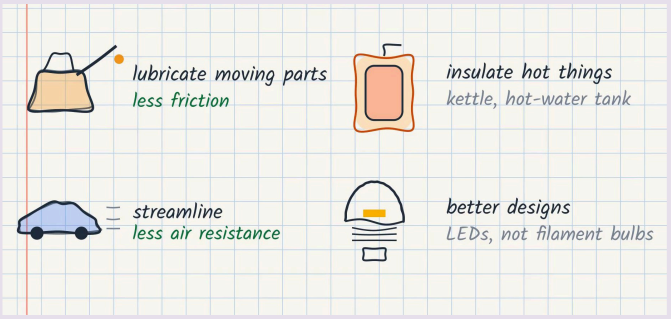
- efficiency = useful output energy transfer ÷ total input energy transfer, or useful power output ÷ total power input. **No unit.**
- Give it as a decimal (0.2) or a percentage (× 100 = 20%). It is **never more than 1 (100%)**: if you get more, look for a mistake.

3 Worked examples



- 200 J in, 20 J light: 20 ÷ 200 = 0.1 = 10%. 500 W in, 400 W useful: 400 ÷ 500 = 0.8 = 80%.
- 25% efficient, 2000 J in: 0.25 × 2000 = **500 J useful**, so 1500 J is dissipated. Efficiency is not power: power is how fast, efficiency is how much is useful.

4 Increasing efficiency (Higher)



- Always: **reduce the energy that is dissipated.**
- Lubricate moving parts (less friction), insulate hot things, streamline (less air resistance), use better designs such as LEDs.

efficiency = useful ÷ total

useful output energy transfer ÷ total input energy transfer

useful	useful output	J or W
total	total input	J or W
efficiency	decimal, or × 100 for %	no unit

Power version: useful power output ÷ total power input. Both on the equation sheet

Exam tip

Explaining an improvement? Link it all the way: oil reduces friction, so less energy is dissipated by heating, so more of the input is useful.

Check yourself

- 1 A heater takes in 1000 J and transfers 900 J usefully. Efficiency as a percentage?
- 2 A student gets an efficiency of 1.2. Why must this be wrong?

Answers: 1. 900 ÷ 1000 = 0.9 = 90% 2. The useful output can't be more than the input.