

Following energy through devices and chains

Grade 7 science (Year 8 · Class 7) · Lesson

Quick answer: An energy transfer is the movement of energy from one store to another or its change from one form to another. Energy is never created or destroyed, so the total stays the same. In every device some energy is wasted as thermal energy, and efficiency compares the useful output with the total input.

Level: Grade 7 science (Year 8 · Class 7) · **Curriculum:** MS-PS3-5

What is an energy transfer?

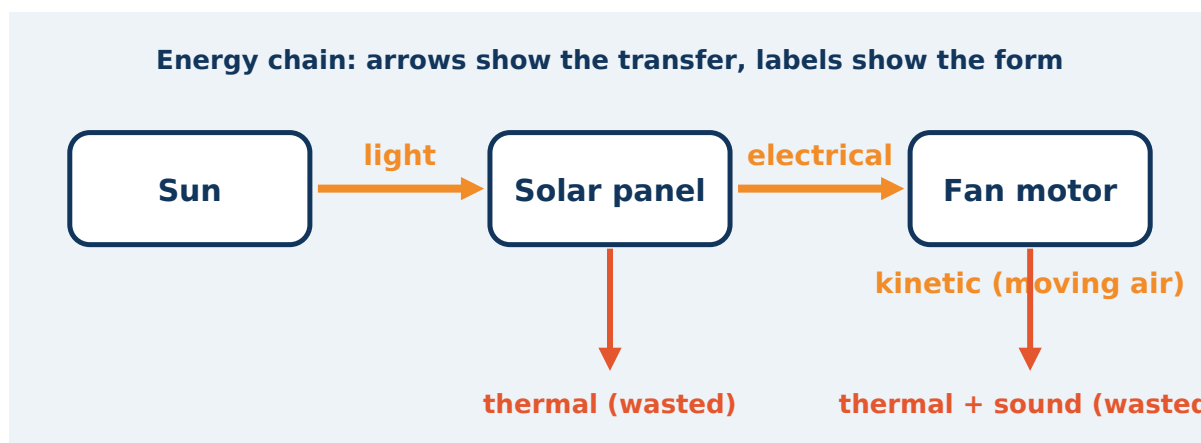
Every device you use takes in energy and gives it out in a different place or form. A phone charger moves energy from the socket to a battery. A fan moves energy into the air. Scientists call each of these an energy transfer.

Definition

An energy transfer is the movement of energy from one store or object to another, or its change from one form to another, such as electrical energy becoming kinetic energy.

Key law

Energy is never created or destroyed. It is only transferred from one store to another. This is the law of conservation of energy: the total energy before a transfer equals the total energy after it.



An energy chain for a small solar-powered fan. Useful transfers are in orange; wasted thermal energy is in red.

How do you draw an energy chain?

An energy chain lists each device in order and labels the forms of energy between them. Start with the energy source on the left. Add one arrow for every transfer and finish with the useful output. Then add side arrows for wasted energy.

Here is a chain for a hand-crank torch used in Kampala: chemical energy in the muscles, then kinetic energy of the handle, then electrical energy from the dynamo, then light energy from the bulb. Thermal energy is wasted at every stage.

Device	Energy in	Useful output	Wasted energy
Electric kettle	Electrical	Thermal (in the water)	Thermal to the air, sound
Wind turbine	Kinetic (wind)	Electrical	Sound, thermal
Phone charger	Electrical	Chemical (battery)	Thermal
Motorbike engine	Chemical (fuel)	Kinetic	Thermal, sound

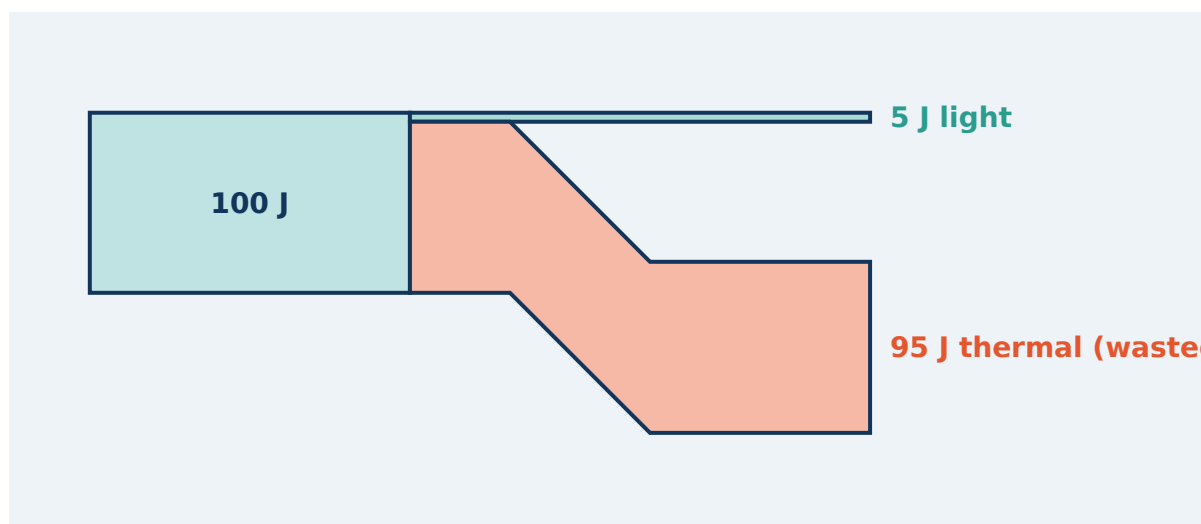
What is wasted energy?

Definition

Wasted energy is energy transferred to stores that are not useful for the job, usually thermal energy that spreads out into the surroundings.

Wasted energy is not lost or destroyed. It is still there, but it is spread out so widely that it is almost impossible to collect and use again. Warm air around a laptop is a good example.

A Sankey diagram shows this. The width of each band is drawn in proportion to the amount of energy.



A Sankey diagram for a filament lamp. The input band splits into a very thin useful band and a very wide wasted band.

Worked example 1

A filament lamp takes in 100 J of electrical energy and gives out 5 J of light. Calculate the wasted energy.

Wasted energy = total input – useful output = 100 J – 5 J = **95 J**.

How do you measure how good a device is?

Formula

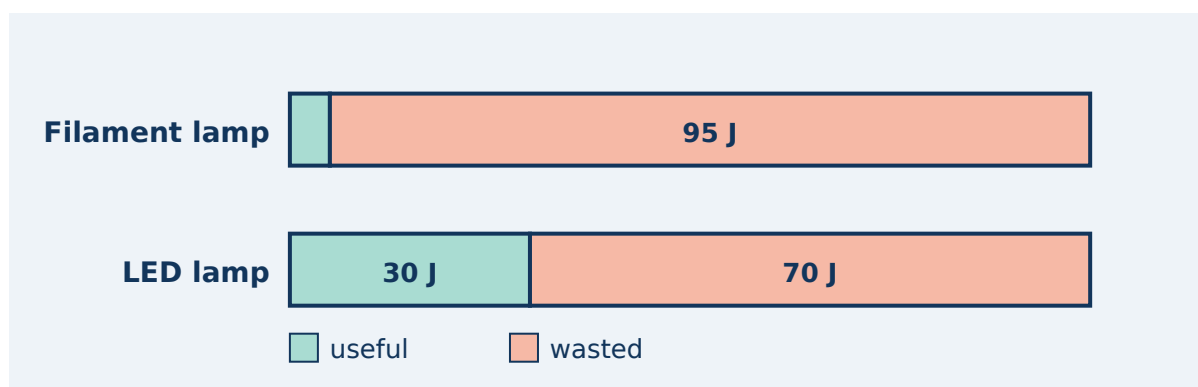
$$\text{efficiency} = (\text{useful energy output} \div \text{total energy input}) \times 100 \%$$

Both energies are in joules (J), so the units cancel and efficiency is a percentage. It can never be more than 100 %.

Worked example 2

Bilal in Lahore notes that his motorbike engine takes in 4000 J from the fuel and gives 1000 J of kinetic energy. Calculate the efficiency and the wasted energy.

Efficiency = $1000 \div 4000 \times 100 = 25 \%$. Wasted energy = $4000 - 1000 = 3000 \text{ J}$.



The two bars both show 100 J of input. The LED turns a much larger share into useful light, so it is more efficient.

Worked example 3

An LED lamp takes in 20 J and gives 6 J of light. Compare its efficiency with a filament lamp that gives 5 J of light from 100 J.

LED: $6 \div 20 \times 100 = 30 \%$. Filament: $5 \div 100 \times 100 = 5 \%$. The LED is six times as efficient.

Device	Typical efficiency
Filament lamp	about 5 %
Petrol motorbike engine	about 25 %
Solar panel	about 20 %
Electric kettle	about 90 %

Common mistake

Do not say that energy is used up or lost. A device does not use up energy; it transfers it. Also, never give an efficiency above 100 %, because a device cannot give out more energy than it takes in.

Lina's tip

Draw the input first, then check your outputs. Useful energy plus wasted energy must add up to exactly the input. If they do not, a transfer is missing.

Key points to remember

- Energy is conserved: it is transferred, never created or destroyed.
- An energy chain lists the forms of energy in order, for example chemical → kinetic → electrical → light.
- Wasted energy = total input – useful output; it is usually thermal energy.
- Efficiency = (useful energy output ÷ total energy input) × 100 %, and it is never above 100 %.

Following energy through devices and chains: frequently asked questions

What is the law of conservation of energy?

It says that energy cannot be created or destroyed, only transferred from one store to another. The total energy before and after any process is the same.

Where does wasted energy go?

Most of it becomes thermal energy that warms the surroundings. It is not destroyed, but it is too spread out to be useful again.

How do you calculate efficiency?

Divide the useful energy output by the total energy input and multiply by 100. For example, 30 J useful from 120 J input is 25 % efficient.

Can a machine be 100 % efficient?

In real life no, because some energy is always wasted by friction and heating. An electric heater is close to 100 % only because its thermal output is the useful output.

What does a Sankey diagram show?

It shows how an energy input splits into useful and wasted outputs. The width of each arrow is proportional to the amount of energy it carries.