Energy and conservation

Teacher review edition. Ask your teacher if anything is unclear.

Where does the energy go when a moving toy stops?

What you will learn

- Identify common energy stores and transfers.
- Explain why energy is conserved when an object stops moving.
- Calculate efficiency.

Energy makes changes possible

> **Energy**
> The ability to bring about changes such as movement or heating. Measured in joules (J).

- Kinetic energy: the energy of a moving object.
- Chemical energy: stored in food, fuels and batteries.
- Gravitational potential energy: stored when an object is raised above the ground.

The law of conservation of energy

Energy cannot be created or destroyed. It can only be transferred or changed from one form to another.

- The total energy stays the same when we include the object and its surroundings.
- When a ball stops bouncing, its energy has spread to the ball, floor and surrounding air.

Energy can be transferred

> **Transfer**
> Energy moving from one place to another, such as from a battery to a lamp.

- A battery transfers energy electrically to a lamp.
- The lamp transfers energy to its surroundings by light and heating.
- Energy can also be transferred by sound or when a force moves an object.
- Pushing a trolley transfers energy from you to the trolley.

A torch: follow the energy



Starting store
Chemical energy in the batteries

→

Transfer
Energy is transferred electrically to the lamp

→

Outputs
Light and heating of the surroundings

Batteries go inside the working torch. Arrows show pathways, not amounts.

A torch transfers energy from the chemical store in its batteries. Energy is transferred electrically to the lamp, then to the surroundings by light and heating.

Following a falling ball

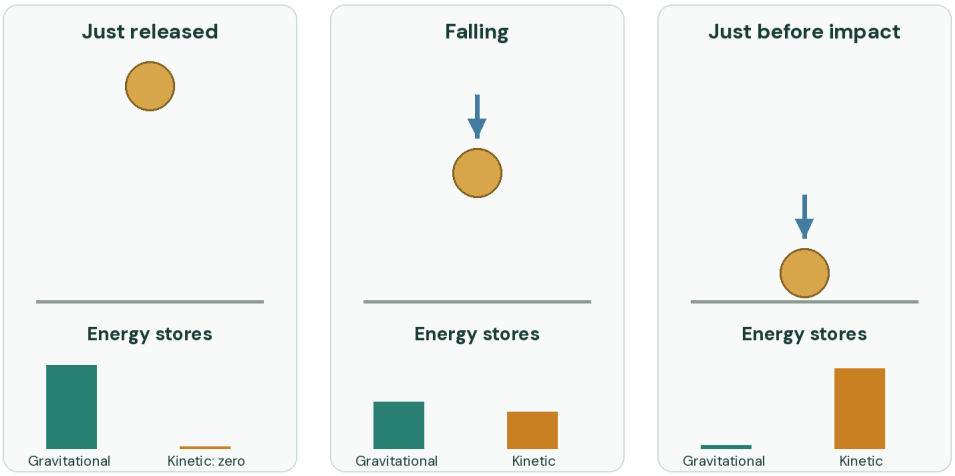
Kinetic energy
Energy an object has because it is moving.

Gravitational energy
Energy stored when an object is raised in a gravitational field.

Follow the energy as a ball falls and bounces.

- Lift the ball: its gravitational potential energy increases.
- Release it: gravitational potential energy decreases as kinetic energy increases.
- At impact, the ball and floor change shape and warm slightly; some energy travels away as sound.
- If the ball bounces, some energy becomes kinetic energy again.

A falling ball: energy changes form



Less gravitational potential energy → more kinetic energy

After impact, energy transfers to the ball, floor and air by heating and sound.

Air resistance ignored during the fall. Bars show relative amounts; not numerical data.

As a ball falls, gravitational potential energy decreases and kinetic energy increases. After impact, energy spreads into the ball, floor and air. It is not destroyed.

Useful and wasted energy

> **Dissipation**
> Energy spreading into the surroundings, usually by heating, so it is harder to use again.

Useful energy helps a device do its job. “Wasted” energy does not help with that job.

- For a lamp, light is useful; heating the room may be unwanted.
- For a heater, heating the room is the useful output.
- Wasted energy is not destroyed. It usually spreads into the surroundings and is harder to use again.
- This spreading out is called dissipation.

Efficiency

Efficiency
The fraction of input energy that becomes useful output, usually given as a percentage.

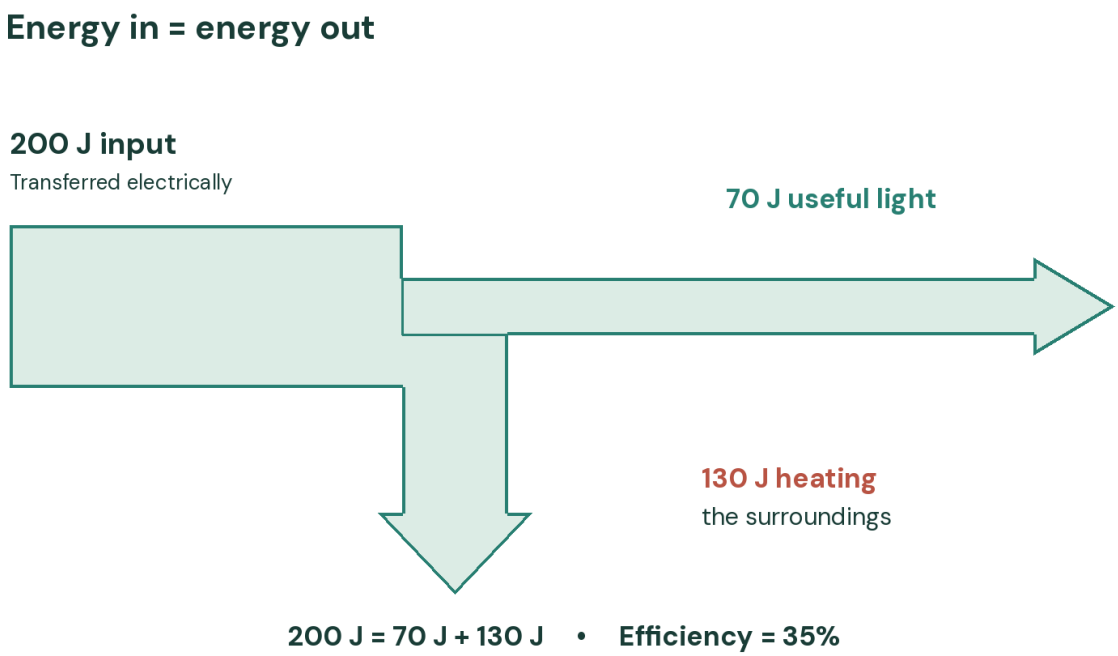
$$\text{efficiency} = \frac{\text{useful output energy}}{\text{total input energy}} \times 100\%$$

- Percentage efficiency = (useful energy output ÷ total energy input) × 100.
- For 200 J input and 70 J useful output: efficiency = 70 ÷ 200 × 100 = 35%.
- The remaining 130 J is transferred in other ways, such as heating the surroundings.

Reading an energy-flow diagram

An energy-flow diagram uses arrows to show energy inputs and outputs.

- In a diagram drawn to scale, a wider arrow represents more energy.
- If the device is not storing more energy, all output amounts add up to the input.
- Some devices also store energy, such as a rechargeable battery while charging.
- Energy is an amount, measured in J. Power is how quickly energy is transferred, measured in W.



Example lamp with no increase in stored energy. Arrow widths show relative energy amounts.

Energy is conserved: 200 J input = 70 J useful light + 130 J heating. The arrow widths represent the amounts. Useful output ÷ input × 100 gives 35% efficiency.

Worked examples

A device receives 200 J of energy and transfers 70 J usefully. Find the remaining energy and the percentage efficiency.

Work through it

1. Find the remaining energy: 200 − 70 = 130 J.
2. Divide useful output by total input: 70 ÷ 200 = 0.35.
3. Multiply by 100: efficiency = 35%. The other 130 J has not disappeared.

$$\text{efficiency} = \frac{70}{200} \times 100\% = 35\%$$

Common mistakes

Common mistake: Saying friction destroys energy when an object stops.

Remember: Energy transfers to the object and surroundings, often by heating and sound.

Common mistake: Dividing input energy by useful output to find efficiency.

Remember: Divide useful output by total input, then multiply by 100 for a percentage.

Answering questions

- For an energy change, name the starting store and follow the transfers to the final stores or surroundings.
- In efficiency calculations, use matching energy units and check that useful output is no greater than total input.

Try an investigation

Observe a battery-powered toy. Identify its useful output, then look for other outputs such as sound and warming. Draw labelled arrows to show where the energy comes from and where it goes. Keep fingers clear of moving parts.

Plan, record and review

- Question and prediction: What are you testing, and what do you think will happen? Give a reason.
- Change, measure, keep the same: What will you deliberately change? What will you measure, and in what units? What stays the same to make it a fair test? For an observation, say what you will record consistently instead.
- Record and look for a pattern: Use a table with headings and units. Look for a pattern or a result that does not fit.
- Conclude from evidence: Answer your question using a result or observation. Say if the evidence is unclear.
- Improve the investigation: What would you repeat or change, and how would that make the evidence better?

Do practical work with your teacher and follow the laboratory safety instructions.