

Efficiency

6.1.2.2 · Physics · revision notes

Efficiency tells you how much of the energy supplied to a device is transferred usefully. You need to calculate it from energy or power values, as a decimal or a percentage, and rearrange the equation. Most questions are 2 to 3 mark calculations.

Key facts

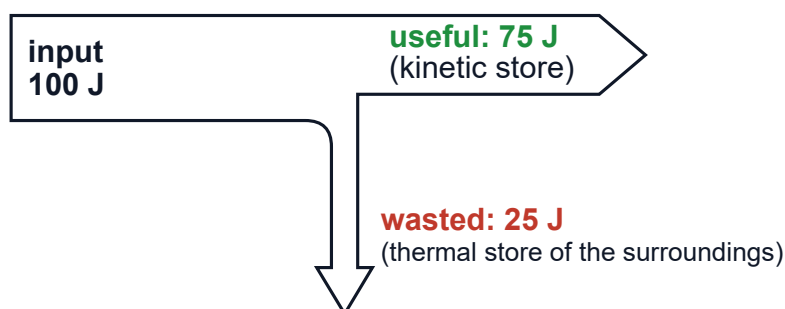
- efficiency = useful output energy transfer ÷ total input energy transfer
- percentage efficiency = efficiency × 100
- Efficiency has no unit and is never more than 1 (100%)
- efficiency = useful power output ÷ total power input
- total input = useful output + wasted
- useful output = efficiency × total input

Notes

What efficiency means

- Energy supplied to a device is either transferred **usefully** (to the store you want) or **wasted** (dissipated, usually to the thermal store of the surroundings).
- total input energy = useful output energy + wasted energy

Electric motor



Sankey diagram: widths show the energy. Efficiency = $75 \div 100 = 0.75$ (75%).

- Efficiency** = useful output energy transfer ÷ total input energy transfer
- You can also use power: efficiency = useful power output ÷ total power input.
- Efficiency has no unit. Give it as a decimal (e.g. 0.35) or as a percentage (× 100, e.g. 35%).
- No real device is 100% efficient, because some energy is always dissipated. Efficiency can never be more than 1 (100%).

Using the equation

- Both energies (or both powers) must be in the same unit, e.g. both in J or both in kJ.
- If you are given a percentage, divide it by 100 before you use it in the equation.
- To find the useful output: $\text{useful output} = \text{efficiency} \times \text{total input}$.

How to answer each type of question

Calculate the efficiency

2 marks

Grade 4

1. Pick out the useful output and the total input.
2. Divide useful by total.
3. Give a decimal, or multiply by 100 for a percentage (with the % sign).

Example. An electric motor is supplied with 2400 J of energy. It transfers 1800 J of this energy usefully.

Calculate the efficiency of the motor.

Model answer. $\text{efficiency} = 1800 \div 2400$ (1)

$\text{efficiency} = 0.75$ (or 75%) (1)

Don't lose marks

- ✗ Dividing the total input by the useful output.
- ✗ Putting the wasted energy on top instead of the useful energy.
- ✗ Using one value in J and the other in kJ.
- ✗ Giving efficiency a unit (such as J), or forgetting the % sign.
- ✗ Putting a percentage (e.g. 80) into the equation instead of the decimal (0.80).

More tips

Memory tricks

- 'Useful over total': the smaller number goes on top.
- Sense check: if your efficiency is more than 1 (or 100%), you have divided the wrong way round.
- Decimal to percentage: multiply by 100, so 0.35 becomes 35%.
- An electric heater is almost 100% efficient, because heating the room is its useful output.

Exam technique

- Check whether the question wants a decimal or a percentage.
- Show the subtraction when you have to find the useful energy first; it can earn a mark on its own.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Identify useful and wasted energy transfers

E.g. for a lamp, light is the useful output and heating the surroundings is wasted.

Grade 4

Calculate efficiency from energy values

Divide the useful output energy by the total input energy.

Grade 5

Give efficiency as a decimal or percentage

Multiply the decimal by 100 to get a percentage; efficiency is never more than 1 (100%).

Grade 5

Calculate efficiency from power values

Divide the useful power output by the total power input.

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