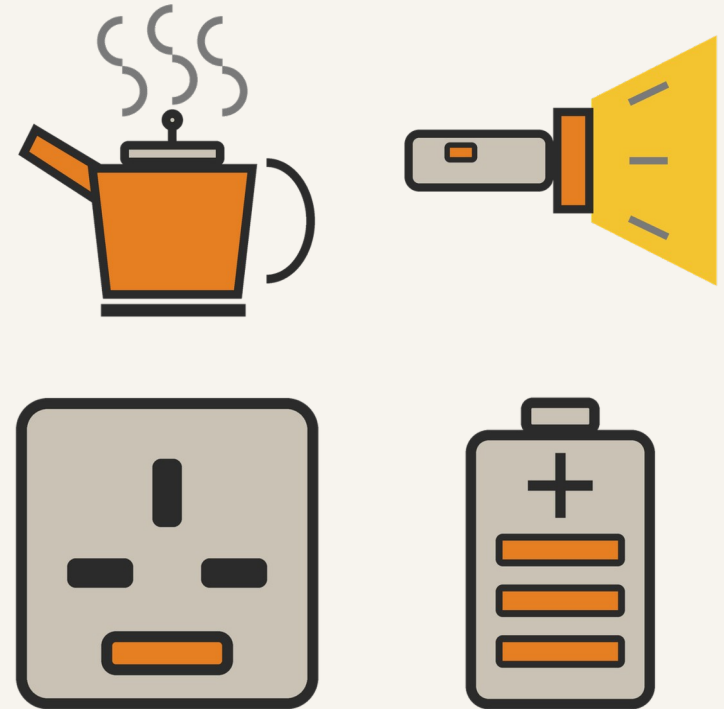


BOOKLET 2 • ENERGY AND EFFICIENCY

Energy Audits

Follow every joule from the plug to the job
— and to the waste.



National 5 Engineering Science

LEARNING INTENTION

To complete an energy audit diagram and calculate the efficiency of the system from it.

Daily Review

SHOW ME BOARDS

- 1 State the law of conservation of energy.
- 2 A motor is supplied with 900 J and wastes 200 J. How much is useful?
- 3 Write the formula for percentage efficiency.
- 4 A heater takes in 500 J and gives 400 J of useful heat. Find η .
- 5 A 300 W motor runs for 20 s. Calculate the energy transferred.

By the end of this lesson...

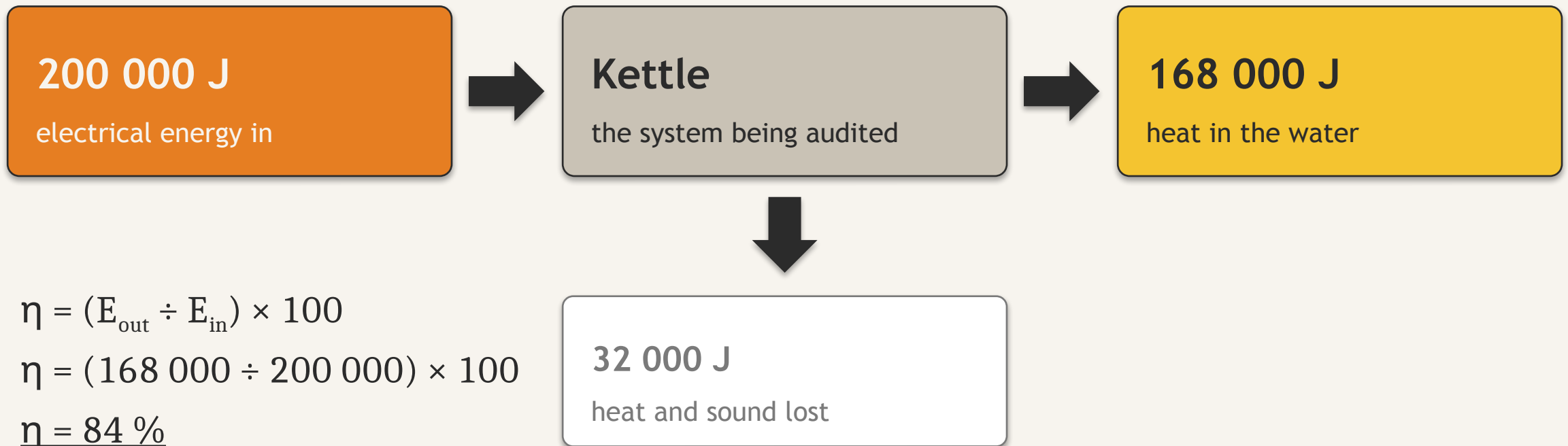
- 1 I can read the input, useful and wasted energy off an audit diagram.
- 2 I can fill in a missing value using conservation of energy.
- 3 I can calculate the efficiency of an audited system.
- 4 I can work backwards from an efficiency to the missing energies.

What an Energy Audit Is

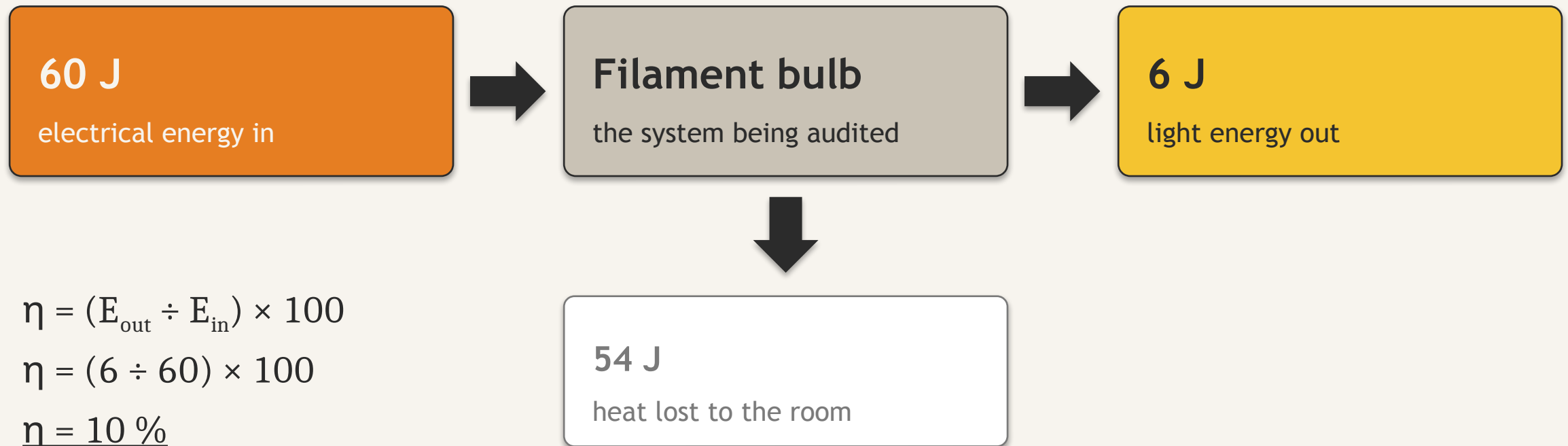
An audit is the engineer's account of where every joule of the input ends up.

- It shows the input, the useful output and the waste together.
- Useful + wasted = input. Nothing vanishes, nothing appears.
- One missing value can always be found from the other two.
- Engineers audit a system before they try to improve it.

Audit 1 – The Electric Kettle



Audit 2 – The Filament Light Bulb



Show Me — Read the Audit

SHOW ME BOARDS

- 1 A drill audit: 5 000 J supplied, 3 500 J of useful output.
- 2 Calculate the wasted energy.
- 3 Calculate the percentage efficiency of the drill.
- 4 Name one likely form of the wasted energy.
- 5 Where does that wasted energy end up?

Show Me — Another Audit

SHOW ME BOARDS

EXTRA PRACTICE

- 1 A floodlight audit: 200 J supplied, 150 J of useful light.
- 2 Calculate the wasted energy.
- 3 Calculate the percentage efficiency of the floodlight.
- 4 State what the wasted energy becomes.
- 5 Would a filament lamp score higher or lower? Give a reason.

Working Backwards

An audit has three energies. Give me any two and I can find the third.

GIVEN THE WASTED ENERGY

Useful = input – wasted. Then divide the useful by the input and multiply by 100.

GIVEN THE EFFICIENCY

Useful = efficiency × input. Then wasted = input – useful.

Either way, the three numbers must still add up. Check them before you write the answer down.

Worked Example – Pump

A pump is supplied with 2 000 J of electrical energy.
The pump is 65 % efficient. Calculate the energy it wastes.

$$E_{\text{in}} = 2\,000 \text{ J}$$

$$\eta = 65 \% = 0.65$$

$$E_{\text{out}} = ?$$

$$\text{wasted} = ?$$

$$E_{\text{out}} = \eta \times E_{\text{in}}$$

$$E_{\text{out}} = 0.65 \times 2\,000$$

$$E_{\text{out}} = 1\,300 \text{ J}$$

$$\underline{\text{wasted} = 2\,000 - 1\,300 = 700 \text{ J}}$$

Task – Complete the Audit

Five systems to audit. Fill in every empty cell.
Two rows give you the wasted energy – work backwards.
The pump row gives you the efficiency instead. Same skill.

Check that $\text{useful} + \text{wasted} = \text{input}$ on every row.

Booklet – “TASK 5: Complete the Audit”

Checkpoint

- 1 A system takes in 2 000 J and wastes 500 J. Calculate the efficiency.
- 2 Explain why the useful and the wasted energy always add up to the input.
- 3 What + why: which would you replace first, the kettle or the filament bulb?

Exam Practice — Past Papers

2022 Q11(c) — complete the energy audit diagram for a lift (3)

The one direct audit question in the papers we hold.
Set your working out the SQA way, then check it adds up.

Find the relationship in the data booklet

LOOKING AHEAD

Making the Decision

Two motors, one budget. Which one should the school buy?

Plenary – Prove Your I Can... Statements

SHOW ME BOARDS

- 1 What does an energy audit show?
- 2 Input 400 J, useful 300 J – calculate the wasted energy.
- 3 Now calculate the efficiency of that system.
- 4 Input 1 000 J, wasted 250 J – how much is useful?
- 5 Why can an audit never show more output than input?

Plenary – More Quick Checks

SHOW ME BOARDS

EXTRA PRACTICE

- 1 Write the formula for percentage efficiency.
- 2 Input 80 J, useful 20 J – calculate the wasted energy.
- 3 Now calculate the efficiency of that system.
- 4 A system is 40 % efficient and takes in 500 J. Find the useful output.
- 5 Name two forms that wasted energy usually takes.

Extension – If You Finish Early

- 1 An LED gives 45 J of light from 50 J supplied. Find its efficiency.
- 2 A filament lamp is 10 % efficient. How many times better is the LED?
- 3 What + why: both lamps give the same light. Which costs more to run?

Extension — More Challenges

EXTRA PRACTICE

1

A motor is 85 % efficient and wastes 300 J. Calculate the input energy.

2

How much useful energy did that motor produce?

3

What + why: why can a cooling fan never make a motor 100 % efficient?

Extension — Design Your Own Audit

EXTRA PRACTICE

Choose any device in the workshop and audit it.
Pick a sensible input energy, then split it into useful and wasted.
Draw the diagram, label every block, and work out the efficiency.
Swap with a partner and check their three numbers add up.

Your jotter — no booklet needed