Daily Review

Booklet p.8–10 — Ohm's Law

1. State the relationship between V, I and R.

2. A 12 Ω resistor carries 0.50 A. Calculate the voltage across it.

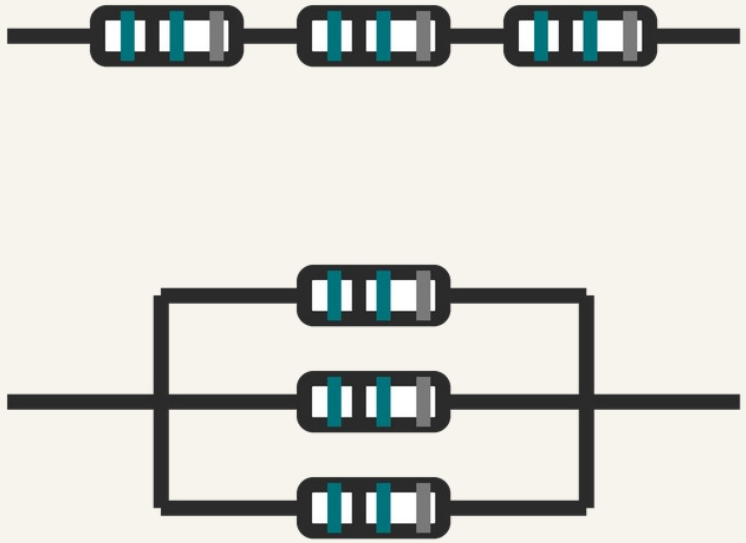
3. What does the gradient of a V–I graph tell you?

4. Which two multimeter sockets measure resistance?

5. What happens to a lamp's resistance as it gets hotter?

BOOKLET 1 · ELECTRICITY — CIRCUITS

Combining Resistors 1



Two resistors in a circuit behave as one. It depends how they are joined.

N5 Physics and Electronics (S3)

PART 1

Resistors in Series

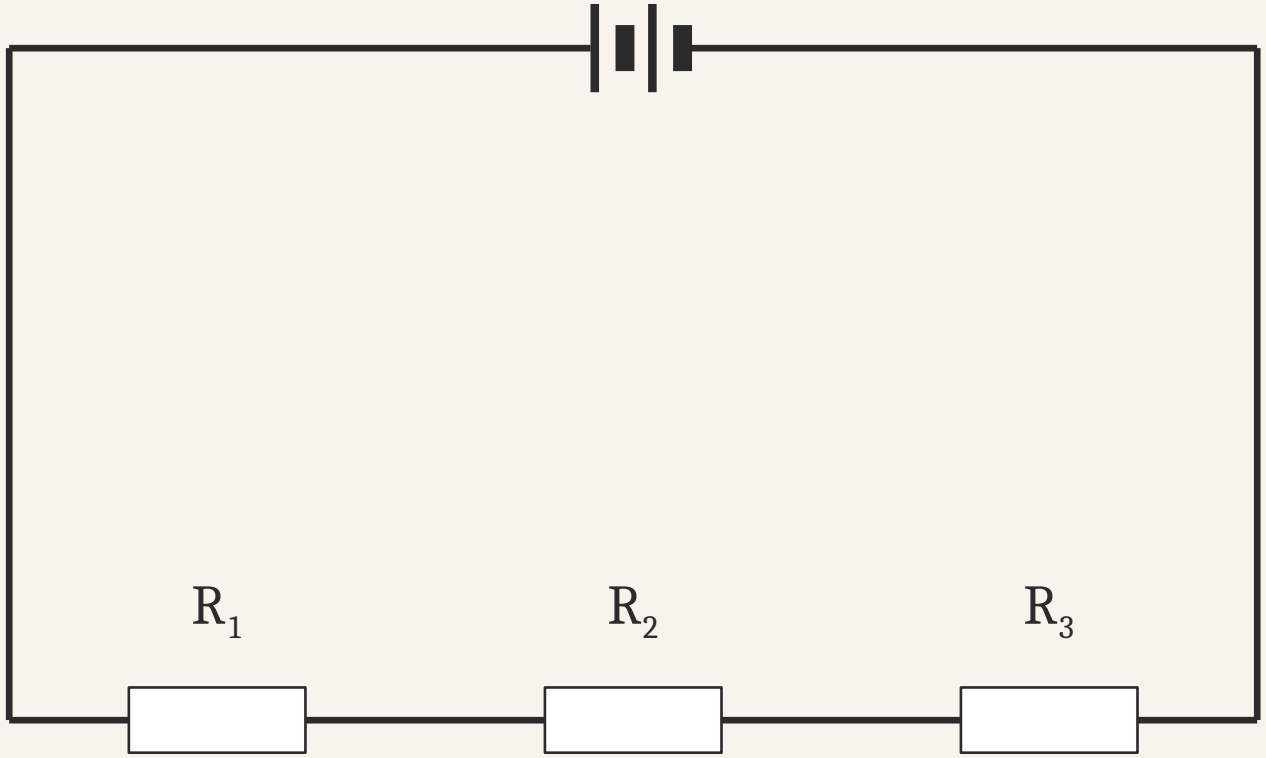
One path, one after the other — so the resistances add up.

By the end of this part…

1. I know what happens when I increase the resistance in a series circuit
2. I can predict the total resistance in a series circuit
3. I can measure the total resistance in a series circuit

Resistors in series

Booklet p.11



There is one path.

The charge meets every resistor in turn, so every one of them opposes it.

The resistances add up.

Safety and the kit

Booklet p.11 — Practical 1

Testing probes

Sharp ends. Point them at the board, never at a person.

Wire strippers

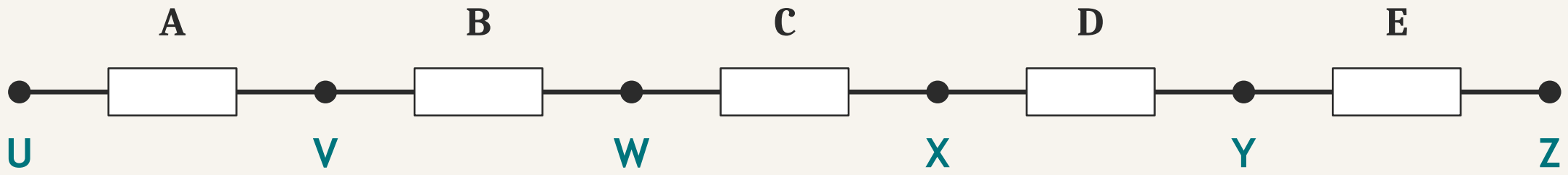
Cut and pull away from your hand.

Prototype board

Push every leg fully in. A loose leg reads as a break.

The chain, as a circuit

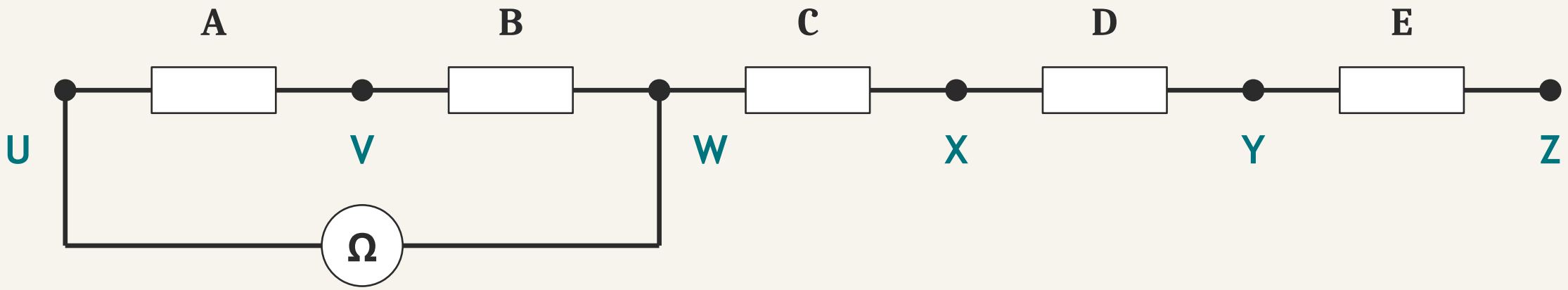
Booklet p.11 — Practical 1



Five resistors in one chain: A to E.
The six points U to Z are where the ohmmeter probes go.

Reading between two points

Booklet p.11 — Practical 1

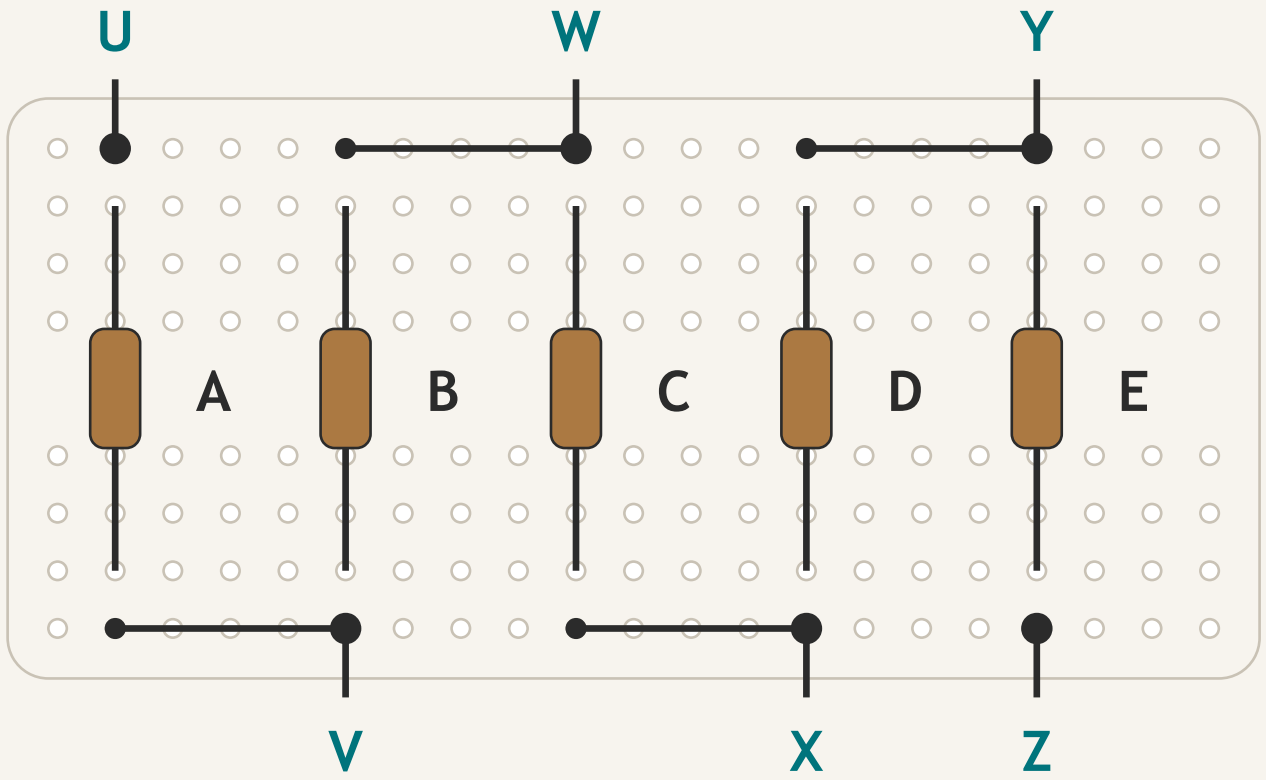


U and W

Probing U and W puts the meter across A and B only, so it reads those two added together.
Probing U and Z puts it across all five.

The same chain, on the board

Booklet p.11 — Practical 1



Each resistor bridges the channel; a jumper joins the next one on.

How to run it

Predict, check, update — then predict again

1. Predict the next reading, using the rule you have so far.
2. Check it — measure with the ohmmeter and write both numbers down.
3. Update your rule if the two do not agree.
4. Predict the next one, and go round again.

Your last prediction should be your best one.

The relationship

Booklet p.11 — resistors in series

$$R_T = R_1 + R_2 + \ldots$$

R_T	R_1	R_2
the total resistance, in ohms (Ω)	the first resistor, in ohms (Ω)	the second resistor, in ohms (Ω)

Worked example 1

Three resistors in series

Resistors of 220 Ω, 470 Ω and 1.0 kΩ are joined in series.

Calculate the total resistance of the combination.

$R_1 = 220\ \Omega$

$R_2 = 470\ \Omega$

$R_3 = 1000\ \Omega$

$R_T = ?$

$R_T = R_1 + R_2 + R_3$

$R_T = 220 + 470 + 1000$

$\underline{R_T = 1690\ \Omega}$

Practical 1 — predict, check, update

Booklet p.11

Build the chain on the board.
Work down the table one row at a time.

Booklet p.11, Practical 1

Task 1 — write the rule

Booklet p.12

Look at your seven readings.
Write a rule for resistance in series.

Booklet p.12, Task 1

Task 1 — Answers

ANSWERS

Booklet p.12 — the series rule

	The rule for resistors in series
In words	The total resistance is the sum of the separate resistances
The check	The total is always bigger than the biggest resistor in the chain

$$R_T = R_1 + R_2 + \ldots$$

Show me — resistors in series

SHOW ME BOARDS

1. A 10 Ω and a 20 Ω resistor are joined in series. Find R_T.
2. Three 100 Ω resistors are joined in series. Find R_T.
3. A 47 Ω and a 33 Ω resistor are joined in series. Find R_T.
4. Two resistors in series total 250 Ω. One is 150 Ω. Find the other.
5. Does adding a resistor in series make the total bigger or smaller?

Show me — resistors in series

SHOW ME BOARDS

EXTRA PRACTICE

1. A 15 Ω and a 25 Ω resistor are joined in series. Find R_T.

2. Four 50 Ω resistors are joined in series. Find R_T.

3. A 1.2 kΩ and an 800 Ω resistor are joined in series. Find R_T.

4. Two equal resistors in series total 90 Ω. Find the value of each.

5. Five 20 Ω resistors are joined in series. Find R_T.

Daily Review

Booklet p.11-12 — resistors in series

1. Write the relationship (equation/formula) for resistors in series.

2. A 220 Ω and a 180 Ω resistor are in series. Find R_T.

3. Three 60 Ω resistors are in series. Find R_T.

4. Which ports on a multimeter are used for resistance?

5. What is the name for the white circuit boards we have used?

PART 2

Resistors in Parallel

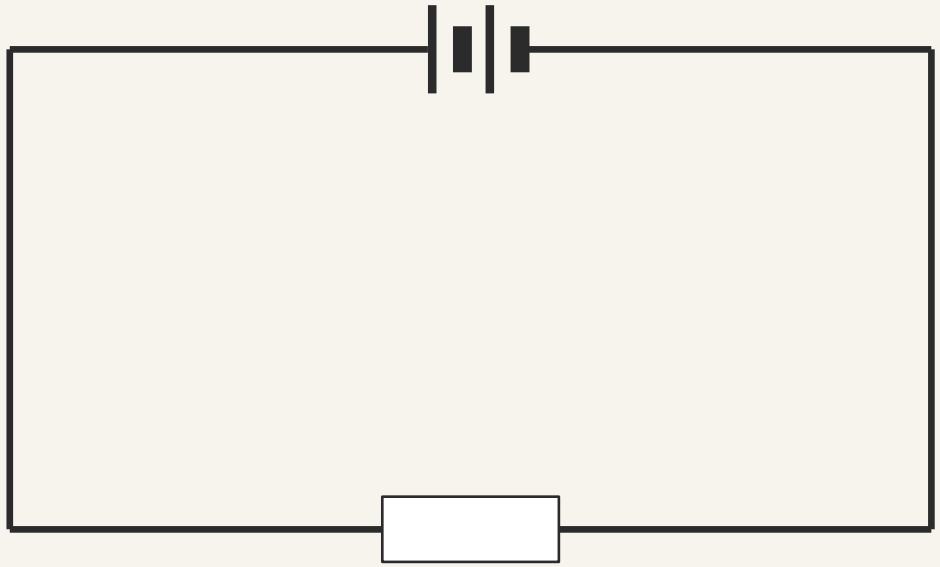
Add a branch and the total resistance goes DOWN. That is not a typo.

By the end of this part…

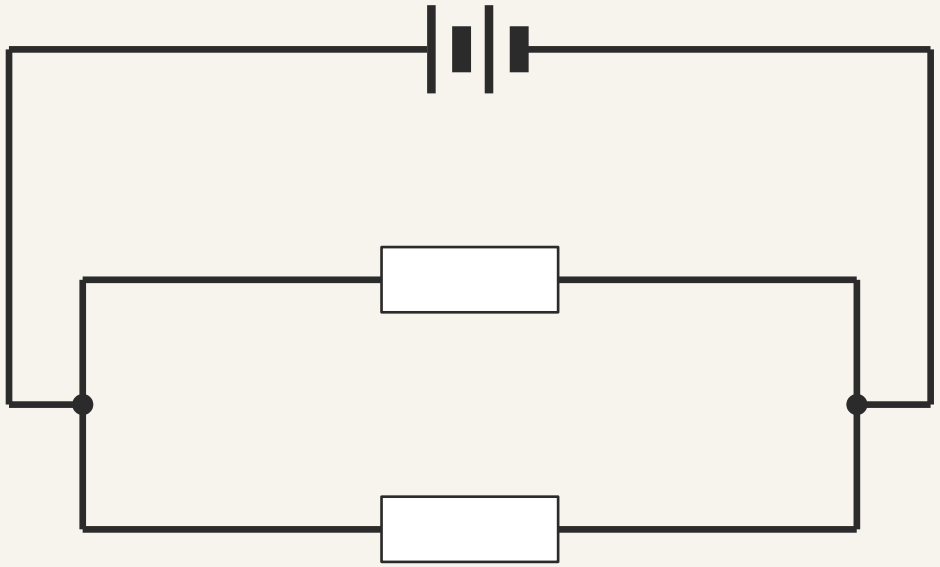
1. I know what happens when I add a branch to a parallel circuit
2. I can predict the total resistance in a parallel circuit with resistors of the same value
3. I can measure the total resistance in a parallel circuit with resistors of the same value

Adding a branch

Booklet p.12



one route



two routes

A second branch is a second route for the charge, so more current flows for the same voltage — and that means LESS total resistance.

The relationship

Booklet p.12 — branches of the same value

$$R_T = R_1 / number\ of\ branches$$

R_T

the total resistance of the combination, in ohms (Ω)

R_1

the value of ONE branch — they must all be the same

Worked example 2

Four equal resistors in parallel

Four 100 Ω resistors are connected in parallel.

Calculate the total resistance of the combination.

$R_1 = 100\ \Omega$

number of branches = 4

$R_T = ?$

$R_T = R_1 / number\ of\ branches$

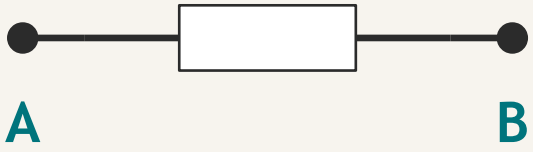
$R_T = 100/4$

$\underline{R_T = 25\ \Omega}$

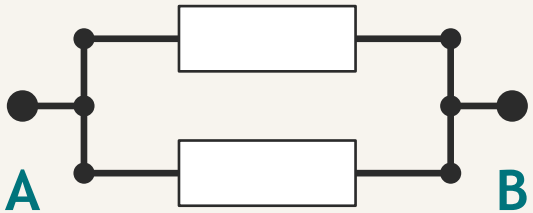
The four circuits

Booklet p.12 — Practical 2

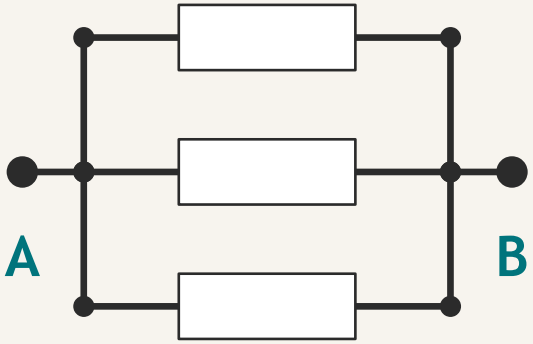
Circuit 1



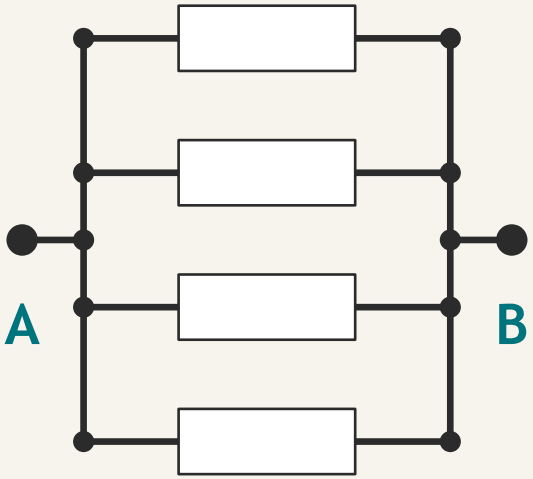
Circuit 2



Circuit 3



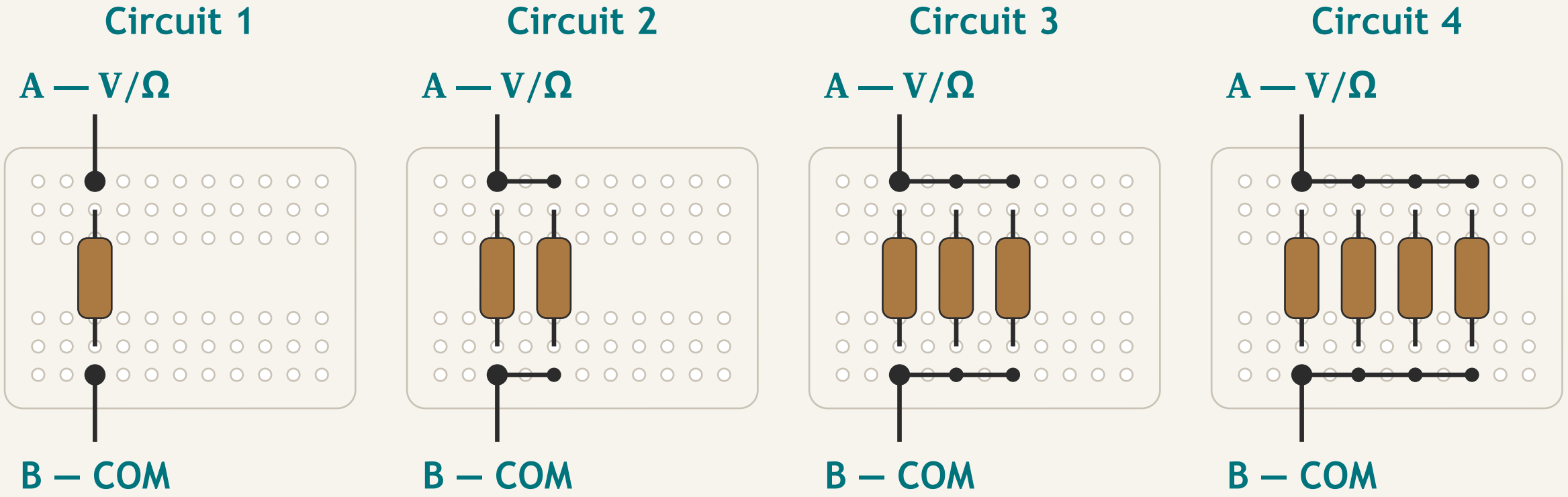
Circuit 4



Every resistor is 1 kΩ. Only the number of branches changes.

The same four, on the board

Booklet p.12 — Practical 2



All four resistors are 1 kΩ. The leads never move.

Same again

Predict, check, update — then predict again

1. Predict circuit 1, then measure it.
2. Use what circuit 1 told you to predict circuit 2.
3. Check it, and update your rule if you were out.
4. Carry that rule on to circuits 3 and 4.

Four circuits, four chances to make the rule better.

Practical 2 — predict, check, update

Booklet p.12

Build one circuit at a time.
Each resistor is 1 kΩ. Predict, then measure.

Booklet p.12, Practical 2

Task 1 — write the rule

Booklet p.12

Look at your four readings.
Write a rule for equal resistors in parallel.

Booklet p.12, Task 1

Task 1 — Answers

ANSWERS

Booklet p.12 — the parallel rule

	The rule for equal resistors in parallel
In words	Divide the value of one branch by the number of branches
The check	The total is always smaller than one branch on its own

$$R_T = R_1/number\ of\ branches$$

Watch out

THE MISTAKE

- Adding the branches up: 4 × 100 = 400 Ω
- “More resistors always means more resistance”
- Using this rule on branches of different values

THE CORRECT ANSWER

- Divide: 100 ÷ 4 = 25 Ω
- In parallel, more branches means LESS resistance
- Different values need the other rule — next lesson

Show me — equal resistors in parallel

SHOW ME BOARDS

1. Two 100 Ω resistors in parallel. Find R_T.
2. Four 200 Ω resistors in parallel. Find R_T.
3. Five 1.0 kΩ resistors in parallel. Find R_T.
4. Three 60 Ω resistors in parallel. Find R_T.
5. Two 470 Ω resistors in parallel — more or less than 470 Ω?

Show me — equal resistors in parallel

SHOW ME BOARDS

EXTRA PRACTICE

1. Two 50 Ω resistors in parallel. Find R_T.
2. Three 900 Ω resistors in parallel. Find R_T.
3. Four 1.0 kΩ resistors in parallel. Find R_T.
4. Two 12 Ω resistors in parallel. Find R_T.
5. Three equal resistors in parallel give 40 Ω. Find the value of one.

Checkpoint

1. State the rule for the total resistance of resistors in series.

2. Four 80 Ω resistors are connected in parallel. Find R_T.

3. Adding a resistor in parallel lowers the total resistance. Why?

LOOKING AHEAD

Combining Resistors 2

What if the branches are NOT all the same value?

Plenary

1. Write the relationship for resistors in series.
2. A 220 Ω and a 180 Ω resistor are in series. Find R_T.
3. Write the relationship for equal resistors in parallel.
4. Three 300 Ω resistors are in parallel. Find R_T.
5. Can a parallel total ever be bigger than one of its branches?

Plenary

EXTRA PRACTICE

1. What happens to the total as you add resistors in series?
2. A 68 Ω and a 32 Ω resistor are in series. Find R_T.
3. What happens to the total as you add branches in parallel?
4. Two 90 Ω resistors are in parallel. Find R_T.
5. Which of the two rules only works when the branches are equal?

Extension

1. Three 60 Ω resistors. What is the biggest total you can make with all three, and the smallest?
2. Explain why a parallel total is always less than the smallest branch.

Extension

EXTRA PRACTICE

1. Four 40 Ω resistors. Give the total in series, and in parallel.

2. Two equal resistors in parallel give 35 Ω. What would they give in series?

Check your understanding

Booklet p.11–12

Work the Yellow Book resistance questions.
Then sit the check test and mark it yourself.

Yellow Books p.42-44
N5 Electricity CT 4 — Practical Circuits