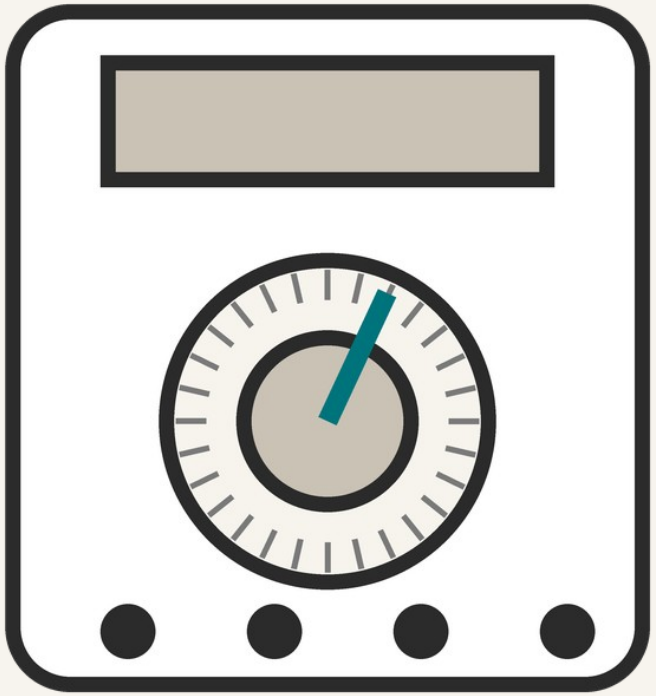
BOOKLET 1 · ELECTRICITY — CIRCUITS

Ohm's Law

One relationship ties voltage, current and resistance together.



N5 Physics and Electronics (S3)

Daily Review

Booklet p.6–7 — Measuring Resistance

1. What is resistance?
2. What unit is resistance measured in?
3. Draw the circuit symbol for a fixed resistor.
4. A resistor is banded Brown, Black, Red. What is its quoted value?
5. Which two multimeter ports measure resistance?

PART 1

Ohm's Law

Voltage, current and resistance are not three separate ideas.

By the end of this part…

1. I can label the symbols and units in $V = IR$
2. I can calculate voltage, current or resistance using $V = IR$
3. I can convert milliamperes to amperes before substituting
4. I can set a multimeter to measure voltage and current

The relationship

Booklet p.8 — Task 1

$$V = IR$$

V	I	R
potential difference, in volts (V)	current, in amperes (A)	resistance, in ohms (Ω)

Task 1 — label the equation

Booklet p.8

Label each letter in $V = IR$ with the quantity it stands for
and the unit that quantity is measured in.

Booklet p.8, Task 1

Task 1 — Answers

ANSWERS

Booklet p.8

Letter	Quantity	Unit
V	potential difference	volt (V)
I	current	ampere (A)
R	resistance	ohm (Ω)

Worked example 1

Finding the voltage

A current of 0.35 A passes through a 12 Ω resistor.

Calculate the potential difference across the resistor.

$\mathrm{I} = 0.35\ \mathrm{A}$

$\mathrm{R} = 12\ \Omega$

$\mathrm{V} = ?$

$V = IR$

$\mathrm{V} = 0.35 \times 12$

$\underline{\mathrm{V} = 4.2\ \mathrm{V}}$

Worked example 2

Rearranging for resistance

A component has 6.0 V across it and a current of 0.25 A.

Calculate its resistance.

V = 6.0 V

I = 0.25 A

R = ?

$$V = IR$$

$$R = \frac{V}{I}$$

$$R = \frac{6.0}{0.25}$$

$$\underline{\text{R} = 24\ \Omega}$$

Worked example 3

Watch the units

A resistor carries a current of 250 mA when the voltage across it is 9.0 V. Calculate its resistance.

V = 9.0 V

I = 250 mA = 0.25 A

R = ?

$$V = IR$$

$$R = \frac{V}{I}$$

$$R = \frac{9.0}{0.25}$$

$$\underline{R = 36\ \Omega}$$

Show me — Ohm's Law

SHOW ME BOARDS

1. A 20 Ω resistor carries 0.30 A. Calculate the voltage across it.
2. A lamp has 3.0 V across it and 0.50 A through it. Find its resistance.
3. A 100 Ω resistor has 5.0 V across it. Calculate the current.
4. Convert 400 mA into amperes.
5. A 2.0 kΩ resistor carries 4.0 mA. Calculate the voltage across it.

Show me — Ohm's Law

SHOW ME BOARDS

EXTRA PRACTICE

1. A 15 Ω resistor carries 0.40 A. Calculate the voltage across it.
2. A component has 12 V across it and 3.0 A through it. Find its resistance.
3. A 250 Ω resistor has 10 V across it. Calculate the current.
4. Convert 1.5 A into milliamperes.
5. A 4.7 kΩ resistor carries 2.0 mA. Calculate the voltage across it.

Watch out

THE MISTAKE

- Putting 250 mA straight into the equation
- Writing $R = I \div V$
- Writing the answer as 36

THE CORRECT ANSWER

- Convert to 0.25 A first, then substitute
- $R = V \div I$ — rearrange, then substitute
- 36 Ω — the unit is part of the answer

Task 2 — your turn

Booklet p.8

Three calculations. Set each one out the way the worked
examples do: what you know, then the working.

Booklet p.8, Task 2

Task 2 — Answers

ANSWERS

Booklet p.8

Q	Working	Answer
1	$V = I\,R = 0.2 \times 33$	6.6 V
2	$I = V \div R = 230 \div 5$	46 A
3	$R = V \div I = 8 \div 0.002$	4000 Ω (4 kΩ)

Task 3 — more practice

Booklet p.8

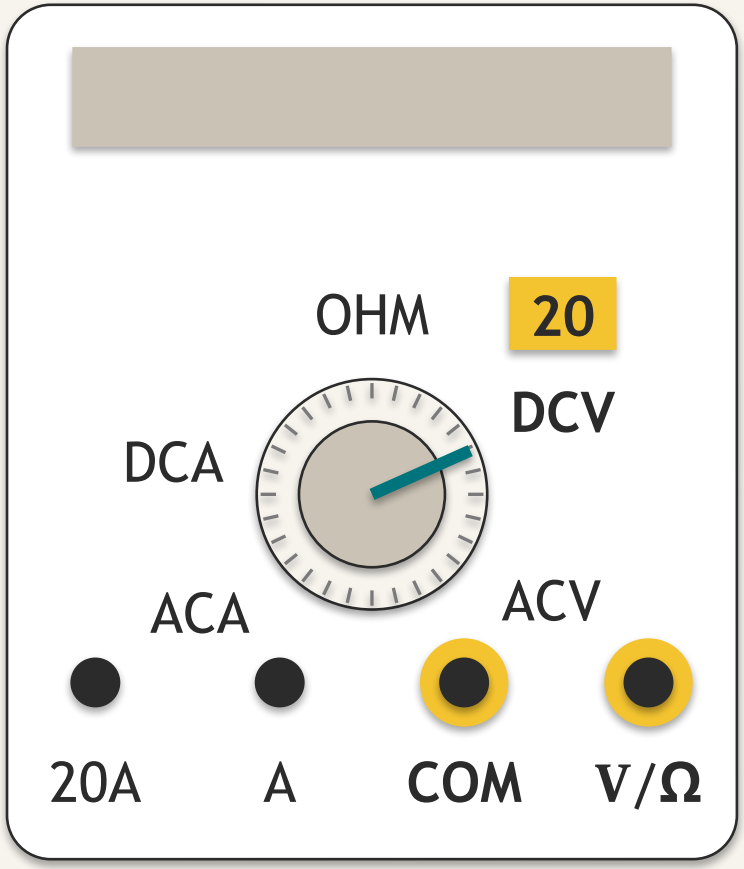
Work through the Ohm's Law questions in the Yellow Book,
then scan the code for the quiz.

Booklet p.8, Task 3
Yellow Books p.45-49

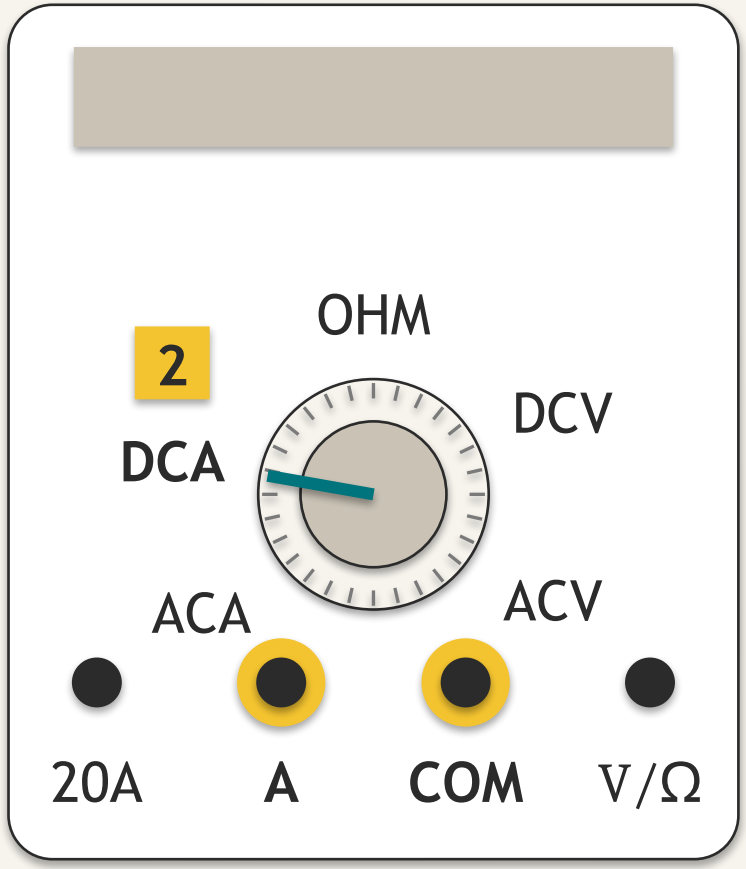
Ohm's Law quiz

Setting the multimeter

Booklet p.9 — Task 4



measuring voltage



measuring current

The dial picks what you measure, and the range it works over.

The sockets pick where the leads go.

COM is always one.

Watch out

THE MISTAKE

- Looking for an mA socket
- Leaving the dial on DCV to read a current
- Starting on the smallest range

THE CORRECT ANSWER

- There isn't one — under 2 A goes in A
- Move it to DCA, and move the red lead too
- Start high and work down, or you overload

Task 4 — label the meters

Booklet p.9

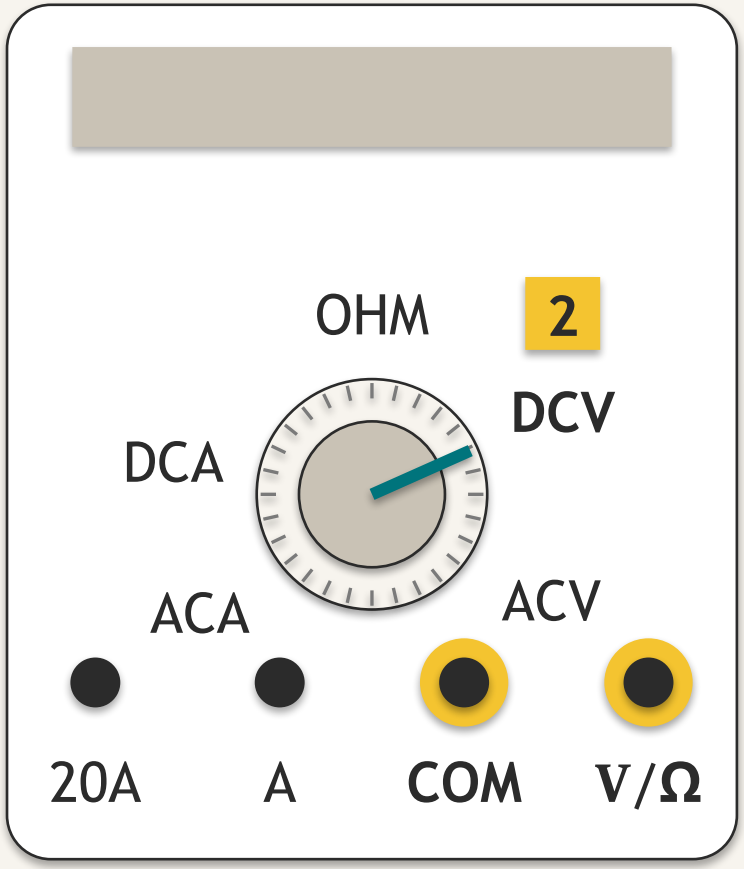
For each measurement, mark the dial setting and the two
sockets the leads go into.

Booklet p.9, Task 4

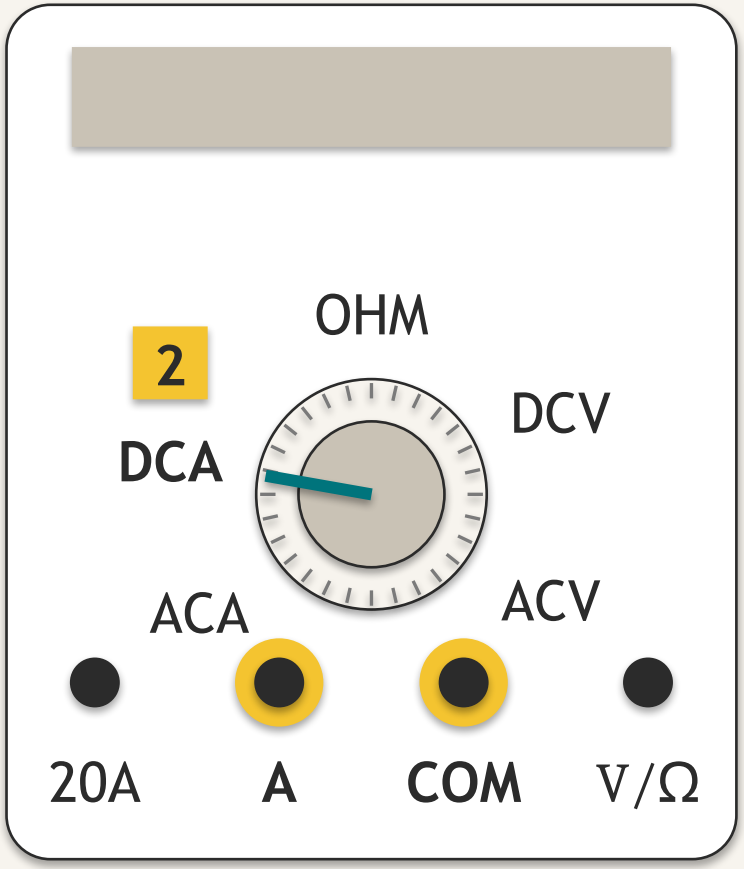
Task 4 — Answers

ANSWERS

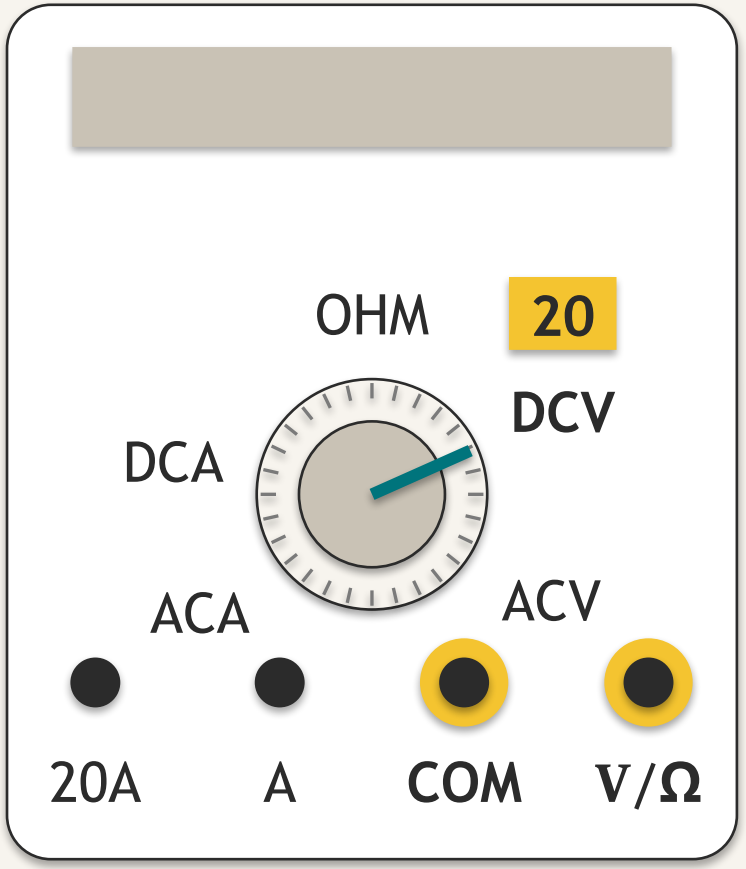
Booklet p.9



a 1.5 V cell



a current of 0.3 A



a 12 V lab pack

Daily Review

Booklet p.8 — Ohm's Law

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

2. What are the units of current?

3. A 12 Ω resistor carries 0.5 A. Calculate the voltage across it.

4. Convert 250 mA into amperes.

5. Is an ammeter connected in series or in parallel?

PART 2

Proving Ohm's Law

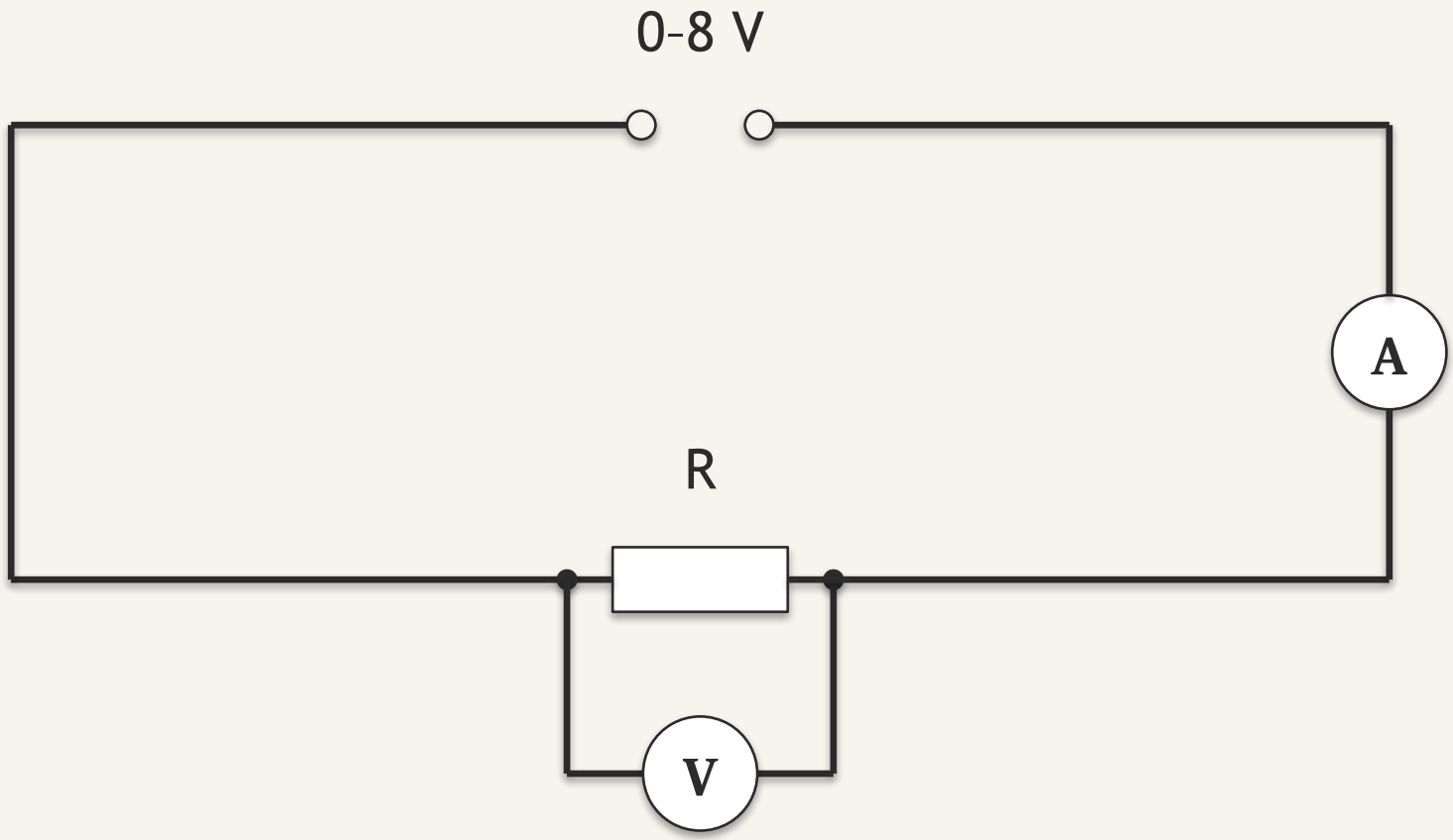
A graph turns a set of readings into a straight-line rule.

By the end of this part…

1. I can build the circuit that measures V and I together
2. I can plot a graph of V against I
3. I can find a resistance from the gradient of that graph
4. I can describe an experiment that proves Ohm's Law

The circuit

Booklet p.9 — Practical 1



The method

Booklet p.9 — Practical 1

1. Set the supply to 1 V.
2. Measure the voltage across the resistor and the current through it.
3. Repeat in steps up to 5 V.
4. Plot a graph of V against I.
5. The gradient of the line is the resistance.

Record your results

Booklet p.9 — Practical 1

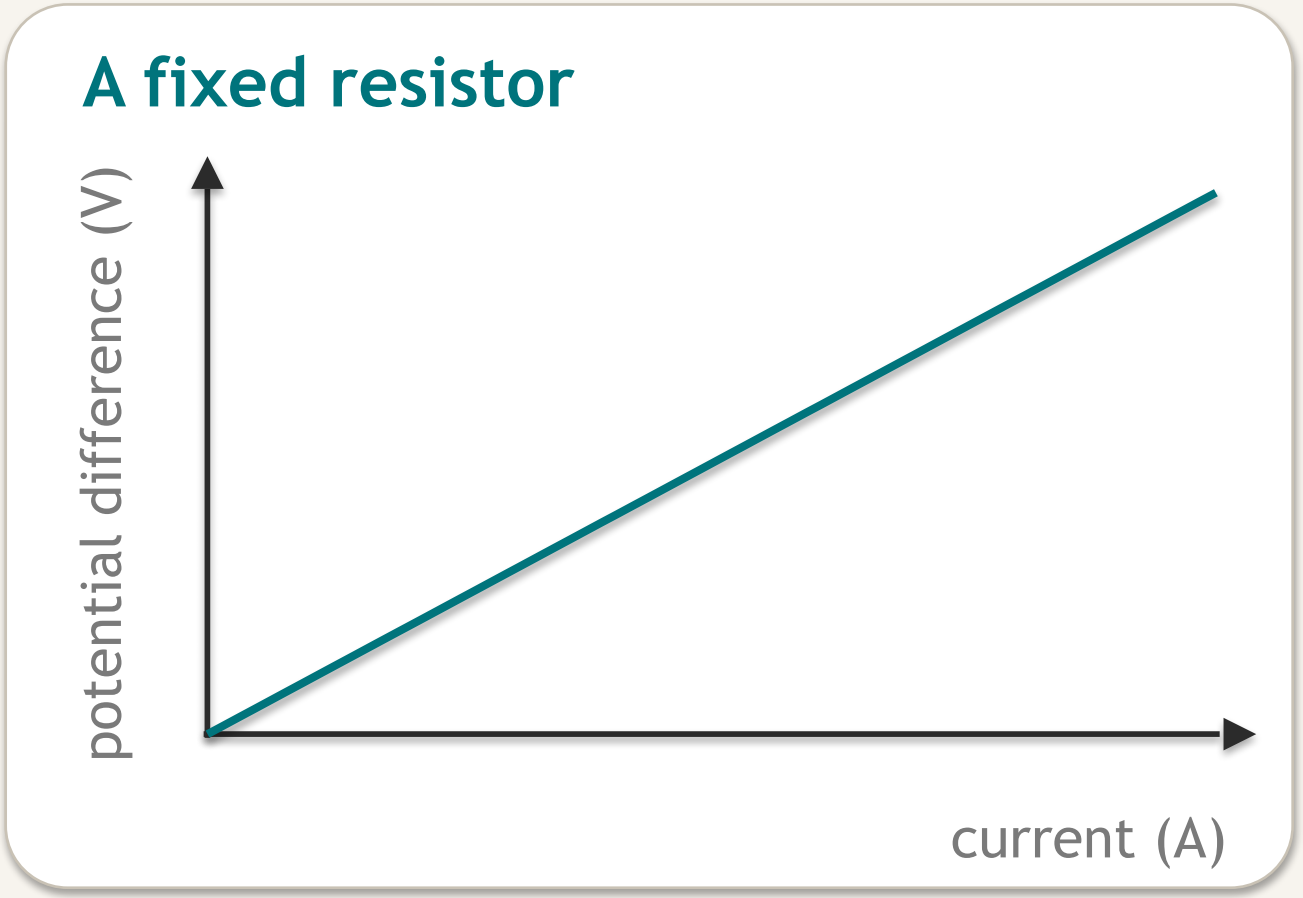
Take five pairs of readings and enter them in the shared workbook. Your group has its own tab.

Booklet p.9, Practical 1

Results workbook

What the graph should look like

Booklet p.9



Worked example 4

Resistance from the gradient

A point on the straight line is read off at 3.0 V and 0.20 A.

Calculate the resistance of the resistor.

$V = 3.0\ \text{V}$

$I = 0.20\ \text{A}$

$R = ?$

$$R = \frac{V}{I}$$

$$R = \frac{3.0}{0.20}$$

$$\underline{R = 15\ \Omega}$$

Task — sketch and conclude

Booklet p.9

Sketch your V–I graph in the space in the booklet, then
complete the two conclusion sentences underneath it.

Booklet p.9, Practical 1 — conclusion

Conclusion — Answers

ANSWERS

Booklet p.9

- As the voltage across a fixed resistor increases, the current through it increases.
- The gradient of the graph is equal to the resistance of the resistor used.
- The line is straight and passes through the origin — the resistance does not change.

Watch out

THE MISTAKE

- Plotting I up and V across
- Forcing the line through the last point
- Taking the gradient from one point only

THE CORRECT ANSWER

- V up, I across — then the gradient is R
- Draw the best straight line through all the points
- Use two points far apart on the line

Daily Review

1. What happens to the current through a resistor when the voltage across increases? (Increases, Decreases or Stays the Same)
2. What equation links Voltage Current and Resistance (open book)
3. A resistor has 4.5 V across it and 0.15 A through it. Find R.
4. What can a multi-meter measure?
5. What shape was the V/I graph for a fixed resistor?

PART 3

When the rule bends

A lamp does not give a straight line. That is not an error.

By the end of this part…

1. I can name a component that obeys Ohm's Law and one that does not
2. I can describe the shape of a V–I graph for a lamp
3. I can describe how temperature affects the resistance of a conductor
4. I can describe how temperature affects the resistance of a resistor

Ohmic and non-ohmic

Booklet p.10

Ohmic

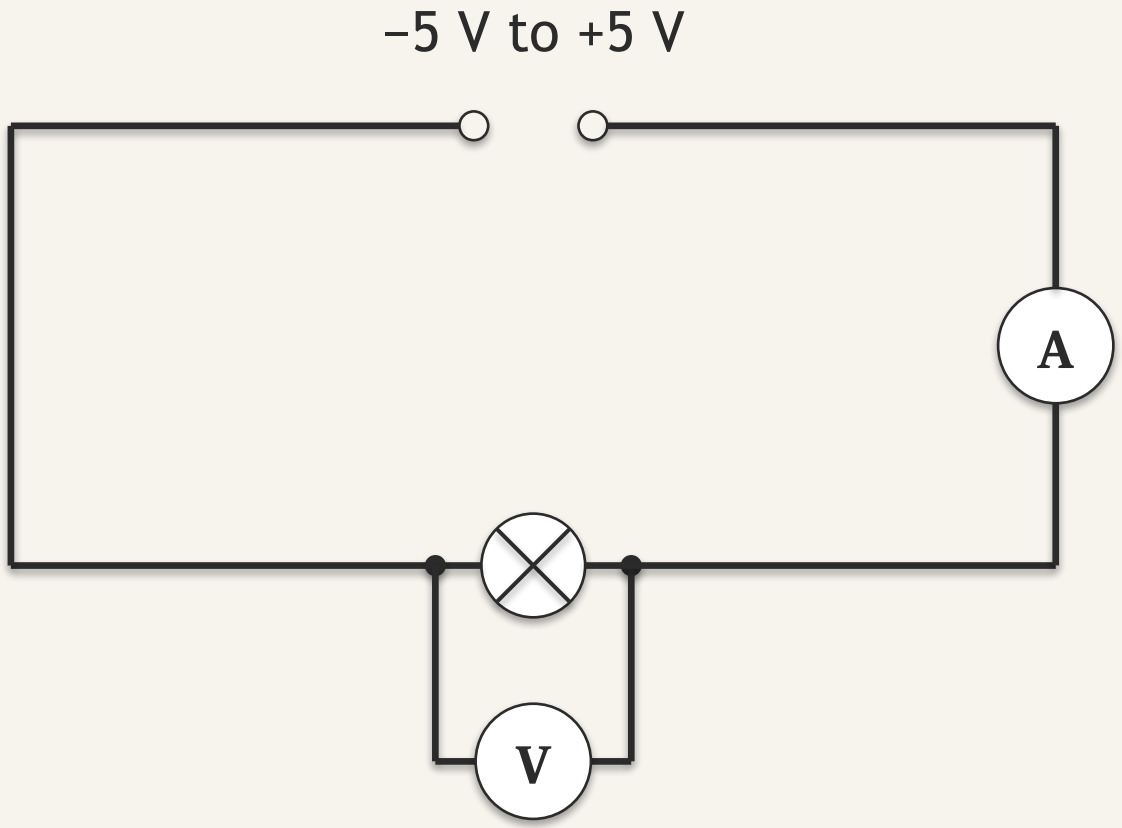
A fixed resistor. Straight line through the origin, so the resistance is constant.

Non-ohmic

A lamp. A curve, so the resistance is not constant.

The circuit and the method

Booklet p.10 — Practical 2



Sweep the supply from −5 V to +5 V.

Measure V and I at each step, then plot V against I again.

Record your results

Booklet p.10 — Practical 2

Take your readings across the full range, negative values
included, and enter them in the shared workbook.

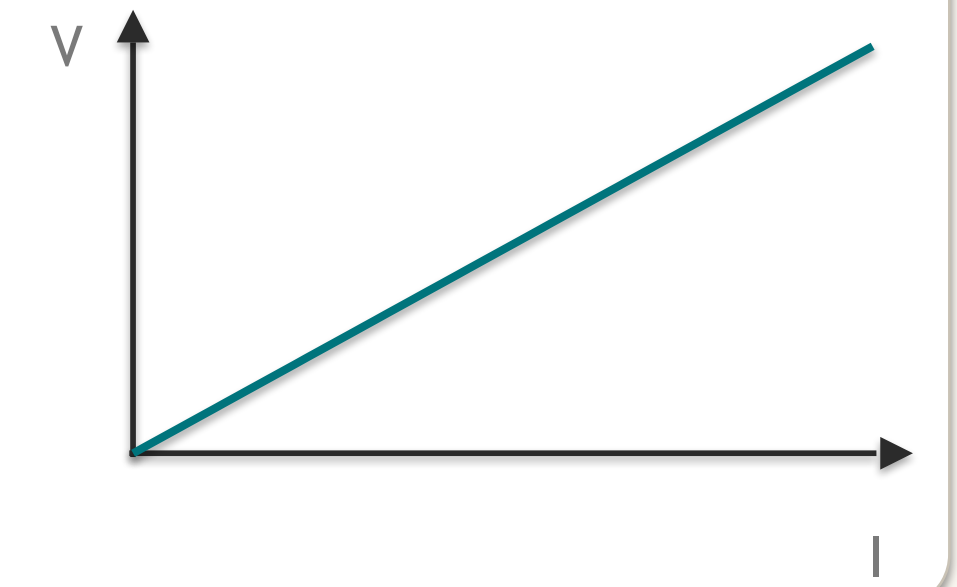
Booklet p.10, Practical 2

Results workbook

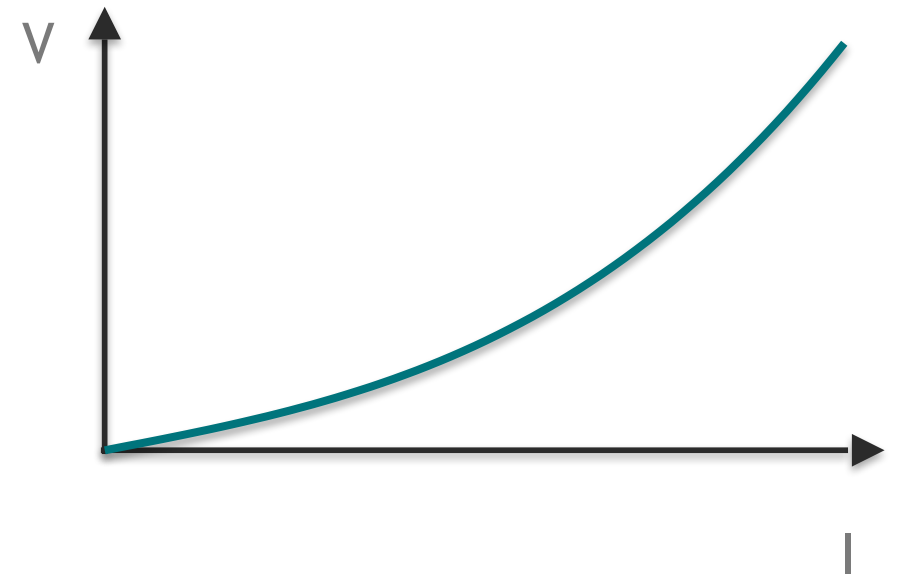
The two graphs together

Booklet p. 7 and 8

A fixed resistor



A lamp



Reverse the supply and each graph repeats, mirrored, below the origin.

Why the lamp curves

Booklet p.10

- A bigger current makes the filament hotter.
- A hotter filament has a higher resistance.
- So the current rises by less and less — the graph gets steeper.

Temperature and resistance

Booklet p.10

A conductor

Temperature up, resistance up.
A lamp filament is the clearest example.

A fixed resistor

Resistance stays practically constant over the range we use it in.

Task 7 — sketch, conclude, compare

Booklet p.10

Sketch the lamp's graph, complete the two conclusion
sentences, then answer the three comparison questions.

Booklet p.10, Practical 2 and Task 7

Practical 2 conclusion — Answers

ANSWERS

Booklet p.10

The sentence	How it finishes
voltage up, current…	increases, but not in proportion
temperature up, resistance…	increases

Task 7 — Answers

ANSWERS

Booklet p.10

Question	Answer
1 the two graphs	resistor: a straight line; lamp: a curve that gets steeper
2 fixed resistor	resistance stays practically constant
3 non-ohmic conductor	as temperature rises, resistance rises

Watch out

THE MISTAKE

- “The lamp breaks Ohm's Law”
- “The filament's resistance stays the same”
- “The curve means our readings are wrong”

THE CORRECT ANSWER

- The lamp is non-ohmic — its resistance changes
- It rises as the filament heats up
- The curve is how a lamp really behaves

Checkpoint

1. State the relationship between voltage, current and resistance.

2. A resistor carries 0.25 A when 5.0 V is across it. Find its resistance.

3. A lamp and a resistor are tested the same way. Which gives a straight line, and why?

LOOKING AHEAD

Combining Resistors

What happens to the resistance when you add a second one?

Plenary

1. Write down Ohm's Law and say what each letter means.
2. A 47 Ω resistor carries 0.20 A. Calculate the voltage across it.
3. Sketch the V–I graph for a fixed resistor.
4. What does the gradient of that graph give you?
5. What happens to a lamp's resistance as it gets hotter?

Plenary

EXTRA PRACTICE

1. What are the units of voltage, current and resistance?
2. A 68 Ω resistor has 3.4 V across it. Calculate the current.
3. Sketch the V–I graph for a lamp.
4. Which of the two graphs shows a constant resistance?
5. Name one ohmic and one non-ohmic component.

Extension

1. A 9.0 V supply drives 30 mA through a resistor. Find its resistance.
2. Two points on a line are (0.10 A, 2.0 V) and (0.40 A, 8.0 V). Find R.
3. Explain why a lamp's V–I graph is steeper at high currents than at low.

Extension

EXTRA PRACTICE

1. A 1.5 kΩ resistor carries 6.0 mA. Calculate the voltage across it.
2. A lamp draws 0.5 A at 12 V. Calculate its resistance at that moment.
3. Why is 'resistance of a lamp' a value that needs a condition attached?

Check your understanding

Booklet p.8–10

Sit the check test closed-book, then mark it against
the solutions. Note anything you need to go back over.

N5 Electricity CT 3 — Ohm's Law

Exam practice

Past-paper questions on this topic

1. 2023 Paper 1 — questions 12, 13 and 14
2. 2023 Paper 2 — question 6
3. 2024 Paper 1 — questions 12 and 13