

BOOKLET 3 • ELECTRONICS AND ANALOGUE
CONTROL

Electrical Power

How fast a component turns electrical energy into something else.



National 5 Engineering Science

Daily Review

Lesson 2 — Ohm's Law and Resistors

- 1 State Ohm's Law.
- 2 12 V across 6 Ω . Find the current.
- 3 State the rule for total resistance in series.
- 4 Two 100 Ω resistors in parallel. Find the total.
- 5 How many ohms is 2.2 k Ω ?

PART 1

Power from Voltage and Current

Power is how quickly energy is transferred — and the first way to find it needs only V and I .

By the end of this part...

- 1 I can calculate electrical power using $P = V I$
- 2 I can rearrange the relationship to find an unknown quantity

What power is

Booklet p.12

The idea

Energy transferred
every second.

The unit

The watt (W). 1 W
is 1 joule per
second.

Three ways

All three forms are
on your data sheet.

Power from voltage and current

Booklet p.12 – on the data sheet

$$P = V I$$

P

power, in watts
(W)

V

voltage, in volts
(V)

I

current, in
amperes (A)

Worked example — a phone charger · p.12

A phone charger supplies 2 A at a voltage of 5 V.
Calculate the power it delivers.

$$V = 5 \text{ V}$$

$$I = 2 \text{ A}$$

$$P = ?$$

$$P = V I$$

$$P = 5 \times 2$$

$$\underline{P = 10 \text{ W}}$$

Worked example — find the current · p.12

A 60 W lamp works from a 240 V mains supply.
Calculate the current in the lamp.

$$P = 60 \text{ W}$$

$$V = 240 \text{ V}$$

$$I = ?$$

$$P = V I$$

$$I = P/V$$

$$I = 60/240$$

$$\underline{I = 0.25 \text{ A}}$$

Show me — power from V and I

SHOW ME BOARDS

- 1 12 V and 2 A. Find the power.
- 2 6 V and 0.5 A. Find the power.
- 3 A 100 W lamp on 200 V. Find the current.
- 4 A motor takes 3 A and delivers 36 W. Find the voltage.
- 5 9 V and 0.2 A. Find the power.

Show me — power from V and I

SHOW ME BOARDS

EXTRA PRACTICE

- 1 24 V and 0.5 A. Find the power.
- 2 10 V and 1.5 A. Find the power.
- 3 A 40 W lamp on 20 V. Find the current.
- 4 A heater takes 4 A and delivers 48 W. Find the voltage.
- 5 5 V and 0.4 A. Find the power.

Your turn – TRY THIS

Booklet p.12 – TRY THIS: Power ($P = V I$)

Answer the three questions in your booklet.
3 marks each: relationship, substitution,
then the answer with its unit.

Booklet p.12 – TRY THIS: Power

TRY THIS – Answers

ANSWERS

Booklet p.12 – Power ($P = V I$)

Q	Working	Answer
1	$P = 230 \times 5$	1150 W (1.15 kW)
2	$P = 24 \times 0.8$	19.2 W
3	$I = 18 \div 12$	1.5 A

Question 3 needs the relationship rearranged first.

Daily Review

Part 1 — Power from V and I

- 1 State the relationship for power from voltage and current.
- 2 What is the unit of power?
- 3 A 12 V lamp takes 0.5 A. Find the power.
- 4 State Ohm's Law.
- 5 How many amperes is 250 mA?

PART 2

The Other Two Forms

Put Ohm's Law inside $P = V I$ and two more relationships fall out.

By the end of this part...

- 1 I can calculate power using $P = I^2 R$
- 2 I can calculate power using $P = V^2 / R$
- 3 I can choose the right relationship for what I am given

Three relationships, one quantity

Booklet p.12-14

What you are given	Use	Booklet
voltage and current	$P = V I$	p.12
current and resistance	$P = I^2 R$	p.13
voltage and resistance	$P = V^2 \div R$	p.14

Read the question first. What you are given picks the relationship.

Power from current and resistance

Booklet p.13 – on the data sheet

$$P = I^2 R$$

P

power, in watts
(W)

I

current, in
amperes (A)

R

resistance, in
ohms (Ω)

Worked example — a resistor heating up · p.13

A $150\ \Omega$ resistor carries a current of $0.3\ \text{A}$.

Calculate the power dissipated in the resistor.

$$I = 0.3\ \text{A}$$

$$R = 150\ \Omega$$

$$P = ?$$

$$P = I^2 R$$

$$P = 0.3^2 \times 150$$

$$P = 0.09 \times 150$$

$$\underline{P = 13.5\ \text{W}}$$

Your turn – TRY THIS

Booklet p.13 – TRY THIS: Power ($P = I^2 R$)

Answer the three questions in your booklet.
Question 3 gives 50 mA – convert it first.
Square the current, then multiply.

Booklet p.13 – TRY THIS: Power

TRY THIS — Answers

ANSWERS

Booklet p.13 — Power ($P = I^2 R$)

Q	Working	Answer
1	$P = 0.2^2 \times 100 = 0.04 \times 100$	4 W
2	$P = 0.04^2 \times 470 = 0.0016 \times 470$	0.752 W
3	$P = 0.05^2 \times 1000 = 0.0025 \times 1000$	2.5 W

50 mA is 0.05 A. Convert before you square.

Power from voltage and resistance

Booklet p.14 – on the data sheet

$$P = V^2 / R$$

P

power, in watts
(W)

V

voltage, in volts
(V)

R

resistance, in
ohms (Ω)

Worked example – from voltage and resistance · p.14

A 2 k Ω resistor has 10 V across it.

Calculate the power dissipated in the resistor.

$$V = 10 \text{ V}$$

$$R = 2000 \text{ } \Omega$$

$$P = ?$$

$$P = V^2/R$$

$$P = 10^2/2000$$

$$P = 100/2000$$

$$\underline{P = 0.05 \text{ W (50 mW)}}$$

Your turn – TRY THIS

Booklet p.14 – TRY THIS: Power ($P = V^2 / R$)

Answer the three questions in your booklet.
Question 3 works backwards from the power.
Square the voltage, then divide.

Booklet p.14 – TRY THIS: Power

TRY THIS — Answers

ANSWERS

Booklet p.14 — Power ($P = V^2 / R$)

Q	Working	Answer
1	$P = 144 \div 220$	0.655 W
2	$P = 81 \div 4700$	0.0172 W (17.2 mW)
3	$V^2 = 1 \times 100$, so $V = \sqrt{100}$	10 V

Question 3 rearranges to $V^2 = P R$ before the square root.

Watch out

THE MISTAKE

- Squaring the answer instead of the current
- Substituting 50 mA as 50
- Squaring only part of $V^2 \div R$

THE CORRECT ANSWER

- Square I first, then multiply by R
- 50 mA is 0.05 A
- Square the whole voltage, then divide

Show me — which relationship?

SHOW ME BOARDS

- 1 You are given 12 V and 0.5 A.
- 2 You are given 0.2 A and 100 Ω .
- 3 You are given 9 V and 300 Ω .
- 4 You are given the power and the voltage, and asked for the current.
- 5 You are given 5 V and 2 A, and asked for the power.

Show me — which relationship?

SHOW ME BOARDS

EXTRA PRACTICE

- 1 You are given 24 V and 2 A.
- 2 You are given 0.5 A and 40 Ω .
- 3 You are given 6 V and 12 Ω .
- 4 You are given the power and the current, and asked for the voltage.
- 5 You are given 0.1 A and 220 Ω , and asked for the power.

Checkpoint

- 1 State the three power relationships and the unit of power.
- 2 A $20\ \Omega$ resistor carries $0.5\ \text{A}$. Find the power.
- 3 Two lamps take the same current, but one has a larger resistance. Which dissipates more power, and why?

Daily Review

Part 2 — The Other Two Forms

- 1 State the relationship for power from current and resistance.
- 2 0.2 A through 50 Ω . Find the power.
- 3 State the relationship for power from voltage and resistance.
- 4 What is the unit of power?
- 5 How many amperes is 50 mA?

PART 3

Putting It Together

Some questions need Ohm's Law first and the power relationship second.

By the end of this part...

- 1 I can rearrange formulae to find an unknown quantity
- 2 I can compare calculated, simulated and measured values

Two-step questions

Booklet p.15-16

The problem

You are given two quantities, but not the two the relationship needs.

The route

Use Ohm's Law to find the missing one first. Then use a power relationship.

Worked example — two steps · p.15

A $48\ \Omega$ heating element is connected to a $12\ \text{V}$ supply.
Calculate the power dissipated in the element.

$$V = 12\ \text{V}$$

$$R = 48\ \Omega$$

$$I = ?$$

$$P = ?$$

$$I = V/R$$

$$I = 12/48 = 0.25\ \text{A}$$

$$P = V I$$

$$\underline{P = 12 \times 0.25 = 3\ \text{W}}$$

Show me — two steps

SHOW ME BOARDS

- 1 10 V across $20\ \Omega$. Find the current, then the power.
- 2 0.5 A through $8\ \Omega$. Find the voltage, then the power.
- 3 A 6 V supply drives 0.2 A. Find the resistance, then the power.
- 4 24 V across $12\ \Omega$. Find the power in one step.
- 5 2 A through $5\ \Omega$. Find the power in one step.

Show me — two steps

SHOW ME BOARDS

EXTRA PRACTICE

- 1 20 V across 40 Ω . Find the current, then the power.
- 2 0.4 A through 15 Ω . Find the voltage, then the power.
- 3 A 9 V supply drives 0.3 A. Find the resistance, then the power.
- 4 12 V across 6 Ω . Find the power in one step.
- 5 3 A through 4 Ω . Find the power in one step.

Your turn – the practice questions

Booklet p.15-16 – PRACTICE: Electrical Calculations

Answer questions 1 to 10 in your booklet.
The marks are printed beside each question.
Question 6 needs a square root.
Question 10 asks for two answers.

Booklet p.15-16 – PRACTICE, Q1-10

PRACTICE — Answers, Q1-4

ANSWERS

Booklet p.15-16 — Electrical Calculations

Q	Working	Answer	Marks
1	$V = I R$	Ohm's Law	1
2	$I = 9 \div 470$	0.0191 A (19.1 mA)	3
3	$R_T = 220 + 470 + 1000$	1690 Ω (1.69 k Ω)	3
4	$R_T = (220 \times 220) \div 440$	110 Ω	3

PRACTICE – Answers, Q5-7

ANSWERS

Booklet p.15-16 – Electrical Calculations

Q	Working	Answer	Marks
5	$P = 24 \times 1.5$	36 W	3
6	$I = \sqrt{(1 \div 100)} = \sqrt{0.01}$	0.1 A	3
7	$P = 144 \div 1000$	0.144 W (144 mW)	3

PRACTICE — Answers, Q8-10

ANSWERS

Booklet p.15-16 — Electrical Calculations

Q	Working	Answer	Marks
8	$R_T = (1000 \times 1000) \div 2000$	500 Ω	3
9	$R_T = 1000 + 2200 + 4700$	7900 Ω (7.9 k Ω)	3
10	$V = 0.05 \times 220$; $P = 11 \times 0.05$	11 V and 0.55 W	4

Q10 also works as $P = I^2 R = 0.05^2 \times 220 = 0.55 \text{ W}$.

Exam practice

National 5 Engineering Science 2025 Q11 — a studio ring light

Part	What it asks	Marks
11(e)	the power used by a $470\ \Omega$ ring light on a 5.0 V supply	2

You are given voltage and resistance. That picks the relationship.

LOOKING AHEAD

Input and Output Devices

The components that let a circuit sense the world.

Plenary

- 1 State the three power relationships.
- 2 A 12 V motor takes 2 A. Find the power.
- 3 A 50 Ω resistor carries 0.4 A. Find the power.
- 4 A 1 k Ω resistor has 10 V across it. Find the power.
- 5 Which relationship would you use if you knew only current and resistance?

- 1 Give the unit of power and what it means.
- 2 A 9 V buzzer takes 0.1 A. Find the power.
- 3 A 20 Ω resistor carries 0.5 A. Find the power.
- 4 A 500 Ω resistor has 10 V across it. Find the power.
- 5 Which relationship would you use if you knew only voltage and resistance?

Extension

- 1 Two resistors in series share a 12 V supply. Does the larger resistance dissipate more power or less? Explain.
- 2 Doubling the current through a fixed resistor does what to the power? Explain using $P = I^2 R$.
- 3 A 3 kW kettle runs from 230 V. Find the current, and say why kettle cable is thicker than lamp flex.

- 1 Two resistors in parallel across 12 V. Does the larger resistance dissipate more power or less? Explain.
- 2 Halving the voltage across a fixed resistor does what to the power? Explain using $P = V^2 \div R$.
- 3 A 2 kW heater runs from 230 V. Find the current, and say why it needs its own fuse rating.