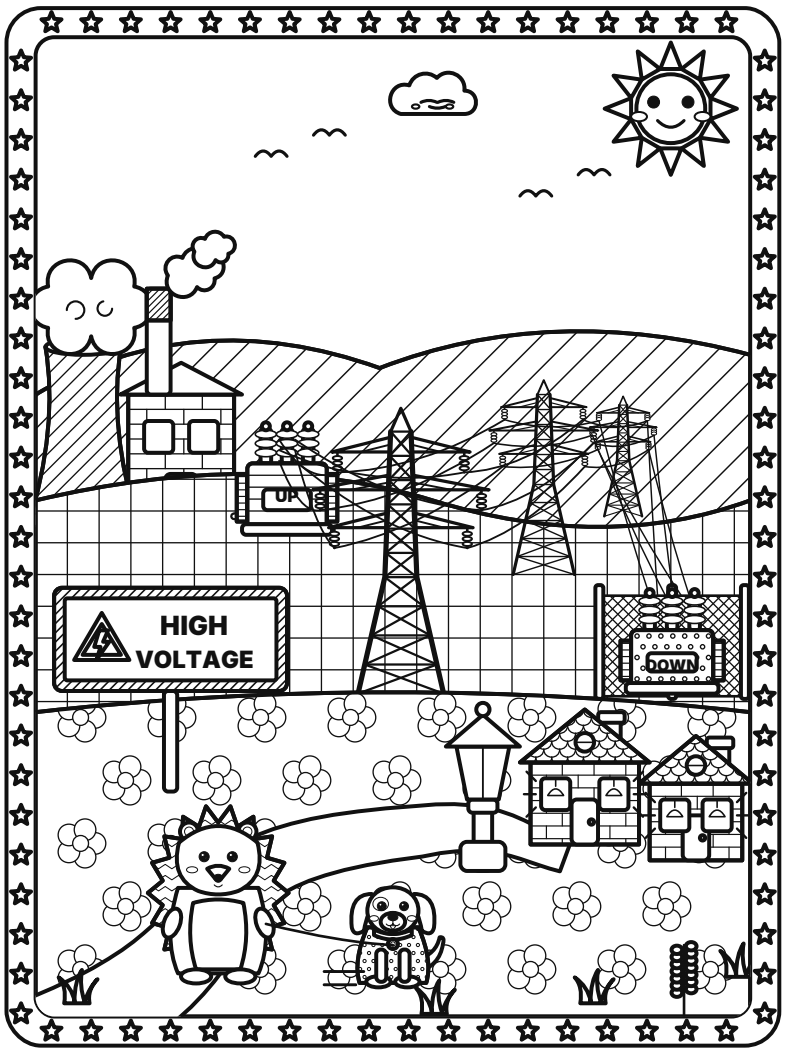
REAL-LIFE PHYSICS

Electricity and Matter

Workbook for National 5 Physics

Unit: Electricity and Properties of Matter



C. Blewis

Blewis
LEARNING

Contents

GETTING STARTED

	How to use this book	4

ELECTRICITY

Topic 1	Electrical charge carriers	6
Topic 2	Potential difference	15
Topic 3	Ohm's law	24
Topic 4	Practical electrical and electronic circuits	33
Topic 5	Electrical power	43

PROPERTIES OF MATTER

Topic 6	Specific heat capacity	52
Topic 7	Specific latent heat	61
Topic 8	Gas laws and the kinetic model	70

AT THE BACK

	My progress tracker	79
	My practical skills	80

How to use this book

This book covers Electricity and Properties of Matter for National 5 Physics: charge, potential difference, Ohm's law, practical circuits, power, specific heat capacity, latent heat and the gas laws. Each topic follows the same pattern, so you always know what comes next.

EACH TOPIC HAS

Opener	the story for the topic, what you will learn and the key words
Learn pages	short explanations with diagrams, and questions to try
Practical	You plan the investigation yourself, carry it out safely, take repeat readings, draw a graph and evaluate your method.
Brain break	a calm puzzle or colouring page
Check-up	a few questions to show what you know, and a checklist

PRACTICAL WORK: STAY SAFE

- Only start a practical when an adult says it is OK.
- Read the whole method and the Stay safe table first.
- Tell your teacher about anything that might affect you, like asthma or an allergy.
- Stop and tell an adult if you feel unwell or something goes wrong.

NO LAB TODAY?

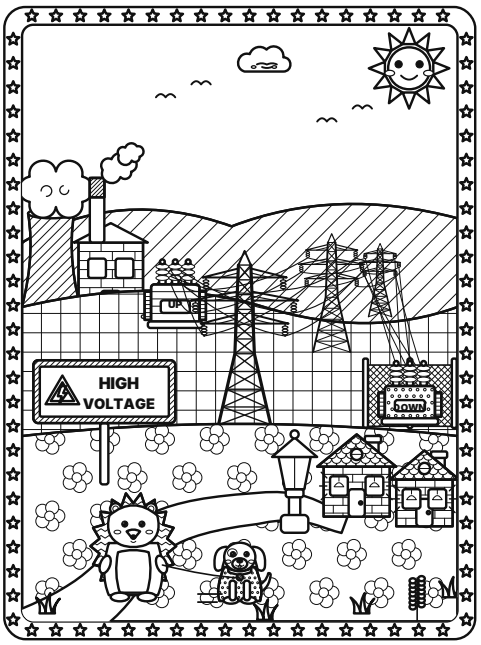
Every practical has a set of example results. If you could not do the experiment, use these to finish the results, graph and conclusion.

DOODLE CORNERS

Some pages have a doodle corner. Colour it or doodle in it when you need a short break.

Electrical charge carriers

Every second, billions of billions of electrons drift along the wires in your phone charger. What exactly is flowing, and how do we measure it?



Theme: powering the glen. Glen Arrin is getting new power lines and a charging hub for electric cars. Zara is spending a week with the electricians and wants to understand what current really is before she starts.

IN THIS TOPIC YOU WILL LEARN TO

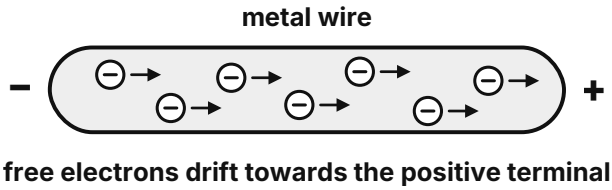
Skill 1	describe current as the flow of charge, carried by electrons in metal wires
Skill 2	use Q = I t to calculate charge, current or time, changing mA, minutes and hours first
Skill 3	tell a.c. from d.c. from an oscilloscope or data-logger trace

KEY WORDS

Charge (Q)	a property of particles such as electrons; measured in coulombs (C)
Electron	a negatively charged particle; free electrons carry the current in metals
Current (I)	the charge transferred per unit time; measured in amperes (A)
Coulomb (C)	the charge carried by a current of 1 A in 1 s
Direct current	charges flow in one direction only, e.g. from a battery
Alternating current	charges keep changing direction, e.g. the 50 Hz mains

❶ What is an electric current?

There are two kinds of **electric charge**: positive and negative. Like charges repel; unlike charges attract. In a metal wire, the charge is carried by **free electrons**. When a circuit is complete, the supply pushes the electrons round, from the negative terminal towards the positive terminal.



free electrons drift towards the positive terminal

Current is the **electric charge transferred per unit time**. A current of 1 ampere (1 A) means 1 coulomb (1 C) of charge passes any point each second. Current is measured with an **ammeter** connected **in series**.

DID YOU KNOW?

One coulomb is the charge of about 6×10^{18} electrons, yet the electrons themselves drift along a wire at less than a millimetre per second.

1 What carries the charge round a circuit made of metal wires?

Answer: .....

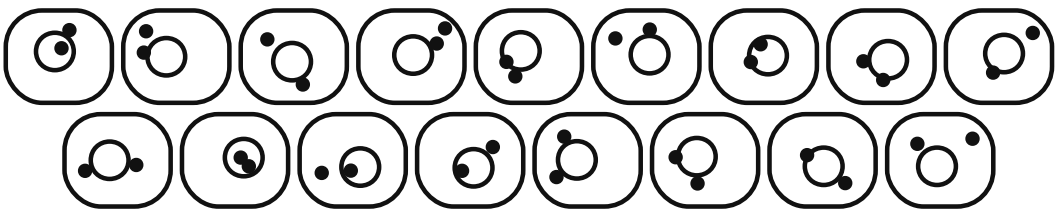
2 Complete the sentence: a current of 3 A means that ..... coulombs of charge pass a point every .....

3 Zara says, "The battery makes electrons, which are used up in the lamp." Explain why she is wrong.

Answer: .....

.....

DOODLE CORNER



❷ Charge, current and time

RELATIONSHIP

$$Q = I\,t$$

Q	charge in coulombs (C)
I	current in amperes (A)
t	time in seconds (s)

WORKED EXAMPLE 1

A charging cable carries a current of 2.4 A for 15 minutes. How much charge flows?

Relationship Q = I t

Substitute Q = 2.4 × (15 × 60)

Answer **Q = 2200 C** (2160 C)

WORKED EXAMPLE 2

A charge of 54 C passes through a lamp in 2.0 minutes. Find the current.

Relationship $I = \frac{Q}{t}$

Substitute $I = \frac{54}{2.0 \times 60}$

Answer **I = 0.45 A**

Units first: minutes × 60 and hours × 3600 give seconds; 250 mA = 0.25 A.

1 A current of 0.60 A flows in a fan for 5.0 minutes. Calculate the charge that flows.

Relationship

Substitute

Answer

2 An electric car is charged with a current of 16 A. Calculate how long it takes for 4.8×10^5 C to flow into the battery. Give your answer in hours.

Relationship

Substitute

Answer

In hours

3 A smoke alarm draws a current of 25 mA. Calculate the charge that flows in one day.

Relationship

Substitute

Answer

PRACTICAL 1

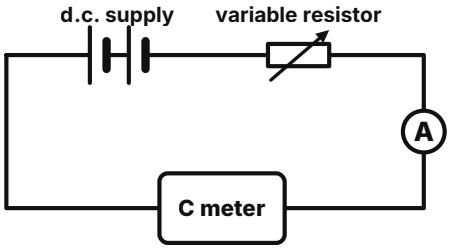
Plan it: current and charge

AIM To find out how the **CURRENT** affects the **CHARGE** that passes in 60 s.

1 Variables

I will change the independent variable	
I will measure the dependent variable	
I will keep the same controlled variables (give two)	

2 Prediction



I think that .....

because .....

3 Equipment

Tick the equipment you need. Not everything here is useful.


☐ Supply


☐ Rheostat



☐ Ammeter



☐ C meter


☐ Stopwatch


☐ Thermometer

4 Stay safe

The first row is done for you. Add two more hazards.

Hazard What could cause harm?	**Risk** What could happen?	**Control** How will I stay safe?
Variable resistor or wires getting hot at higher currents	Burns to fingers	Keep currents to 0.5 A or less. Switch off between readings. Do not touch the resistor coil.

Method and results

5 Write your method

Write clear steps someone else could follow.

1. How will you connect the supply, variable resistor, ammeter and coulomb meter?

2. How will you set each current, and keep it steady?

3. How will you reset the coulomb meter and time exactly 60 s?

4. How many repeats? Mean, and random uncertainty = (max − min) ÷ number of readings.

6 Results

Complete the headings, including units. Then fill in your results.

				Mean charge	Uncertainty

NO LAB TODAY? USE THESE RESULTS

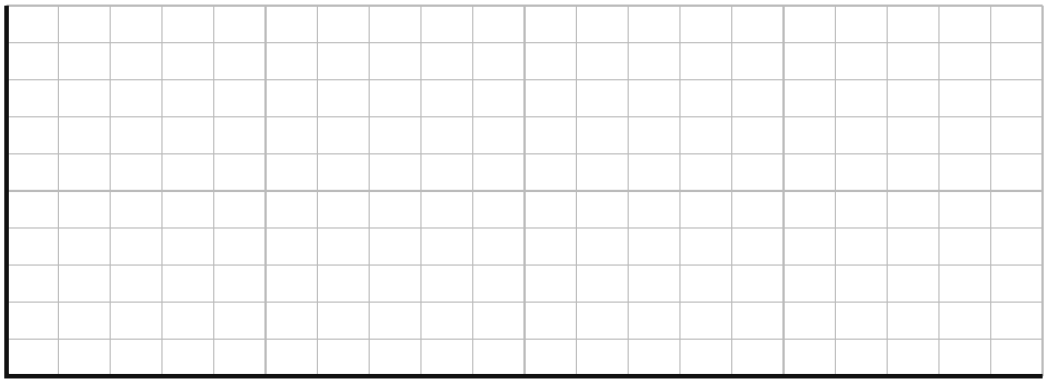
Current (A)	Charge 1 (C)	Charge 2 (C)	Charge 3 (C)	Mean charge (C)	Uncertainty (C)
0.10	6.1	5.8	6.0		
0.20	11.9	12.3	12.1		
0.30	18.4	17.8	18.0		
0.40	24.2	23.6	24.3		
0.50	30.4	29.7	29.9		

Each reading is the charge shown on the coulomb meter after 60 s. Work out the means and uncertainties yourself.

Analyse and evaluate

7 Draw a line graph

Plot mean charge (y axis) against current (x axis). Choose your own scales, label both axes with units and draw a line of best fit.



8 Conclusion

As the current increased, the charge

9 Use your results

a Calculate the gradient of your line. What quantity should it equal, and does it?

Answer:

b Use Q = I t to calculate the charge expected at 0.30 A. Compare it with your mean.

Answer:

10 Evaluate

a Which current had the largest random uncertainty? Suggest one way to make the results more reliable.

Answer:

b Suggest why measuring for 60 s gives more accurate results than measuring for 5 s.

Answer:

> **ASSIGNMENT LINK**
> Your conclusion is stronger if you compare it with a source: look up the definition of the coulomb and reference where you found it.

FREE SAMPLE

Electricity and Properties of Matter (N5 Physics)

This sample shows a few pages. The full printed workbook is available from Amazon.

blewislearning.co.uk

Blewis
LEARNING