Chapter 18. Electrical Quantities

Contents:

New word list:

4.2.2 Electric current

Core

1 Know that electric current is related to the flow of charge

2 Describe the use of ammeters (analogue and digital) with different ranges

3 Describe electrical conduction in metals in terms of the movement of free electrons

4 Know the difference between direct current (d.c.) and alternating current (a.c.)

Supplement

5 Define electric current as the charge passing a point per unit time; recall and use the equation

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

6 State that conventional current is from positive to negative and that the flow of free electrons is from negative to positive

4.2 Electrical quantities continued

4.2.3 Electromotive force and potential difference

Core

1 Define electromotive force (e.m.f.) as the electrical work done by a source in moving a unit charge around a complete circuit

2 Know that e.m.f. is measured in volts (V)

3 Define potential difference (p.d.) as the work done by a unit charge passing through a component

4 Know that the p.d. between two points is measured in volts (V)

5 Describe the use of voltmeters (analogue and digital) with different ranges

Supplement

6 Recall and use the equation for e.m.f.

$$E = \frac{W}{Q}$$

7 Recall and use the equation for p.d.

$$V = \frac{W}{Q}$$

4.2.4 Resistance

Core

1 Recall and use the equation for resistance

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

2 Describe an experiment to determine resistance using a voltmeter and an ammeter and do the appropriate calculations

3 State, qualitatively, the relationship of the resistance of a metallic wire to its length and to its cross-sectional area

Supplement

4 Sketch and explain the current–voltage graphs for a resistor of constant resistance, a filament lamp and a diode

5 Recall and use the following relationship for a metallic electrical conductor:

(a) resistance is directly proportional to length

(b) resistance is inversely proportional to cross-sectional area

4.2.5 Electrical energy and electrical power

Core

1 Understand that electric circuits transfer energy from a source of electrical energy, such as an electrical cell or mains supply, to the circuit components and then into the surroundings

2 Recall and use the equation for electrical power

$P = IV$

3 Recall and use the equation for electrical energy

$E = IVt$

4 Define the kilowatt-hour (kW h) and calculate the cost of using electrical appliances where the energy unit is the kW h

Supplement

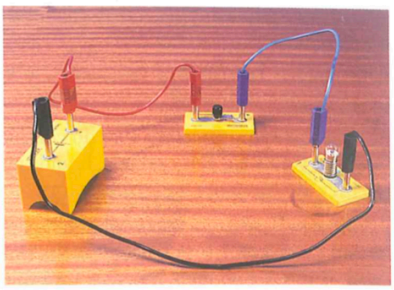
18.1 Current

In chapter 17, we discussed static charge. Apart from static charge, do we have “non-static” charge? What is **electric current**?

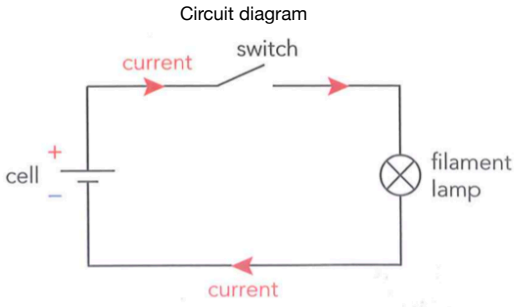
How to make a current?
1. Complete circuit

What are used when connecting component to a circuit?

a



b



Why do we use Cooper/steel as wire?

2. “push" provided by battery (two or more cells connected end-to-end)

Electric current: flow of charge
Def:
Symbol:
Unit:

Current and charge:

Quantity	Symbol for quantity	Unit	Symbol for unit
current	I	amps	A
charge	Q	coulombs	C
time	t	seconds	s

Exercise18.2

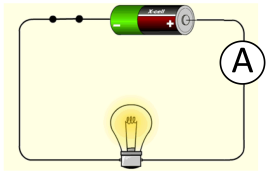
A current of 120 microamps flows around a circuit for one hour. How much electric charge flows around the circuit in this time?

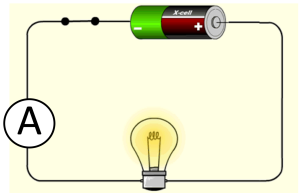
Exercise18.3

Calculate the missing values a-d in the table on the right.

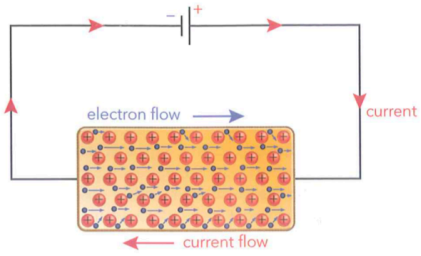
Charge	Current	Time
charge	current	time
220 C	2 A	**a**
57.6 C	**b**	3 hours
c	0.5 A	9 minutes
5.4 C	70 mA	**d**

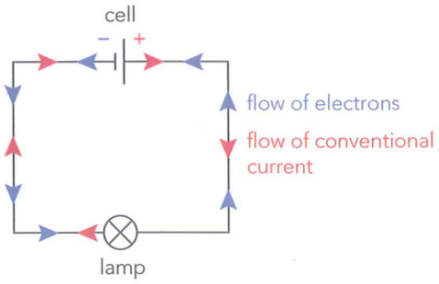
Measuring electric current: Ammeter vs galvanometer





Conventional current:





18.2 Voltage

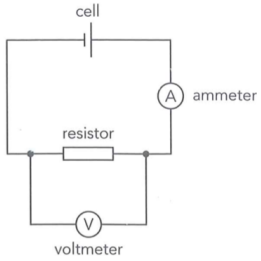
What make electric current flow?

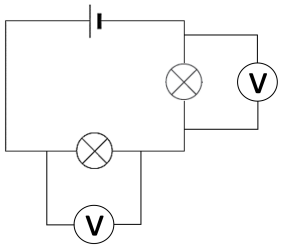
Work done and voltage:

Voltage/potential difference(p.d.)
Def:
Symbol:
Unit:

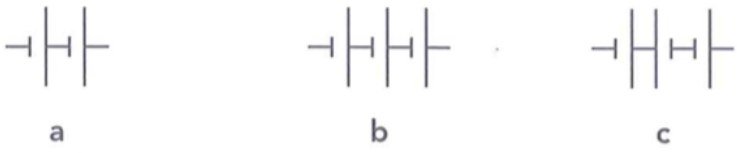
Electromotive force(e.m.f.):

Measuring voltage:





Combining e.m.f.s



Exercise 18.4

Calculate the e.m.f. of a battery that gives 60J of energy to a charge 5C.

Exercise 18.5

The p.d. across a lamp is 12V. The lamp is connected for 10s. Calculate how many joules of energy are transferred when:
A. a charge of 1C passes through it.
B. a charge of 5C passes through it.
C. a current of 2A flows.

18.3 Electrical resistance

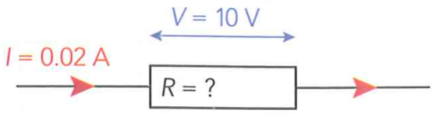
What if we connect the positive and negative terminal of a cell together with a short wire?

Resistance

Def:
Symbol:
Unit:

Exercise 18.6

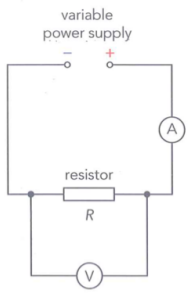
A resistor allows a current of 0.02A to flow through it when there is a p.d. of 10.0 V between its ends. What is its resistance?



18.3.1 Resistance and thickness & length
Assumption:

Method: measuring resistance:

Conclusion:



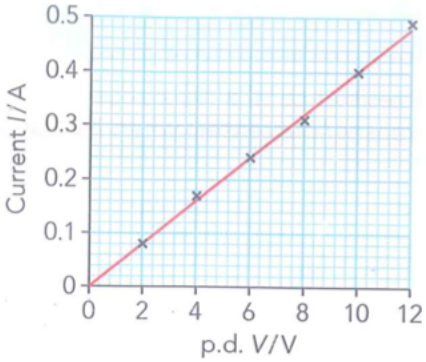
Exercise 18.7

A 2.0 meter length of wire has a resistance of 4.0 ohm.
A what is the resistance of a piece of the same wire of length 20.0 meters?
B what is the resistance of a 4.0 meter wire with half the cross-sectional area, made of the same material?

18.3.2 current-voltage characteristics: ohmic vs non-ohmic resistor

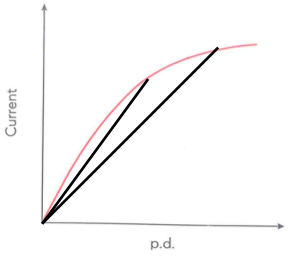
Example:

p.d. V/V	Current I/A	Resistance R/Ω
2.0	0.08	25.0
4.0	0.17	23.5
6.0	0.24	25.0
8.0	0.31	25.8
10.0	0.40	25.0
12.0	0.49	24.5



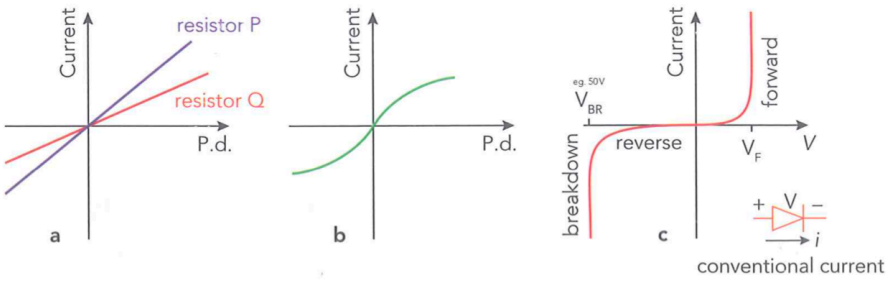
Ohmic resistor:

Non-ohmic device:



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

Typical current-voltage characteristics



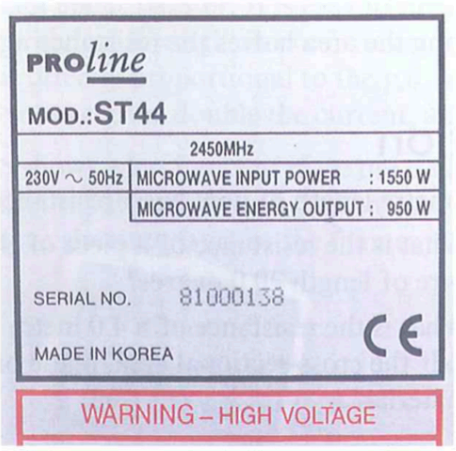
18.4 Electrical energy, work and power

Why do we need electric current?

Electrical power & energy

Exercise 18.8

A electric fan runs from the 230V mains supply. The current flowing through it is 0.40A. At what rate is electrical energy transferred by the fan? How much energy is transferred in one minute?



Unit of electrical energy: kWh

Exercise 18.9

Marcus switches on a water heater for two hours. The power of the heater is 3.5 kW. How much energy is transferred in kWh?