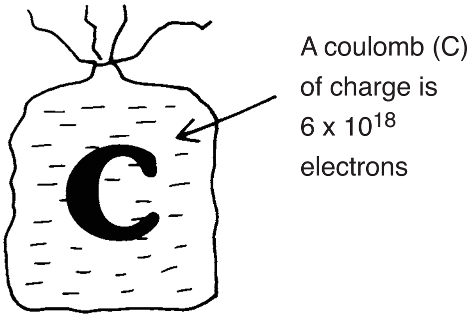
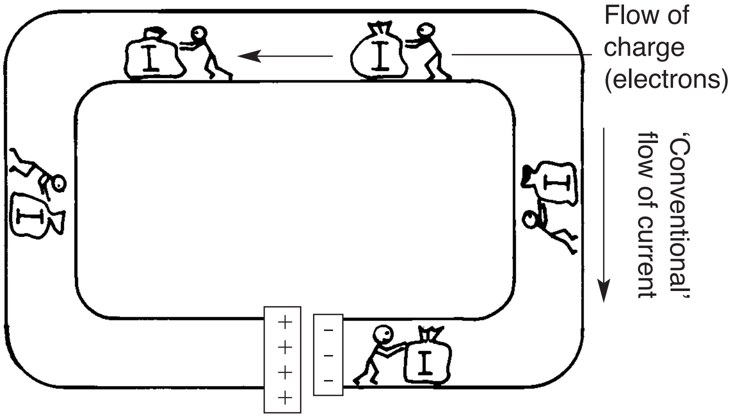
Volts and Ohms

A **battery** is made up of chemicals. The chemicals react with each other and produce a surplus of electrons in one terminal (the negative) and a shortage of electrons at the other terminal (the positive). We say that there is a **potential difference** (p.d.) between the two terminals. This potential difference is the 'push' or 'force' which drives the electrons from the negative terminal, through a wire towards the positive terminal.



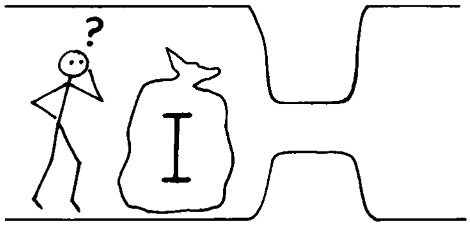
The flow of electrical charge constitutes a current (I)



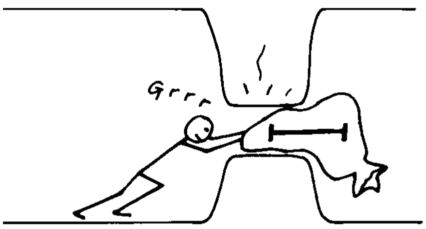
Potential difference within a battery causing a flow of charge within a circuit

Since we are moving electrical charges from one place to another, work has to be done. When 1 **joule** of work is needed to push 6×10^{18} electrons (one **coulomb**) from one place to another, we say that there is 1 **volt** of potential difference between these two points.

It is very easy to push electrons through large pieces of metals but if you make the wire very thin, it is like causing an obstruction in a pipeline. A lot of work is now needed to push the current (I) through the thin wire. We say that the thin wire has a high **resistance**.



Relatively difficult flow of current through a narrow conductor



Greater force, or pressure (voltage), required to drive a current through a narrow conductor

The work needed to squeeze the electrons through can cause the wire to heat up, by the **friction** of forcing the electrons through. The amount of resistance (R) which a material has for electrons to move in it is measured in units of **ohms** (Ω). The more ohms, the more difficult to get electrons to pass through – you will need a lot of volts to push the electrons. The smaller the ohm value, the easier (and hence fewer volts needed) to push electrons through.

Ohm's Law

Ohm's Law expresses the relationship between the amount of volts (V) you need to push a current (I) through a substance with resistance R:

$$\mathbf{V = I \times R}$$

Questions

Tick the box next to the correct answer.

1 The units of electrical resistance are:

- A watts ☐
- B joules ☐
- C amperes ☐
- D ohms ☐

2 A conductor of electricity gets very hot when a current is passed through it. Which of the following properties does this conductor have? It must:

- A be non-magnetic ☐
- B be an insulator ☐
- C have high resistance ☐
- D have low resistance ☐

3 Which of the following is a measure of electrical potential difference?

- A ampere ☐
- B volt ☐
- C watt ☐
- D coulomb ☐

4 In a domestic electrical circuit, a 100 W light bulb gives off more light than a 60 W bulb. Therefore, the filament of the 100 W bulb:

- A has a higher resistance than the filament of the 60 W bulb ☐
- B has a lower resistance than the filament of the 60 W bulb ☐
- C is more efficient than the filament of the 60 W bulb ☐
- D uses more voltage to produce more light ☐

5 Which of the following means one-thousandth of an ampere?

- A milliamp ☐
- B microamp ☐
- C kiloamp ☐
- D mega-amp ☐

6 The diagram below shows the information plate underneath an electric kettle:

®	50 Hz	5 A
664845	240 V	1200 W

What current flows through the element of the kettle?

- A 50 Hz ☐
- B 240 V ☐
- C 1200 W ☐
- D 5 A ☐

7 The flow of electrical charge is known as:

- A capacitance ☐
- B current ☐
- C work ☐
- D potential difference ☐

8 A coulomb is:

- A the work needed to be done to carry one ampere of current ☐
- B a current of one ampere flowing for one second ☐
- C 6×10^{18} electrons ☐
- D the charge in a circuit powered by one volt ☐

9 The heat produced in a wire carrying electrical current is caused by:

A friction forcing electrons through the wire ☐
B the work needed to overcome electrostatic attraction ☐
C voltage in the circuit ☐
D the potential difference between the ends of the circuit ☐

10 If you wanted to find the resistance of a wire, which two pieces of electrical apparatus would you need?

A a joulemeter and a voltmeter ☐
B an ammeter and a transistor ☐
C a capacitor and a voltmeter ☐
D an ammeter and a voltmeter ☐

11 What current flows through a resistor of 60 ohms when powered by a battery of 12 volts?

A 0.2 A ☐
B 5.0 A ☐
C 72 A ☐
D 720 A ☐

12 In order to find out the resistance of a resistor, an experiment was carried out by measuring the voltage across the resistor and the current flowing through it. The following readings were recorded. Which was the incorrect set of readings?

	Potential difference (volts) across resistor	**Current (amps) through resistor**
A	20	0.4
B	30	0.5
C	45	0.9
D	50	1.0

13 Which of the following are units of current and voltage?

A joule and ampere ☐
B joule and volt ☐
C volt and kilowatt ☐
D ampere and volt ☐

14 If you wanted to calculate the resistance of a coil of wire, you would need to know what current was passing through the coil and:

A how many seconds the current had been passing ☐
B the temperature of the wire in the coil ☐
C the potential difference across the ends of the coil ☐
D the thickness of the wire making up the coil ☐

15 The voltage of our domestic electricity supply is a constant 240 V. If we were to replace an appliance in a circuit with a different one which has a higher electrical resistance, what happens to the current flowing in the circuit?

A The current decreases. ☐
B The current increases. ☐
C The current remains the same. ☐
D The current changes with the voltage. ☐

Answers

1 **D** (1)

2 **C** (1)

3 **B** (1)

4 **B** (1) This is not as easy as one might think at first glance. If we look at the relationship between power and resistance: $P = I^2 \times R$. As P is greater for the 100 W bulb, we could be misled into responding that R must therefore be greater. This, of course, is not the case, since it is the current which increases. We should look at the alternative formula for power, $P = V^2/R$. Here, since V must remain constant, it is obvious that R must decrease if P is to increase.

5 **A** (1)

6 **D** (1)

7 **B** (1)

8 **C** (1)

9 **A** (1)

10 **D** (1)

11 **A** (1)

12 **B** (1)

13 **D** (1)

14 **C** (1)

15 **A** (1)

Total for unit = 15 marks