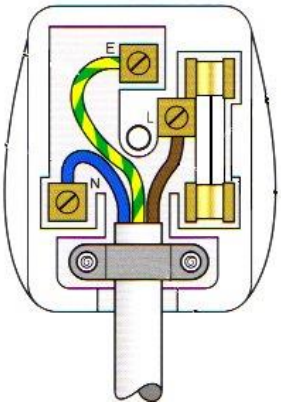
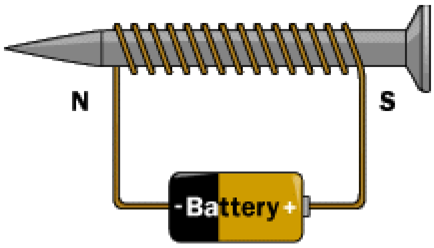
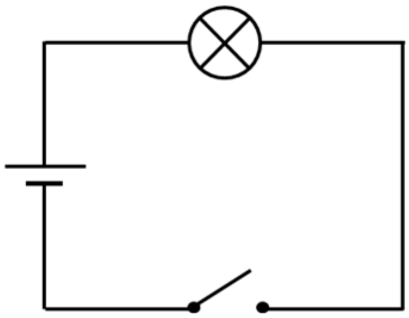
Wallace Hall Academy

Physics Department

S2
Electricity Notes Booklet





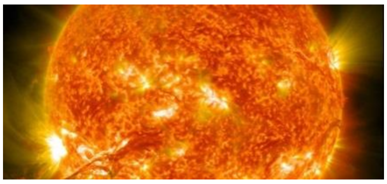


Name: ______________________________

Electrical Energy

Energy allows something to work or function. It cannot be destroyed, it can only be changed into different forms of energy. There are 8 main types of energy.

Types of Energy
1.
2.
3.
4.
5.
6.
7.
8.

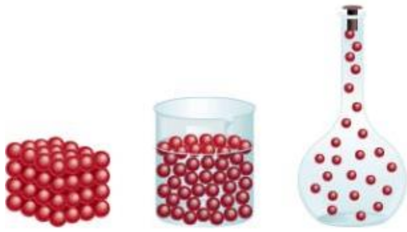


In your pairs, write down 5 appliances in your home which use electricity. Then write in the energy change for each of these appliances.

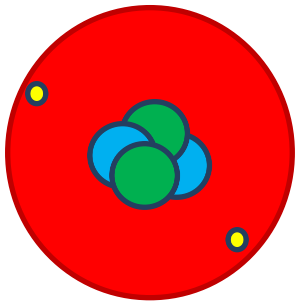
Appliance	**Energy Change**
	Electrical →
	Electrical →
	Electrical →
	Electrical →
	Electrical →

Electrical Charge

Everything on Earth is made up of matter. Matter is made up of small particles called atoms. These atoms are arranged in different ways for gases, liquids and solids.

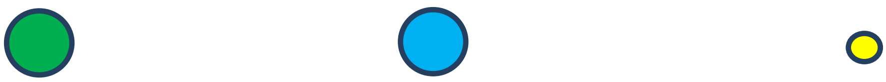


Each individual atom is made up of even smaller particles.



At the centre of the atom there is a nucleus which is made up of protons and neutrons. On the outside of the nucleus is electrons. These orbit the nucleus kind of like how the moon orbits the Earth.

Protons have a positive charge, neutrons have a neutral charge/no charge and electrons have negative charge.



When electrons pass from atom to atom an electrical current is created. This means electricity is produced!

<u>Static Electricity</u>

The type of charge particles have determines how they interact with other charged particles.

For instance,

when two charged particles have the *same type of charge* they *repel* one another.

However,

when two charged particles have **opposite types of charge** they **attract** one another.

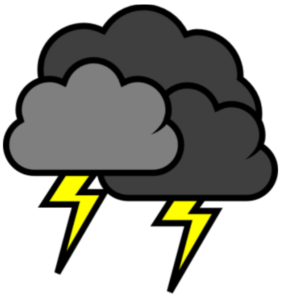
People and objects can become charged up if they gain or lose lots of electrons. If they gain electrons then overall they become negatively charged. If they lose electrons then overall they become positively charged.

When a balloon is rubbed on someone's hair it steals electrons. This means the balloon becomes negatively charged and your hair becomes positively charged.

Static Electricity: Types

There are many ways that static electricity can be built up.

The most natural is lightning where clouds become negatively charged in warm conditions then discharge by sending a huge spark down to the ground (fork lightning) or a huge spark to another cloud (sheet lightning).

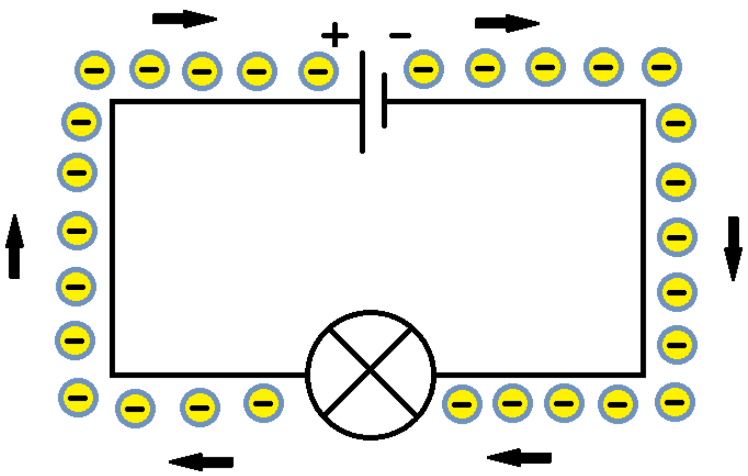


Sometimes on trampolines when your feet are rubbing against the springy surface they can steal electrons and you can become charged. When you try to leave the trampoline and touch the metal poles at the side you can get a shock!

It's the same for shopping trolleys. When the wheels rub off the floor the trolley starts to charge up. When you go to touch it you can also sometimes get shocked.

Electrical Current

Electrical current is the flow of electrons. It is a measure of how _________ the electrons are able to travel around a circuit.



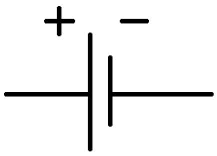
To do this we use a very special device to count how many _________ are going passed every _________. The device is call an ammeter. The units we use to measure current are called amperes, but usually we call it amps or A for short.

Electrons have a _________ charge so they are ___________ from the negative side of a battery and ___________ to the positive side of the battery. This is part of the reason why batteries are required for electricity to work.

Circuits and Symbols

Symbols are used to represent many things in life. In electricity we use symbols to set up circuits, rather than writing lots of sentences explaining how to set them up.

The following symbols represent different pieces of equipment we use in electrical circuits. Write in what each symbol is.



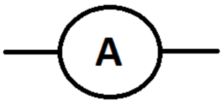
1.____________

2.____________

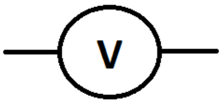
3.____________

4.____________

5.____________

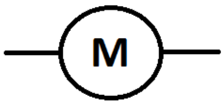


6.____________



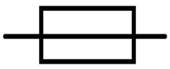
7.____________

8.____________



9.____________

10.____________



11.____________

12.____________

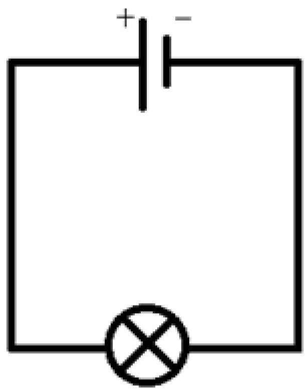
Why do you think symbols are a better way of giving instructions for setting up a circuit rather than written instructions?

-
-
-

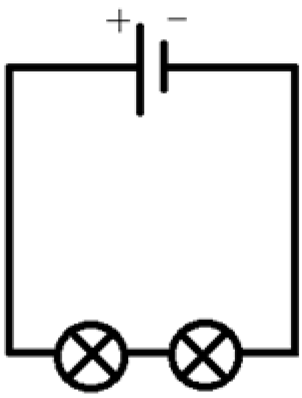
Batteries and Voltage

Set up the three circuits below and try to answer the questions.

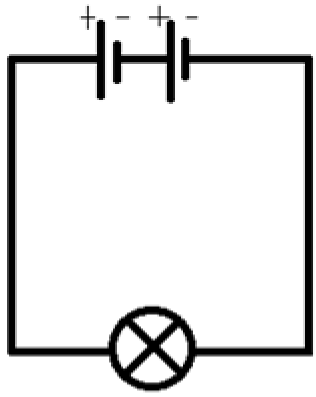
Circuit A



Circuit B



Circuit C



a) Which of the three circuits would have the brightest bulb(s)?
b) Which of the three circuits would have the dullest bulb(s)?
c) Why do you think the circuit you chose had the dullest bulb(s)?
d) If we added another battery to circuit B do you think the bulbs would be duller, brighter or the same as the bulb in circuit A? Why?

Answers

a)

b)

c)

d)

<u>Batteries and Voltage</u>

Voltage is the _______ per _________. The higher the voltage that a battery has the more electrical energy it gives out to the electrons flowing through the circuit. When the electrons then go on to appliances, like light bulbs, they give away their electrical energy. For a light bulb this electrical energy turns into _______ energy and _______ energy. The bigger the voltage, the ________ the light bulb comes.

However, for some appliances that get too much voltage they _______!

We use a ___________ to measure voltage. The units for voltage are _______ or __ for short.

Batteries and Voltage

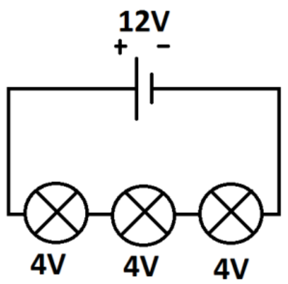
The circuits below might help explain what voltage is more clearly.

You should already know that electrons flow around electrical circuits.

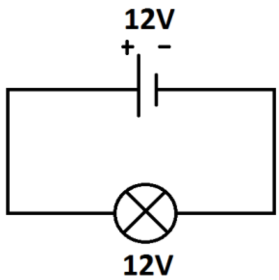
Just before going into a battery or a power source an electron will have no energy. When it comes out of a battery it has taken electrical energy. How much energy depends on the **voltage** of the battery (the **energy per electron** of the battery).

The electron then makes its way round the circuit with its energy. It doesn't lose any energy to the wires but it will lose energy to appliances like light bulbs, hair driers, washing machines, etc. These appliances then turn the electrical energy into other forms of energy such as light, sound and kinetic.

Different appliances take a different share of the electron's energy.



In this case the electron passes through the battery picking up 12 bits of electrical energy. It then goes through three light bulbs. At each one it gives away 4 bits of energy. By the time it passes through the bulbs it has no energy left, so it goes back up to the battery to get more energy. Then the whole process happens again.



In this case the electron passes through the battery picking up 12 bits of energy. It then goes through one light bulb, giving all of its energy away. The bulb is 3x brighter in this circuit as it gets 3x more energy per electron passing through.

Conductors and Insulators

Aim

Method

Results

Material	Did electricity flow through it?	Conductor or Insulator?

Conclusion

Conductors and Insulators

_____________ are materials that **do not** allow electricity to flow through them.

_____________ are materials that do allow electricity to flow through them.

All __________ do let electricity pass through so these are _____________. A few examples of these are __________ and ___________.

The only non-__________ which will let electricity pass through is ___________.

S2 Electricity Homework 1

1. What are the energy changes for the following (remember the eight types of energy):

a) A toaster ____________ ⇒ ____________

b) A washing machine ____________ ⇒ ____________

c) Eating food ____________ ⇒ ____________

2. Look around the room. Name two materials in it that are conductors and then two materials that are insulators. Label each material.

3. What does a voltmeter do?

4. What is the symbol for the following appliances?

a) A resistor

b) A light bulb

c) A fuse

5. What does a fuse do? *Use the internet at home or in the school library to find this out.*

6. Why are circuit diagrams better than written instructions for setting up circuits?

Resistance

Aim

Method

Results Table

Resistor Value (Ω)	Current (mA)	Current (A)

Results Bar Graph

Do your bar graph on graph paper then fold it in half and glue it on to here.

Conclusion

Ohm's Law

Aim

Method

Resistor Value = __________

Results Table

Voltage (V)	Current (mA)	Current (mA) rounded to a whole number

Ohm's Law (continued)

Results Line Graph

Do your line graph on graph paper then fold it in half and glue it in to here.

Gradient of the Graph

Conclusion

Ohm's Law Equation

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}}$$

(measured in ohms or Ω) — Resistance

(measured in volts or V) — Voltage

(measured in amps or A) — Current

or for short

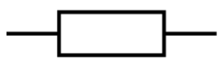
$$R = \frac{V}{I}$$

Using this equation we can determine the resistance of an appliance or the amount of voltage it uses or how fast the current passes through it.

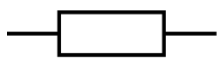
Examples

a) The voltage across a light bulb is 12V and the current passing through is 2A. Calculate the resistance of the bulb.

b) The voltage across a resistor is 9V and the current passing through it is 0.25A. Calculate the resistance of the resistor.



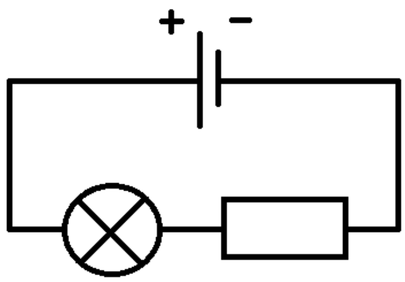
c) The resistance of a resistor is 10Ω and the current passing through is 2A. Calculate the voltage across the resistor.

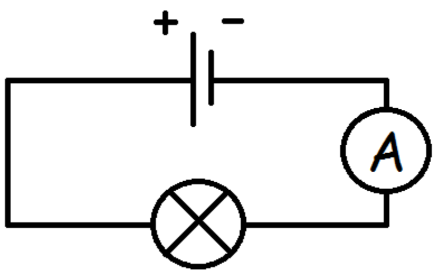


Series Circuit

In a series circuit there is **only one path** for the electrons to flow around. This means the electrons pass through **all** the appliances in the circuit before making their way back to the battery for more energy.

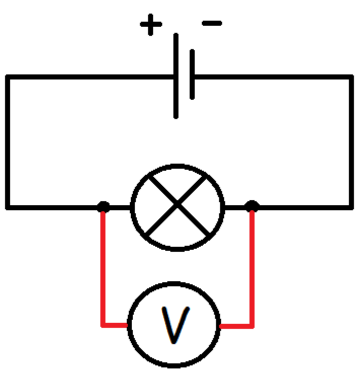
Below are three examples of series circuits.





It is important to note that electrons don't go through the voltmeter.

The voltmeter just checks how much energy an electron has before it goes through an appliance then how much energy it has left after it passes through.



Series Circuit: Current Experiment

Aim

Method

Results

Circuit Created	Current (A)
Circuit 1	
Circuit 2	
Circuit 3	

Conclusion

Series Circuits: Voltage Experiment

Aim

Method

Results

Measuring the voltage of the...	Voltage (V)
Batteries	
Light Bulb	
Resistor	

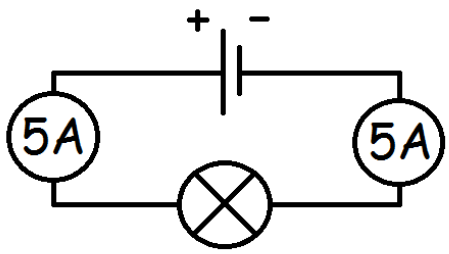
Light bulb voltage + resistor voltage = _______V

Conclusion

Series Circuits

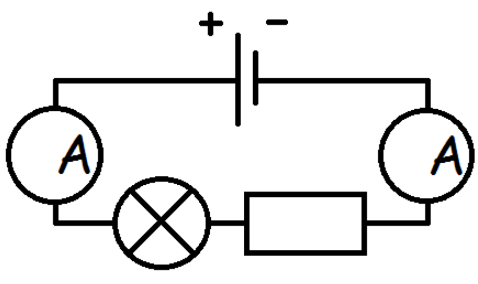
Current

In a series circuit the number of electrons passing a point in the circuit every second is the same at all points. This means that in a series circuit the flow of electrons (current) is the same at all points.



In this circuit the current is 5A at all points. This means 5 electrons whizz passed every second. So when 5 electrons pass through the battery in one second then another 5 electrons are passing through the light bulb in the same second. No matter where you look in the circuit you would see 5 electrons going passed every second.

Say I added a resistor to the circuit. What would happen to the value for the current?

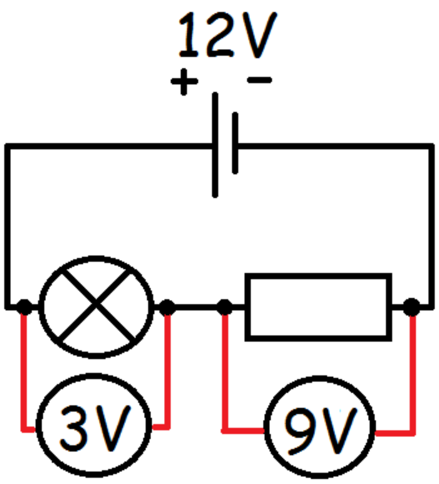


Series Circuits

Voltage

Remember that the voltage is the energy **each** electron has. A battery gives out energy to electrons and appliances use up the electron's energy.

In a series circuit all the energy an electron picks up from the battery gets shared out to all the appliances in the circuit. An electron will have no energy left once it has passed through all the appliances, so it goes back to the battery to pick up more energy.

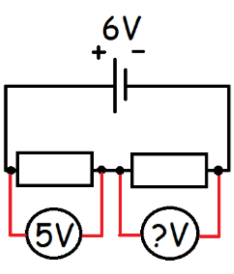


In this circuit the battery gives out 12 bits of energy to every electron (12V). When an electron moves round the circuit and passes through the resistor it loses 9 bits of energy. It then passes through the bulb and loses its last 3 bits of energy.
As it has no energy left it needs to go back to the battery to get more energy and the cycle repeats.

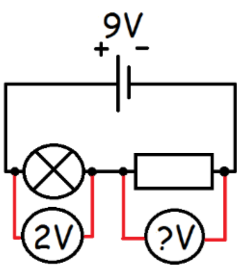
Examples

What would the voltage reading be at the unknown voltmeter (the one that doesn't have a number)?

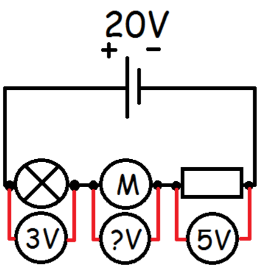
a)



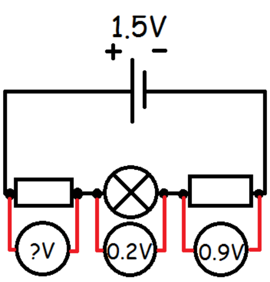
b)



c)



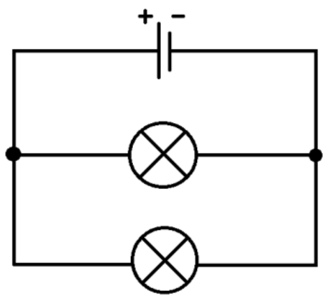
d)



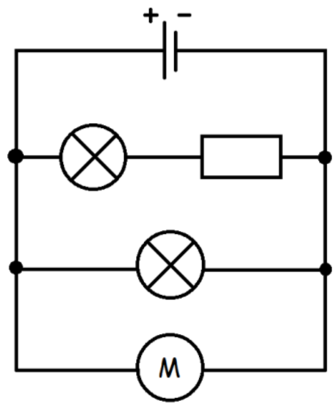
Parallel Circuits

In a parallel circuit there is **more than one path** for the electrons to flow around. Electrons can only go through one path at a time, before going back to the battery.

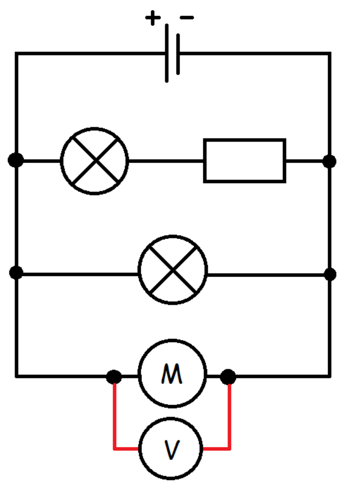
Below are three examples of parallel circuits.



Two paths the electrons may go through.



Three paths the electrons may go through.



Still only three paths the electrons may go through. Remember, electrons cannot go through a voltmeter. Voltmeters just feel for the electron's energy before and its energy after passing through part of the circuit.

Parallel Circuits: Current Experiment

Aim

Method

Results

Ammeter Checked	Current (A)
Ammeter 1	
Ammeter 2	
Ammeter 3	

Ammeter 2 + Ammeter 3 = ______A

Conclusion

Parallel Circuits: Voltage Experiment

Aim

Method

Results

Voltmeter Checked	Voltage (V)
Voltmeter 1	
Voltmeter 2	
Voltmeter 3	

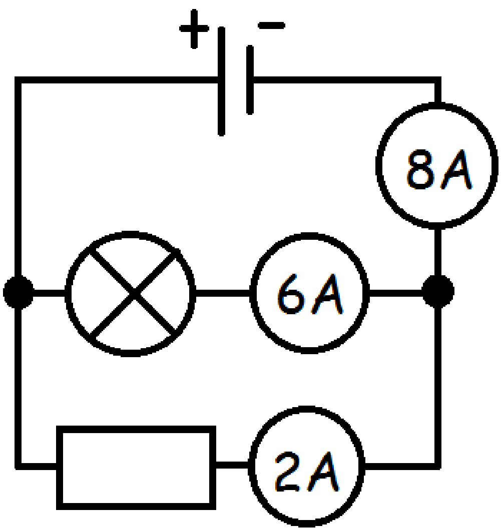
Conclusion

Parallel Circuits

Current

In a parallel circuit the total current close to the battery will get to a junction in the circuit. At the junction some electrons go down one path and the rest go down the other available path.

We say that the current splits in a parallel circuit but if you add up the current in each path then you will be able to find the total current close to the battery.



The ammeter closest to the battery is 8A, meaning 8 electrons are whizzing through it every second.

When the electrons get to the black circle (a junction) they get forced into one path or the other.

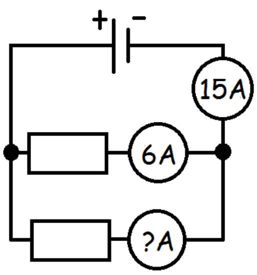
If 6 electrons are going passed the ammeter in the top path every second then the remaining 2 electrons must be going passed the bottom path ammeter every second.

At the junction on the other side all of the electrons would meet up again, so the current entering the battery is 8A again.

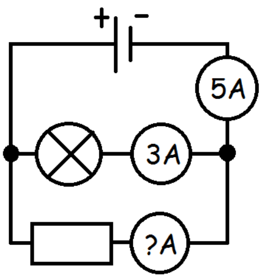
Examples

What would the current reading be on the unknown ammeter (the one without a number)?

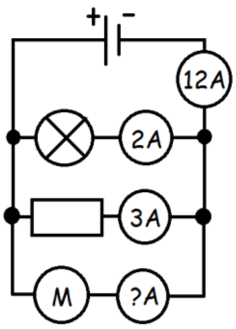
a)



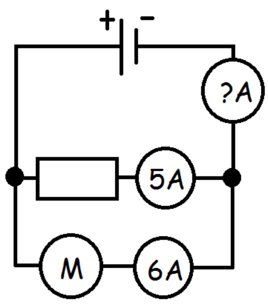
b)



c)



d)

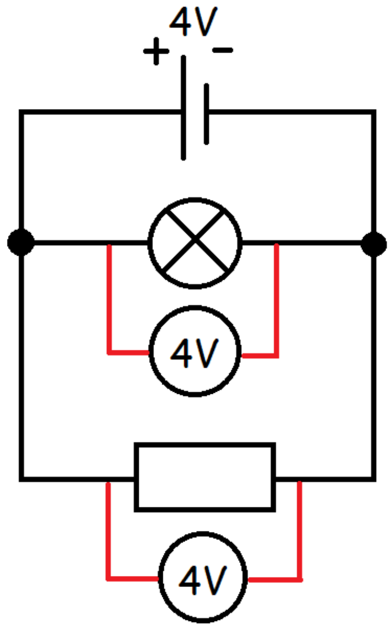


Parallel Circuits

Voltage

In a parallel circuit the total voltage in a path is equal to the battery voltage.

Remember **electrons can only go down own path**, so they will lose all of the energy the battery gave them in that path.



In this circuit the electrons **each** pick up 4 bits of energy from the battery.

They then move round the circuit until they reach a junction.

At the junction all the electrons will split up and go through one of the paths before going back to the battery to get more energy.

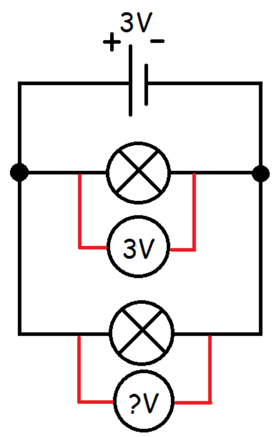
If an electron goes through the top path then it will lose **all** its energy to the light bulb (so 4 bits of energy per electron = 4V).

If a different electron goes through the bottom path it will lose **all** its energy to the resistor (so again 4 bits of energy per electron = 4V).

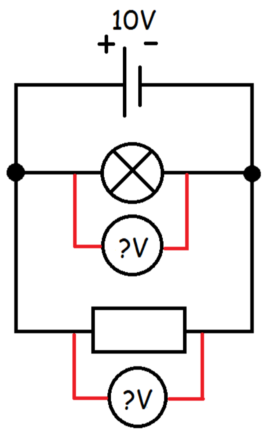
Examples

What would the reading be on the unknown voltmeters?

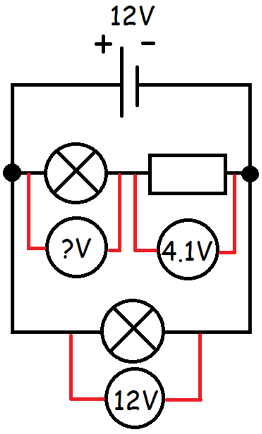
a)



b)



c)



S2 Electricity Homework 2

For questions 1-3 each answer should include the word "electron(s)".

1. What is voltage?

2. What is electrical current?

3. What is electrical resistance?

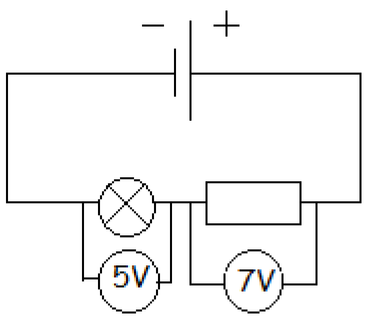
4. In the space below using a battery, 2 light bulbs, a resistor and connecting wires draw a diagram for

a) a series circuit

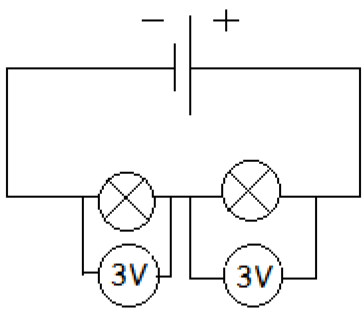
b) a parallel circuit

5. Find the voltage of the **battery** in each of the circuits.

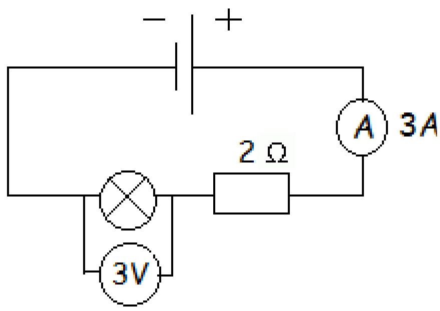
a)



b)



c)



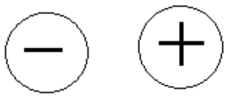
6. A bulb has a resistance of 2 Ω and a current going through it of 2 A. Calculate the voltage across the bulb.

7. A motor has a resistance of 10 Ω and a current going through it of 0.5 A. Calculate the voltage across the motor.

8. A resistor has a resistance of 8 Ω and a current going through it of 250 mA. Calculate the voltage across it.

9. Name **two** factors which will affect the strength of an electromagnet.

10. What happens when I place a negatively charged object next to a positively charged object?



Electromagnets Experiment

Aim

Method

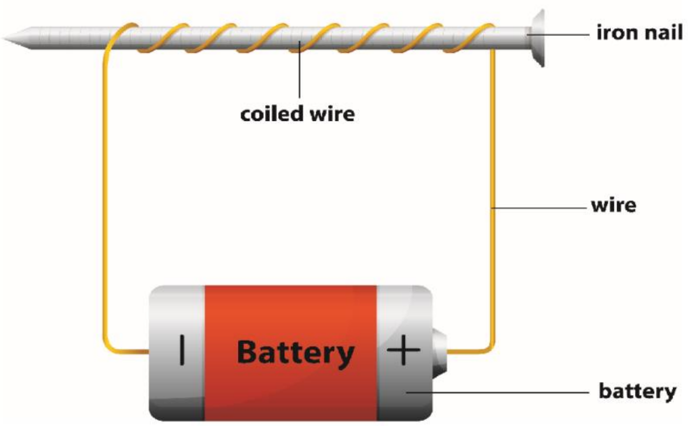
Results

Number of Coils	Number of Paperclips

Conclusion

Extension: Create a line graph of your results. Remember the factor we control (the independent variable) always goes on the x-axis. The factor, which depends on the thing we control, is called the dependent variable and goes on the y-axis.

Electromagnets



An electromagnet is a type of magnet which only becomes magnetic when an electrical current flows through its coils.

Electromagnets are stronger when they have more coils around them or more voltage across them. These are the main factors which contribute to an electromagnets strength.

Their strength can also be affected by factors like the type of metal used or the quality of the metal used.

Uses of Electromagnets

Anything nowadays which has a motor inside will use an electromagnet to make things move (give them kinetic energy).

Some better known uses include:

- Door bells
- Computer hard drives
- Loudspeakers
- MagLev trains
- Automatic doors
- Car door locks