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Photocopy Master Sheets

Years 9-10

Electricity

Disk filename = "14.Electricity"

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Topics Available

Year 7-8 General Science

Disk Filename	Topic Name
01.Energy	Energy
02.Forces	Forces
03.Matter	Solids, Liquids & Gases
04.Mixtures	Separating Mixtures
05.Elements	Elements & Compounds
06.Cells	Living Cells
07.Life	Living Things
08.LifeSystems	Plant & Animal Systems
09.Astronomy	Astronomy
10.Earth	The Earth
11.Ecosystems	Ecosystems

Year 9-10 General Science

Disk Filename	Topic Name
12.Waves	Wave Energy (inc. Light)
13.Motion	Forces & Motion
14.Electricity	Electricity
15.Atoms	Atoms & Elements
16.Reactions	Compounds & Reactions
17.DNA	Cell Division & DNA
18.Evolution	Evolution of Life
19.Health	Health & Reproduction
20.Universe	The Universe
21.EarthScience	Earth Science
22.Resources	Resources & Technology

Year 11-12 Science Courses

Biology

Preliminary Core
Local Ecosystem
Patterns in Nature
Life on Earth
Evolution Aust. Biota
HSC Core
Maintain. a Balance
Blueprint of Life
Search for Better Health
Options
Communication
Genetics:Code Broken?

Chemistry

Preliminary Core
Chemical Earth
Metals
Water
Energy
HSC Core
Production of Materials
Acidic Environment
Chem.Monit.&Mngment
Options
Shipwrecks, Corrosion...
Industrial Chemistry

Earth & Envir. Science

Preliminary Core
Planet Earth...
Local Environment
Water Issues
Dynamic Earth
HSC Core
Tectonic Impacts
Environs thru Time
Caring for the Country
Option
Introduced Species

Physics

Preliminary Core
World Communicates
Electrical Energy...
Moving About
Cosmic Engine
HSC Core
Space
Motors & Generators
Ideas to Implementation
Options
Quanta to Quarks
Astrophysics

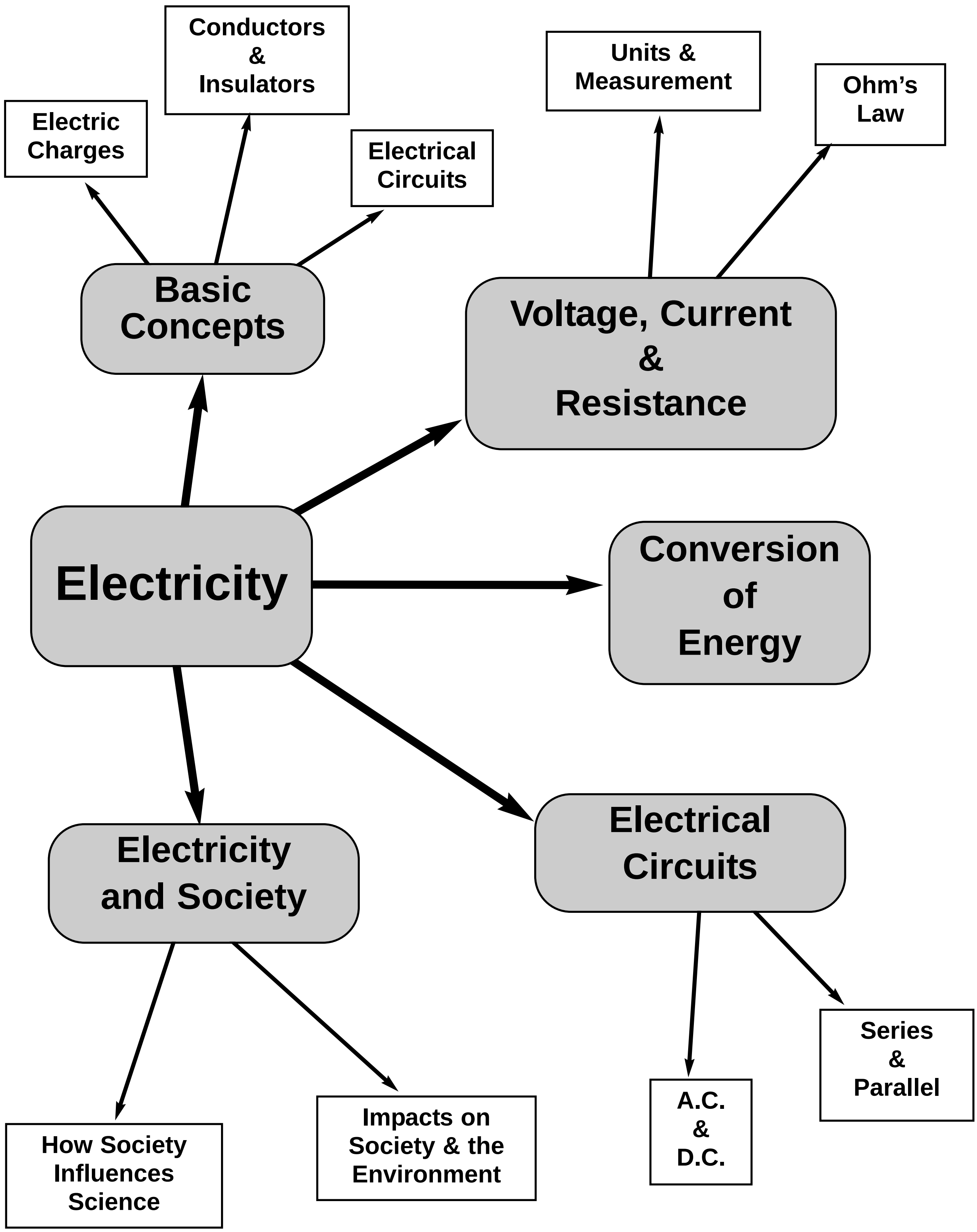
All Topics Available as PHOTOCOPY MASTERS and/or KCiC

Photocopy Masters (PDF files)
Black & White, A4 portrait-orientation for clear, economical photocopying.

KCiC = Key Concepts in Colour
Full colour, formatted for on-screen study and data projection. PDF + Powerpoint®

"Mind-Map" Outline of Topic

This topic belongs to Physics, the study of energy, force and motion.
In this topic you will study the Physics of one vitally important type of energy...



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Make your own "Mind-Map" TITLE PAGE.
Cut out the boxes. Sort them into an appropriate lay-out on a page of your workbook, then glue them down. Add connecting arrows and colour in.

Electricity

Basic Concepts

Conversion of Energy

Electrical Circuits

Ohm's Law

Conductors & Insulators

Voltage, Current & Resistance

Units & Measurement

Electrical Circuits

Electric Charges

A.C. & D.C.

Impacts on Society & the Environment

Series & Parallel

Electricity and Society

How Society Influences Science

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How Society Influences Science

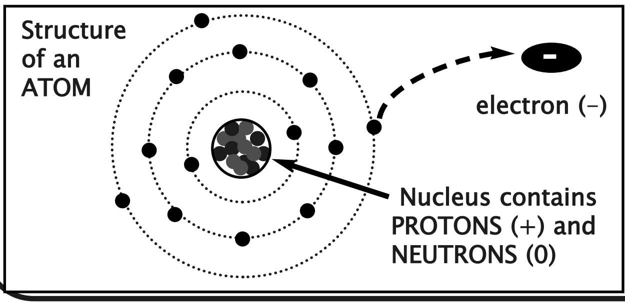
Electrical Charge

You are reminded of the basic facts about atoms and electric charge.
This knowledge is essential for an understanding of Electricity.

Atoms & Charged Particles

You already know that every substance is made up of tiny units of matter called <u>atoms</u>.

Each atom often acts as if it was a tiny solid ball, but in fact it is composed of smaller particles arranged as shown in this diagram.



The little <u>electrons</u> are whizzing around the central <u>nucleus</u>, like miniature planets around the Sun.

(Note: this is NOT a gravitational orbit,)

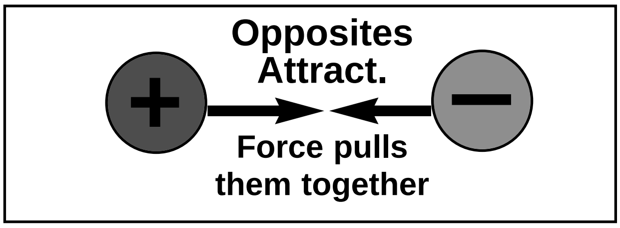
Each electron, and each proton in the nucleus, carries a field-force which we call <u>electrical charge</u>.

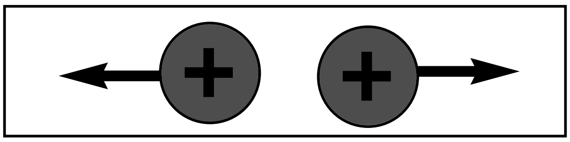
There are 2 opposite types of electrical charge which have been called simply "<u>positive</u>" (+ve) and "<u>negative</u>" (-ve).

Electrons carry negative charge.

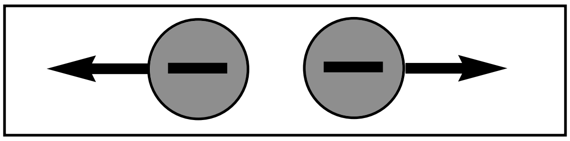
Protons carry positive charge.

Forces Between Electrical Charges





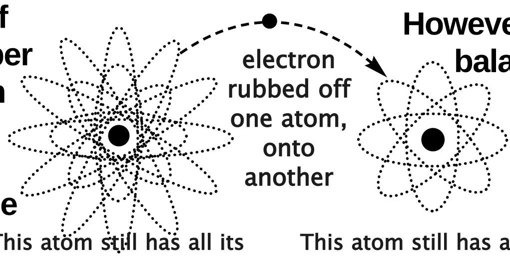
Same Charges Repel.



How Things Get an Electrical Charge

Normally, the number of electrons and the number of protons in each atom is exactly the same.

The +ve charges and the -ve charges "cancel out" and no electrical effects are apparent.



This atom still has all its (+ve) protons, but has <u>lost</u> a (–ve) electron. Overall, it now has a (+ve) charge.

This atom still has all its (+ve) protons, but has <u>gained</u> a (–ve) electron. Overall, it now has a (–ve) charge.

However, it is very easy to upset this balance by transferring electrons from the atoms of one substance onto the atoms of a different substance.

Gentle friction is enough. Just rubbing 2 different substances together can transfer electrons from one to the other.

If these substances are electrical insulators, the charges cannot flow away, so the substance stays charged, at least for a while.
The charges can push or pull each other (FORCE!) because each has a force-field.

Electrical Conductors and Insulators

Conductors

Electrons can be removed from atoms and will jump from one atom to another.

If this happens easily, it means that electrons will readily flow through the substance. This is a conductor.

Good Conductors

Metals
(esp. copper)
Graphite
(a form of carbon)
Salty water

Insulators

Some substances will not allow electrons to flow through them easily.

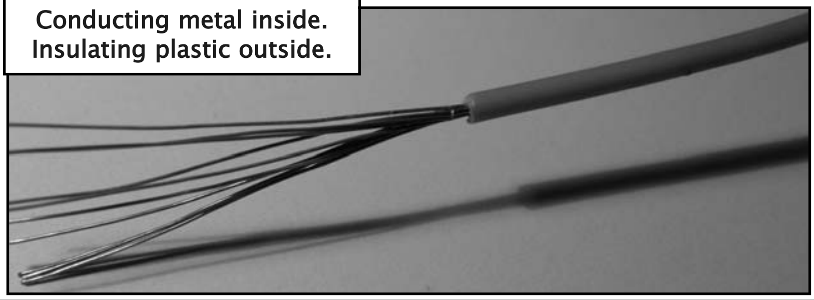
These are insulators.

Insulators can be charged with static electricity, but won't allow a flow of electrons through them.

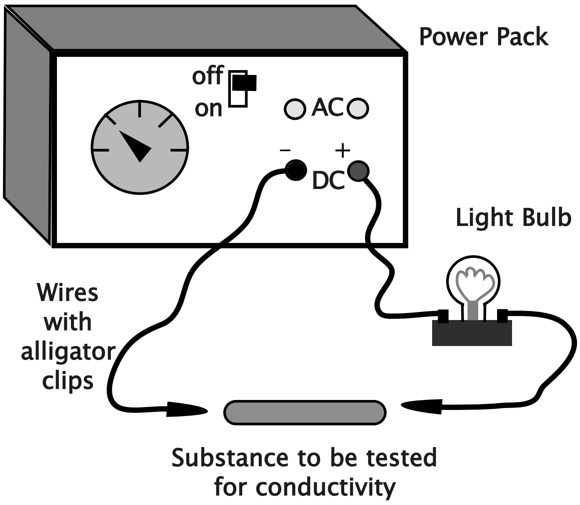
Good Insulators

Plastic
Glass
Wood
Air
Pure water

An Electrical Wire.
Conducting metal inside.
Insulating plastic outside.



Conductor or Insulator?



This equipment set-up is suitable to test the electrical conductivity of a variety of objects or substances.

The alligator clips are attached to the test object, then the power is turned on.

If the bulb lights up, it means that electricity is flowing through the entire circuit. Therefore, the test object is a conductor.

If the bulb does not light, then electricity is not getting through. Therefore, the test object is not a conductor... it is an insulator.

This also demonstrates an important point about electrical circuits...
Electricity will only flow around a circuit if every part of it is a conductor.

An Electrical Circuit

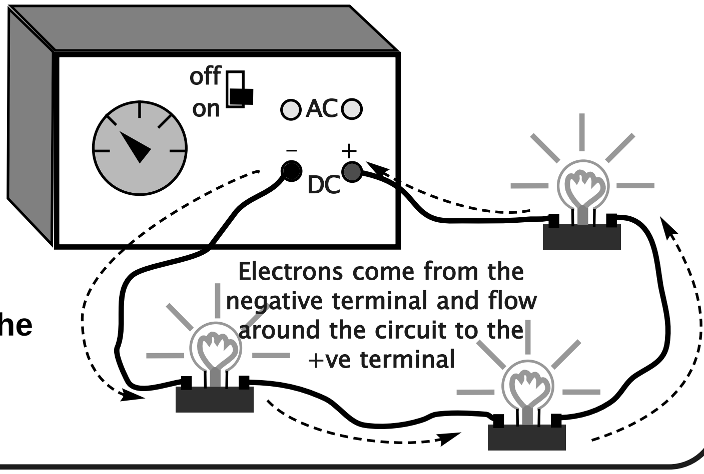
An electrical circuit always contains 3 parts:

- **A power source, such as a battery, "power pack" or mains power point.**
- **One or more energy converters, such as light bulbs, heaters or motors.**
- **Electrical wires (good conductors) which connect the parts.**

Complete Circuit

For electricity to flow at all, there must be a complete circuit (an unbroken chain of conductors) from the negative (-ve) terminal to the positive (+ve) terminal.

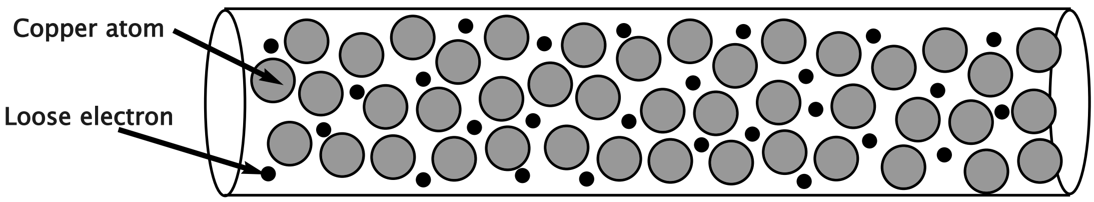
If there is any break in the circuit (e.g. a wire not connected properly) the electrons cannot get through and the whole circuit stops working.



What Makes the Electrons Flow?

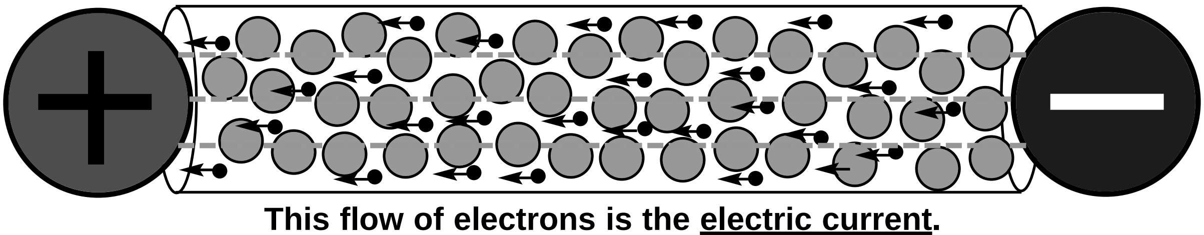
If you could see the atomic world inside a copper wire, you'd see that the atoms of copper can lose electrons so easily that there are billions of "loose electrons" hanging around between the atoms.

These electrons are not going anywhere, but can easily jump from atom to atom.



Every battery or other power source has an electric field. The field of a battery is produced by chemical reactions. The "mains" power is produced by magnetic effects in a generator at a power station.

When the wire becomes part of a circuit, the electric field instantly reaches through the wire and exerts a force on every electric charge. The charged particles within the copper atoms cannot move, but the "loose" electrons immediately gain energy from the field and begin flowing in the wire.

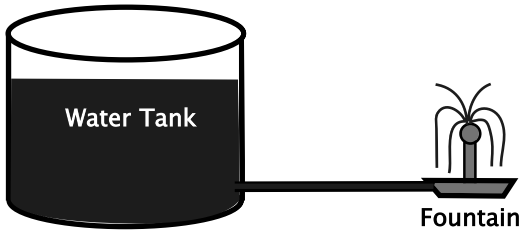


This flow of electrons is the electric current.
The amount of "push" that the electric field can give the electrons is called "voltage".

Voltage & Current

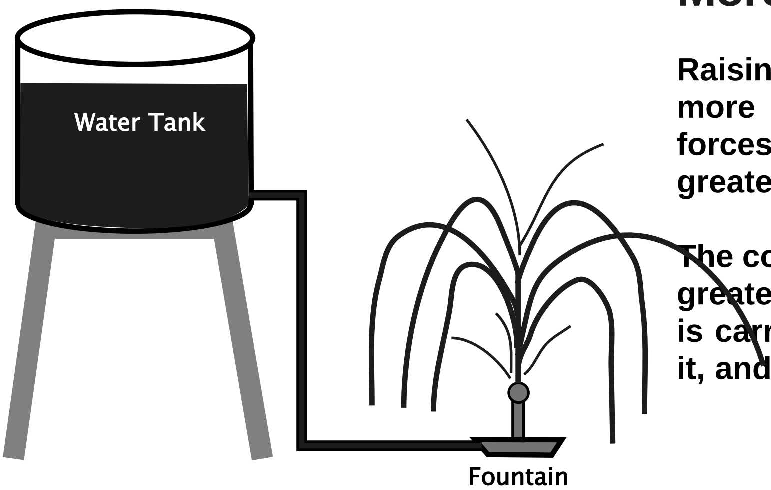
One way to get an understanding of electrical voltage and current is to use an analogy; a comparison to a more familiar substance... water.

Imagine a water tank supplying water to a garden fountain.



Notice how much water is spraying from the fountain, and how high it squirts into the air.

Now imagine exactly the same water tank, same fountain, same size pipes, but the tank has been raised onto a tower.



More Pressure = More Flow

Raising the water tank higher creates more water pressure. More pressure forces more water to flow... there is a greater current of water in the pipe.

The combination of higher pressure and greater water flow means more energy is carried by the water. There's more of it, and it squirts higher into the air.

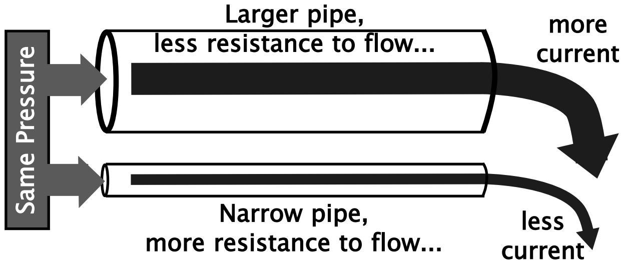
The analogy to electricity is simple:
The water pressure is like VOLTAGE. Higher voltage = more push.
The water flow is like CURRENT of electricity. More current = more electrons flowing.

If the voltage is higher, it pushes more electrical current through the circuit.
The combination of voltage and current determines the energy delivered.

Another Factor... Resistance to Flow

Continuing the water analogy, imagine 2 water pipes of different diameter.

They are connected to the same water supply and the pressure in the pipes is exactly the same. Will the same amount of water flow?

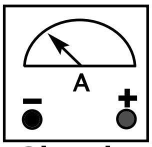


Different wires, different light bulbs, etc in an electrical circuit have different amounts of electrical resistance. If there is more resistance, less current can flow. If there is less resistance, more current can flow. (For the same amount of voltage "push".)

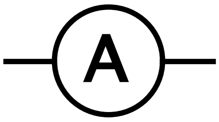
Measuring Voltage & Current

Current

The flow of electrical current can be measured by a special device called an “ammeter”.



Sketch



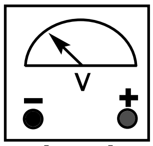
Symbol used in a circuit diagram

The unit of current is an <u>ampere</u>, often abbreviated to “amp”, symbol “A”.

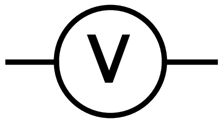
1 amp of electrical current actually means there are billions and billions of electrons flowing in a circuit.

Voltage

The “push” in an electrical circuit can be measured by a “voltmeter”.



Sketch



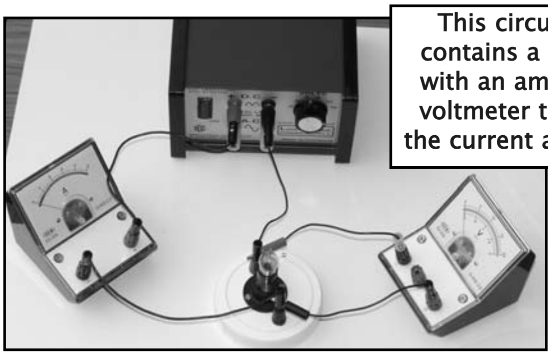
Symbol used in a circuit diagram

The unit of voltage is a <u>volt</u>, symbol “V”.

1 volt is a rather small “push” for the current. A car battery supplies 12 V and mains electricity is 240 V. This is a very dangerous level.

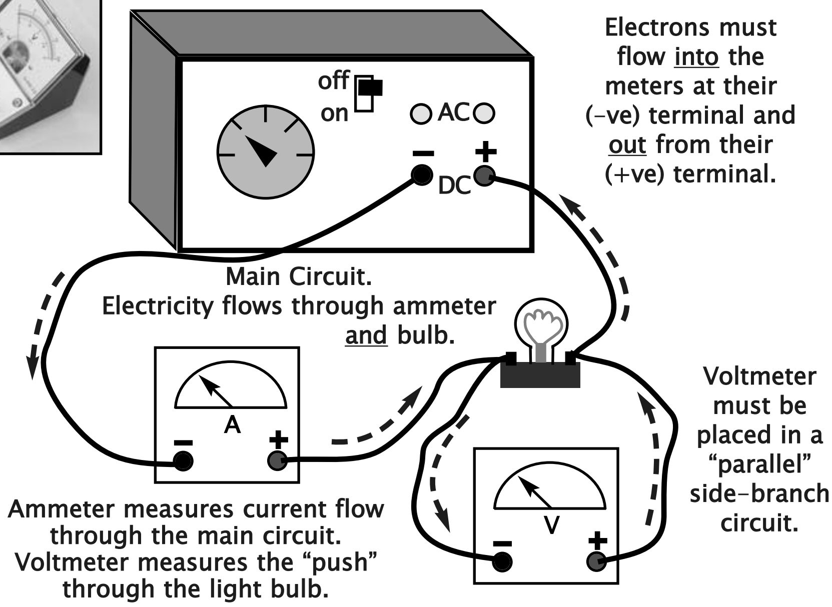
Building a Circuit

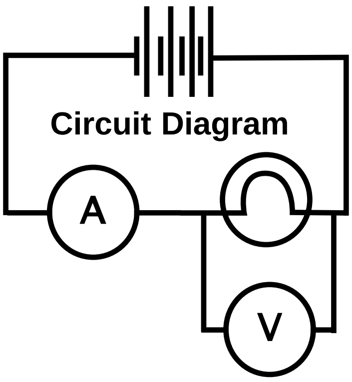
When you put together an electrical circuit, it needs to be done correctly.



This circuit simply contains a light bulb, with an ammeter and voltmeter to measure the current and voltage.

Sketch of Circuit and Explanation of Correct Construction.





Worksheet 1
Electrical Charge & Circuits

Student Name..

Fill in the blank spaces.

Every atom contains small particles which have a property we call electrical charge. In the nucleus, the a)................... have b)................... charge. In orbit around the nucleus the c)........................ carry d)...................... charge.

Charges can exert forces on each other. Charges of the same type e)................... each other. Opposite charges will f).......................... each other.

"Static electricity" occurs when g)...................... from atoms in one substance are h)............................. to another substance. The substance which lost electrons now has a i)....................... charge, while the substance gaining electrons now has a j).......................... charge.

Some substances allow k)...................... to easily flow through them. These are called l) "..". Most m).......................... are like this. n) "................................." are substances which do NOT allow electrons to easily flow through. Common examples are o)...................... and ....

An electrical circuit must have an unbroken chain of p)................................ for the electrons to flow through.

Electrons are forced to flow by an electrical q).................... produced by a battery or generator. A conductor (like a copper wire) contains many "loose" electrons. When "pushed" by a field, the electrons r)..................... along the wire. This flow of electrons is an electrical s) "................................". The "push" given by the field is called t).............................

Worksheet 2
Current & Voltage

Student Name...

Fill in the blank spaces.

The flow of a)........................ in a wire can be compared to the flow of water in a pipe. If there is more "push" or water pressure, then more water flows in a pipe.

With electricity the "pressure" is called b) ".................................". The unit of measurement is called the c) "..............." and it can be measured by a d).................................. (type of meter).

The amount of electrons flowing is called the e) "................................". The unit of measurement is the f) "............." and it can be measured by an g)...

The more h).......................... (push) in a circuit, the greater the i)......................... which flows.

The degree to which the flow of current is opposed is called j) "..........................". If a circuit has a <u>higher</u> resistance then k)..................... current will flow, for a given voltage. Less resistance will allow l)................ current to flow.

The total energy in a circuit depends on both m)........................ and ....

When constructing a circuit you must place an ammeter n)................................. ...., but the voltmeter must be placed o)..................................... .... In both cases the electrons must flow into the p)............... terminal of the meter and out of the q).................. terminal.

The Relationship of Voltage, Resistance & Current

You have probably already figured out that there is a simple relationship between

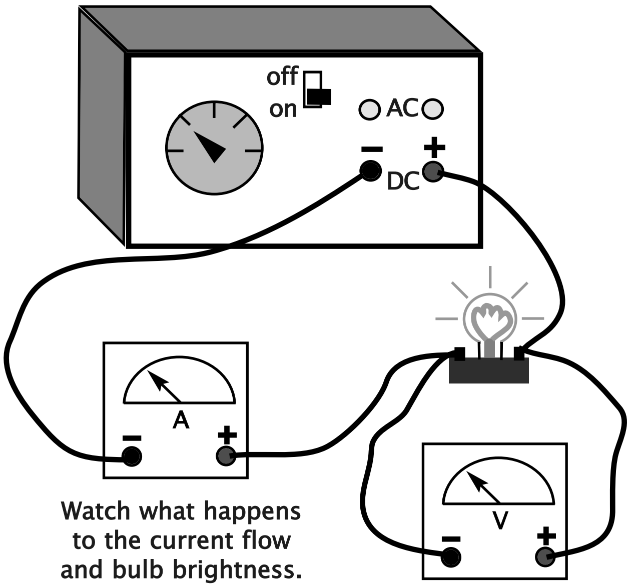
- **the amount of "push", or voltage, in a circuit, and**
- **the amount of resistance in the wires and components, and**
- **the amount of electrical current which flows.**

What happens to the CURRENT if you...

Increase the Voltage?

(and the Resistance stays the same)

Set up a simple circuit as shown and then watch what happens as the voltage is increased by adjusting the power pack voltage setting.

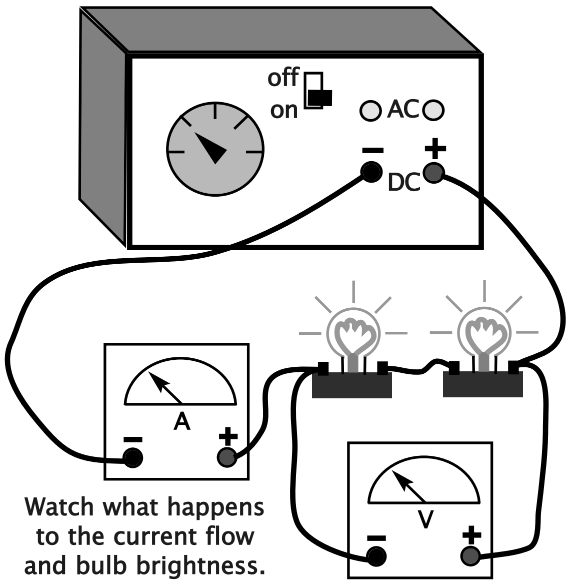


If the voltage is increased, the current increases. (For the same resistance.)

Increase the Resistance?

(and the Voltage stays the same)

Start with the same circuit as at the left, then increase the resistance by adding another light bulb as shown. Leave the power pack setting as it was.



If the resistance is increased, the current decreases. (For the same voltage.)

Light Bulbs as Resistors

It's always handy to use light bulbs in a circuit because you can see clearly when the circuit is working. Also, the more current that flows, the brighter the bulb glows.

However, when working mathematically, light bulbs are useless because their resistance values are never constant.

From here on, when we show a light bulb in a circuit it means that the values don't matter and we're only looking at general trends (as we did above).

When actual values are important, you need to use fixed-value resistance coils or "solid-state" resistors.

Ohm's Law

The relationship between Voltage, Current and Resistance can be decribed mathematically as well as in a general, descriptive way.
This mathematical relationship was first discovered in the 1830's by a German called George Ohm. It is known as "Ohm's Law" in his honour.

Mathematically, Ohm's Law is often written this way:

Voltage = Current x Resistance, V = IR

but it is more meaningful if written as:

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

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

I = electrical current, in <u>amps</u> (A).

V = voltage, in <u>volts</u> (V).

R= resistance, in <u>ohms</u> (Ω).

The "ohm" unit is named in honour of George Ohm. The symbol "Ω" is a Greek letter for "O". It is used because symbol "O" or "o" could be confusing.

Written in the form I = V/R, The Ohm's Law equation tells you that the amount of current flowing in a circuit depends on both the voltage "pushing" and on the amount of resistance trying to stop the electricity.

More voltage → more current.
More resistance → less current.

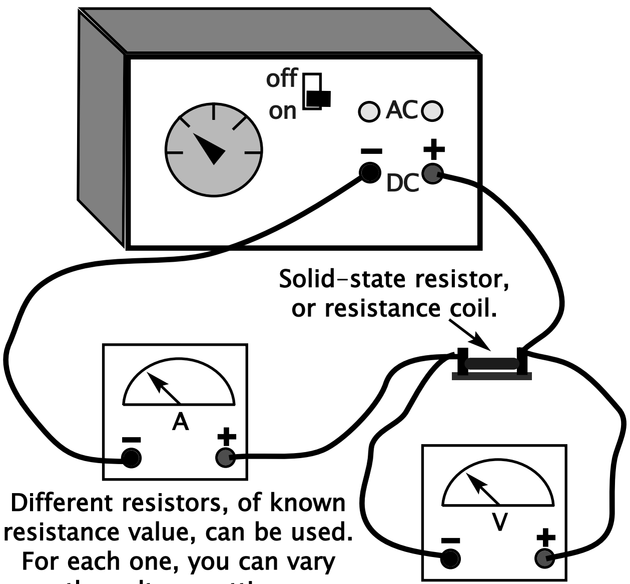
<u>Example Calculation</u>

An electrical circuit has a resistance of 6.0Ω. What current would flow if connected to a 12V car battery?

<u>Solution</u>: $I = \frac{V}{R} = \frac{12}{6.0} = 2.0\text{ A}.$

Ohm's Law by Experiment

Ohm's Law can be "re-discovered" and tested by making your own measurements on an electrical circuit similar to that shown below.



Different resistors, of known resistance value, can be used. For each one, you can vary the voltage setting.

For each combination of voltage and resistance, you can measure the current flow on the ammeter and check if it agrees with Ohm's Law.
(Use <u>Voltmeter</u> readings for voltage, NOT power pack settings.)

<u>Typical Results</u>:

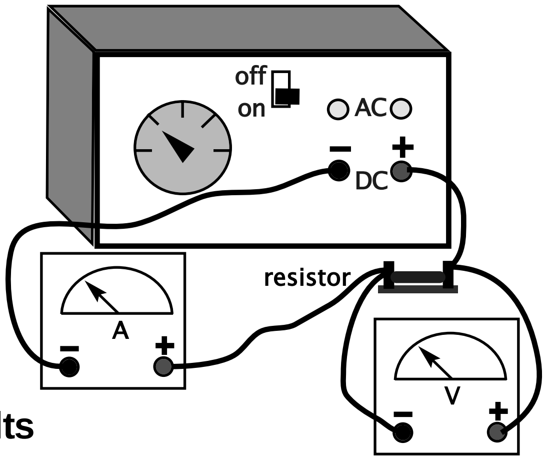
Voltage (V)	Resistance (Ω)	Current <u>Calculated</u> (by Ohm's Law)	<u>Actual</u> Current (Ammeter reading)
7.8	10	0.78 A	0.8 A
12.0	6	2.0 A	1.9 A

You will find that the results agree with Ohm's Law, with some experimental error.

Worksheet 3
Graphing Skills

Student Name...

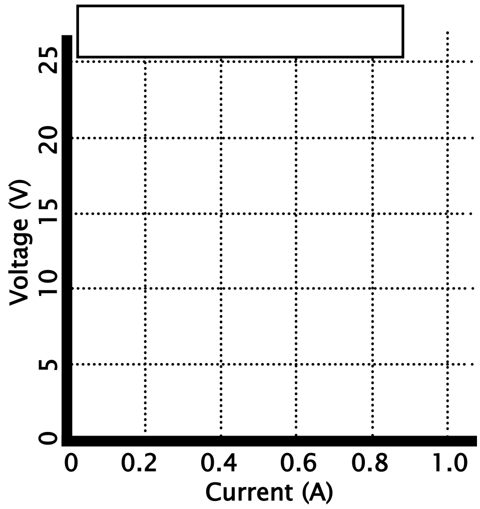
The equipment shown was used to measure the voltage and current through the resistor, which has a fixed value.



Results

Voltage (V)	Current (A)	Ohm's Law calculation V/I
5.0	0.2	
10.0	0.4	
20.0	0.8	
25.0	1.0	

Construct a line graph of the results on this grid.



Q1. Calculate the gradient of the graph line.

Gradient = $\frac{\text{rise}}{\text{run}}$ = __________ = ...

Q2. Use Ohm's Law to complete the final column of the data table. Use R = V/I to calculate the resistance for each line of data.

Q3. Can you explain why the graph gradient is equal to the resistance value?

Worksheet 4
Ohm's Law Calculations

Student Name...

Use the Ohm's Law equation to solve these problems.

1. A toy electric motor with resistance of 12Ω is connected to a 6.0 V battery. What current would flow?

I = $\frac{V}{R}$ = ________ = ... A

2. A 240 V jug element has a resistance of 80Ω. What current would flow?

3. How much current flows in the same jug element (from Q2) if connected to a 12V car battery?

4. What is the resistance of a light bulb which allows 1.5 A of current to flow when connected to a 12 V battery? (R = V/I)

5. What is the resistance of a 240V toaster if 4.0A of current flows when it is connected to the mains?

6. What voltage is needed to force 15A of current to flow through a 6.0Ω resistor?

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Converting Electrical Energy

The great value of electricity in our society is that it can be easily converted into other forms of energy such as light, sound, heat or movement (kinetic energy).

Examples of Energy Changes

Light Bulb
Electricity ⟶ Light energy

Fan
Electricity ⟶ Movement (K.E.)

Power Tools
Electricity
↓
Kinetic Energy

Toaster
Electricity ⟶ Heat

Microwave Oven
Electricity ⟶ Microwaves ⟶ Heat

Television
Electricity ⟶ Light Energy + Sound Energy

Power and Efficiency

The amount of electrical energy converted per second is called "power". Electrical power is measured in "watts" (W). For example, a light bulb rated at 100W uses five times more energy (per second) compared to a bulb rated at 20W.

How Much Power?

The higher the "wattage" of any electrical appliance, the more electrical energy it uses per second.

The amount of power used depends on both voltage and current. Voltage (remember?) refers to the "push" or energy given to each electron. Current is related to the number of electrons flowing.

The total energy is related to both voltage and current together.

Efficiency

We use electricity to produce other forms of energy we want, such as light or heat. However, some electrical appliances are very inefficient at converting the energy.

A light bulb only converts about 10% of the electrical energy used into light. The rest is wasted as heat.

Compact fluorescent lights are much better, and L.E.D. lights are better still.

Designing Practical Electrical Circuits

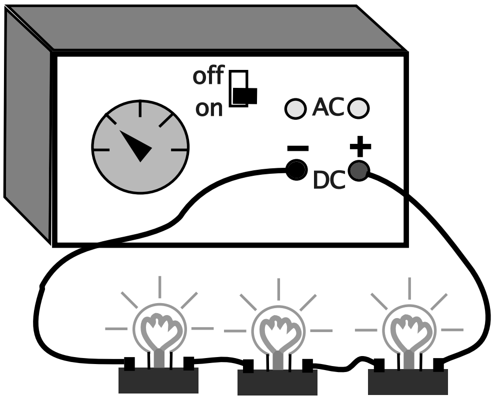
In a home, office or school, electrical circuits are designed to have a number of items in one circuit. For example, there may be 10 separate lights in one circuit, but each one can be switched on or off separately.

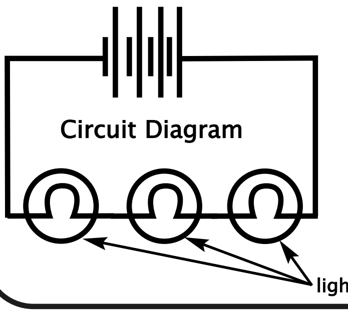
How is this done?

It turns out there are 2 different ways to arrange items in an electrical circuit.

Series Circuits

The diagram shows 3 light bulbs arranged "in series" in a simple circuit.



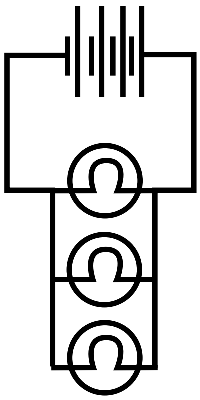


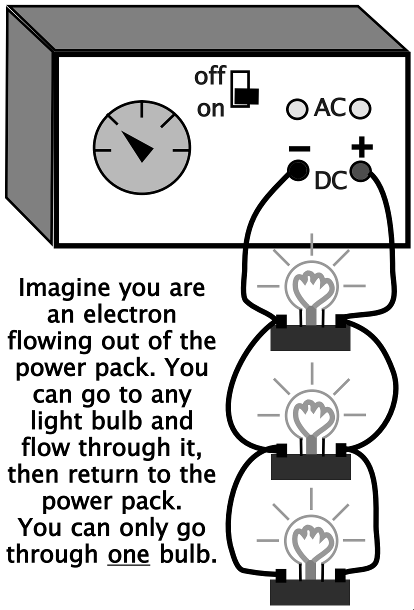
In this circuit the electricity must flow through all the bulbs, one after the other.

Parallel Circuits

In the circuit below, the current can divide into 3 parts. Some current flows through each bulb, but a particular electron only goes through one of the bulbs, not all 3.

These bulbs are arranged "in parallel".





Imagine you are an electron flowing out of the power pack. You can go to any light bulb and flow through it, then return to the power pack. You can only go through one bulb.

An Experiment You Might Do

Build the series circuit shown above.

Turn on the power and note the brightness of the bulbs.

Turn power off and remove one bulb from its socket. Turn power back on.

Do the other 2 bulbs work if one is missing or "burned-out"?

Add one or more switches to the circuit. Is it possible to switch one light on, while the others stay off?

Now build the parallel circuit shown above. Use exactly the same bulbs and the same power pack setting.

Turn on the power and note the brightness of the bulbs.

Turn power off and remove one bulb from its socket. Turn power back on.

Experiment with one or more switches in various locations.

Get the picture?

Advantages of Parallel Circuits

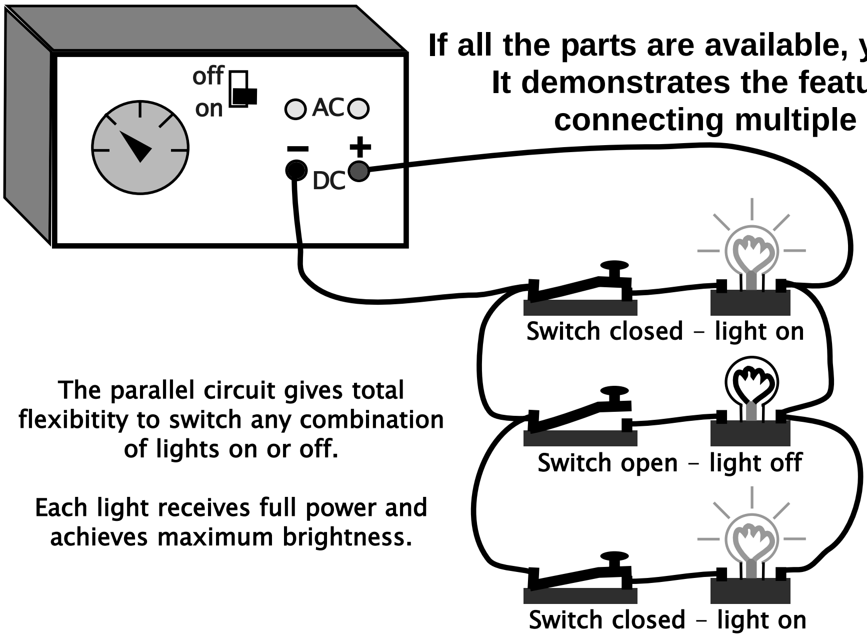
Parallel electrical circuits offer many advantages compared to series circuits.

- **Full delivery of power to each device in the circuit. (e.g. brighter lights)**
- **Each device can be switched on or off independently.**
- **If one device "burns-out" all others continue to operate.**

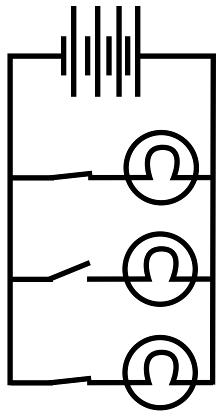
A series circuit has a much higher resistance so less current flows and less power can be delivered to each device. Multiple devices in series <u>cannot</u> be independently switched on or off... one off, all off.

Parallel Circuits are always used in practice.

If all the parts are available, you could build this circuit. It demonstrates the features and advantages of connecting multiple devices in parallel.



<u>Circuit Diagram</u>



AC & DC

Direct Current (D.C.)

The electrical current produced by a battery flows steadily from the -ve terminal to the +ve terminal. This is described as "direct current" or D.C.

The electrical field of a battery (which provides the voltage "push") is constant and always points in the same direction.

The electrons are always pushed in the same direction so the current flows steadily.

Alternating Current (A.C.)

Large-scale production of electricity in power stations relies on electrical generators, not batteries.

Because of the way generators work, the electrical field they produce fluctuates back-and-forth very rapidly.

The electrons do not flow steadily, but jump back-and-forth under the influence of the field. The current is called "alternating current" (A.C.).

Our "mains" electricity alternates 50 times per second (frequency = 50 Hz), so it is described as "240 V, 50 Hz A.C."

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Worksheet 5
Energy and Circuits

Student Name...

Answer the practice questions.

1. What is the main energy conversion occurring in:
a) an electric stove?

b) an electric "loud-speaker"?

c) a power drill?

d) an electric lawn mower?

e) A TV set?

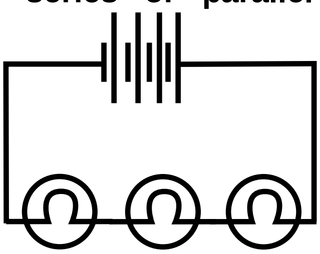
2.
a) What is meant by electrical "power"?

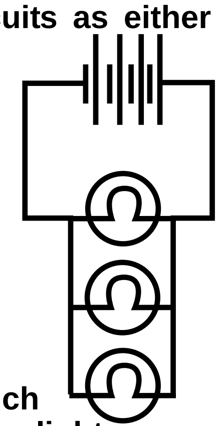
b) Which two measurements are both involved in determining the amount of power in an electrical circuit?

.... and ....

c) If an electrical appliance is said to be "inefficient", what does this mean in terms of energy?

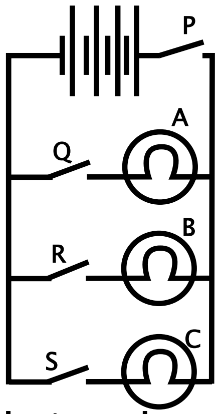
3. a) Identify these 2 circuits as either "series" or "parallel".





b) If all the parts of each circuit are identical, in which circuit would you expect the light bulbs to glow brighter?

4. This electrical circuit contains 3 lights (A,B,C) and 4 switches (P,Q,R,S).



a) Which switch(es) must be turned on to make bulb "C" only light up?

b) Which switch(es) must be turned on to light up bulbs "A" and "B" only?

c) If all the bulbs were lit up, which single switch can turn them all off?

d) If all the switches were on, but bulb "B" suddenly burned out, what would happen to "A" & "C"?

5. List 3 advantages of arranging multiple appliances "in parallel".

....

....

....

6.
a) What is the difference between "AC" and "DC" electricity?

b) Which type is produced by a:

i) battery? ....

ii) generator? ....

Impacts of Electricity...

Our widespread use of electricity has resulted in some huge benefits to people, and some terrible damage to the environment.

... on Society

The scientific understanding of electricity has led to the invention of thousands of types of electrical appliances, devices and technologies. The impacts of these on humans has been hugely beneficial.

- **Electrical lights, heating, air-con, refrigerators, washers, etc. make our lives more comfortable, easy and convenient.**

- **Electrical tools and machinery save time and make our jobs easier.**

- **Electricity powers our phones and computers and make possible our communications (e.g. TV, internet), financial and trade systems and entertainment.**

<u>Electricity</u>

Has it become a necessary evil?

... on the Environment

While the impacts of electrical technologies on people have been beneficial, the impacts on the natural environment have all been negative.

- **Most electricity is generated from burning coal, which releases huge amounts of CO_2 into the atmosphere.**

We now believe this is a major cause of the "<u>Greenhouse Effect</u>" causing "<u>Global Warming</u>" and climate change.

- **Even "greenhouse-friendly" power production can cause problems:**
  - **Dams for hydro-electricity can destroy ecosystems.**
  - **Wind generator turbines kill thousands of birds every year.**
  - **Nuclear power involves the risk of accidents (e.g. Chernobyl, 1986) and the serious problem of nuclear waste disposal.**

How Society Influences Science

Not only does scientific development have an impact on human society, but the reverse is sometimes true... social factors can influence the development and acceptance of scientific ideas.

Development of Electric Cars

In the early history of motor cars there were several attempts to make and sell electrically powered cars.

At a time when petrol was cheap and people didn't know about environmental damage, the electric cars did not survive commercially because petrol engines were cheap and powerful.

Now, society's attitudes have changed. More people are concerned about environmental damage & climate change.

Although expensive and less powerful, more and more electrically-powered cars (and "hybrids" with petrol engines and batteries) are now being developed and sold. These new technologies are now welcome in our greenhouse-conscious world.

keep it simple science

Topic Test
Electricity

Student Name.. Score = /21

Answer all questions in the spaces provided.

1. (5 marks)
Match each description to an item from the list. To answer, write the letter (A,B,C, etc) of the list item beside the description.

Description	matches with	**List Item**
a) Substance which allows electricity to flow through it.		....
b) Part of an atom with a negative electrical charge.		....
c) A measure of the "push" given by an electrical field.		....
d) A circuit which is "one off, all off".		....
e) A measure of the number of electrons flowing.		....

List Items Not all will be used.
Some may be used more than once.

A. voltage	D. current
B. series	E. conductor
C. electron	F. proton

2. (2 marks)
In an electrical circuit, what happens to the current if:

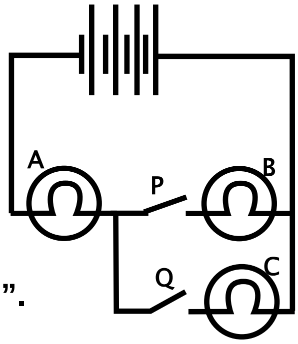
a) the voltage is increased? (same resist.)

b) the resistance is increased? (same V)

3. (4 marks)
a) What do the abbreviations "A.C." and "D.C." stand for?

b) Explain the difference between AC & DC.

4. (5 marks)
The diagram shows an electrical circuit containing 3 lights (A,B,C) and 2 switches (P&Q).



a) Name 2 lights which are arranged "in series".

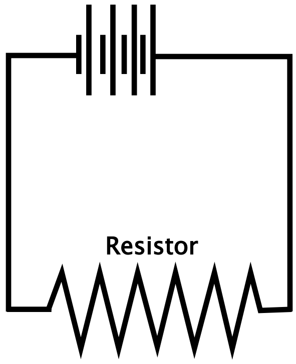
b) Name 2 lights which are "in parallel".

c) Which light(s) would come on if you closed switch "P" only?

d) Which light(s) would come on if you closed switch "Q" only?

e) Which light(s) would come on if you closed both switches "P"&"Q"?

5. (5 marks)
The circuit contains a resistance coil of unknown resistance.



a) Show clearly on the diagram the <u>positions</u> in which you would place an ammeter and voltmeter in order to measure voltage and current for the resistor.

b) Using these meters you obtain readings of 12V and 0.2A.

Use Ohm's Law (I = V/R, so R = V/I) to find the value of the resistance. Show working.

Answer Section

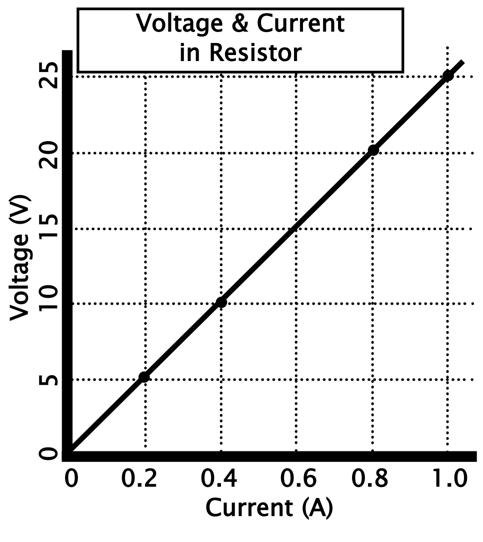
Worksheet 1

a) protons
b) positive
c) electrons
d) negative
e) repel
f) attract
g) electrons
h) transferred
i) positive
j) negative
k) electrons
l) conductors
m) metals
n) Insulators
o) plastic/glass/paper/air
p) conductors
q) field
r) flow / move
s) current
t) voltage

Worksheet 2

a) electrons
b) voltage
c) volt
d) voltmeter
e) current
f) amp / ampere
g) ammeter
h) voltage
i) current
j) resistance
k) less
l) more
m) voltage and current
n) in series / in the main circuit
o) in parallel / in a side branch circuit
p) negative
q) positive

Worksheet 3



Q1. Gradient = $\frac{\text{rise}}{\text{run}}$ = $\frac{25}{1.0}$ = 25

Q2. in table.

Q3. The gradient = voltage/current.
Ohm's Law says R = V / I
Therefore, gradient = resistance.

Voltage (V)	Current (A)	Ohm's Law calculation V/I
5.0	0.2	
10.0	0.4	
20.0	0.8	
25.0	1.0	

Worksheet 4

1.
I = V/R = 6.0/12 = 0.5 A

2.
I = V/R = 240/80 = 3.0 A

3.
I = V/R = 12/80 = 0.15 A

4.
R = V/I = 12/1.5 = 8 Ω

5.
R = V/I = 240/4.0 = 60 Ω

6.
V = IR = 15 x 6.0 = 90 V

Worksheet 5

1.
a) electricity → heat
b) electricity → sound
c) electricity → kinetic energy
d) electricity → kinetic energy
e) electricity → light and heat

2.
a) Power is the amount of energy being converted (per second).
b) voltage and current
c) That some energy is being wasted and not converted into the desired energy.

3.
a) Left-hand diag. is series circuit, parallel on the right.
b) parallel circuit

4.
a) P & S
b) P,Q & R
c) P
d) They would remain on.

5.
1. Max. power to each device.
2. Able to switch on/off independently.
3. If one burns-out, other remain on.

6.
a) DC = steady flow in one direction.
AC = current flows back-and-forth.
b) i) DC ii) AC

Topic Test

1.
a) E b) C c) A d) B e) D

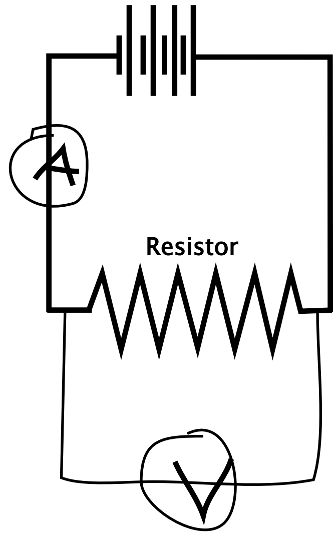
2.
a) current increases.
b) current decreases.

3.
a) AC = Alternating current
DC = Direct current

b) In DC the current flows steadily in one direction. AC oscillates back-and-forth.

4.
a) A&B or A&C
b) B&C
c) A&B
d) A&C
e) A,B&C

5.
a) Ammeter must be in series.
Voltmeter must be in parallel with resistor.



b) R = V/I
= 12 / 0.2
= 60 Ω

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