Ωhm CΩmfΩrts

The Topic of Electricity

June 29

2016

Teachers' Notes for the S1 Electricity Unit at Lockerbie Academy. This is a collection of the documents in the Resources files with a few additions from J A Hargreaves on how she teaches the material. This does not make it fixed that this is the only way to teach. This is the things I have taught the topic over the years. If we follow it to some extent, using the same terms etc. it will give all students a similar experience and give confidence to staff who may feel a little out of their depth with the physics. As usual this is an application and skills led course and it is as important for students to learn practical skills and confidence as they are to learn the content. Please do as little talk and chalk as possible.

Try not to print!

Contents

Prior to the course

Please introduce students to what Physics is. Chemistry and Biology are easier to describe to students than Physics and it is amazing how many still don't have a good concept of what Physics is long after sitting in a Physics class.

What is Physics?

Physics is the scientific study of matter and energy and how they interact with each other. This energy can take the form of motion, light, electricity, radiation, gravity . . . just about anything. Physics deals with matter from sub-atomic particles (i.e. the particles that make up the atom and the particles that make up those particles) to stars and even galaxies.

Or summing up

Physics is the subject that delves (explores) into our wonderfully and beautifully made universe and tries to describe things using laws.

How Physics Works

Experimental Physics

Physics uses the scientific method to formulate and test hypotheses that are based on observation of the natural world. The goal of physics is to use the results of these experiments to formulate scientific laws, usually expressed in the language of mathematics, which can then be used to predict other phenomena.

Theoretical physics

Theoretical physics is the area of physics that is focused on developing these laws, and using them to make new predictions. These predictions from theoretical physicists then create new questions that experimental physicists then develop experiments to test.

Aims of the Course (including SALs)

This is a practical course, which focuses on skills as well as content and knowledge. I am looking for students to confidently be able to visually inspect electrical equipment and have an idea of why an electrical appliance might not work. I am not expecting any student to be handling mains equipment, but it might be possible for them to check wiring and change a fuse. This must come with a health warning that getting it wrong can be fatal and if in doubt to ask. All work must be completed under adult supervision (and an experienced adult!)

SALs

- ✓ *Measuring (current, voltage, length, resistance)*
- ✓ *Observing (effects of static current, effects of series and parallel circuits)*
- ✓ *Taking Readings (Including Using Alba)*
- ✓ *Line Graphs (plot a line graph of length of wire against resistance)*
- ✓ *Literacy Task (The Atom/ Definitions)*
- ✓ *Evaluating Experiments (Measuring I &V in series and parallel)*
- ✓ *Problem Solving (building circuits)*
- ✓ *Designing, Constructing, Testing & Modifying Solutions (fault finding and building circuits) as well as supplementary time to design and build circuits for the doll's house.*

Terms To Avoid- Please!

Please avoid using the following terms wherever possible as it will cause trouble later

Electricity –	***What does this mean? it is more a group term and doesn't explain exactly what you are describing. Use it for titles only and never for anything specific. (Ditto for gravity)***
Current flow	***– a current is a flow, instead try to use the term electron flow, or flow of charge.***
Battery	***– the thing you use eg double A, triple A are cells and not batteries. A battery is a collection of cells.***
Voltage in/ voltage through	***- voltage does not go in, or through. It is a measure of the energy drop per coulomb of charge as it passes around the circuit.***
Current across	***- current is a flow of electrons or charge and it travels through conductors.***

Introduction to the course

This course covers the following outcomes

SCN:2.09, SCN:2.10 SCN:3.09, SCN:3.10a,

Potentially the following could be covered

SCN: 4.09a, SCN: 4.09b, SCN: 4.09c, SCN:4.10a, SCN:4.10b

The development of literacy skills plays an important role in all learning.

LIT 3-01a / LIT 4-01a, LIT 3-02a, LIT 4-02a, LIT 3-04a, LIT 4-04a, LIT 3-05a / LIT 4-05a, LIT 3-06a / LIT 4-06a ,, LIT 3-07a, LIT 4-07a, LIT 3-09a, LIT 4-09a, LIT 2-10a / LIT 3-10a, LIT 4-10a, LIT 3-10a, LIT 3-13a, LIT 4-13a, LIT 3-14a /, LIT 4-14a, LIT 3-15a / LIT 4-15a, LIT 3-16a, LIT 4-16a, LIT 3-21a, , LIT 4-21a, LIT 3-22a / LIT 4-22a, LIT 3-23a, LIT 4-23a, LIT 3-24a, LIT 4-24a, LIT 3-25a, LIT 4-25a, LIT 3-26a / LIT 4-26a, LIT 3-28a, LIT 4-28a, LIT 3-29a, LIT 4-29a

I develop and extend my literacy skills when I have opportunities to:

- *communicate, collaborate and build relationship, ps*
- *reflect on and explain my literacy and thinking skills, using feedback to help me improve and sensitively provide useful feedback for others*
- *engage with and create a wide range of texts in different media, taking advantage of the opportunities offered by ICT*
- *develop my understanding of what is special, vibrant and valuable about my own and other cultures and their languages*
- *explore the richness and diversity of language, how it can affect me, and the wide range of ways in which I and others can be creative*
- *extend and enrich my vocabulary through listening, talking, watching and reading.*

My learning in numeracy enables me to:

- *develop essential numeracy skills which will allow me to participate fully in society*
- *understand that successful independent living requires financial awareness, effective money management, using schedules and other related skills*
- *interpret numerical information appropriately and use it to draw conclusions, assess risk, make reasoned evaluations and informed decisions*
- *apply skills and understanding creatively and logically to solve problems, within a variety of contexts*
- *appreciate how the imaginative and effective use of technologies can enhance the development of skills and concepts.*

MNU 3-01a (NB When they say accuracy I think they mean precision!), MNU 4-01a, MNU 3-03a, , MNU 3-03b,, MNU 4-03a, MNU 3-04a , MNU 3-07a, MNU 3-08a, MNU 3-11a, , MNU 4-11a, MNU 3-20a, , MNU 4-20a, MNU 3-22a

Learning in health and wellbeing ensures that children and young people develop the knowledge and understanding, skills, capabilities and attributes which they need for mental, emotional, social and physical wellbeing now and in the future.

Each establishment, working with partners, should take a holistic approach to promoting health and wellbeing, one that takes account of the stage of growth, development and maturity of each individual, and the social and community context.

I can expect my learning environment to support me to:

- develop my self-awareness, self-worth and respect for others
- meet challenges, manage change and build relationships
- experience personal achievement and build my resilience and confidence
- understand and develop my physical, mental and spiritual wellbeing and social skills
- understand how what I eat, how active I am and how decisions I make about my behaviour and relationships affect my physical and mental wellbeing
- participate in a wide range of activities which promote a healthy lifestyle
- understand that adults in my school community have a responsibility to look after me, listen to my concerns and involve others where necessary
- learn about where to find help and resources to inform choices
- assess and manage risk and understand the impact of risk-taking behaviour
- reflect on my strengths and skills to help me make informed choices when planning my next steps
- acknowledge diversity and understand that it is everyone's responsibility to challenge discrimination.

HWB 0-01a / HWB 1-01a / HWB 2-01a / HWB 3-01a / HWB 4-01a, HWB 0-03a / HWB 1-03a / HWB 2-03a / HWB 3-03a / HWB 4-03a, *HWB 0-04a / HWB 1-04a / HWB 2-04a / HWB 3-04a / HWB 4-04a,* HWB 0-05a / HWB 1-05a / HWB 2-05a / HWB 3-05a / HWB 4-05a, HWB 0-07a / HWB 1-07a / HWB 2-07a / HWB 3-07a / HWB 4-07a, HWB 0-09a / HWB 1-09a / HWB 2-09a / HWB 3-09a / HWB 4-09a, HWB 0-10a / HWB 1-10a / HWB 2-10a / HWB 3-10a / HWB 4-10a, HWB 0-11a / HWB 1-11a / HWB 2-11a / HWB 3-11a / HWB 4-11a, HWB 0-12a / HWB 1-12a / HWB 2-12a / HWB 3-12a / HWB 4-12a, HWB 0-13a / HWB 1-13a / HWB 2-13a / HWB 3-13a / HWB 4-13a, HWB 0-14a / HWB 1-14a / HWB 2-14a / HWB 3-14a / HWB 4-14a, HWB 0-15a / HWB 1-15a / HWB 2-15a / HWB 3-15a / HWB 4-15a, HWB 0-16a / HWB 1-16a / HWB 2-16a / HWB 3-16a / HWB 4-16a, HWB 0-17a / HWB 1-17a / HWB 2-17a / HWB 3-17a / HWB 4-17a, HWB 3-19a, *HWB 2-20a / HWB 3-20a / HWB 4-20a HWB 2-20a / HWB 3-20a / HWB 4-20a, HWB 2-21a / HWB 3-21a, HWB 3-23a, HWB 3-24a, HWB 3-33a, HWB 3-41a / HWB 4-41a*

Ωhm CΩmfΩrts

Teachers INTRO

It would be good to wheel in the doll's house and show the students that this is wired up. If there is time at the end of the course the students can build something for the doll's house (this could be a homework task or to complete after the test)

The students are aiming to be awarded- the Ohm Comforts Official Members Badge, you can find sheets of these for printing in Resources

Ωhm
CΩmfΩrts'
Official Member

There are "particulars" of the Doll's house with the story line that this house is up for sale and when sold a family wants some electricians to check the wiring and improve the electrical appliances in the house. (See Appendix 1 and 2). These are stored in YELLOW folders in the filing cabinet in H208.

There is a note in the root welcoming students as trainee apprentices, again there are copies of these per students.

Homework is a vital part of this course.

STUDENTS SHOULD NOT BE IN CLASS COPYING OUT NOTES, INSTRUCTIONS ETC. THIS SHOULD BE COMPLETED AT HOME AND PRACTICAL SHOULD BE COMPLETED IN THE CLASS. All the work will be up on the website www.mrsphysics.co.uk/bge I give students permission to print out notes at home if required. Sign notes in and out for those students who do not have access to a computer, and a few sets can be printed for ASN students.

This provides a great training for students on the purpose of homework. Any student who hasn't completed homework can be placed in a corner and can write out the work whilst other students are completing the practical. This generally increases students who do homework as they want to be involved in doing the practicals.

NB It is great when students work out the title of the course. I can't take any credit for this it was Andrew Bowles who came up with the name.

I have used headings and broken things into lessons but some will take over a period. I will add this into the commentary.

Student INTRO

Welcome to Ωhm CΩmfΩrts a company set up to provide electrical services to those in and around Lockerbie. We are delighted that following your first Science test you have been accepted on the apprenticeship scheme.

The course is designed to give you a basic insight into electricity and how it can be used in the house. Your apprenticeship will take the following form

1. *A video to show why it is important to be careful around electricity.*
2. *A brief introduction "What is this electricity anyway?"*

3. *A check of building and drawing circuits using symbols.*

4. *Your assessment will be in several parts, one will be fault finding in circuits and one will be producing plans for a circuit plus a written test.*

On successful completion of your apprenticeship you will be invited to join the company and be given responsibility for a project.

LEARNING OUTCOMES FOR ELECTRICITY.

You should know that:

Electrical Safety

1. *Electrical energy can be dangerous.*
2. *Recognise some of the dangers of electrical energy in the home and outside.*

Atoms

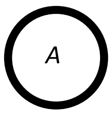
3. *All objects are made up of small particles called atoms.*
4. *Inside each atom there are three small particles called neutrons, protons, and electrons.*
5. *A proton has a positive charge.*
6. *An electron has a negative charge.*
7. *A neutron is uncharged or has a neutral charge.*

How to make Electricity.

8. *Electric charge can be made by rubbing two surfaces together.*
9. *A Van de Graaff generator produces electric charges.*

Electric Current.

10. *When electric charge moves we call it an electric current.*
11. *Current is a flow of charge (or electrons) around a circuit.*
12. *Materials that allow current through them are called electrical conductors.*
13. *Materials that do not allow current through them are called electrical insulators.*
14. *We use the symbol **I** to mean current.*
15. *Current is measured in amperes or amps.*
16. *Current is measured using an ammeter.*
17. *Ammeters are connected in series.*
18. *The symbol for an ammeter is*



19. *For electrons to flow there must be a complete circuit.*
20. *A multimeter can be set up to measure current, resistance or voltage.*
21. *When a multimeter is set up to measure current we call it an ammeter.*

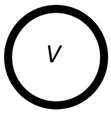
Resistance

22. *Some materials have a high resistance and make it difficult for current to flow.*
23. *A continuity tester can be used to test for conductors and insulators.*

24. *Resistance is a measure of how difficult it is for the charges to move through an object.*
25. *The longer a wire the higher the resistance of the wire.*

Voltage.

26. *For most materials, as you increase the voltage, the current increases.*
27. *Potential difference (p.d.) is often called voltage.*
28. *p.d. is the push that makes the charges move around a circuit.*
29. *Voltage is measured in volts.*
30. *Voltage is measured using a voltmeter, symbol V.*
31. *Voltmeters are connected in parallel.*



Drawing Circuits.

32. *Circuit symbols are used to show how circuits can be built.*
33. *The circuit symbol for a cell, switch, bell, ammeter, voltmeter, lamp, power supply, resistor, wire, connected wire.*
34. *Make sure that you can draw circuits using the proper symbols and following the rules for drawing circuits.*

Series and Parallel Circuits

35. *The two types of circuit are called series and parallel.*
36. *In series circuits the current is the same all around the circuit.*
37. *In parallel circuits the current splits up and some goes down each branch.*
38. *In series circuits the voltage across the components adds up to give the voltage of the supply.*
39. *In parallel circuits the voltage is the same across each branch.*
40. *The current drawn from the supply increases the more components are connected in parallel.*
41. *When lamps are added in parallel the current drawn from the supply increases. This is because the overall resistance of the circuit is reduced.*
42. *I can help to design simple chemical cells and use them to investigate the factors which affect the voltage produced.*

Additional Learning Outcomes

43. *Using experimental evidence, I can place metals in an electrochemical series and can use this information to make predictions about their use in chemical cells. SCN 4-10a*
44. *Using a variety of sources, I have explored the latest developments in chemical cells technology and can evaluate their impact on society. SCN 4-10b*

The Effects of a Current

45. *The flow of electric current through a conductor produces several useful effects, heat, light, magnetism, and chemical effects.*

Ohm's Law-

46. *I can try the Ohms Law task, (a level 4 outcome and there is a sheet provided to help) This could form a Nat 4 or 5 outcome 1. V=IR (Voltage = current multiplied by voltage)*

Ωhm CΩmfΩrts

Note that all resources are now uploaded onto www.mrsphysics.co.uk Please show students how to log on to this website.

LESSON PLANNING- ORDER

Order/ Lesson No.	**Content**	**Homework**	**Resources**
1	*Intro to course (WHAT IS PHYSICS), issue outcomes,* *Intro to Ωhm CΩmfΩrts* *Safety, video*	*ELECTRICTY title page* *The Atom sheet* *Locate the main electrical switch to turn off all electricity to the house. This is a red large switch.*	*http://dingo.care2.com/cards/flash/5409/galaxy.swf* *(NB this contains a rude word. Please warn the students and cough loudly at the end) https://www.youtube.com/watch?v=p_o4aY7xkXg* *http://htwins.net/scale2/?bordercolor=white* Doll's House, with wiring, particulars sheet *Atom sheet- This has been uploaded as a pdf file onto my website and students can view and download at home. www.mrsphysics.co.uk Give copies for those who don't have computer access.* *http://www.twothirtyvolts.org.uk/electrical-safety/around-your-home/* *http://www.classtools.net/education-games-php/timer/*
2+ 3	*Go through atom homework.* *Static, what is static, experiments including the VdG*	*Locate the mains switch in your home* *write up the experiment, mainly as pictures with small amount of text..*	*Static experiments sheets.* *http://www.kasuku.ch/pdf/monde_etrange_atomes/EN_amazing_world_atoms.pdf* *Order electrostatics tray (rods, watchglasses, salt and pepper mixed, loo roll cloths etc)*

Order/ Lesson No.	Content	Homework	Resources
4	What is a circuit? Testing for conduction starting with a torch lamp (or go from what is a circuit to why draw circuit symbols)	Draw Symbols and Circuits	Build a circuit with one lamp (2.5V), 1 cell and 1 wire only. Add in holders, add in switch, Equipment: Lamps, cells, leads, switches. If possible get a box of cells rather than removing them from holders which wrecks the springs. Starting Science Book 1 pp 85+ (if required) Marbles (all the same size) Circuit symbol sheet. (website)
5	Conductors & insulator		Tray of conductors and insulators. Cells lamps, leads and switches. SAFETY Do not allow students to go near sockets or electrical appliances
6	Current Voltage & Resistance (written exercise + quiz, terms and words)	Learn 16 words and definitions in word list	Definition and word boards . NB Do NOT give the lower ability students the definitions on the cards, this is a much harder task. For most students add the word on a card to the definition on the board. Activinspire definition sheet, white boards if required.
7+ 8	Meters (effect on resistance and current of long wires)		Meter table (showing ammeter, voltmeter and ohmmeter) Meter sheet showing the connections. Both of these can be cut out and stuck in. Conductors and insulators tray can be used as previous.

Order/ Lesson No.	Content	Homework	Resources
8,9	*Building Circuits briefly introduce series and parallel*	*Meters*	*Laminated fault finding cards, one per group for checking their circuits.* *ppp of Building circuits for if you want to keep students together, or better still give them the small printed sheets with the 7 circuit descriptions on.* *3 xLamps 2 x switches 7x leads 2 x cells (per group) + spares*
9,10	*Explanation of series and parallel from the model*	*Review Definitions start revision*	*Flipchart paper, or board.*
11	*Measuring Current and Voltage in series and parallel*	*Electrical Dominoes* *Revision*	*A4 electrical dominoes sheets. (in the yellow filing cabinet)*
12	*Fault finding*	*Revision*	*11 fault finding boards and repair kits (please check in and out at the end of each lesson), fault finding laminated sheets, multimeters*
13	*Fruity Batteries*	*Students can try to bring in some fruit or veg before this lesson and have some in reserve*	*Fruit and veg, different metals as electrodes, croc clips, leads.*
14	*Assessment* *Introduction to the Dolls House*	*Give students opportunity to build something for the doll's house (do not move, or change anything already there), things created include a bbq, fridge, revolving microwave, door bell.*	*Tests in H208 (please return after use)*
15	*Go through test + start design and make or Ohm's Law*	*Plan for the design and make*	*For Ohm's Law, ceramic mounted resistors, leads, power supplies and 2 multimeters per group*

Order/ Lesson No.	Content	Homework	Resources
16+	Students design and make		Motors, wires, cells, potentiometers you might want to look at the electronic boards etc.

LESSON 1-What is Physics?

AIM of LESSON 1

1. *I have an understanding of the subject of Physics*
2. *I know the types of topics that make up Physics*
3. *I understand I am responsible for my learning.*

- ***Express views***
- ***Present an argument***
- ***Hypothesising***
- ***Literacy Task (homework)***

Introduction- This may well take up to 1 lessons

Task 1 for students

1) Write the homework in your jotters

ELECTRICITY TITLE PAGE complete for next period

The Atom Sheet: Give one week's notice to complete this. The answers are in the sheet (literacy task)

Task 2 for students

2) What is Physics?

Brainstorm- draw a bubble in books students write what they think Physics is. See how many of them fail to write the word ELECTRICITY (not very thoughtful, why would I give them homework if it is not relevant).

Task 3 Teacher Questioning

Drop a pen and ask why it falls, most will say it is gravity but ask them what that is? (I am sure I did a video for this last year but it will be rubbish as I am not an actor!). Get them to talk to their parents about it. Most will not have a clue or will say it is because the Earth sucks or spins. The real reason is because of its mass. Anything that has mass attracts other things so everyone in this room is attractive- ask what the difference is between us and the Earth, Earth more massive. If we were as massive as the Earth we would pull things towards us which could be embarrassing for us all especially if we were bending down.

https://www.youtube.com/watch?v=p_o4aY7xkXq (only for the brave)

Do we feel like we are moving? No, well how do we have day and night? Earth is spinning? Which way? Sun rises in East and sets in the west so we must be turning anticlockwise as we stand. That means we are going pretty quickly.

Circumference/24 hours= speed in miles per hour

$$\pi d/24$$

$$3.14 \times 7,918/24 = \text{approx. } 1000 \text{ mph}$$

Obviously we are travelling slower than that? Why? Less distance *http://dingo.care2.com/cards/flash/5409/galaxy.swf*

http://htwins.net/scale2/?bordercolor=white

Plenty of other discussion ideas just ask me about some or make some up.

Also can students stick a bit of tin foil on the front of their jotters with a label "This person is responsible for your learning". This came from an idea I had whilst at CX, where the mirrors in the bathroom said this person is responsible for your safety. Students can't and shouldn't blame anyone else for their failure to learn.

Task 4 Student task, uses of electricity

This is a really interesting task to find out about your students. It is amazing what they can learn. I tend to tell them that I will adopt one of them if they pass the test. Ask the students to write down 30 uses of electrical current. Time with classroom tools.

http://www.classtools.net/education-games-php/timer/

You'll get farmers choosing milling machines, some picking hair driers, all picking mobiles and computers and occasionally you'll get one student in a class that record such things as irons, washing machines and tumble driers! They pass the test. It gives a good indication of who is spending what time on their computers and square boxes.

LESSON 2 + 3- Safety & Static current

AIM for LESSON 2

1. *I know that using electrical items can be dangerous.*
2. *I know how to be safe with electrical items*
3. *I can recognise some of the dangers of electricity in the home and outside.*
4. *I know how to generate static electricity*
5. *I know that electrical charge can be made by rubbing two surfaces together.*
6. *I know that a Van de Graff Generator produces electric charges.*

S A L

- *Risk Assessment*

Lesson 2 + 3. This may take at least 2 periods but can be started period 1

This lesson, which may take between 1 and 2 periods covers Safety of Electrical energy and generating static electricity in the lab. It carries on nicely from the last lesson, so if you are really short of ideas you can ask them about safety. If students have a clear idea that static and current are the same thing, just one is flowing and the other isn't it goes some way to clearing up the problems that arise later, that electricity is really energy carrying electrons.

Possible breakdown of time depending on when you see students

1. *Safety + VdG lesson 2. Review Atom homework + Static Experiments*
2. *Safety + review of atom homework lesson 2: Static Experiments then VdG*

What is "Electricity" and why we shouldn't use that word

The term electricity can mean so many things it is not a very scientific word so is best avoided. We usually use it to mean electrical energy or electrical current but can be used to describe voltage . As we cannot be sure what you mean by the term we will use it only for the title of the block and not for any other context. I play BUZZ where if I use the term in the wrong context students can buzz to remind us all that it isn't appropriate- usually works well, or use the term "Electricity Topic"

Electrical safety videos

It is vital before students start that they have a good healthy respect for the topic of electricity (!). We don't want students terrified but we do need to get over the point of the damage that can be caused if things go wrong or if it is not treated sensibly.

We will not have time to watch ELECTRICAL GRAFFITI but we might do a few lunchtime viewings. We should be able to see some clips of electrical safety but there are other good ones on the web. If you don't get to see all of these in the class try viewing some at home, but DO NOT TRY ANY OF THE STUNTS AT HOME- THEY COULD KILL!

Here are a few I have selected, some are American so the plugs might look different but still the same rules apply.

1. http://www.twothirtyvolts.org.uk/electrical-safety/around-your-home/

   (use this in the first instance)

2. http://www.esc.org.uk/
3. http://video.google.co.uk/videosearch?hl=en&q=electrical%20safety&cr=countryUK%7CcountryGB&um=1&ie=UTF-8&sa=N&tab=wv#
4. http://www.youtube.com/watch?v=l-wXyw0tvSA
5. http://www.veoh.com/browse/videos/category/educational_and_howto/watch/v18592895eRqz2Net
6. http://www.youtube.com/watch?v=ay_Wzyec36A&feature=player_embedded#
7. http://www.youtube.com/watch?v=PvPmuReff6U
8. http://www.youtube.com/watch?v=rTbBqGFdJF4
9. http://www.break.com/usercontent/2008/11/The-Electrical-Safety-Foundation-International-Launches-607009.html
10. http://www.5min.com/Video/Learn-About-Electrical-Safety-61996853
11. http://www.metacafe.com/watch/2031644/electrical_safety_foundation_international_warns_consumers_about_the_dangers_of_counterfeit_electrical_products/
12. http://video.google.co.uk/videosearch?hl=en&q=electrical%20safety&cr=countryUK%7CcountryGB&um=1&ie=UTF-8&sa=N&tab=wv#
13. http://www.escweb.org.uk/news-and-events/latest-news/View-Our-Television-Advert-id-31.html
14. http://www.youtube.com/watch?v=CYhILq1naZo

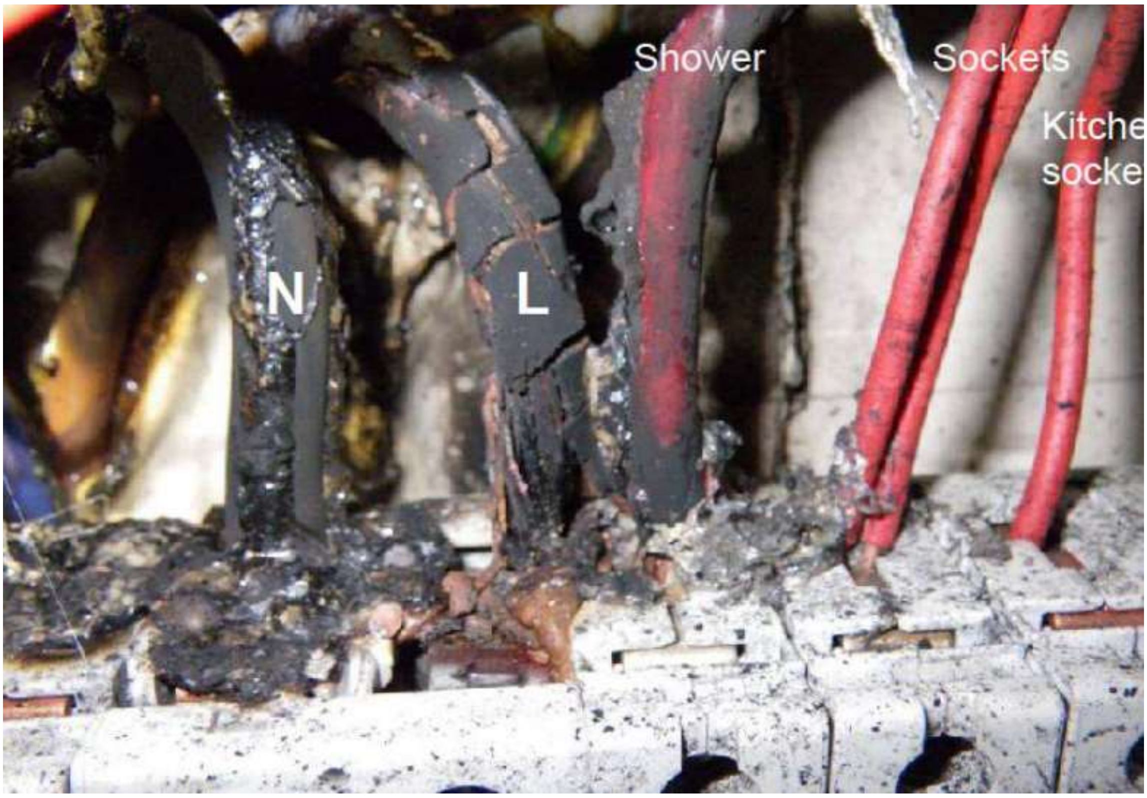
Important safety points

1. *Do not mess around with "electricity". It can be fatal.*
2. *Main Dangers of electricity*
    a. *Electric shock and burns from contact with electricity*
    b. *Exposure to electrical arcing*
    c. *Fire from faulty electrical equipment or installations*
    d. *Explosion due to electrical equipment or static electricity igniting flammable vapours or dusts*
3. *All wiring should be inspected to make sure the wires are not frayed*
4. *Never put things into sockets, metal or otherwise, only fully compliant insulated plugs.*
5. *Never put electrical items in damp places (it is illegal to have 13A sockets in the bathroom, and other sockets should be isolated from people, eg shower switches are generally pull cords, etc)*
6. *Don't overload sockets, this can cause a fire. The maximum load in one socket should be 3000 W. Students can check this by looking at the rating plate on their appliances. If the total in one socket is more than this value then something must be removed.*
7. *Items that produce heat use more electrical energy ever second.*
8. *Don't put items in the toaster to eject toast.*
9. *Outside stay away from sub stations, pylons and other electrical equipment. Much of it is high voltage and can kill.*
10. *Please note it is the current that kills rather than the voltage across a person. Usually a high potential difference will cause a high current but this is not always the case. For example you may get a p.d. of 1000 V across the VdG but the current is miniscule so should not cause harm.*

I tell the story of a young woman who had a baby in the buggy. She came home after shopping to find her kitchen flooded from the washing machine. I ask the students what they should do. Most say switch off the electricity and I say this is above the washing machine; is this OK? What happened was the young lady walked through the water to switch the electricity off and was electrocuted. Her 18 month old called the alarm from the screams. The lady ought to have switched off the electricity at the MAIN ELECTICITY box. If this wasn't accessible they should ring the electricity company and ask for it to be disconnected as an emergency. Wearing wellies, is too risky and should not be attempted.

Contact with Live Parts can result in:

- *Shock leading to cardiac arrest and death (electrocution)*
- *Non-fatal shock can cause other injuries*
- *Current through the body can cause deep burns*
- *Current through the body will depend upon the voltage & resistance of the circuit, including body resistance*



See ROSPA. For details
http://www.rospa.com

The Atom

If this is the following day for the atom and students have not had time to complete this task then do conductors and insulators lesson first and then come back to statics. Remember, any student who hasn't completed homework should so this as students are doing the practical work.

Go over the homework for the atom and make sure that students have an understanding of the atom and that it contains several parts. They should be aware that diagrams of the atom are never to scale. I was told that if the atom was a football field the nucleus would be the size of a pea. (It is a good idea to ask them what they think the size would be, eg, goal, centre circle, whole midsection, football etc)

*ATOMS make up all materials. There are 3 parts to atoms. They are called neutrons, protons & electrons. The protons are positively charged. The electrons are negatively charged and the neutrons have no charge **or neutral**. The centre of the atom is called the nucleus . This contains the protons and neutrons . The electrons move round the centre of the atom. It is the electrons that can be removed from the atom and make electricity . Atoms usually have 0 charge and are called neutral because the number of protons in the nucleus is equal to the number of electrons in the orbits. However, rubbing one object on a different object can remove electrons from atoms. When the electrons are "stolen" and made to move we have an electric current. We sometimes call these electrons charges because they have a negative charge.*

Naff Joke

A neutron goes into a pub and asks for a pint and asks the landlord how much it will cost. The landlord replies, for you "no charge!"

For the bright students you might want to tell them that Atom means indivisible as people originally thought this was the smallest thing there was. Then we discovered protons and electrons and thought they were the smallest thing there is, now we've found quarks, so who knows where we'll end up!- bright students could research this. CERN do some great teaching resources.

To be consistent across the Sciences, it has been requested we use the term neutral as it fits with remembering the term neutron. A particle can be <u>neutral</u> or have <u>no charge</u> it cannot be neutrally charged. Please make sure they understand this term. We will all use this term..

How to generate static electricity in the lab

There are a range of experiments that can be completed to generate static current or charge. When we rub too different materials electrons can be ripped off one of the materials and be stored on the other material. If the material is an insulator then those electrons will remain on the material. If they are a conductor they will move through the material and it will not remain charged. Cashmere and fluffy jumpers charge the best.

Usually polythene charges up negatively, acetate positively. Acetate never charges as well as the polythene. Charging is most effective if it is in one direction and gripped hard, along the elbow.

Electricity Types

Background information Static and Current Electricity

NOTE: If you attempt to do any experiments which involve electrical energy – NEVER use the current from the mains. It is very powerful and very dangerous. You should only use cells for electrical experiments., unless told by your teacher.

There are two types of electricity:

1.) <u>Current Electricity</u> – is caused by tiny invisible things called electrons that move through metal. This flow is called an electric current. Objects that need current electricity (moving electricity) are powered by batteries or by electricity which travels along wires from a power station. The circuit is completed by a switch, which turns the appliance on. When the switch is turned off, the circuit is broken and the appliance is turned off, no electrons flow around the circuit.

Many objects that we use every day are powered by electricity – from computers and hairdryers to lamps and washing machines.

2.) <u>Static Electricity</u> - this type of electricity stays in one place. Static electricity is produced when some materials are rubbed together. Static electricity is the result of an imbalance between negative and positive charges in an object. These charges can build up on the surface of an object until they find a way to be released or discharged. One way to discharge them is through a circuit.

<u>How does static electricity work?</u> Static electricity happens when there is an imbalance between negative and positive charges in objects. It causes crackles when you comb your hair and makes dust stick to television screens. Static electricity experiments work best on a dry day.

<u>Lightning</u> is caused by a natural build-up of static electricity in clouds. The lightning strike is just a giant spark of electricity.

Have you ever walked across the room to pet your dog, but got a shock instead?

The rubbing of certain materials against one another can transfer negative charges or electrons. For example, if you rub your shoe on the carpet, your body collects extra electrons. The electrons cling to your body until they can be released. As you reach and touch your furry friend, you get a shock. Don't worry; it is only the surplus electrons being released from you to your unsuspecting pet.

Have you ever taken your hat off on a dry winter's day and had a "hair raising" experience?

As you remove your hat from your head, electrons are transferred from the hat to your hair, creating and re-arranging your interesting hairdo. Remember, objects with the same charge repel each other. Because they have the same charge, your hair will stand on end. Your hairs are simply trying to get as far away from each other as possible. Combs attract bits of paper. Clothing "clings" to your body because of static electricity.

Have you ever made a balloon cling on to a wall after rubbing it against your clothes?

When you rub a balloon against your clothes and it sticks to the wall, you are adding a surplus of electrons (negative charges) to the surface of the balloon. The wall is now more positively charged than the balloon. As the two come in contact, the balloon will stick because of the rule that opposites attract (positive to negative).

All physical objects are made up of atoms. Inside an atom are protons, electrons and neutrons. The protons are positively charged, the electrons are negatively charged, and the neutrons are neutral. Therefore, all things are made up of charges. Opposite charges attract each other (negative to positive). Like charges repel each other (positive to positive or negative to negative). Most of the time positive and negative charges are balanced in an object, which makes that object neutral.

For each of the following experiments that you try draw a diagram or diagrams to show what you did and write a conclusion explaining your observations

Static electricity experiments

1. Stuck on You A sticky experiment!

<u>Materials you will need</u>:

• A Balloon

• Strong Lungs

• A Woollen or Nylon Sweater (Jumper)

Steps:

1. *Blow up the balloon and tie the end so that the air does not escape.*
2. *Take the balloon and rub it vigorously against your jumper/sweater or your head of hairs about ten times.*
3. *Now hold the balloon against your jumper/sweater or hairs for a minute.*
4. *Let go of the balloon. What happens? Does it stick?*

When a balloon and a jumper/sweater or hairs are rubbed together; each will gain a different type of electrical charge. The balloon becomes a negative charge and the jumper/sweater or hairs becomes a positive charge. Opposite charges attract each other.

2. Bending Water Experiment

Materials you will need:

- ✓ *A Plastic Comb or rod*
- ✓ *Woollen Jumper or cloths*
- ✓ *Running Tap (Water)*

This is a cool experiment!

Steps:

1. *Rub the plastic comb against your jumper or comb through your hair around ten times.*
2. *Turn the tap on so that it has a slow, steady stream of water.*
3. *Place the comb close to the water (don't let the comb touch the water).*

3. Resisting Balloons

Materials you will need:

- ✓ *Tape*
- ✓ *Scissors*
- ✓ *Door Frame*
- ✓ *Two Balloons*
- ✓ *String/Thread*
- ✓ *A Woollen Sweater/Jumper*

Steps:

1. *Cut two equal lengths of thread/string and tape them to the top of a door frame in the middle about 1 inch or 2.5 cm apart.*
2. *Blow up the balloons and tie each end so that the air does not escape.*
3. *Tie each of the blown up balloons to the end of each thread/string so that they are hanging at the same height and are resting next to each other.*
4. *Rub each of the balloons with the woolly jumper/sweater to charge them (one at a time).*
5. *What happens when you let them go? How do they react to each other?*

Both of the balloons have become negatively charged once they have been rubbed with the woollen jumper/sweater and will push each other away. Items that are made up of the same material will always take on the same charge. If you have a matching charge of static electricity in like items, they will repel each other just like the same poles of magnets will repel each other.

Try to bring the two balloons together after they have been rubbed with the woollen sweater/jumper. What happens when you try to bring the balloons together?

Place your hands in between the two balloons, does something different happen?

4a. Rising Tissue Paper

This is a fun experiment to watch as the tissue paper is pulled up by the charged comb/pen.

Materials you will need:

- *Scissors*
- *Tissue Paper*
- *Woollen Jumper/Sweater*
- *A Plastic Comb/Pen*

Steps:

1. *Cut up some small pieces of tissue paper.*
2. *Charge up the comb/pen by rubbing it against a jumper/sweater or combing through your hair about ten times.*
3. *Hold the comb/pen over the small pieces of tissue paper.*

4b. Rising Tissue Paper

Materials you will need:

- *Ruler*
- *Tiny pieces of colourful tissue paper*
- *Several objects available that you can rub the ruler with that will prevent it from picking up the tissue paper (paper, metal, water)*
- *Several objects that will enable you to pick up the tissue paper (fake fur, silk)*

Steps:

1. *Ask the students if they think you can pick-up the tissue paper with the ruler.*
2. *Try to pick up the pieces of paper with a ruler that has not been charged.*
3. *Next, ask the students if they can think of what you could do to the ruler to enable it to pick up the pieces of paper.*
4. *Use the materials listed above to try to demonstrate to the students what materials will charge the ruler and which ones won't.*

Note: You must neutralize the ruler each time before you rub the ruler with a new object. You can neutralize it by rubbing on your shirt or wetting it with water.

5. Charged or Not Charged Balloons

Materials you will need:

·Tape
·Scissors
·Two Balloons
·String/Thread
·A Woollen or Nylon Sweater (Jumper)

Steps:

1. Inflate both balloons so they are the same size. Tie a knot in the neck of each balloon so that the air does not escape.
2. Tie one end of the string to one of the balloons.
3. Using tape, secure the free end of the string to the edge of a table.
4. Charge the second balloon by rubbing it with the wool scarf.
5. Hold the charged balloon near, but not touching the hanging balloon.
6. Observe the motion of the hanging balloon.

Before rubbing, like all materials, the balloons and the wool scarf have are neutral. This is because they each have an equal number of positively charged subatomic particles (protons) and negatively charged subatomic particles (electrons).

When you rub the second balloon with the wool scarf, electrons are transferred from the wool to the rubber because of differences in the attraction of the two materials for electrons. The balloon becomes negatively charged because it gains electrons from the wool, and the wool becomes negatively charged because it gains electrons from the wool, and the wool becomes positively charged because it loses electrons.

When the negatively charged balloon is brought near the neutrally charged hanging balloon, the electrons on the surface of the hanging balloon move away because like charges repel. This leaves the surface facing the charged balloon more positive. Since opposite charges attract, the positive charge on the surface of the hanging balloon is attracted to the negative charge on the hand-held balloon. This attraction is strong enough to move the hanging balloon.

6. Charging up a Lamp

Materials you will need:

- A Dark Room
- Fluorescent Neon Light Bulb (it works best when put on your knee!)
- A Comb/Woollen Scarf

Steps:

1. Go into a dark room with the light bulb and the comb (woollen scarf).
2. Run the comb through your hair around 20 times. You could rub the comb over a woollen scarf for the same effects.
3. Place the comb on the metal end of the light bulb and watch as the filament in the bulb lights up.

The friction between your hair and the comb causes electrons to travel from your hair to the comb. This causes your body to become positively charged and the comb becomes negatively charged. With the comb being charged, it discharges into the light bulb causing the bulb to emit the small pulses of light.

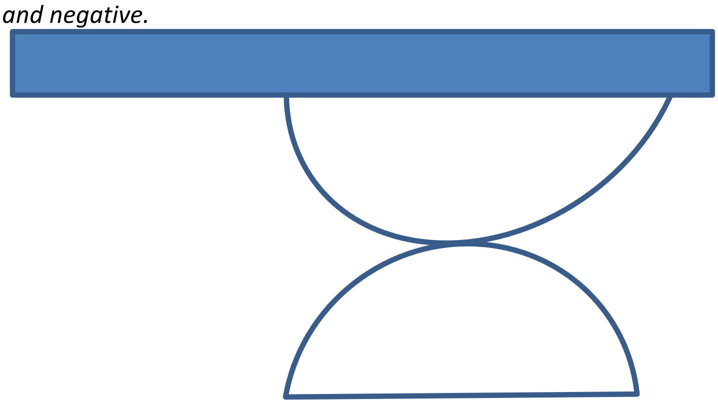
7. Two Charges

Place one watch glass upside down on top of another one. The top one should be free to rotate. It can be achieved with one, but it is not usually as effective

Charge a rod with a cloth and carefully place it onto the watchglass leaving one side overhanging. DO NOT touch the rod as it is placed on the watchglass as it will discharge.

Charge another rod and bring it close to the charged rod (do not touch it)

Depending on the charge of the rod the other rod should rotate towards or away from the rod. Try similar and opposite rods. Always use the same cloth to rub each of the roads. This shows that there are two types of charge original with the names – positive and negative.



8. Separating Salt and Pepper

Materials you will need:

- *One teaspoon of Pepper*
- *One teaspoon of Salt*
- *A piece of Wool or Fake Fur*
- *Plastic petri dish or Sheet of Paper and a Clear plastic ruler*

Steps

Using a Sheet of Paper

1. *Have the students measure out one teaspoon full of salt and one teaspoon full of pepper onto the sheet of paper.*
2. *Use a pencil's eraser top or pen top to mix the salt and pepper together.*
3. *Have the students take the plastic ruler/rod and rub it with the wool/fake fur.*
4. *Approach the pepper with the ruler/rod from above slowly. The pepper will begin to jump onto the ruler. As you get closer to the mixture, the salt will eventually begin to jump to the ruler. The pepper will jump to the ruler/rod and stick.*

Using a Petri Dish

1. *Have the students measure out one teaspoon full of salt and one teaspoon full of pepper into the petri dish.*
2. *Place the cover on the petri dish and mix well by gently swirling.*
3. *Have the students rub the top of the petri dish with the fur. Turn the petri dish over for a few seconds and then turn it back to the original position. The pepper should stick to the top of the petri dish.*

The uncharged pepper particles were attracted to the petri dish or ruler as opposite charges were induced in the pepper. Since pepper is lighter than salt, it takes less effort for pepper to overcome the force of gravity.

Rubbing the plastic surface with the fur/wool caused the plastic surface to become charged with static electricity. (There was an excess of electrons left on the plastic from the fur/wool).

Since pepper is lighter than salt, it takes less effort for pepper to overcome the force of gravity.

You can place both the salt and pepper into water. The pepper will float and the salt will sink. You can skim the top of the water and remove the pepper.

Using the stencil allowed rubbing the petri dish lid at certain confined areas. Only those areas that were touched with the fur/wool were charged.

8b. Stencilling in Salt and Pepper

Extensions

If using a petri dish, you can expand on this lab.

Steps:

1. *Place the salt and pepper back in the bag and clean the petri dish.*
2. *Start with a clean, dry petri dish.*
3. *Next, let add a pinch of pepper to the petri dish.*

4. Place the lid back on the petri dish.

5. Take a piece of paper and cut it the same size as the lid to the petri dish.

6. Once this is done, have them cut out a stencil from this paper.

7. Next, hold the stencil on the lid and rub the open area (the cut-out area) with the fur.

8. Remove the stencil and turn the petri dish over for a few seconds and turn it back over again to the original position.

9. You should see their stencil of pepper sticking to the cover.

Don't even try to try all these experiments. If you feel brave this is best done as a circus.

9.Charging cornflakes , charging balloons

- ✓ Cornflakes, suspended on thread
- ✓ Balloon
- ✓ Clamp stand, bosshead and clamp

Rub the balloon on your hair or a cloth, bring it towards a hanging cornflake and see what happens.

Then suspend two balloons on thin threads and hang from clamps, be sure the metal clamps are as far from the balloons as possible (maybe clamp two metres sticks etc)

Rub the balloons on your hair and gently release then without touching the part that you rubbed. The balloons should repel.

Alternative Teacher Led demonstrations

1. **Try to stick a rubber balloon on the ceiling or wall after you have put electric charges (remember that charges are positive or negative parts of an atom) on it.**
2. **Now answer the questions in your jotter.**
   a. What do you think affects the length of time the balloon sticks to the wall?
   b. Explain how you put electric charge onto the balloon.

3. **Use a plastic comb, ruler or rod to pick up some small pieces of paper.**
4. **Now answer the questions in your jotter.**
   a. Can you make the comb pick up more paper?
   b. If you could pick up more paper explain how you did it.

5. **Describe what happens when an electrically charged plastic pen is held near a thin stream of water.**
6. **Rub a balloon on your jersey and try to make your hair stand on end.**
7. **Now answer the questions in your jotter.**
   a. Can you give a reason for why this happens?
   b. Does your hair standing up depend on whether you have rubbed the balloon?
   c. Is your hair being pulled towards the balloon or away from it?

8. **If you have time or are waiting for apparatus complete the following task in your jotter. Read and answer the questions on page 84 of Starting Science Book 1.**
9. **The following task must be completed with your teacher. Read the following paragraph and then copy and complete the summary to check that you have understood the work.**

10. When you rubbed the rod against a cloth or your jumper some of the outer electrons from the materials were 'stolen' by the rod. This means that the rod has less electrons and so is negatively charged. The material has lost some

electrons and so is positively charged The material and the rod are likely to remain like this for some time. This is because the materials from which they are made do not allow charges to move or escape.

Van Der Graaff

NB There is an instruction sheet that the students will be able to download explaining how they can make their own VdG generator. It has been checked by Gregor Steele. No one has made one yet.

http://practicalphysics.org/van-de-graaff-generator-basics.html

http://practicalphysics.org/Van_de_Graaff_generator_apparatus.htm

Van de Graaff generator safety

Van de Graaff generator demonstrations can provide useful insights into electrical phenomena, which are at the same time memorable.

- *It is essential the Van de Graaff generators for school science are obtained through reputable school science equipment suppliers. The electrostatic energy stored by the sphere should not exceed 0.5 J.*
- *Do not add devices to the sphere that increase the capacitance.*
- *Van de Graaff generators with mains powered pulleys must be electrically inspected and tested in the same way as other mains powered equipment.*
- *When carrying out the hair-standing-on-end demonstration, do it with one person at a time. After the demonstration, to avoid a sudden discharge, the person should take their hand off the sphere and touch the surface of a wood bench top (avoiding metal fittings such as gas taps). Alternatively, hand the charged person a wooden metre rule. After a few moments, they will be discharged.*
- ***It is not advisable for people to participate in practical work with Van de Graaff generators if they have heart conditions, or a pacemaker, or other electronic medical equipment fitted.*** *Neither should they participate if they have epilepsy. YOU MUST ASK AND CHECK AT THE START OF EVERY LESSON.*
- *The electrical discharge from a Van de Graaff generator can wreck electronic circuits, so equipment such as computers and instrumentation with electronic circuits should be kept well away.*

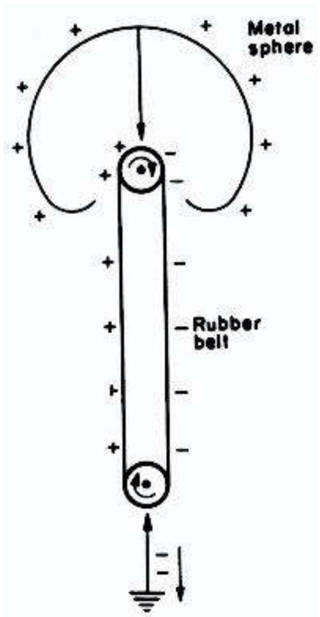
The Van de Graaff generators designed for schools are usually the triboelectric type – these are the most suitable. The transfer of charge is achieved by a rubber belt driven by a plastic pulley, with an arrangement of metal combs at either end of the belt. Charge is transferred to a metal sphere – a capacitor – and very high voltages are achieved between the sphere and ground, typically in the range 200 kV to 300 kV.

Using a Van de Graaff generator, one is quite likely to receive a short shock by accidental or intentional contact with the charged dome. An enquiry to CLEAPSS has revealed no recorded incident of direct injury caused by shocks from the correct use of school Van de Graaff generators. However, some people are more sensitive than others and can find the shocks very unpleasant and painful. For this reason, only volunteers should take direct part in the practical work.

The shock is a single unidirectional pulse of short duration - The current flowing and energy transferred should be well below that which could cause any risk of ventricular fibrillation.

Generally speaking, sphere diameters of Van de Graaff generators should be about 20 cm or less.

Van de Graaff generator - the basics and the background (skip if you don't find this hair raising!)



PRINCIPLE OF OPERATION

Some insulating materials when separated from the surface of others, leave those surfaces electrically charged, each with the opposite sign of charge and with a high potential difference (p.d.).

A machine to make charges was invented in 1929 by a young American called Van de Graaff. Huge machines, some over 30 m high, based on his ideas have been built to produce extremely high potential differences.

BELTS AND ROLLERS

A flexible belt made from an insulating material and running continuously over two rollers can, by the same process, produce a supply of charge where the surfaces separate. The two rollers have to have different surfaces (often acrylic and metal) and together with the belt-rubber, are chosen by experiment.

COMBS

Charges are "sprayed" on to and removed from the moving belt by "combs" situated adjacent to the rollers. Actual contact between the combs and the belt is not essential because of the high potential differences. Combs can be simply a stretched wire, or a sharp or serrated edge: action depends on very high potential gradients due to their small radii (similar action to lightning conductors).

The lower comb is maintained at or close to earth potential and is a drain for negative charge, leaving the belt with positive charges that are carried up to the top comb.

COLLECTING SPHERE

The top comb is connected to a collecting sphere which, having inherent electrical capacity (proportional to its radius) will collect and store the charge on its outer surface until discharged either by breakdown of the surrounding air as a spark, or by conduction to an adjacent earthed object.

CHARGING CURRENT

So long as the belt continues to move, the process continues, the drive (motor or manual) supplying the power to overcome the electrical repulsion between the charges collected on the sphere and those arriving on the belt.
The charging current is usually a few mA and potential difference achieved by "junior generators" will be 100-150 kV and by "senior" generators up to about 300 kV.

THE WHOLE APPARATUS

The mechanical arrangement of the belt/roller system is very simple. The lower roller is driven either manually or by motor. The motors, control switches and mains input socket are housed in a metal or plastic enclosure, although some junior models have used a transparent plastic cake-cover.

The support column for the collecting sphere can be a simple PVC plastic rod or acrylic tube or a pair of acrylic strips with separators. In some models the belt is enclosed within a plastic pipe with "windows" along its length. Not all generators have means of adjusting the separation of the upper and lower rollers i.e. the belts have to be tailored for a particular machine.

Since the diameter of the collecting sphere determines the maximum p.d. (voltage) achievable, large spheres are mounted on taller columns to be more remote from the earth motor and control box.

Machines are usually supplied with a "discharger", often another, smaller, sphere mounted on a metal rod that has to be earthed to draw sparks from the collecting sphere.

Demonstrations and accessories

Certainly the Van de Graaff generator can produce striking demonstrations. The usual experiments are:

***Faraday's cylinder** to show electric charge resides on the outer surface of a charged hollow conductor.*

***Bouncing ball** Suspend a conducting ball a non-conducting thread. When the ball touches the charging sphere, it will become charged and be repelled away from the sphere. If the ball is then allowed to discharge (touching an earthed surface, or leaking charge to the air) it will be attracted once more to the sphere, to be recharged ... and so the process continues.*

***The head of hair** is another demonstration of repulsion. Real hair or shredded paper strips bunched at one end are used and provide a sensitive means of detecting charge.*

An apparatus note on the Van de Graaff generator gives information about good housekeeping and repairs.

Van De Graaff Demonstrations

Students must not complete the experiments if they are epileptic, have a heart murmur or if they're a chicken.

NB Do not let the students push DOWN on the dome. This breaks the mechanism. The students only have to be lightly touching the VdG for it to conduct. It is not necessary for students to remove anything. It is best for students to put their hands on the lower sides of the dome than on the top, this prevents the pressure on the belt. Providing contact is made with the VdG and the student is insulated then they should become charged.

The best hair for charging is fine dry hair. It doesn't work as well with greasy or thick hair.

Demos are not usually very good on humid or damp days as the VdG discharges into the air.

It is usually best to complete this at the end of the lesson, as the students usually get quite excitable. If not have it at the very start and then move on to something else fun after a quiet time.

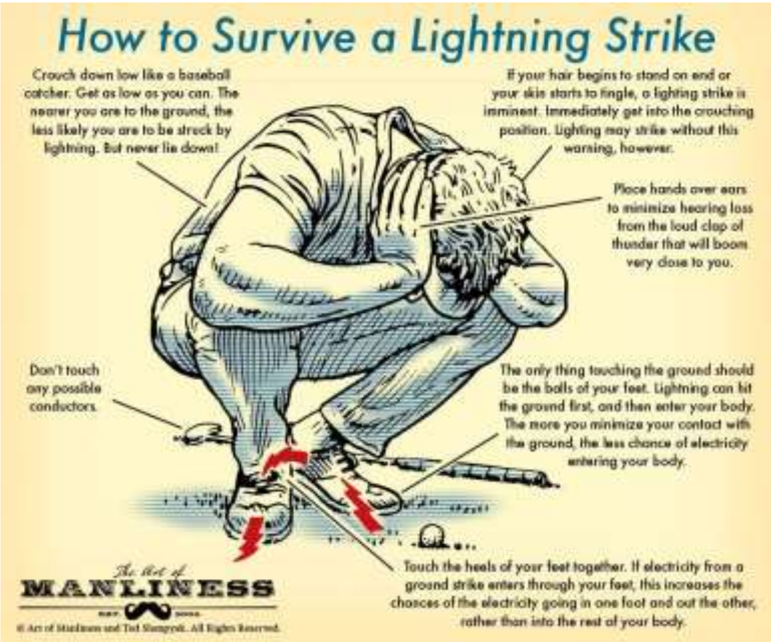
Firstly. DO NOT GO STRAIGHT ON TO GETTING THE STUDENTS HAIR TO RISE. The VdG must be explained. It is basically an improved version of rubbing rods on jumper. Charge moves up the belt (or down!) jumps off at the metal combs and collects around the outside. If you were inside you would have no charge on the inside. Charge collects on the outside only. This is why you are safe in a bird cage, car or steel boat during a thunderstorm.

https://www.youtube.com/watch?v=PdrqdW4Miao

- ✓ *Then stick a piece of thread (very thin) with a small piece of blu-tak onto the VdG dome.*
- ✓ *Turn the VdG on and see how the thread rises up.*
- ✓ *Bring another piece of thread towards the VdG and see how it is attracted to the dome. Notice that it doesn't need to be touching the thread.*
- ✓ *A student can touch the VdG (discharge between each use)*

NB when the student is not insulated the current passes through the body and into the ground. It is not storing the charge.

- ✓ *Then get the student to stand on a box (a deep old tray usually works well and can cope with approx. 11 stone if it is carefully spread)*
- ✓ *Repeat the process and now the hair ought to rise up. This is because similar charges are repelling and so to get as far away from each other the hairs rise and separate.*
- ✓ *Again bring a piece of thread close to the student and see how the electric field is quite far from the student. The electric field is the region where there is an electric force. Move the thread further away until it hangs down. This is then outside the field. As you move closer to the student the thread should rise more as the strength of the force and field is greater.*
- ✓ *Do not get too close to the student as you could discharge them and cause a spark*
- ✓ *Students should be moved at least 60cm from the student being charged and should not be moving around the back to prevent discharge.*



I think this isn't quite correct as here the strike would be in back down arms, knees feet. The bottom should be the highest point and the arms and chest should not be the best path as this puts the heart in the path of the current. You need the easiest route to be bottom, legs, out of your feet.

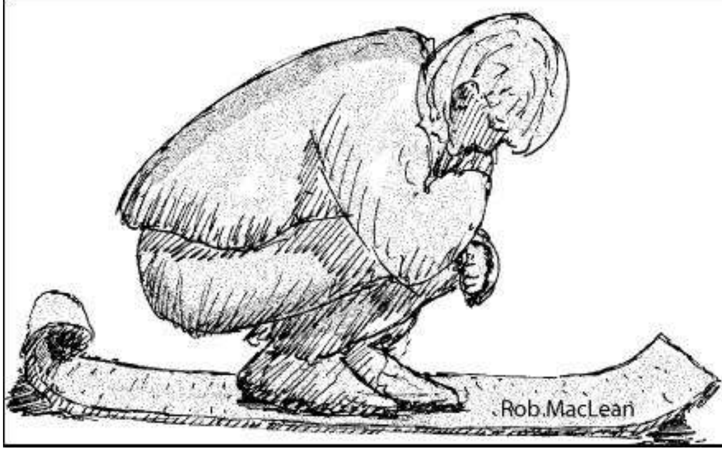


Fig. 8: **the lightning position** is for waiting out storms in stationary situations when it is impractical to move to a safer location.

1) **Put your feet together** to *significantly* reduce the effects of ground current which causes about half of lightning fatalities.
2) **Crouch** to *slightly* reduce the effects of side flash and upward leaders which together cause ~40% of lightning fatalities.
3) **Don't touch** long conductors to avoid contact voltage which causes ~20% of lightning fatalities.

Lesson 4 -CONDUCTORS and INSULATORS

This is likely to be lesson 4 or 5. This could be completed prior to the static lessons as it is slightly different. It would then give students the chance to go through the structure of the atom before doing the static experiments which explain static.

Aims of LESSON 4- Conductors and Insulators

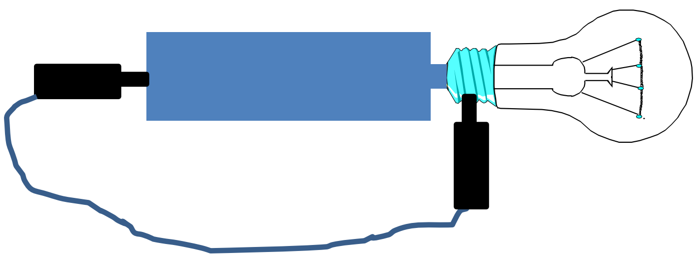
1. *When electric charge moves we call it an electric current.*
2. *Current is a flow of charge (or electrons) around a circuit.*
3. *Materials that allow current through them are called electrical conductors.*
4. *Materials that do not allow current through them are called electrical insulators.*
5. *For electrons to flow there must be a complete circuit.*
6. *A multimeter can be set up to measure current, resistance or voltage.*
7. *When a multimeter is set up to measure current we call it an ammeter.*

- ***Hypothesising***
- ***Equipment Handling***
- ***Observing***
- ***Design/construct/test/modify***

These experiments build up the idea of a circuit. It should introduce the idea that current needs a path for the electrons to take, which usually (but not always) returns to the start. Please note. Electrons don't all start at the cell but are in the whole circuit. This is shown well with marbles tightly in a line, Push anyone and they all move. It is sometimes good to start the current from somewhere other than the cell to remind students of this

Task 1- light a lamp

1. ***Try to light a small lamp using the minimum amount of equipment. Draw what you did in your jotter.***
2. *You ought to be able to use just 3 pieces of equipment.*
   For example:
   i. *a wire, lamp holder, lamp, batter battery holder etc.*
   ii. *Each of these counts as one piece of equipment*
3. *If you use two wires, this counts as two pieces of equipment, a lamp holder or battery holder also counts as an extra piece of equipment.*
4. ***Draw a large diagram showing how you lit the lamp.***

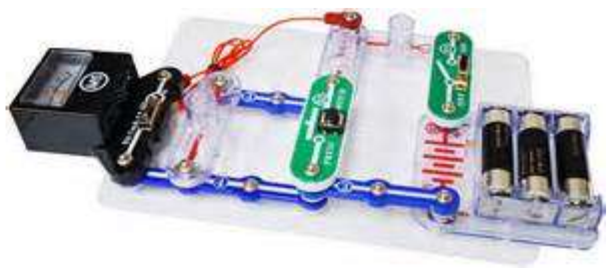


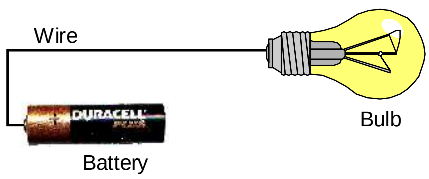
NB the terminals of the lamp are on the bit at the bottom that sticks out and the sides. If both were on the sides current would not pass into the filament! Please draw the students attention to the connectors for the

lamp

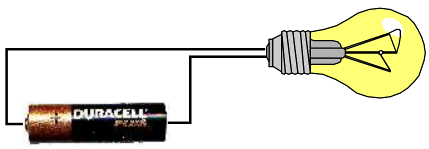
5. *NOTES: It is awkward having to cope with small fiddly equipment so we put the lamp and battery in holders.*
6. *Remake your circuit so that it is easier to use (ie add a lamp holder and cell holder, notice an additional lead is required).*
7. *Answer the following questions in your jotter.*
    a. *How many pieces of equipment does this use?*
    b. *Draw a diagram of your new circuit.*
8. *The circuit that you have just made can be used as a torch. It will also be used later to find out if materials allow current through them (are they conductors).*
9. *Can you improve it further (depending on the brightness of the lamp, you might want to use another cell) but also add a switch. This should be added so that the switch turns the lamp ON and not OFF*

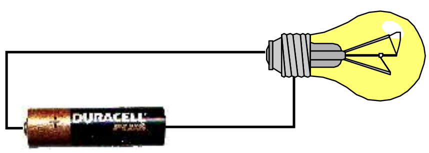
You could introduce the idea of circuit symbols and why that is better than trying to draw the diagrams that you have been drawing. For example is this diagram anything like the circuits that the students were producing? Put up other diagrams of students with other kit. How would you tell if it was the same circuit? Therefore we introduce a new "language", that of circuit symbol. Issue as a homework exercise. Do not copy these out at school.





In which of the circuits would the lamp light?





10. *Good conductors of electrical current allow electrons to flow through them easily. Sometimes they bump into atoms in the wire and this slows them down. This braking effect is called the wire's resistance.*
11. *The longer the wire, the more resistance it has.*
12. *A thin wire has a higher resistance than a thick wire. There is a smaller area of wire for the electrons to pass along.*
13. ***We*** *will come back and look at resistance in more detail later.*

Additional Notes (not required yet)
ELECTRIC CURRENT and conductors and insulators

When electric charge moves we have an electric current. Current will only flow if there is a complete path for it to follow. This is known as a circuit. You noticed this with the light lamp. It only lit if there was a complete circuit. Electric charge cannot flow through all materials. Current would not flow if one of these materials that electric charge cannot flow through was put in the circuit.
If a material, such as copper, lets electric charges move through it, we call it a conductor. An insulator does not let electric charges through, for example rubber. This is similar to the conductors and insulators of heat that you met in the first unit.

TEACHERS' NOTES & EXTENSION

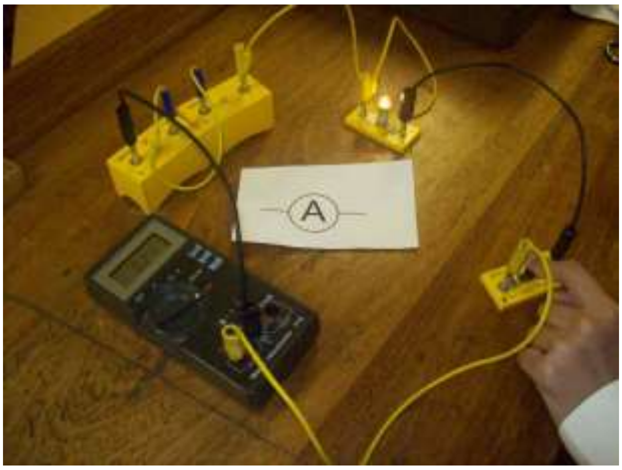
Read and answer the questions on page 85 of Starting Science Book 1.

Collect six to ten marbles and line them up between two jotters so that they are touching each other. Push the marble closest to you. Record what you noticed.

Then answer the following questions.
1. *Did all the marbles move?*
2. *Which marble moved first or did they all move together?*

Now get your partner to put their finger at the end of the row. Now gently push the marble closest to you again. What happens?
1. *How is this different from the last experiment?*
2. *How do you think this compares with charge trying to move in a conductor or insulator.*

Get your teacher to go over this demonstration to show how it is similar to electrons passing around a circuit and shows the difference between conductors and insulators.



If pupils replace the switch with the material to test this is the correct circuit for experiment 1. Please use the YELLOW meters and connect up as shown in the other sheets ONE WIRE IN THE COM and ONE WIRE IN THE 10A. SWITCH THE DIAL to A WITH 2 STRAIGHT BARS not the other wiggly line above the A (this is for using on a.c.)

Testing materials for conduction and insulation

Building on from the torch circuit, which you could have introduced a switch if we have any (which we currently don't), you can introduce the idea of conductors and insulators.

You are going to complete TWO experiments to show which materials are conductors of electrical current and which materials are insulators of electrical current You already have a good idea of what types of materials you are looking for so try to test some unusual ones.

Write the heading in your jotter "Testing materials for Conduction of Electrical Current"

Draw a table out like the one shown. You will need a whole page for the table. You will use this table for <u>two</u> experiments. For the first experiment only fill in the <u>first four columns</u>.

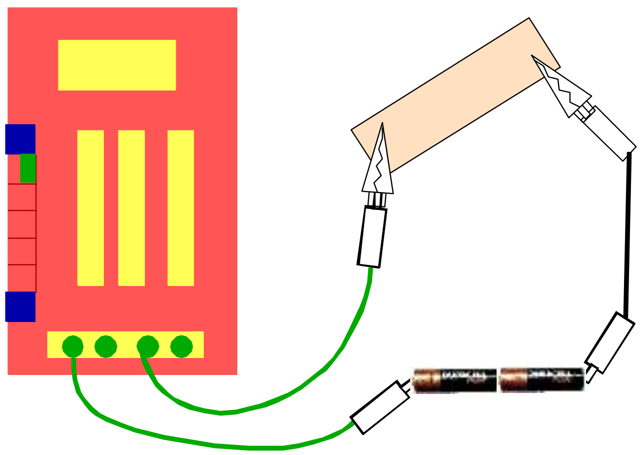
□The first four columns are for Expt 1

□For Expt 2

1. Material	2. Prediction	3. Does the lamp light?	4. Conductor or Insulator?	5. Current (A)	6. Order (best conductor no 1 etc)

YOU MUST THINK SAFELY AND NOT TRY ANYTHING THAT COULD BE DANGEROUS. ASK YOUR TEACHER IF YOU ARE IN ANY DOUBT.

DO NOT PLACE ANY IECE OF ELECTRICAL APPARAT



METHOD

1. ***Set up the circuit like the one above.***
2. ***Choose a material to test.***
3. ***Record your material in column 1.***
4. ***Predict whether your material is a conductor or an insulator of electrical current.***
5. ***Fill in column 2.***
6. ***Carefully try out your material.***
7. ***Fill in columns 3 & 4 for your material.***
8. ***Repeat for other materials.***
9. ***You should be able to test at least 20 different objects or materials.***

Explain how the light lamp would tell you which objects were the best conductors of electrical current.

The experiment that you have just completed is not a very accurate way of measuring how much electrical current (electric current) is going round the circuit. The small light lamp that you used can be replaced with a meter which will measure how much current is flowing around the circuit (see the diagram below).

At this point you might want to introduce the meters and come back to this task later. Or order Ammeters only from the technicians. NB Ammeters go in series.

1. *Retest all your conductors and insulators using your meter.*
2. *Fill in the fifth column in the table.*
3. *From your current readings try to list your objects in order, starting with the best conductor at the top.*

The circuit that you built to test whether something was a conductor or an insulator is called a continuity tester.
Not all conductors are equally good at letting charge through. Some resist the current more than others. We say these materials have a high resistance
The meter is called a multimeter and it can be set up to measure current, resistance or voltage. When it is set up to measure current we call it an ammeter.
An ammeter is used to measure current.

LESSON 5,6: METERS

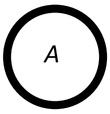
This lesson can be done very quickly or you can give the students a chance to use their skills in which case this will take 2 periods.. Go through with the students how each meter is connected. The COM is the common terminal so the negative lead (one closest to the negative terminal always goes in here). Students should be issued with a cut out of the types of meter and the table. This should be 2 students material to 1 A4 page. If you don't feel confident with multimeters use individual Ammeters and voltmeters, but students are unlikely to meet these anywhere else in their life, so I believe in training them young. Feel free to disagree.

When dealing with "the topic of electricity" it is sometimes helpful to be able to use a meter to measure current, resistance and voltage. For example, if you muddled up old and new batteries how do you sort them out? Using a voltmeter will distinguish between the old and the new. An ohmmeter can tell you if there is a break in the circuit. An ammeter will show you if you are overloading a circuit.

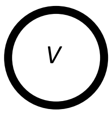
Rather than using a separate meter to measure each of the quantities, it is easier to buy a meter that can be adapted to take readings of different quantities. Such a meter is called a MULTIMETER. They are fairly cheap to buy and with careful setting up can be very useful

Aims of Lesson 5 & 6 Meters.

1. We use the symbol I to mean current.
2. Current is measured in amperes or amps.
3. Current is measured using an ammeter.
4. The symbol for an ammeter is



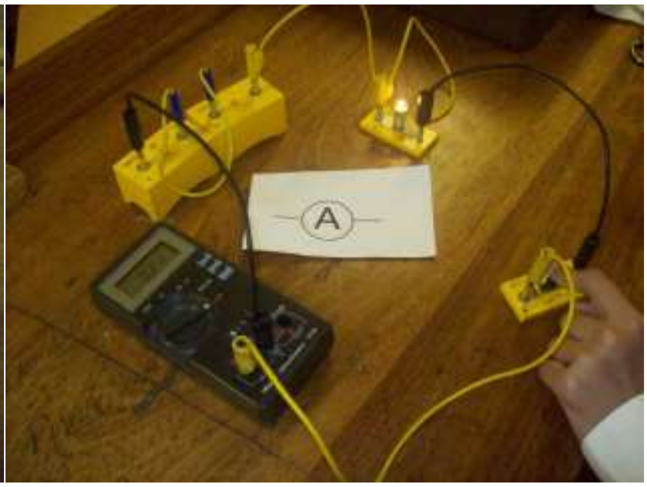
5. A multimeter can be set up to measure current, resistance or voltage.
6. When a multimeter is set up to measure current we call it an ammeter.
7. Some materials have a high resistance and make it difficult for current to flow.
8. A continuity tester can be used to test for conductors and insulators.
9. Resistance is a measure of how difficult it is for the charges to move through an object.
10. The longer a wire the higher the resistance of the wire.
11. Voltage is measured in volts.
12. Voltage is measured using a voltmeter, symbol V.
13. Voltmeters are connected in parallel.



- **Measuring**
- **Equipment Handling**
- **Observing**
- **Design/construct/test/modify**
- **Line graphs**
- **Taking Readings**

Examples of multimeters are given below.





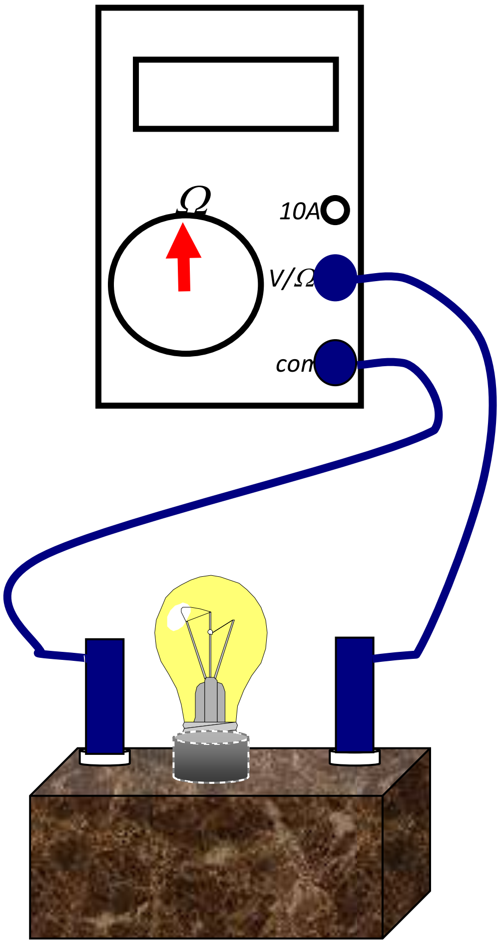
The symbols for each meter are given below.

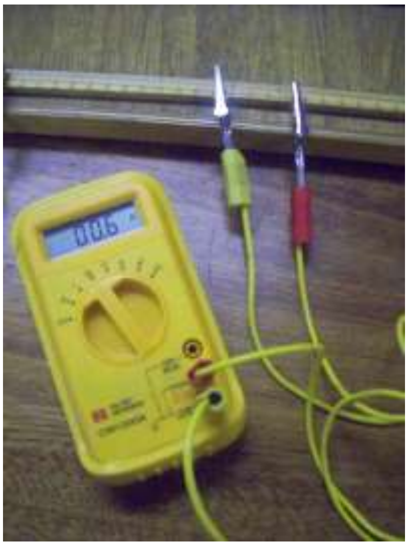
Meter symbol	*Meter*	*IMPORTANT INFORMATION ON CONNECTING*
—(A)—	*Ammeter*	*Ammeters are used to measure the current in a circuit.* *The wires connect to the COM (negative) and 10A (positive). Only if the current is small can you connect it on the mA scale, but beware, too much current and the fuse will blow and the meter wont work. AMMETERS are connected IN SERIES*
—(Ω)—	*Ohmmeter*	*Ohmmeters are used to measure the resistance of a component or a circuit. The wires connect to the COM (negative) and Ω (positive). OHMMETERS must not be used with a power supply*
—(V)—	*Voltmeter*	*Voltmeters are used to measure the voltage in a circuit.* *The wires connect to the COM (negative) and V (positive).* *VOLTMETERS are connected in PARALLEL across the component.*

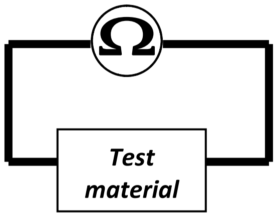
A cut out of the table above has been copied for each student.

Connecting An OHMMETER to measure resistance

Notice there is no power supply and no other component, just what you want to test. Just add two wires to your meter and place it across your test component. Connect one wire into the COM terminal of your meter and the other to the Ω/V. Turn the dial to the Ω symbol.



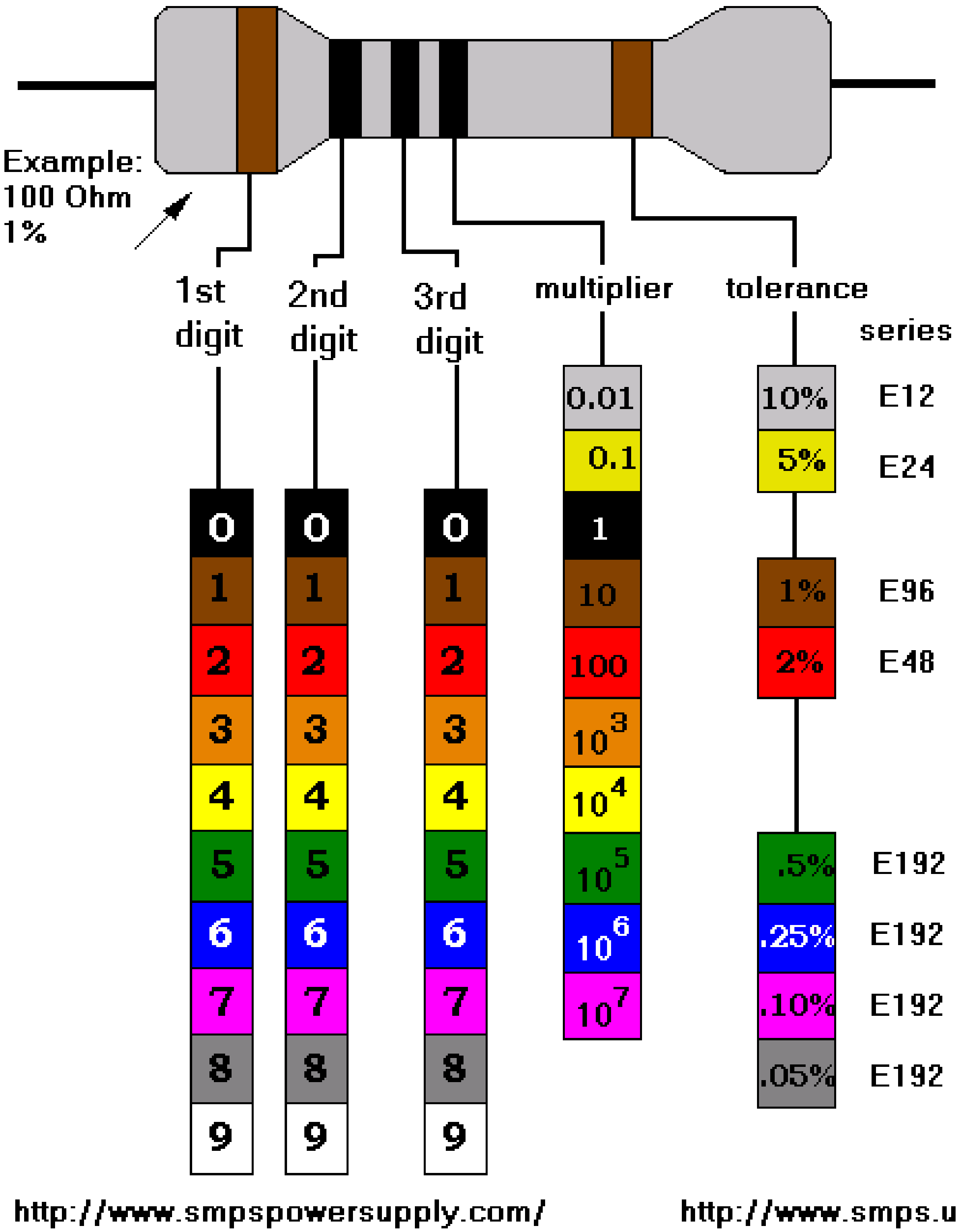




A cut out of all three meters on ½ an A4 sheet is available in the filing cabinet in H208.

Ωhm CΩmfΩrts

Some Resistors that we use in School are very big and their real purpose is to help students understand how they work. In everyday appliances the resistor is found in the majority of electrical circuits and the length of the resistances is very small. Here is a diagram showing the code to work out the resistance of resistors.



Laminated A3 posters of these are available from the technician. Use them for the block, but please return after use.

Go through the use of meters with the students, make sure they have diagrams of the connections to be made when using a multimeter. If you wish you can use the ammeters and separate voltmeters but these are generally in everyday use.

Measure + Record. TASK

Each group needs to complete at least 2 of the following tasks

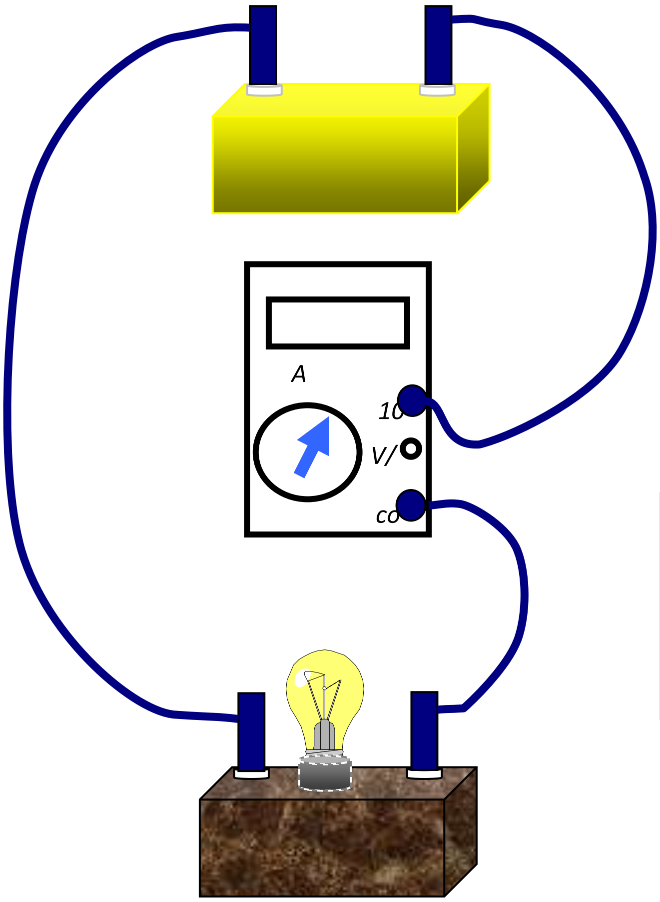
1. *Voltage across a Cell. Measure the voltage across the 1.5V cells, are there any that are "flat" or have used the energy they contained*
2. *Current in the circuit of 1 cell, 1 lamp*
3. *Resistance of each object in the pots*
4. ***Resistance of a wire of length 10cm, 20cm, 30cm, 40cm, 50cm, 60cm etc NB This is a great task to introduce graph, averages and repeated measurements. This is a very repeatable experiment and you should get almost identical results each time. This gives great opportunities to plot graphs using excel or paper method. A good line of fit is achievable.***
5. *Return to the experiment completed last lesson with the adapted torch ciruit which is being used as a Continuity Tester Test the current in the circuit where Current in the circuit when each item in pot is placed in the c*
6. *Comparing quoted resistance and measured resistance. Take 4 or 5 resistors with different markings.*
   a. *Record the colour markings on the resistors.*
   b. *Work out from the diagram the expected resistance of each resistor.*
   c. *Now use an ohmmeter and check whether you are correct.*
   d. *Explain why there could be differences between what you expect as an answer and the value you obtain.*

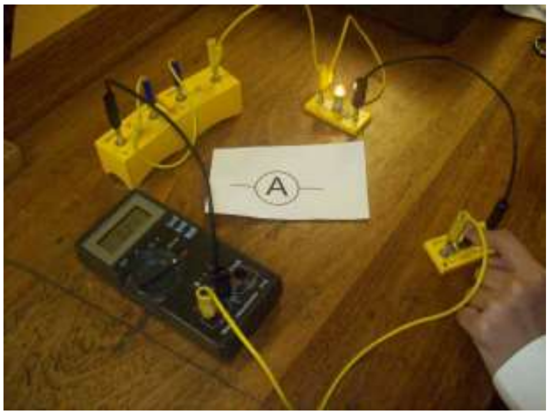
Teacher notes, you can allow all students time to produce a graph of length against resistance or you can introduce excel to the students or this can be given to the those who complete the task as a homework exercise. This can form one of the SALs though

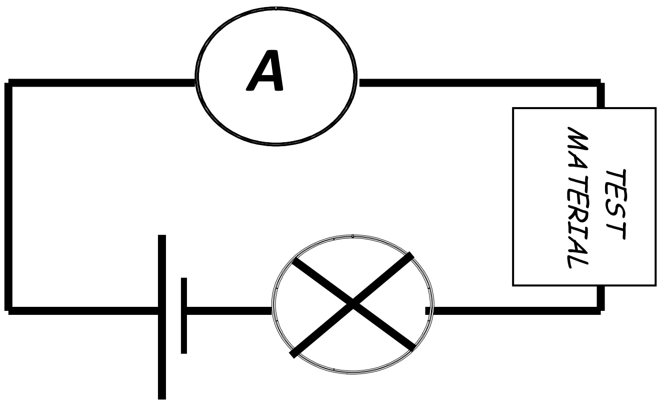
Connecting An AMMETER to measure current

An Ammeter must have a load (component) and power supply to make it work. Connect one wire to the COM terminal and one to the A symbol. If the current is very small then the second wire can be connected to the mA terminal but if the current is too large and you connect to this terminal you will blow the fuse inside and it will not work. Turn the dial to the A symbol (this should have straight lines above it not wavy which is used for a.c)

The lamp is not necessary but it shows you quickly if you are getting current in your circuit.

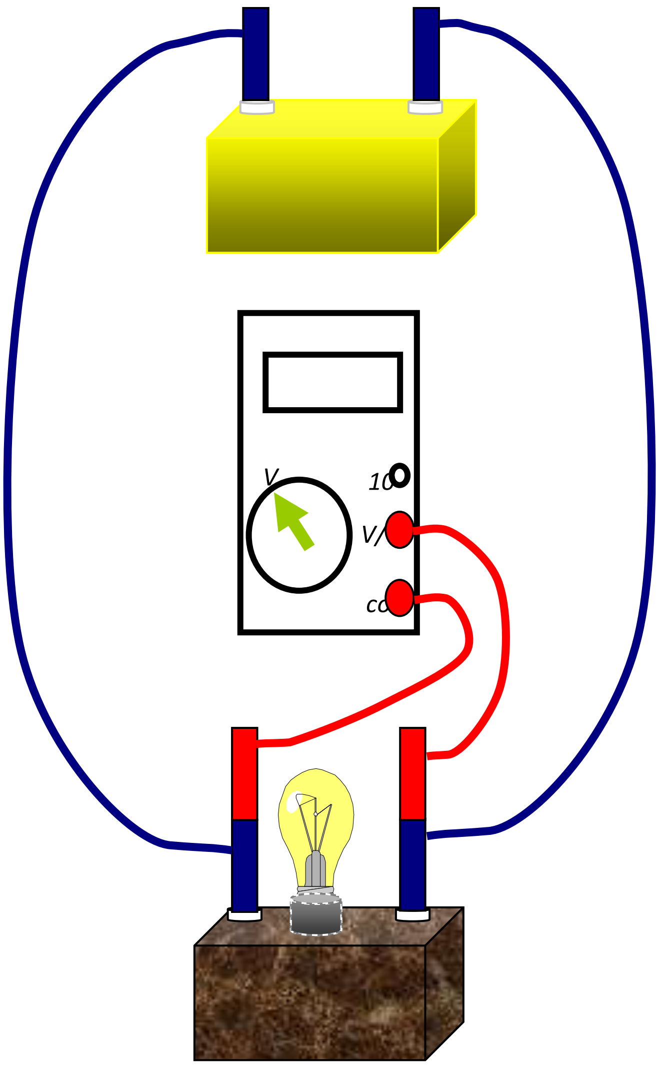


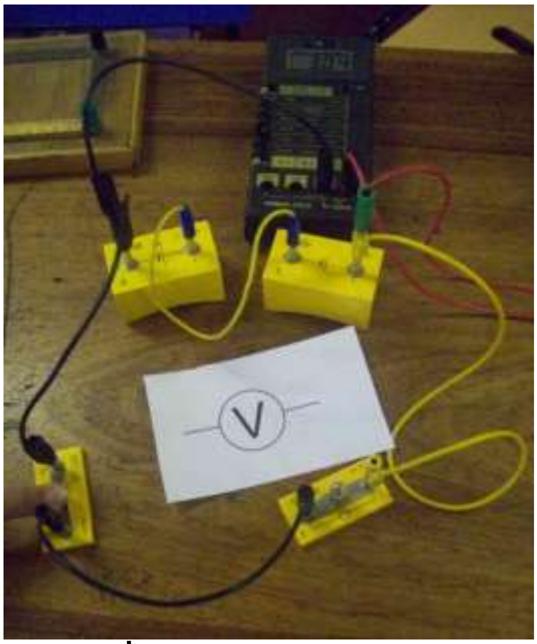


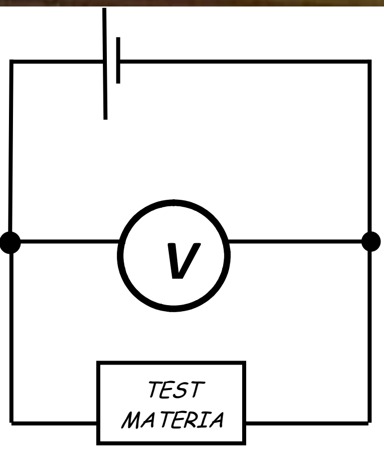


Connecting A VOLTMETER and measuring voltage

A Voltmeter must be placed ACROSS a component in a circuit. Voltmeters always go in parallel. Connect one wire to the COM terminal and one to the Ω/V symbol. The easiest way is to build your test circuit and then connect the Voltmeter across the terminals where you thing the circuit is not functioning or where you wish to measure the voltage. It is probably the easiest meter to use. If you want to see if one of your cells is near the end of its working life then connect a voltmeter staright across the terminals (top and bottom) and it will give you the voltage. Usually most cells are rated at 1.5V. A new cell could give you a reading of 1.65V but some devices will no longer function if the cell voltage drops below 1.3V.







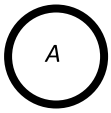
These notes are available on the website www.mrsphysics.co.uk

LESSON 7: Learning Terms

Aims of Lesson 7 Learning Terms

- *Literacy Task*

1. *We use the symbol I to mean current.*
2. *Current is measured in amperes or amps.*
3. *Current is measured using an ammeter.*
4. *Ammeters are connected in series.*
5. *The symbol for an ammeter is*



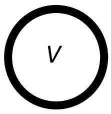
6. *For electrons to flow there must be a complete circuit.*
7. *A multimeter can be set up to measure current, resistance or voltage.*
8. *When a multimeter is set up to measure current we call it an ammeter.*

Resistance

9. *Some materials have a high resistance and make it difficult for current to flow.*
10. *A continuity tester can be used to test for conductors and insulators.*
11. *Resistance is a measure of how difficult it is for the charges to move through an object.*
12. *The longer a wire the higher the resistance of the wire.*

Voltage.

13. *For most materials, as you increase the voltage the current increases.*
14. *Potential difference (p.d.) is often called voltage.*
15. *p.d. is the push that makes the charges move around a circuit.*
16. *Voltage is measured in volts.*
17. *Voltage is measured using a voltmeter, symbol V.*
18. *Voltmeters are connected in parallel.*



We can't get around it there are some terms that are associated with electrical current that the students are required to know. I have found a fairly successful method of learning these is to complete this group reading task! There are laminated boards with the terms. NB it is much harder to add the meanings to a board of terms than the terms to a board of meanings, so use this as a method for differentiation. There are various sheets that students can use at the end, either copying these into their jotters, or being given the word and write the meaning, meaning and write the word or a completed table. This is the one long written task I do over the whole block, the rest is written at home.

NB there is no definition of charge in the text but it is the one definition they ought to have not covered at the end of the task. This then indicates which is correct. Some of the boards have numbers and letters on them. If you read across from right to left then the numbers and letters go in order. Some students work this out for themselves.

Ωhm CΩmfΩrts

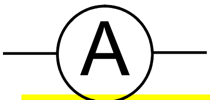
Definitions

I play this as a "BUZZ" game. Students call out BUZZ after I mention a definition given in the text. Students then repeat the meaning and the word and place the word on the board. If you find a more successful method let me know. There is an activinspire board that has the definitions and terms produced by Stuart Bell. ***PLEASE don't save this Activinspire with the completed answers unless you keep your own version. It will be awkward for the next person if the answers are already given. I find this Activinspire works well as a revision tool the next lesson to check who has learned the terms. I will get the words onto the website or GLOW for students to download***

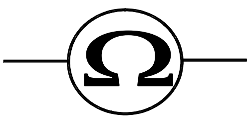
Using the words below write a report or your own dictionary to explain their meaning

a)	***Current***	**b)**	***Charge***	**c)**	***Voltage***
d)	***Resistance***	**e)**	***Ammeter***	**f)**	***Voltmeter***
g)	***Ohmmeter***	**h)**	***Multimeter***	**i)**	***Conductor***
j)	***Insulator***	**k)**	***Potential Difference***	**l)**	***Circuit***
m)	***Series circuit***	**n)**	***Parallel circuit***	**o)**	***continuity tester***
p)	***The effects of a current***				

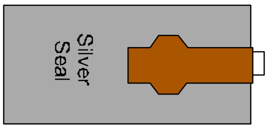
1. *Electric charge is produced from the outer parts of atoms called electrons. When these small charges or electrons move around a circuit we call this a current, electric current or electrical current. When an electric current passes through a conductor it produces several useful effects, heat, light, magnetism, and chemical effects.*
2. *You will only get an electric current if there is a complete path for it to follow. This is known as a circuit. For example a light lamp will only light if there is a complete path from the power supply through the lamp and back to the power supply. We use the symbol I to represent current so we don't have to write out the whole word. I was used as people used to refer to current as intensity. The unit of current is the ampere or amp. Current is measured using an ammeter. Ammeters are connected in series. The symbol for an ammeter is*



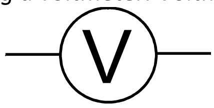
3. *Electric charge cannot flow through all materials. Materials that charges flow through easily, such as copper, are called conductors. Materials that charges cannot flow through, for example rubber, are called insulators. These materials are similar to conductors and insulators of heat. Notice, materials that are good conductors of heat are also good conductors of electrical current, and materials that are bad conductors of heat are also bad conductors (or good insulators) of electrical current.*
4. *The number of free electrons in a substance determines how well it conducts electrical current. Metals such as aluminium, copper, silver and gold are good conductors because they have at least one free electron per atom. Some metals, such as lead and tin, are poorer conductors than other metals because they have less than one free electron per atom. Substances with no free electrons, such as glass, and rubber, do not normally conduct electrical current. They are called insulators.*
5. *Resistance is a measure of how difficult it is for these charges to move through an object. Poor conductors resist the flow of electrical current more than good conductors. Resistance changes electrical energy into heat. Not all conductors are equally good at letting charge through. Some resist the current more than others. We say these materials have a high resistance. Resistance is represented by the symbol R and is measured in units called Ohms (symbol Ω) Resistance is measured with an Ohmmeter which has the symbol*



6. *The electrical push that allows charge to flow is called voltage. It is also a measure of the energy given to each of the charges as it passes through the power supply.*

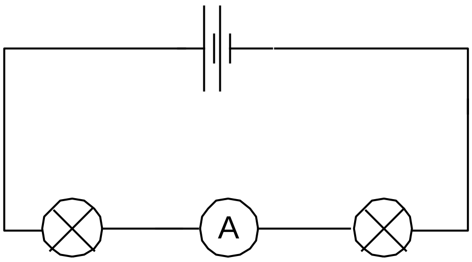


7. *Potential difference (p.d.) is often called voltage. p.d. is the push that makes the charges move around a circuit. Voltage is measured in volts. Voltage is measured using a voltmeter. Voltmeters are connected in parallel and have the symbol*

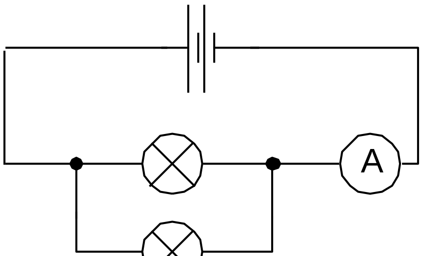


8. *A circuit that can be built to test whether something was a conductor or an insulator is called a continuity tester. Rather than using a separate meter to measure current and voltage and resistance one meter can be used on different settings. This meter is called a multimeter.*

9. *Soon we are going to find out that there are two types of circuit that we can build. Remember that in a series circuit there is only one path for the current to take. Charge flows through all the components. In a parallel circuit there is more than one path for the current to take. An example of each is given below.*



A series circuit



The lamps are in parallel

Lesson 8: S2 APPRENTICESHIP ASSESSMENT BUILDING CIRCUITS LESSON

Aims for Lesson 8- Building Circuits

By this time students should have drawn the circuit symbols and so ought to know the familiar symbols they will be using.

The purpose of today's lesson is

- ✓ *to draw circuits using symbols*
- ✓ *to build circuits from a description*
- ✓ *to build circuits from a diagram*
- ✓ *to distinguish between different circuits*

1. *Circuit symbols are used to show how circuits can be built.*
2. *The circuit symbol for a cell, switch, bell, ammeter, voltmeter, lamp, power supply, resistor, wire, connected wire.*
3. *Make sure that you can draw circuits using the proper symbols and following the rules for drawing circuits.*
4. *The two types of circuit are called series and parallel.*

- ***equipment handling***
- ***Observing***
- ***Diagram***
- ***Problem solving***
- ***Design/ construct/ test and modify***

To complete all the circuits will take most students between 1.2 and 2 lessons, there will always be a group of students who have difficulty with their equipment. These are generally the most scared students! Sometimes it is best for the students to put all the kit back and start again, or swap it with the group that are storming ahead!

INTRO TO LESSON: FAULT FINDING (1)

If possible try to introduce this at the end of the last lesson so it will give you a chance to do the building circuits lesson in one or 1.5 lessons. Do not take longer than this to complete the task or the students will get frustrated. If they finish I will make up some additional work sheets, or use the old electricity notes and they can build some of the circuits given after paragraph 125. This can also be completed or introduced when doing the torch circuit and conductors and insulators. There are fault finding laminated cards in the filing cabinet, please collect all 20 up at the end of the lesson.

INFORMATION

You may often find that circuits do not always work when you connect them up. There are a few useful things that you can do before you panic and call in the teacher.

CHECK THAT:-

1. *the batteries are all connected up the right way,*
2. *the wires are all connected up and make a complete circuit,*
3. *the batteries are not flat,*
4. *the lamp has not blown,*
5. *the lamp holder is not broken,*

6. your meter is connected properly and that the right buttons are pushed in (there should be a poster on the wall to show you),
7. the equipment is plugged in and is switched on,
8. Check that you have checked everything.

If you have checked all that could have gone wrong and your circuit still doesn't work now panic and call in the teacher!

PLEASE NOTE THIS TASK IS ABOUT STUDENTS FINDING OUT ABOUT SERIES AND PARALLEL FOR THEMSELVES. Students ought to have completed this at primary school but if 1 in 20 can do this I'd be surprised. There is always one group with kit that doesn't work. So it is a good idea to give each group a Fault Finding card. Have plenty of spare kit. Generally the cells are flat or connected the wrong way around. You are more likely to get this to work if you use 1.5V lamps but they can be easily damaged. So beware!

We are asking a lot of students this period and it is exhausting for the teacher, but the students and teacher gets so much out of it. It is about students seeing their improvement. PLEASE CHECK STUDENT DIAGRAMS, ESPECIALLY THE FIRST FEW, BEFORE ALLOWING THEM TO MOVE ON TO THE NEXT CIRCUIT. Generally the students put symbols in the corners, are unable to turn a switch upside down and make their cells look like a capacitor. Alex Fuhrmann came up with an excellent idea to use a quiz board underneath the circuit so they can use the quiz board to help draw out the circuit. NB THIS TASK MUST BE COMPLETED AFTER STUDENTS HAVE DRAWN OUT THE CIRCUIT SYMBOLS.

The purpose of today's lesson is

- ✓ to draw circuits using symbols
- ✓ to build circuits from a description
- ✓ to build circuits from a diagram
- ✓ to distinguish between different circuits

TO DO

Come in get out your jotters.

Check that you have copied all the necessary circuit symbols.

If not sit in the corner and copy these ALL out from the sheets

Collect the following apparatus

- ✓ 7 x leads
- ✓ 2 x 1.5V cells & holders
- ✓ 3 x 2.5V lamps & holders
- ✓ 2 x switches

Wait silently for instructions.

Complete the circuit for the activity. For each circuit you must read the description and build the circuit correctly

Summary

We built 7 circuits. A circuit is a complete PATH. There are 2 types of circuit. In a series circuit when one lamp is unscrewed the others go off. In a parallel circuit when one is unscrewed the other stays on.

In a series circuit there is only ONE path for the current. In a parallel circuit there is MORE THAN ONE path.

LESSON 9: MODELLING ELECTRICAL CURRENT

Aims of Lesson 9 Modelling

1. *In series circuits the current is the same all round the circuit.*
2. *In parallel circuits the current splits up and some goes down each branch.*
3. *In series circuits the voltage across the components adds up to give the voltage of the supply.*
4. *In parallel circuits the voltage is the same across each branch.*
5. *The current drawn from the supply increases the more components are connected in parallel.*
6. *When lamps are added in parallel the current drawn from the supply increases. This is because the overall resistance of the circuit is reduced.*

- ***Hypothesising***
- ***Processing***

The electricity topic is a difficult concept for students and so it can be a good idea to model the topic of electricity and I find this model works really well. Students are able to predict the rules for current and voltage for series and parallel from this model.

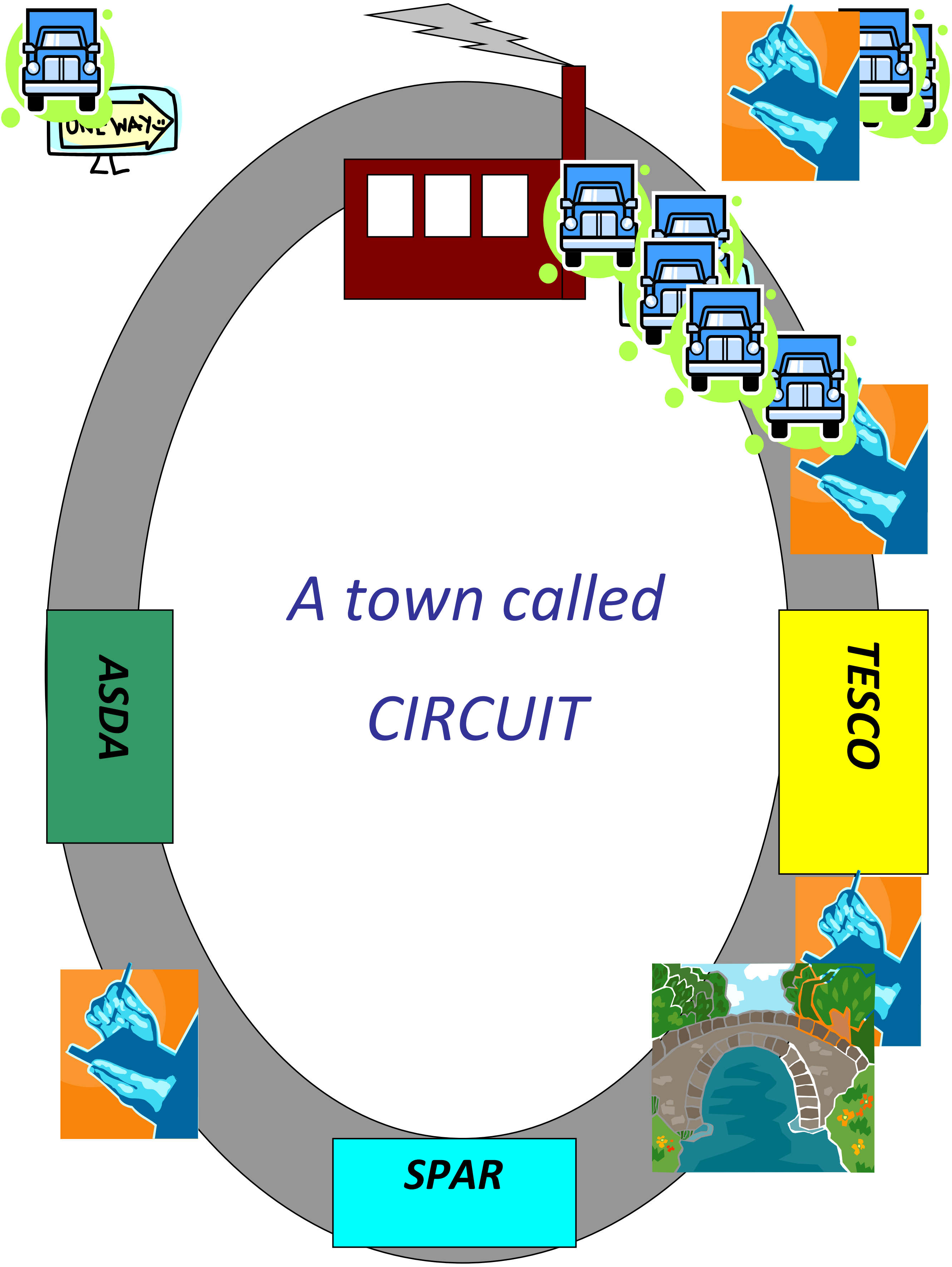
I have had a board made once and it might be something we might want to consider redoing, using smarties as the energy source. Alternatively a large sheet of flip chart paper on the table works well and it can be quite interactive. Students can play the role of ammeter, lorry driver/ electrons/ battery- factory owner etc.

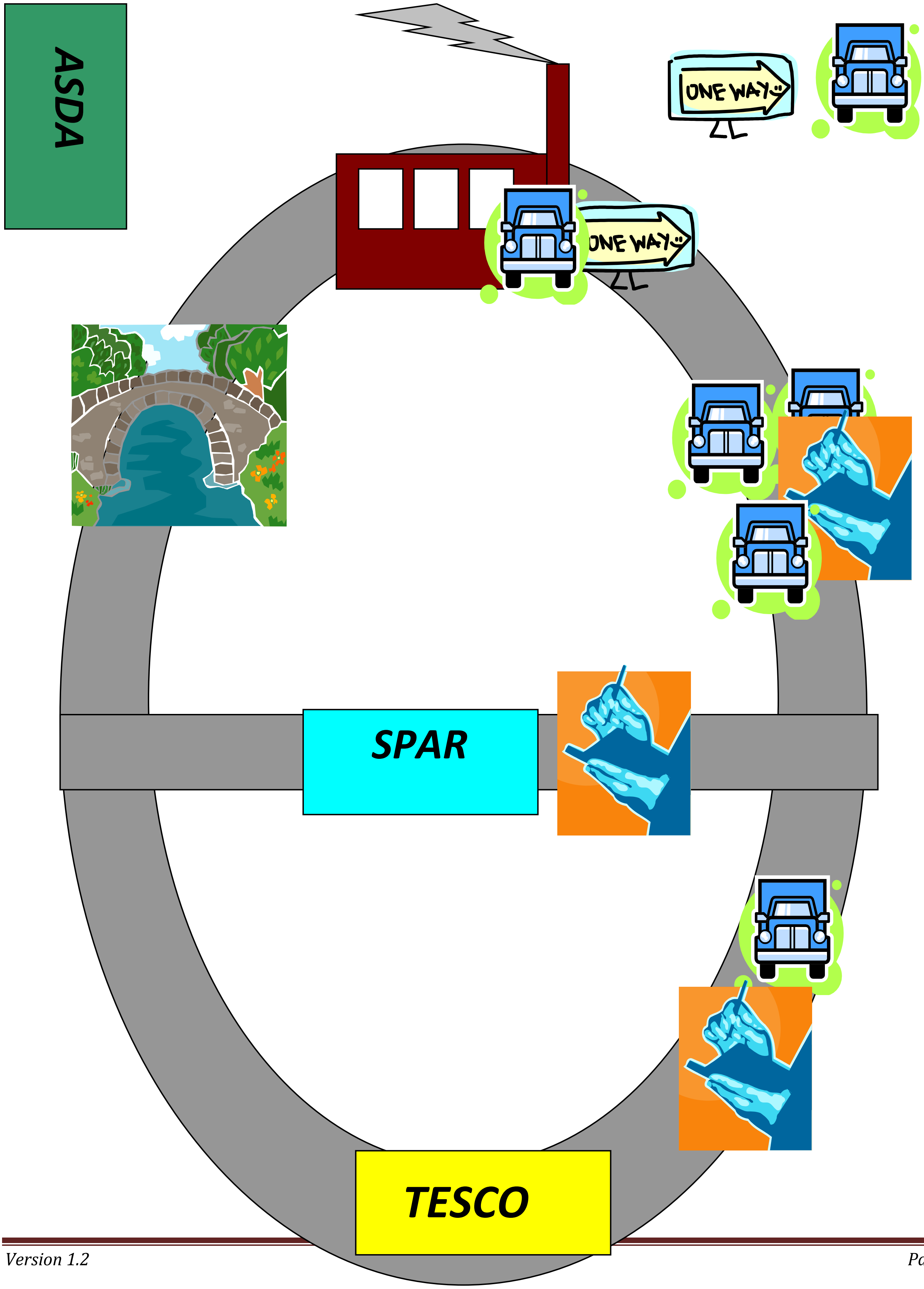
This is often more difficult for the more able students who are not as keen or do not feel that they need the model. This might be a place for the most able students to complete the Ohm's Law practical.

Students should draw their own models in the jotters as you go along.

It can take 2 periods to do the model thoroughly, but the result is that they can complete the measuring current and voltage in series and parallel much quicker, under a period.

If you want the run down let me know. I'll train the technician and he can decide if we want to remake the model (my DIL had produced a board from a wall paper pasting table with the road signs fixed in and egg box individual egg slots as the lorries. We might be able to buy ready made signs from children toys.


ONE WAY
A town called
CIRCUIT
ASDA
TESCO
SPAR


ASDA
ONE WAY
ONE WAY
SPAR
TESCO

Model	***The topic of electricity***
Factory	***Battery/ cell/ power supply***
Lorry	***Electrons***
Traffic (lorries on the road at one time)	***Current***
Shops	***Light lamps***
Road	***Wires***
One way street	***Current goes one way***
Counting cars *(in the street)*	***Ammeters*** ***(go in series)***
In a series circuit the counters all count the same number of lorries	***In a series circuit current stays the same.***
No. of boxes of mars bars=voltage	***Voltage is the ENERGY per CHARGE***
Weighbridge (see place at Carlisle) *PARALLEL*	***Voltmeter GOES IN PARALLEL***
The boxes of mars bars in our series circuit adds up to what is delivered to each shop	***In a series circuit the voltage across each lamp adds up to the total.***
The boxes of mars bars in our series circuit adds up to what is delivered to each shop	***In a series circuit the voltage across each lamp adds up to the total.***
In a 2 branch town the number of mars bars each lorry delivers is the same as the total	***IN a parallel circuit the voltage across each branch is the same as the supply.***

IN CIRCUIT TO AVOID CONGESTION ALL ROADS ARE ONE WAY!

This means all electrons flow in one direction only.

Circuit was built to provide a route from the factory.

The factory is the cells or battery or power supply and this pushes electrons around the circuit. No factory no lorries.

This is like the power supply. The power supply pushes the charges around the circuit. They provide the energy to the charges. The energy per charge is the voltage.

Voltage is BOXES OF MARS BARS PER LORRY.

Measure the voltage by "sampling a very small number of charges" Voltmeters must go in PARALLEL.

This is like the Weighbridge at Carlisle. Some lorries are taken off and the cargo of mars bars checked.

Shops are equal to component eg lamps, resistors, motors, buzzers.

The factory produces MARS BARS

Mars bars give us ENERGY.

Cells produce energy

If we made the factory bigger it could produce more mars bars, more energy, need more lorries.

The more cells the more energy is produced and the higher the current.

Lorries take the mars bars to the shops.

Electrons or charge take energy to the components.

People count lorries at the side of the road.

Ammeters count the charge flowing each second in the circuit. Ammeters go in series.

In our town of circuit when the shops come one after the other, all the people count the same number of lorries.

In a series circuit the current stays the same.

$$I_t=I_1=I_2=I_3$$

When counting trucks you stand at the side of the road. When checking mars bars per truck you need to pull off some trucks.

Ammeters go in series, Voltmeters go in parallel.

Mars bars are energy-

Voltage is the energy supplied to each charge or electron

Voltage is also known as potential difference. This is like the difference between the energy each charge has before the component compared to after. (how many boxes of mars bars have been dropped off!)

In our town, the number of boxes of mars bars delivered to each shop adds up to the total on the truck at the factory.

In series the voltage across each lamp adds up to the total from the supply.

$$V_s=V_1+V_2+V_3$$

In parallel in our town, the number of trucks in each branch adds up to the total.

In parallel circuit, the current in each branch adds up to the total.

$$I_t=I_1+I_2+I_3$$

In our town in parallel each truck delivers the same number of boxes of mars bars as was given at the factory.

In parallel the voltage across each branch is the same as the supply.

$$V_s=V_1=V_2=V_3$$

Model	What it means
Road	***wires***
Trucks	***charge***
Traffic	***current***
Factory	***Cells, power supply, battery***
Mars Bars	***energy***
Counting lorries (at side of the road)	***Ammeters (go in series)***
Lay-by with weighbridge counting mars bars per lorry	***Voltmeter (go in parallel)***
Road	***Wires/ circuit***
One way	***All electrons flow in one direction only***
Factory extension, would mean more lorries on the road and more mars bars per lorry	***Bigger power supply*** ***More energy per charge, bigger current and higher voltage***
Two street town	***Parallel circuit***

NB this is not the completed model and I will add to it as I remember.

LESSON 10: MEASURUNBG CURRENT AND VOLTAGE

Aims for Lesson 10 Measuring current and Voltage

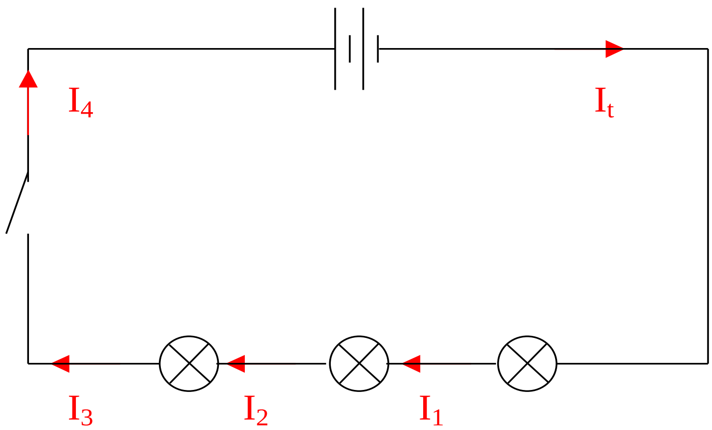
1. *In series circuits the current is the same all round the circuit.*
2. *In parallel circuits the current splits up and some goes down each branch.*
3. *In series circuits the voltage across the components adds up to give the voltage of the supply.*
4. *In parallel circuits the voltage is the same across each branch.*
5. *The current drawn from the supply increases the more components are connected in parallel.*
6. *When lamps are added in parallel the current drawn from the supply increases. This is because the overall resistance of the circuit is reduced.*

- ***equipment handling***
- ***Hypothesising***
- ***Planning***
- ***Measuring***
- ***Observing***
- ***Processing data***
- ***Diagram***
- ***Problem solving***
- ***Design/ construct/ test and modify***

If you've already gone through the model this can be completed very quickly. If the students have rushed through in other areas here is a chance to take time and carefully allow students to become confident with the apparatus. Measuring current in parallel is the most difficult to set up. I will see if we can get some boards makde up so that meters or wires can just be plugged in, although this is not giving students the skills to do this for themselves. You may wish to allocate groups to each of the 4 measuring tasks and then students can move around collecting results from each group. This works well and give the ASN students voltage in series to set up, as it is by far the easiest. You are likely to find that the voltage values do not remain constant in the parallel circuit as they should and students will talk about it being further to get to the bottom branches, which is mince, so please go through this. The real reason will be poor connections and therefore losses elsewhere that aren't measured. Also please ensure students don't get the idea that the current "runs out" by the time it has got around a series circuit!

MEASURING CURRENT IN A SERIES CIRCUIT

Position	*Current (A)*
I_t	0.135
I_1	0.135
I_2	0.135
I_3	0.135
I_4	0.135

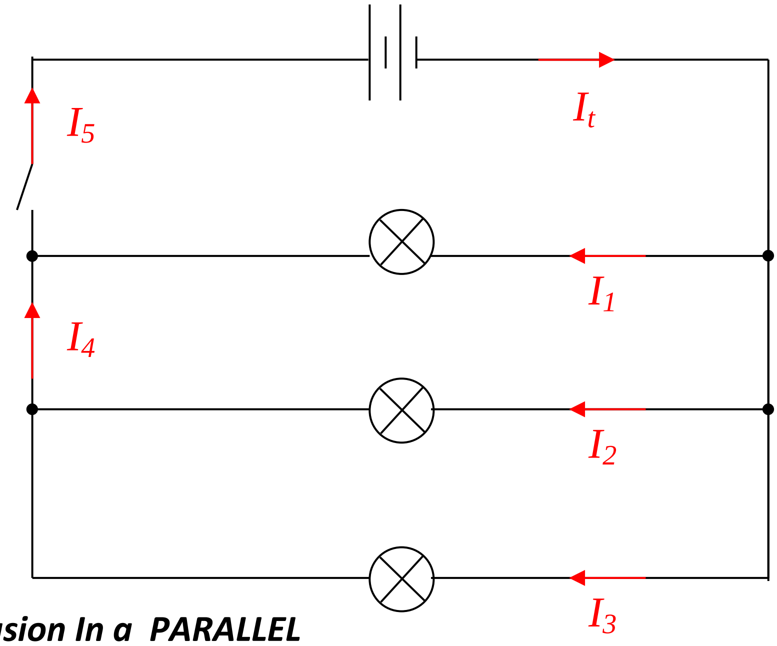


Conclusion:

In a series circuit the current stays the same. There is only 1 path for the current so all electrons flow along this path.

MEASURING CURRENT IN A PARALLEL CIRCUIT

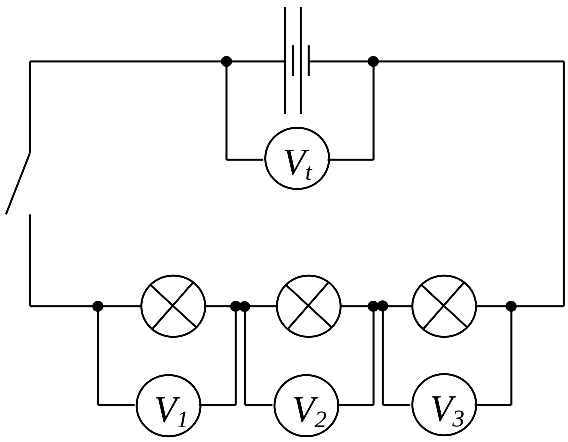
Position	*Current (A)*
I_t	0.57
I_1	0.19
I_2	0.18
I_3	0.20
I_4 (I_1+I_2)	0.38
I_5	0.58



Conclusion In a PARALLEL circuit the current splits up and flows down different branches. The current in the branches adds up to the total current in the circuit which passes through the cells.

MEASURING VOLTAGE IN A SERIES CIRCUIT

Position	VOLTAGE (V)
V_s	2.8
V_1	0.878
V_2	1.095
V_3	0.881



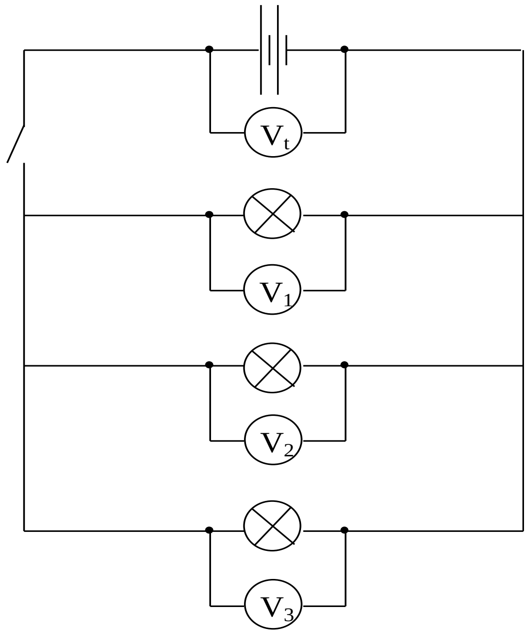
Conclusion

In a series circuit the voltages across the components (lamps) adds up to the supply voltage (V_s)

REMEMBER VOLTMETERS ARE CONNECTED IN PARALLEL, AMMETERS ARE CONNECTED IN SERIES

MEASURING VOLTAGE IN A PARALLEL CIRCUIT

Position	VOLTAGE (V)
V_s	2.30
V_1	2.26
V_2	2.26
V_3	2.30



Conclusion. In a parallel circuit the voltage in each branch remains the same.

LESSON 10: TESTING FOR FAULTS

Aims for Lesson 10- Testing for Faults

- equipment handling
- Observing
- Problem solving
- Design/ construct/ test and modify

(MUST BE COMPLETED AFTER METERS best COMPLETED AFTER THE SERIES AND PARALLEL WORK), could be before measuring current and voltage in series and parallel if you're short of kit

This is a tiring lesson that the students find great fun. It is best completed when there is technical support around as the students often fix the boards and you can't remember what was wrong with them or they create a new fault.

IF YOU ARE WORRIED OR HAVE A POOR CLASS IT MIGHT BE ADVISEABLE TO SWITCH OFF THE ELECTRICITY AT THE RCD, if you know where the key is to put it back. I will provide a list of faults and why they occur, but as they are ever changing it might not be reasonable in here.

PLEASE ISSUE

Resistance is very low

Resistance depends on the size of the resistor.

*It can be **low** → **high**.*

Resistance is very very very high

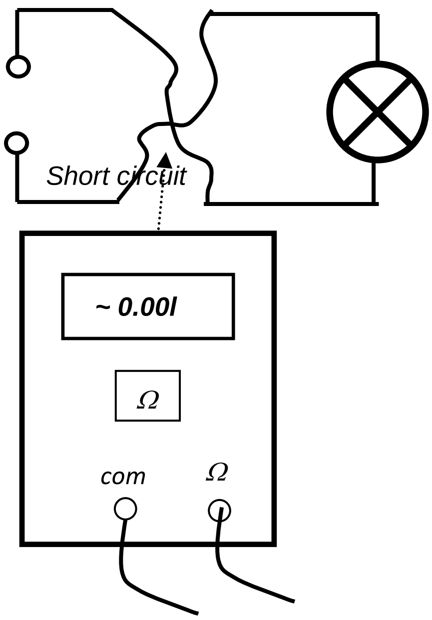
Resistance – a measure of "how hard it is for electric current to flow"

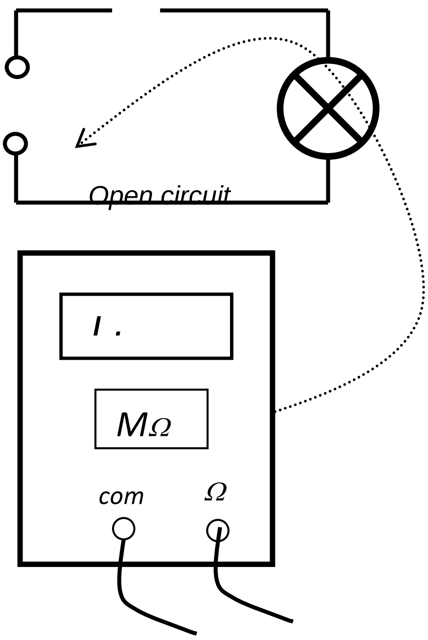
*With a **large** resistance – "**hard**" for current to flow*

*With a **small** resistance – "**easy**" for current to flow*

If there is a break in the circuit, there would be a very, very high resistance. (OPEN CIRCUIT)

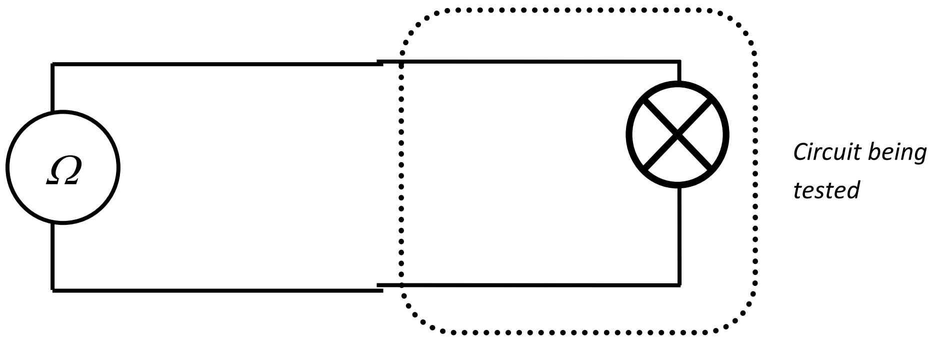
If there was a wire across a component, the resistance across the component would be very low (SHORT CIRCUIT)4



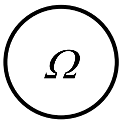


Reads a very low number

Reads a very high number

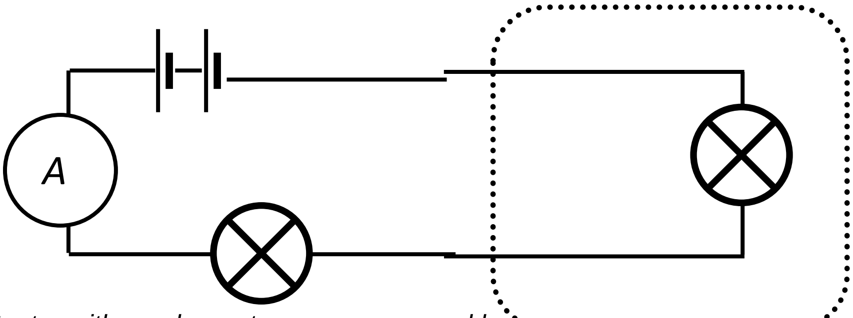


Test continuity with an ohmmeter.



Remember the power supply must be off or disconnected before using it.

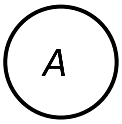
If the lamp is ok, then the ohmmeter will give a small reading. However, if the lamp is "blown" then it will be an open-circuit and there will be a very, very large reading on the ohmmeter.



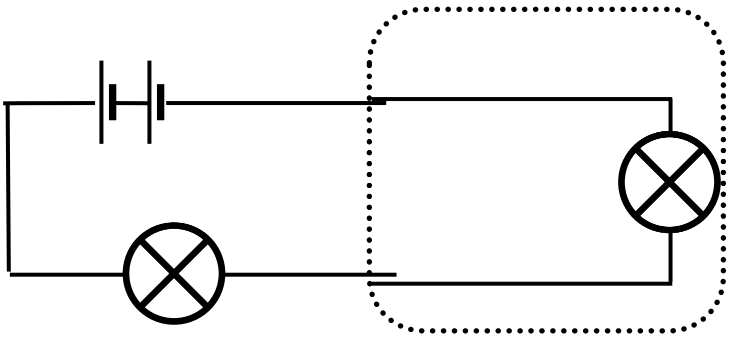
Circuit being tested

Make a continuity tester with an ohmmeter and lamp.

When connected to the lamp on the right, if there is an open circuit, no current would flow, therefore, 0.00A on ammeter.



Below is a circuit of a lamp and a battery being using as a continuity tester



Circuit being tested

Test with a lamp. The lamp would be bright to indicate a short circuit and off to indicate an open circuit.

TASK

Around the room are circuits that are not working. OR if your teacher says it is safe set up a circuit that will not work for another group. ***ELECTRICAL HAZARD. NO EQUIPMENT FROM TODAY MUST BE INSERTED INTO THE SOCKETS. IF IN DOUBT TURN OFF YOUR ELECTRICAL SUPPLY***

Your task is to identify what is wrong with the circuit. Try to fix the circuit by following the checklist. MAKE SURE THAT YOU PUT THE CIRCUIT BACK AS YOU FOUND IT AFTER YOU HAVE FOUND OUT WHY IT DOES NOT WORK.

Did you find the following faults?

1. *cells connected the wrong way (beware that these will go flat unless they have a switch)*
2. *flat battery*
3. *a wire across the lamp, thus shorting out the lamp*
4. *a blown lamp*
5. *a broken wire*
6. *a wire connected without the insulation removed.*
7. *a fuse in the circuit which is too low powered and blown*
8. *a lamp holder wrongly wired so the wires are shorting out the lamp*
9. *a blown lamp in a series circuit*
10. *a blown lamp in a parallel circuit*
11. *the circuit is incomplete.*

LESSON 12: Fruit Batteries

I have included both sheets for the fruity batteries and you can decide which one to use.

Aims of Lesson 12- Fruit Batteries

1. *I can help to design simple chemical cells and use them to investigate the factors which affect the voltage produced.*

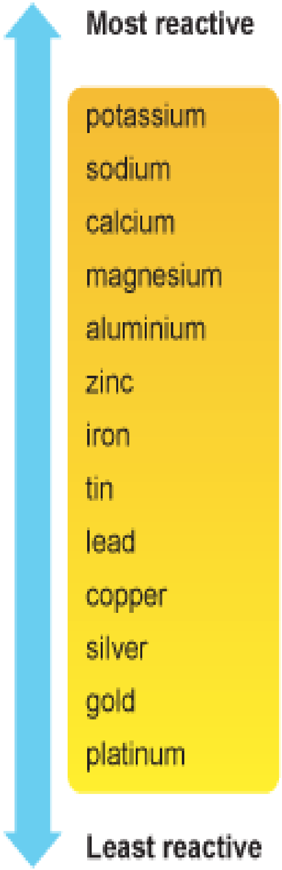
- ***equipment handling***
- ***Planning***
- ***measuring***
- ***Observing***
- ***Diagram***
- ***Problem solving***
- ***Design/ construct/ test and modify***

Additional Learning Outcomes (extension)

2. *Using experimental evidence, I can place metals in an electrochemical series and can use this information to make predictions about their use in chemical cells. SCN 4-10a*
3. *Using a variety of sources, I have explored the latest developments in chemical cells technology and can evaluate their impact on society. SCN 4-10b*

If you want to learn the reactivity series, you could try making up a mnemonic or silly sentence to help. Here's one - can you do better?

"Pond slime can make a zoo interesting -the long crinkly sort goes purple."



Fruity Batteries 2

By Jerry Loomer *http://www.usc.edu/org/edisonchallenge/2008/ws1/FruitBatteries.pdf*

A battery *is an electronic device that* ***changes chemical energy into electrical energy****. The chemical energy is sort of like the energy in the food we eat. When we want to run or jump, our bodies change the food (chemical energy) into motion (kinetic energy). Similarly, the chemicals in a battery are storing energy that can be released as a flow of electrons (electric energy).*

Batteries need three parts*.*

1) ***A cathode (negative electrode), and***
2) ***anode (positive electrode), and***
3) ***an electrolyte (material to push the electrons)****.*

When making a fruit battery, the juiciness of the fruit or vegetable is the electrolyte, and the two metals inserted into the fruit are the electrodes. Which is the cathode and which is the anode depends on what pair of materials you are using.

Materials

- *Fruits or vegetables: lemon, orange, apple, kiwi, grapefruit, potato, sweet potato, onion.*
- *Metals: copper (penny), nickel (nickel), iron (regular nail), zinc (galvanized nail), aluminum, tin (solder), carbon (mechanical pencil lead), wood (dowel), plastic*
- *Paper Towels*
- *Multimeter*

Purpose:

- *The purpose of this experiment is to determine the electrical voltage output of different combinations of electrodes and fruits.*

It will also find out:-

- *which fruits give the highest voltage outputs.*
- *if the separation of the electrodes affects the voltage output.*
- *the voltage across different pairs of electrode materials.*
- *And examine the voltage outputs when the electrodes are connected in series and in parallel.*
- *the current produced by different pairs of electrodes.*
- *and examine whether the depth the electrode is inserted into the fruit affects either the voltage or amperage outputs.*

Procedure:

1) *Roll the fruit a little to make it a little juicier in the inside.*
2) *Insert one electrode material into the juicy part of the fruit.*
3) *Insert a second electrode into the juicy part of the fruit, but not so the two electrodes touch.*
4) *Measure the voltage across each pair of electrodes as explained below.*
5) *Place the ammeter in series and measure the current as explained below. You may require a small resistor to produce a load.*
6) *As you collect data, be sure to identify the fruit, the cathode material, the anode material, and the voltage that it reads so you can identify which experiment you were conducting.*
7) *As in all scientific work, only change one variable at a time. By keeping all of the other variables constant, you will be able to see if the one that you are changing is causing the effect. If you vary two or more between trials (different electrodes placed at different separations in different fruits and inserted down to different depths), the different voltage or current values that you get can't be tied directly to any particular variable.*

Voltage measurements:

- *Set the Multimeter so that it is measuring DCV (Direct Current Voltages).*
- *The 200mV setting will give voltage readings up to 2.000 volts. If the readings are too high or too low, just change the dial setting.*
- *It may be hard to maintain a solid contact with the pointed multimeter probes, it might be better if you use a pair of alligator clip leads and attach one side to the end of the pointed probe and clip the other end of the lead to the electrode. If you get a negative voltage reading, reverse the clips on the electrodes. The red lead goes to the anode of the fruit battery and the black lead goes to the cathode.*

Current measurements:

- *When making current measurements turn the dial on the Multimeter to and set the dial at the range setting most appropriate for the range of current readings you are experiencing. The 200 µA is the most sensitive, which means that it will record the smallest currents while the 200 m is the range for the largest currents. (Some multimeters adjust themselves automatically) You may need to use a digital meter.*

Analysis:

A line graph should be drawn if both sets of data are numerical values (ie. separation, depth) and the results (ie. Voltage or current) to show how the values change.

When the variable quantity is not a numerical value (ie. Type of fruit, type of anode), bar graphs of your results should be drawn.

Fruit Batteries Data Sheets

Question 1: Does the distance between the electrodes affect the voltage?

Measure the voltage as you change the distance between the electrodes. Be sure the electrodes are inserted parallel to each other and that they are inserted the same distance into the fruit each time. Use only one type of fruit.

Fruit				
Cathode				
Anode				
Separation (cm)	*1.0*	*2.0*	*3.0*	*4.0*
Voltage (V)				

Question 2: Does the distance between the electrodes affect the amperage?

Measure the current (mA) as you change the distance between the electrodes. Be sure the electrodes are inserted parallel to each other and that they are inserted the same distance into the fruit each time. Use only one type of fruit.

Fruit				
Cathode				
Anode				
Separation (cm)	*1.0*	*2.0*	*3.0*	*4.0*
Current (mA)				

Question 3: Does the type of fruit affect the voltage?

Measure the voltage as you change the type of fruit. Be sure the electrodes are inserted parallel to each other, that they are always the same distance apart, and that they are inserted the same distance each time.

Cathode				
Anode				
Separation (cm)				
Fruit				
Voltage (V)				

Question 4: Does the type of fruit affect the current?

Measure the current (mA) as you change the type of fruit. Be sure the electrodes are inserted parallel to each other, that they are always the same distance apart, and that they are inserted the same distance each time.

Cathode				
Anode				
Separation (cm)				
Fruit				
Current (mA)				

Question 5: Does the type of anode (-) affect the voltage?

Measure the voltage as you change the anode. Be sure the anodes are inserted parallel to the cathode and that they are inserted the same distance into the fruit each time. Use only one type of fruit. Use only one type of cathode although the experiment can be repeated with different cathodes and checked against the different types of anode materials.

Fruit				
Cathode				
Separation (cm)				
Anode				
Voltage (V)				

Question 6: Does the type of anode (-) affect the current?

Measure the current (mA) as you change the anode. Be sure the anodes are inserted parallel to the cathode and that they are inserted the same distance into the fruit each time. Use only one type of fruit. Use only one type of cathode although the experiment can be repeated with different cathodes and checked against the different types of anode materials.

Fruit				
Cathode				
Separation (cm)				
Anode				
Current (mA)				

Other Questions:

- *Does the insertion depth of the electrodes affect the voltage and/or current?*
- *Does the angle of insertion of the electrodes affect the voltage and/or current?*
- *How does having the electrodes touch above (or inside) the fruit affect the voltage and/or current?*
- *Using a crocodile clip leads, make a series set of fruit cells and see what maximum voltage you can get.*
- *Using crocodile clip leads, make a parallel set of fruit cells and determine what the largest current you can get is.*

Make a stack of alternating pennies and separated by paper towel pieces.

Use the multimeter to find the voltage and current across the stack. Now, dampen the paper towel pieces with salt water and see the voltage and current readings. Dry toweling is an insulator while the salt water brine is a conductor. Do lemon juice or other liquids work as well as (or better than) the salt water?

This stack of coins is a multi-celled battery just like your 12 volt car battery is really a collection of six 2-volt cells that are connected in series to add up to 12 volts.

The method below fits our course better.

ALTERNATIVE FRUITY BATTERIES

Oh no! You come home from work to discover there is no electrical current! Its winter and the days are getting short. You need to rig up some form of lighting so you can see what's gone wrong (or at least find your mobile to call the electricity company!). Luckily, you have items about the house to help you do this…..

*Alessandro Volta was a 19th Century Italian scientist. He made the first true cell that gave a controlled current. This was an electro-chemical cell. He realised that if you have two metals (**electrodes**), separated by a liquid (an **electrolyte**), electrical energy is produced as a result of a chemical reaction between the electrodes and electrolyte. Volta used paper soaked in salty water sandwiched between circles of zinc and copper for his cell – and piled many layers up to make a battery which is known as the **Voltaic Pile.***

How do these cells work?

There is a chemical reaction between two different types of metal electrodes and the electrolyte that connects them. Electrolytes include salty water and acids (like in car batteries). Metal electrodes pass electrons to each other through conducting wires if they are connected in a circuit. Some metals give energy away more easily than others. The electrolyte completes the circuit. This means we have a voltage because the electrical energy is flowing.

Different combinations of metal electrodes will give different voltages. Even different sizes of the same metals used will affect the voltage. The electrolyte may also affect the voltage produced. The number of cells joined together is the final factors that will affect your voltage output.

After having a look around the house, you have gathered the following equipment together:

Paper towels, selection of coins, salt, water, a lemon; a lime, an orange, a potato, a tomato, various strips of different metals, a selection of light lamps, crocodile clips, connecting wires, a voltmeter.

*Your task is to make two kinds of cells (or batteries) **– a voltaic pile** and **a fruit battery**. You will need as bright a light as possible to find the fault in the house, so you need to provide as much electrical energy to the lamp as you can. Use the voltmeter to measure the voltage from your 3 best combinations of cells/batteries. Complete the table below.*

Fruity batteries

1. Experiment with different combinations of electrode and electrolyte to find the cell that produces the highest voltage. You should work methodically and only change one variable at a time. Why is this important?

2. When you have found the best combination of fruit and electrodes, complete a table in your book to show the results from your 3 best combinations:

Highest voltages produced from electrode and electrolyte combinations

Fruit/vegetable used	*Electrodes used*	*Voltage (V)*

Voltaic pile

3. Experiment with different combinations of metals to fins the battery that produces the highest voltage. Again, make sure you only change one variable at a time to help you work out the best combination.

4. When you have found the 3 best combinations of metals, complete the table to show your results:

Highest voltages produced from different metal combinations

Combination of metals	*Voltage (V)*

5. For each of the batteries/cells, explain how you could increase the voltages produced.

Now try out your ideas and make a record of whether they worked.

6. What energy change takes place inside the batteries when they are operating?

7. Your batteries will eventually stop working. Explain why.

Homework/Extension

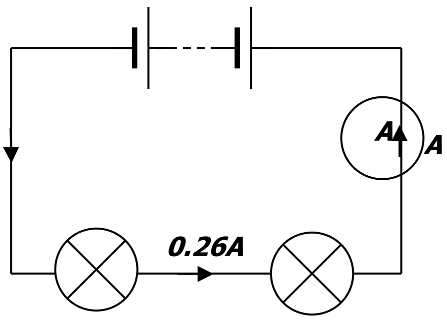
Find out how the following people were involved in the discovery and development of batteries:

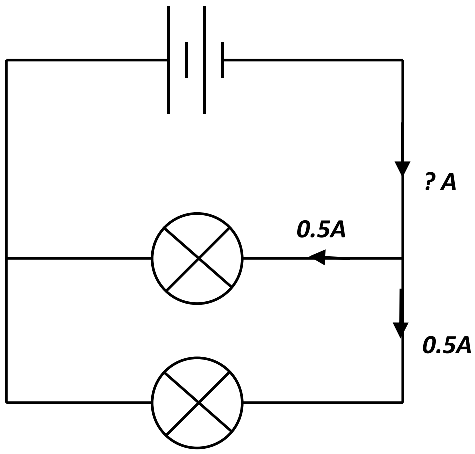
- Ω *Benjamin Franklin*
- Ω *Luigi Galvani*
- Ω *William Cruickshank*
- Ω *John Daniell*

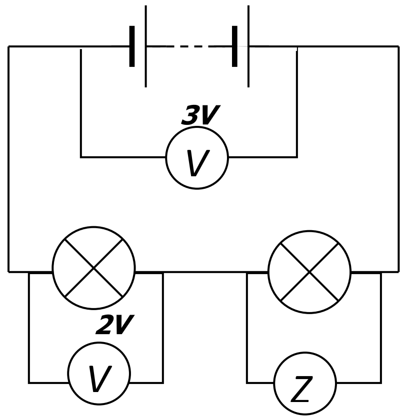
Describe their observations, experiments, problems encountered and how they were overcome.

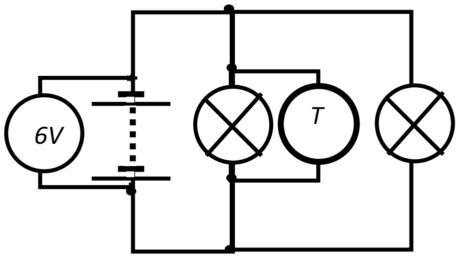
Revision

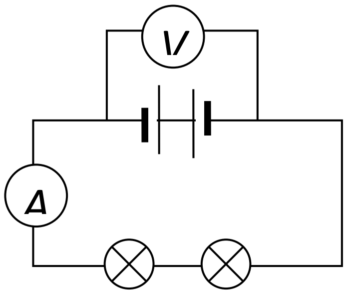
There is a revision sheet and a set of electrical dominoes. If you cut down the middle of the sheet and then into about 10 you get an answer, then a new question underneath with a further answer. If you match them correctly your last question should give you your first answer.

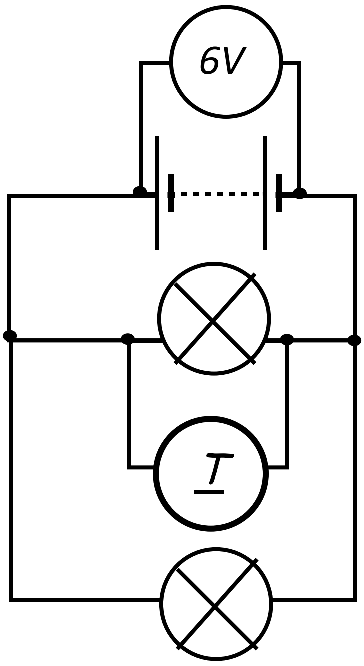

A
A
0.26A

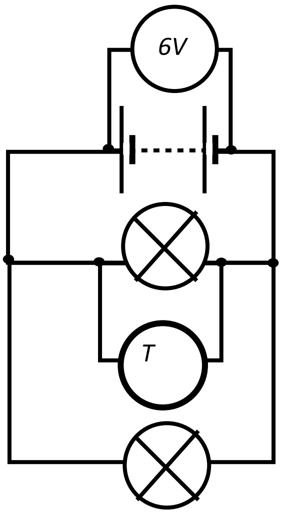

? A
0.5A
0.5A

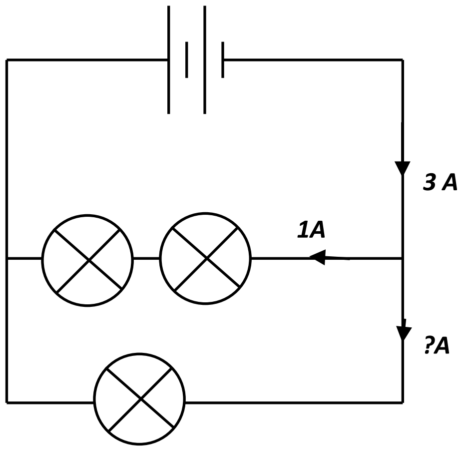

3V
V
2V
V
Z











Extension exercises

Resistance

Resistance is measured in OHMS (Ω)

Resistance opposes the flow of electrons or charge.

Measuring Resistance in series

PRACTICAL TASK

1. *Choose four resistors from the tray with a range of quoted values.*
2. *Using short leads and an ohmmeter find the measured resistance of each resistor and record this in the table.*
3. *Now connect two or more of the combine different resistor*

To find the total resistance in series we add up all the individual resistances

$R_T = R_1 + R_2 + R_3$

For example what is the total of a 5Ω, 7Ω and 15Ω resistor in series?

$R_1 = 5\Omega$
$R_2 = 7\Omega$
$R_3 = 15\Omega$

$R_T = R1 + R2 + R3$
$R_T = 5 + 7 + 15 = 27\Omega$

OHM'S LAW- Level 4

Ohm's law forms the basis for understanding how electrons or charge flows through circuits.

This is a very simple relationship that involves three things:

1) *the voltage or the push that move electrons through the circuit,*
2) *the current (or amps), which is a measure of how much electrical current is flowing through that circuit as a result of that push, and*
3) *the resistance (in ohms), which does all it can to make it difficult for the electrical current to flow.*

Ohm's Law deals with the relationship between voltage and current in an ideal conductor.

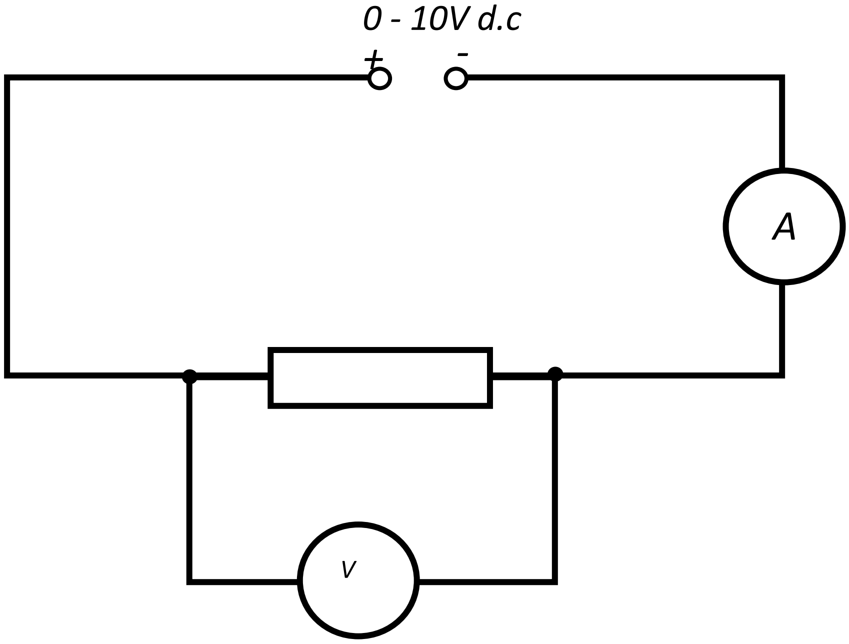
This relationship states that:

The potential difference (voltage) across an ideal conductor is proportional to the current through it.

Your task is to prove that OHM'S LAW is correct.

Collect the following equipment

1. *Power supply*
2. *5 wires/leads*
3. *a multimeter set up as an ammeter*
4. *a multimeter set up as a voltmeter*
5. *one of the ceramic resistors from the tray (3.3Ω, 5.6Ω, 10Ω, 15Ω, 22Ω)*



1. *Measure the actual resistance of your chosen resistor using an ohmmeter and record this in your jotter. Remember that you do not need a power supply to do this step*

2. *Then connect up the circuit as shown in the diagram below. The power supply must be set to 0 Volts. Use the*

d.c supply connections (red and black).

3. *Have your circuit checked by a teacher.*

4. *Make a table in your jotters, or preferably make a similar table in excel to record your results.*

5. *Take the readings from the Ammeter and Voltmeter for every turn of the power supply. Only take readings between 0 and 10V.*

6. *Plot a graph of voltage against current and try to find the gradient of your graph. If you use excel you can add a trendline and you can choose from the options to record the equation for the line in your graph.*

7. *If you have time repeat this for other resistors.*

Voltage	*Current*	*Resistance*
(V)	*(A)*	*(ohms)*
		5.4

Voltage	Current	Resistance
(V)	(A)	(ohms)
0.00	0.00	5.4
0.98	0.18	
1.34	0.25	
2.65	0.49	
3.77	0.70	
5.12	0.95	
6.19	1.15	
7.93	1.47	
8.97	1.66	

Here is an example of a table completed for one of the resistors with the corresponsding graph.

It is highly unlikely that all of your points will be on the straight line. Do not plot the point 0,0 on your graph

QUESTIONS/ EVALUATION

1. *What do you notice about the value of the current when the voltage increases?*
2. *What do you notice about the gradient of your graph?*
3. *Why might your graph not go through (0,0)? Look at the equipment to give you a clue?*
4. *You should have found out one of the most important formula for electrical current, and that is that the Voltage is equal to the current mulitplied by the resistance or as we would usually write it*

$$V = IR$$

where V=voltage or potential difference measured in volts

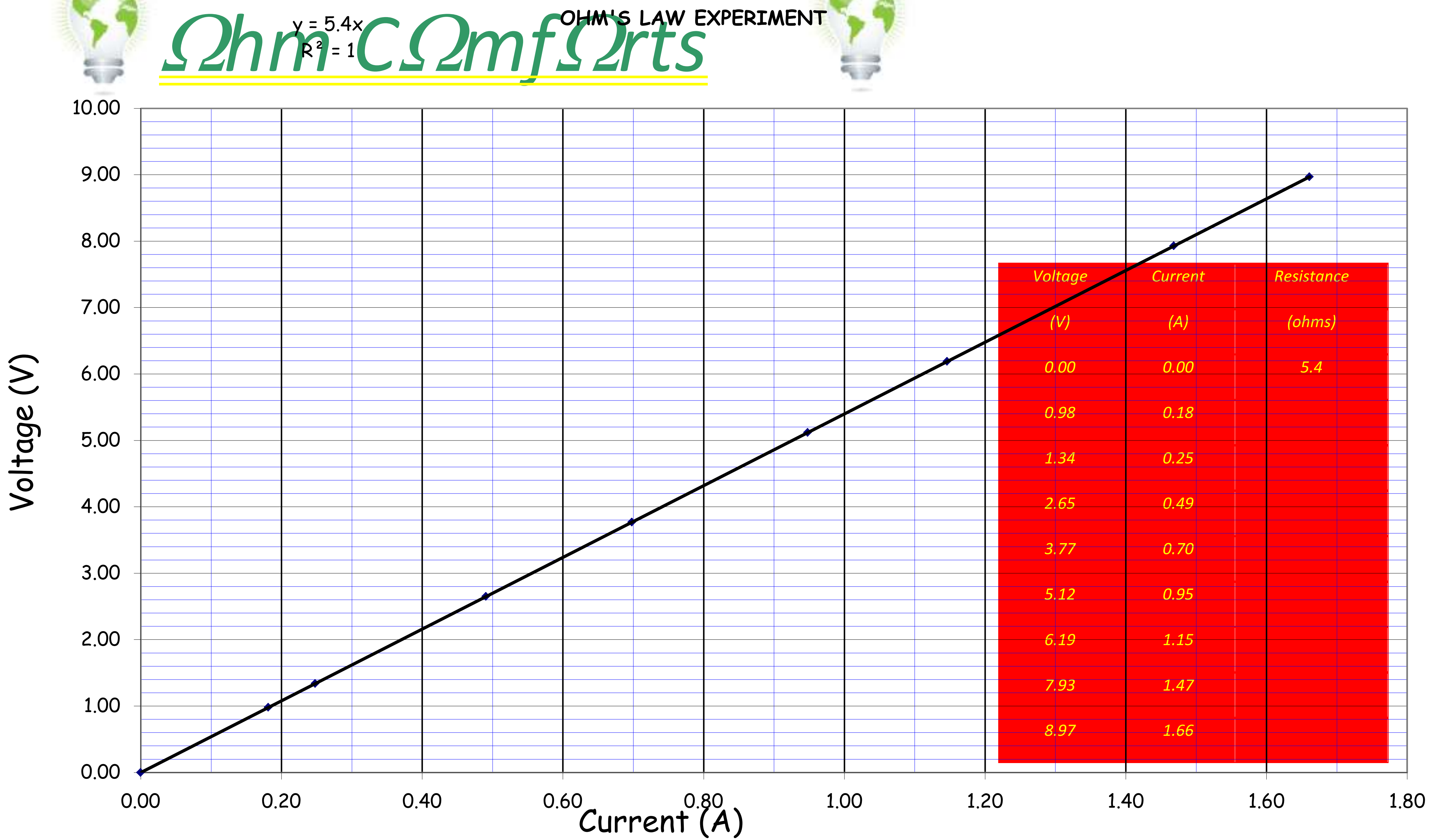
I= current measured in amp

and R= resistance measured in ohms

Now try these questions

1. *If there is a current of 3A through a 2.5Ω resistor, what is the voltage across the resistor?*
2. *A voltmeter across a power supply reads 12V, this is connected to a 6Ω resistor. What current would there be through the resistor?*
3. *What is the resistance of a resistor if a voltmeter across it reads 4V and the current in the resistor is 0.2A?*

ΩhmCΩmfΩrts



Voltage (V)	Current (A)	Resistance (ohms)
0.00	0.00	5.4
0.98	0.18	
1.34	0.25	
2.65	0.49	
3.77	0.70	
5.12	0.95	
6.19	1.15	
7.93	1.47	
8.97	1.66	

Lesson 16+ Design and Build

Aims for lesson 16- Design and Build

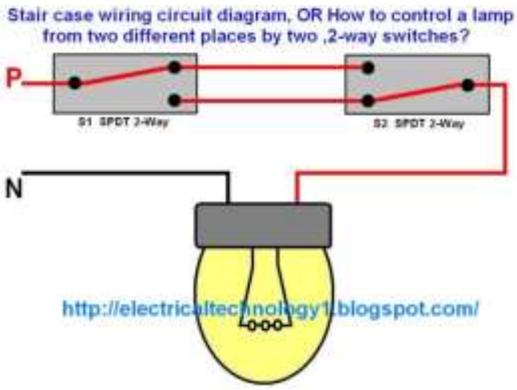
- ***equipment handling***
- ***Design/ construct/ test and modify***
- ***Risk Assessment***
- ***Diagram***
- ***Problem solving***
- ***observing***

There are various examples of circuits that the students can build.

RULES- unlike 2 in the picture it has to be an electrical circuit (not a pool table or an electrical chair unless it really lifts!) Someone really did make this running machine from Lego!

For example,

- *can they make a front and back door bell, either switch must operate the bell*
- *make a two way stair light for lighting the bottom and top of the stair, this will require 2 two way switches*



- *.BBQ see photos*
- *Microwave (see photos)*
- *Fridge with a light that comes on as the door is opened.*
- *Door Bell*
- *Burglar Alarm*

We also have some electronic boards that the students can use. I will try to make up some sheets to explain how these work, unless someone wants to help me with this.

-  

Any concerns if the circuit is safe or buildable see Mrs H or Mr H, or set it up and don't turn it on until it is checked. I am afraid I can't find the excellent fridge that was made. This had a door where the light came on as the door was opened. Students brought in clay to make the food. Great fun and great Physics!

Don't forget to wear your badge if you get through the course and certificate of completion!

Hope you found this useful and not a bore. Cut out what's superfluous!

Appendix 1

Storyline for the Ohm Comforts Programme

Terry & June Easdale are purchasing a brand new house in the Lockerbie Area. The survey report is in and they have contacted Ωhm CΩmfΩrts to provide them with additional comforts for their house.

You are to design and build one or more of the following to help the Easdales.

For each circuit you need to include a plan, circuit diagram, description, and photo of what you did. Record any information that you learned as you put together the material. Can you cost the project for the Easdales?

1. *Design a door bell circuit that can work from the front and back door.*
2. *A set of lights for the outside of the house for their house warming party celebrations. It is also nearly Christmas and they might want to celebrate that too.*
3. *Currently there are several flight of stairs in the house and no stair lights (this was pointed out in the survey as very dangerous). Can you design a stair light that can be switched on and off from either the top or the bottom of each flight of stairs.*
4. *The Easdales are worried about their security. What circuits can you build to deter burglars?*
5. *MAKE UP YOUR OWN CIRCUITS that would improve the quality of life for the Easdales in their new home.*

Appendix 2

Magnox Cottage, 23 Ulverston Way Walton, Lockerbie, CU2 8RS

A delightful detached three and a half storey dwellinghouse situated in a prominent position in a well established residential area convenient for town centre and local amenities. The property has a bay front window and offers flexible accommodation. The house benefits from a basement with separate entrance with potential for conversion to a granny flat. The house has gas central heating, lead effect glazed windows and beautifully presented patio. The property is situated in a sought after residential neighbourhood, in the Lockerbie Academy catchment area.

Offers in the region of £247.490

For further information contact:
The seller Ms D Barton or the agent on
Tel: 01229 231707

Lockerbie is a busy town which gives easy access to the nearby M74 motorway. There is a wide range of local amenities including church, library, railway station, shops, hotels, and various leisure activities.

ACCOMMODATION comprises

Entrance

Climb up a flight of 6 stairs and enter via a wooden front door with leaded windows. The entrance hall connects to the kitchen and dining room

Kitchen

3.22m by 3.96m

The house benefits from a fitted kitchen. The kitchen has one window to the front with leaded glass. The light is of rise and fall style.

Dining Room

A separate large dining room 4.25m by 3.96m with a bay window to the front with leaded windows. Fitted carpets and ceiling light

Stairs from the dining hall lead to the third floor.

Sitting Room

3.22m by 3.96m. Double glazed leaded window to the front, spectacular Georgian fire place with electric fire; polished brass wall lights with white shades either side of the fireplace; fully fitted carpet.

Bedroom 1

4.26m by 3.96m. Double glazed leaded windows with fitted carpet.

Stairs from the third floor lead to the attic floor

Bathroom

3.28m by 3.96m. Dormer leaded windows.

Three piece white suite comprising w.c., pedestal sink and bath connected to full services; fitted carpet; wall mirror and shaving point

Bedroom 2 / Nursery

4.32 by 3.96m

Dormer leaded windows; fitted carpets

BASEMENT

Bedroom 3 /Games Room/ Granny flat

4.21m by 4.72m

Large leaded window to front; fitted carpet.

Office / Granny flat/ Snug

3.24m by 4.73m

Large leaded window to front; fitted carpet

OUTSIDE

GARDEN

A lower level terrace, good for alfresco dining.

Drying area

Secluded paved seating area to the front which can be a sun-trap.

Notes

Council Tax Band F.

Services

Mains water, electricity, gas and drainage. The telephone may be taken over subject to the usual British Telecom regulations.

Burdens

The subjects are sold subject to the burdens and conditions and others contained or referred to in the title deeds or otherwise affecting the same.

OFFERS

A closing date for offers may be fixed therefore it would be most advisable for prospective purchasers to register their interest with the Selling Agents.

ENTRY

Entry as may be arranged. Interest at the rate of 5% above the Royal Bank of Scotland Base Rate will be payable on the price from the date of entry to the date of settlement notwithstanding consignation.

We, Jules Watt & Partners, the Agents, have not tested any structures, apparatus, equipment (electrical or otherwise), fixtures, fittings or services and therefore cannot verify that they are sound, in working order to fit for purpose, and room sizes are not guaranteed. Prospective purchasers are advised to have any matters critical to their needs, verified by their Solicitor, Surveyor or appropriate adviser.