Topic: Circuits and Electric Charge

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Issues tackled:

1. **Key ideas, use of language and terminology - Explaining static electricity.**
2. **Models and analogies – Explaining simple circuits.**
3. **Practical work – The Van de Graaf generator.**
4. **Investigative skills – Graphs of current and voltage.**

Issue 1: Key ideas, use of language and terminology – Explaining static electricity.

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:

1. Investigate balloons, rods and dusters and how they can be used to explain the basic idea of static electricity.
2. Research explanations of static electricity in terms of electron movement and charge.

Possible activities during tutorial:

1. Show some simple demonstrations of static electricity as trialled. Work together to explain what is happening.
2. Mentor will demonstrate some effects of static electricity. Use the knowledge researched to explain why they happen.

AST Input:

- Talk through static charges and explain / describe everyday examples that can be brought into the discussion e.g. operating theatres, thunder and lightning, refuelling planes, crop spraying, car spraying, photocopiers and ink jet printers.
- Link these to electron movement and charge.

Reading:

Subject knowledge and understanding

GCSE syllabus.

Any GCSE text book (up to date).

Subject pedagogy

Johnson, K. and Ryan, L. (2004) Physics for You, Nelson Thornes, Cheltenham. Has suggestions for demonstrations/experiments on static electricity.

Useful websites and applications

Resources:

Task 1 and **Tutorial**

Equipment for demonstrations of static electricity, which may include:
nylon/perspex/ebonite/glass rods,
wool and cotton cloths,
gold leaf electroscope,
balloon, comb, tissue paper, polystyrene beads.

Issue 2: Models & analogies – Explaining simple circuits.

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:
1. Research models and analogies on the internet to explain simple series circuits. Choose two analogies to discuss the merit of in the tutorial.
2. Use the school electrical equipment to make and test some simple series circuits.

Possible activities during tutorial:
1. Present the analogies researched to explain a simple series circuit. Discuss the merits and limitations of each analogy.
2. Build and explain a simple series circuit (e.g. 2 lamps). Discuss possible analogies to explain what is happening.

AST Input:

- Demonstrate the rope analogy.
- Input ideas and limitations of analogies.

Reading:

Subject knowledge and understanding

KS4 & AS Textbooks available.

Subject pedagogy

Solomon, J., chapter 4 in Sang, D (Ed), (2002), **Teaching Secondary Physics**, John Murray, London.

Useful websites and applications

The excellent CD-ROM **Supporting Physics Teaching 11-14**, produced by the IOP, shows an analogy to explain circuits. See www.iop.org for information.

There are some applets and worksheets which may be of use at www.hazelwood.K12.mo.us/~grichert/sciweb/applets.html

There are some useful self study notes to be found at www.le.ac.uk/se/centres/sci/selfstudy/eam8.htm

Resources:

Task 2
Circuit apparatus used at KS4 in school. For example:
Power packs, connecting wires, light bulbs in holders, buzzers, motors.

For the **Tutorial**
Lengths of 8m rope loops

Issue 3: Practical work – The Van de Graaff generator.

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:

1. Get out the Van de Graaff generator and use it to produce sparks. Explain why it works. Ask a teacher or technician to show you what to do.
2. Prepare a worksheet that can be used in a lesson with the Van de Graaf generator.
3. Look up health and safety issues relating to the Van be Graaf generator and prepare a risk assessment.

Possible activities during tutorial:

1. Demonstrate the Van de Graaff generator. Discuss the various experiments and demonstrations available.
2. Present the worksheet and show how it fits with the demonstration of the Van de Graaff generator.
3. Present the risk assessment and discuss the precautions which should be taken when using the generator a) with your own class and b) on an open evening.

AST Input:

- Explain how it works and the learning points which can be drawn out during the lesson.
- Show some tricks to improve the performance e.g. hair drier, open windows, weather to avoid, talc on belt.
- Introduce the concept of breakdown voltage of air and the size of spark. Link to safety with electrical pylons and in situations where there is a flammable gas or liquid (gas leak, refuelling aircraft etc.).

Reading:

Subject knowledge and understanding

Any KS4 Text.

Subject pedagogy

Useful websites and applications

Resources:

Task 1 and **tutorial**
Van de Graaff generator and accessories.

Task 3
CLEAPSS folder.

Issue 4: Investigative skills – Graphs of current and voltage.

Prior knowledge and experience:

Possible tasks:

Preparation for tutorial:

1. Do an experiment to collect a set of data of the potential difference across and current through a filament lamp. Take enough readings (about 10) of p.d. and current to plot a graph.
2. Use data provided to plot a graph of current versus potential difference for a filament lamp and a resistor.

Possible activities during tutorial:

1. Discuss the experiment and whether it should be conducted as a demonstration, class practical or investigation with the class. Discuss the difficulties which pupils may experience with finding an appropriate range and with negative readings.
2. Discuss the problems pupils have in drawing line graphs of this nature; choice of scales, plotting results to 1 or 2 d.p. and adding a line of best fit.

AST Input:

- Look at the conclusions which can be drawn by considering graph shape alone (i.e. not the numbers).
- Show the graphs expected for a wire, resistor, filament, lamp and diode and explain their shape.
- Work with trainees to plan a lesson activity or investigation.
- Show digital multimeter, or ammeters and voltmeters as appropriate.
- Go through Ohm's Law (not V=IR) with the trainee.

Reading:

Subject knowledge and understanding

Any KS4 text book as available in school.

Appropriate exam board specification.

Subject pedagogy

Solomon, J., chapter 4 in Sang, D. (2002), **Teaching Secondary Physics**, John Murray, London.

Useful websites and applications

There are lots of links on this web page; some a bit heavy going but others good.
www.sheffcol.ac.uk/links/Science/Physics/Electricity_and_Magnetism/

For virtual circuit building have a look at **crocodile clips** , available on many school networks. Or for information and downloads go to www.crocodile-clips.com

Information about current, voltage and resistance can be found at
www.doctronics.co.uk/circuits.htm

Resources:

For **task 1**
Equipment to measure p.d. and current for a filament lamp e.g.
Power pack, voltmeter, ammeter, (or multimeters), rheostat, 12V filament lamp, leads.

For **task 2**
Sets of data of p.d. and current for a resistor and a filament lamp.

Tutorial
Equipment as suggested for task 1
Diode and protective resistor,
Various resistors,
Mulitmeters,
Assorted wire – copper and nichrome – beware of heating effect!