Microteaching Lesson Plan
(Final)

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1 Background: Topic, Subtopics, Class, Location

Static Electricity: Introduction to electrostatics, charging by induction, and practical uses of static electricity for Secondary Four Express mixed ability class.

As this is a mixed ability class, the lesson will not attempt to cover the entire topic of static electricity (forgoing the sections on electric fields and hazards of electrostatics). Instead, a more comprehensive approach to conceptual development and induction by experimentation is favoured.

The class is to be conducted in a computer laboratory, but the students will not need to use their computers until the second half of the class.

2 Lesson Objectives

At the end of the lesson, students should be able to

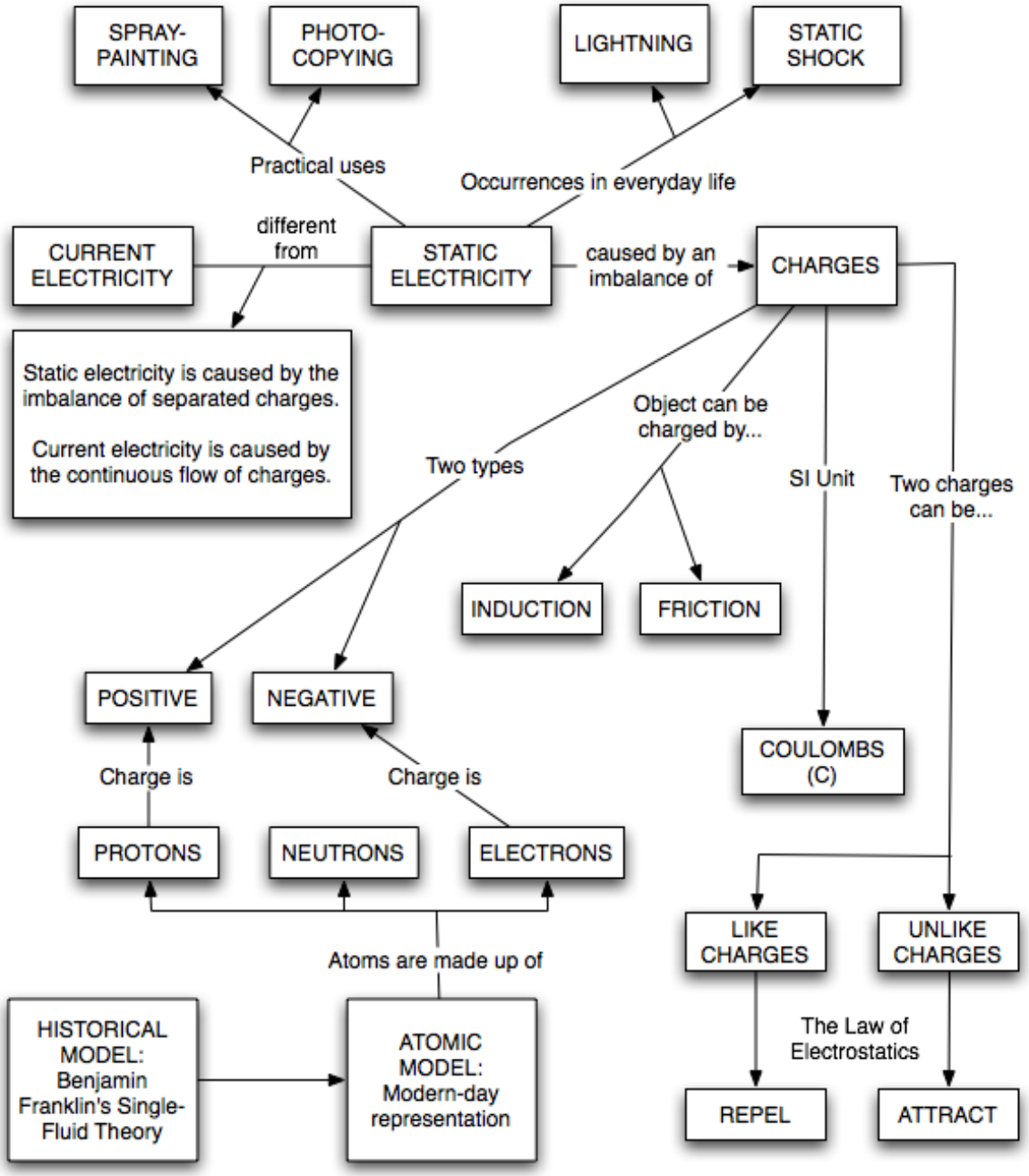
1. state that there are two types of charges, positive and negative, and that charge is measured in coulombs.
2. state qualitatively the difference between current and static electricity.
3. explain that electrostatic charging by friction or rubbing results in a transfer of electrons.
4. state the law of electrostatics, that unlike charges attract and like charges repel.
5. describe experiments to show electrostatic charging by induction.
6. describe an example of the use of electrostatic charging (such as a photocopier or spraying of paint).

3 Prior Knowledge

Before the lesson, students should be able to

1. describe an atom as an electrically neutral entity making up of a positively charged nucleus (protons and neutrons) with negatively charged electrons moving round the nucleus
2. describe that a charged ion is formed when an atom gains or loses electron(s)
3. explain qualitatively what is meant by current in a circuit

4 Concepts



5 Learning Resources

- Students' material:
  - Perspex rods
  - Polythene rods
  - Retort stand with string
  - Plastic ruler

  - Pieces of paper
  - Long balloons
  - Cloth
- Teacher's demonstration material:
  - Gold-leaf electroscope
  - Metal spheres on insulating stands

6 Set Induction

The lesson begins with a series of hands-on experiments – "make your own magic" – to pique the students' interest in the subject. The material designated "students' material" above is distributed to each pair of students, together with "Worksheet 1" which looks like a quiz, but is mostly blank except for spaces to fill in their names and class. The (fake) "quiz" element would help to capture the students' attention.

The students are told to inflate the long balloons and try two experiments: run the balloon over their partners' hair and note that it can make his/her hair stand. Next, try to stick the rubbed side of the balloon against the wall – it will seemingly defying the laws of gravity.

The students will then be told to tear up "Worksheet 1" into small pieces of paper, a guideline for the size of which will be shown on the OHP. This will provide kinaesthetic learners a chance for hands-on activity and greater involvement in their own learning. Students will place their small pieces of paper on the table and rub their provided plastic rulers with the cloth. By bringing the ruler near the pieces of paper, students would observe that the ruler "magically" attracts the pieces of paper to itself, seemingly defying gravity.

At this point, ask the students what kind of forces they know about other than gravity, and introduce the term "static electricity" to begin the topic. Further hooks into the topic can be provided with some real-life static electricity examples, such as thunderstorm clouds and anecdotes of static shock (though the latter is not as applicable in this country).

7 Lesson Development

7.1 Teaching Method, Class Organisation

The lesson will be led by the teacher, alternating between teacher-centred explanations of new concepts and student-centred experimentation and discussions. Students will have access to computers for demonstration purposes and for simple research tasks such as finding examples for the use of static electricity in practical applications. Teacher-centred instruction will be interspersed with leading / Socratic questions to encourage higher-order thinking in the students.

7.2 Key Questions

Below are some key questions that will either encourage the students to think and apply scientific reasoning skills to the topic at hand, or gauge the students' understanding of what they have been presented with thus far.

- What do you observe from the initial demonstrations? What do you think it is caused by?
- If an atom is electrically neutral, what happens when you remove an electron of charge negative-one from it?
- Where else have you seen the phenomenon of static electricity?
- What do you remember learning about electricity? How is this different?
- Why do fuel-carrying trucks usually have a metal chain dangling from the metal body of the truck to the ground?

7.3 Historical Perspective

The work of Benjamin Franklin, the "father of electricity", will be introduced, specifically his "single-fluid" theory which forms the conceptual base of electrostatics. This provides some historical perspective into how charge was discovered, and some interesting facts such as how Franklin coined the terms "battery", "charge", "conductor" and positive and negative charges way back in the 1700's. Furthermore, Franklin's discovery that lightning is a form of electricity (from the famous, and possibly embellished, story of his flying a kite in a lightning storm) is an effective lead-in to one demonstration of static electricity in nature: the formation of storm clouds.

7.4 Use of IT

After the experiments of the Set Induction, there will be a brief teacher-centric portion of the class that focuses on concept development. To liven up the class, a video will be shown at the beginning of class (obtained from *Teachers' Domain* – see references for actual URLs) that demonstrates more dramatically electrostatic attraction between objects. As a refresher for the students on the topic of atomic structure, an applet from *Physics 2000* will be used to illustrate the atomic structure of various elements.

Animations will be used to provide visual learning aids. These are obtained from the *The Physics Classroom*, which provide animated sequences demonstrating charging by induction on a single metal sphere and two metal spheres. This will be used to enhance the experience of seeing the demonstration with the metal spheres, since the charges on each sphere are not immediately obvious. Since the demonstration can only be to a small group at a time, other groups will have to do their own reading on this site to fill up the worksheet provided.

Furthermore, students will be given time to visit the Science Joy Wagon electrostatics site "Electrostatic Lab Activities Explained" to further their understanding of the topic.

7.5 Collaborative Learning

Students will be working in pairs for the mini-experiments that they have to perform, for example with the balloons and paper in the first experiment, and later again with the different types of rods to determine the existence of like and unlike charges. The students will be encouraged to work together to determine answers to their worksheets. Using the "think-pair-share" strategy, the students will discuss in pairs and some will be called upon to present their findings to the class.

8 Lesson Closure

Students will be asked to recall what they have learnt during the lesson before being presented with a brief summary, serving to address the content and process learning outcomes of the lesson. They will be told to complete their worksheets. These worksheets will serve as indicators of successful learning, hence one of the worksheets is a simple concept map of what they have learnt in this class that can be completed and discussed in class to clarify any alternative conceptions.

As the topic is only to be concluded in the next lesson (this lesson plan has not covered electric fields and the hazards of static electricity), the students will be shown a picture of a petrol-transporting truck, and will be asked to think about why such trucks usually have a metal chain dangling from the metal body of the truck to the ground.

9 References

- Educator's Reference Desk. Lesson plan on "Attracting Balloons": `http://www.eduref.org/cgi-bin/printlessons.cgi/Virtual/Lessons/Science/Physics/PHS0003.html`
- GCE 'O' Level Physics Syllabus 5052
- Johnson, K. (1987). *GCSE Physics for you*. Hutchinson Education: London, UK.
- Longman Singapore. Schools/Teachers resources website: `http://www.longman.com.sg`

- Ministry of Education. *Lower Secondary Science Syllabus.* Singapore.
- Physics 2000, University of Colorado at Boulder. Applet "Dave Whizzy's Periodic Table": `http://www.colorado.edu/physics/2000/applets/a2.html`
- Physics Classroom. Tutorial on "Inducing a Positive Charge on a Sphere": `http://www.physicsclassroom.com/mmedia/estatics/isop.html`
- Physics Classroom. Tutorial on "Charging a Two-Sphere System by Induction Using a Negative Object": `http://www.physicsclassroom.com/mmedia/estatics/itsn.html`
- Science Joy Wagon. Site on "Electrostatic Lab Activities Explained": `http://www.regentsprep.org/Regents/physics/phys03/aeleclab/default.htm`
- Teachers' Domain. Site on "Static Electricity: Snap, Crackle, Jump": `http://www.teachersdomain.org/3-5/sci/phys/mfe/zsnap/index.html`
- US History.org. Site on "The Electric Franklin": `http://www.ushistory.org/franklin/kite/`

10 Detailed Lesson Plan

Time	Activities	Resources	Rationale
8 min	Trigger activity Ensure that students are seated in pairs. Hand out worksheets and material. Students are to write their names on their (blank) "Worksheet 1" (which looks suspiciously like a quiz) and inflate the balloon given. The first experiment involves having the students rub their balloons against their partner's hair and moving it away. **What do they notice about the balloons and hair after rubbing?** The students should then attempting to stick their balloons on the wall, using the side that was rubbed against hair. Questions: **Would the balloon normally stick to the wall? Is there anything working to keep it stuck?** The students will be told to tear up their "Worksheet 1" into little pieces. Show how small the pieces should be in order to have a working experiment. Once this is complete, the students should rub their rulers with the cloth – ask **if they notice a common step in both experiments?** (both require frictional contact or rubbing) – and then the students are to bring their rulers close to the paper to attract the little pieces to the ruler.	Pieces of paper, balloon, ruler, cloth	These are student-centred activities that will engage the students' interest in the new topic by giving the students something to actually touch and do instead of diving straight into conceptual development. These two mini-experiments demonstrate that rubbing objects together causes something to happen, a concept that will be further developed into charging by physical contact.

Time	Activities	Resources	Rationale
12 min	Introduction of charges and charging by contact Show video[1] on charging an old record to pick up light cereals. Ask students **what causes things to move from rest?** (Forces). **What kind of forces are at work on the balloon and on the pieces of paper?** (Gravity, and...?) Leave question unanswered for now. Tell the story of Benjamin Franklin and his single-fluid theory using slides, re-establishing that there are two types of charges, positive and negative. Recap on modern representation of atomic structure, and show Java applet for structural representation of elements in the periodic table of elements[2]. Ask students to recall: **What are the charges of protons, neutrons and electrons?** Follow-up with: **Why is an atom electrically neutral? What happens when you take away electrons from a neutral atom?** Establish that neutral bodies have equal amounts of positive and negative charges, and that charging requires a transfer of electrons, achieved by contact / rubbing. Hence introduce concept of static charge as a result of electron transfer, unit and positive and negative charges. Demonstrate with slides on Ben Franklin and balloon. Show IT demo from "Science Joy Wagon" site[3] that shows what happens to balloon, hair and wall. Provide concrete example of how lightning is formed through static electricity (transfer of electrons). Recall previous concepts of electricity and current from lower secondary Science syllabus, and ask **what is different about current electricity and static electricity?** Prompt the students, **what else do the words "static" and "current" mean outside of electricity?** Clarify that one is moving, and one stationary, hence the name. Students to fill up part of concept map, "Worksheet 2" and get ready for experiments in "Worksheet 3".	Powerpoint slides, Quicktime video, Java applets, worksheet	This section is more teacher-centric in order to introduce the concepts of charge and charging by friction. As such, there is greater use of multimedia in this section to attract the students' attention and keep them focused. By covering past topics from lower secondary Science, this part of the lesson plan builds on past knowledge (assimilation and accommodation). However, there is a need to prevent students from confusing the concepts of static and current electricity, which the last portion addresses. Relating to atomic structure of matter spurs interest as cross-module linkage (relates to Chemistry).

[1] http://www.teachersdomain.org/3-5/sci/phys/mfe/zsnap/index.html
[2] http://www.colorado.edu/physics/2000/applets/a2.html
[3] http://www.regentsprep.org/Regents/physics/phys03/aeleclab/ballrub.htm

Time	Activities	Resources	Rationale
15 min	Law of electrostatics: Experimentation Students, working in pairs, are to perform experiments listed on "Worksheet 3" designed to establish the laws of electrostatics using hanging perspex and polythene rods (and the other insulators previously handed out). The experiments are simple: Students are to hang one test item on a string from the retort stand, and bring other test items near. This way, students will determine for themselves that the same items repel each other, whereas some different items will attract each other. If the students complete their worksheets early, they can begin answering the thinking questions on the next page, which induce an understanding of the law of electrostatics from the experiment. Students will be encouraged to discuss in pairs.	Perspex rods, polythene rods, plastic ruler, retort stand, ruler, cloth, worksheet	Allow students the chance for discovery and a platform for drawing their own conclusions. By letting the students engage in pair work, build their collaborative learning abilities and gain from one another's insights into the process of scientific discovery.
7 min	Law of electrostatics: Theory Students to stop experiment and discussions. A few pairs will be called upon to share their results and conclusions from the experiment. Other students will be encouraged to critique and lend their opinions on results observed by those sharing. Through a series of Socratic questioning, students will be able to determine that the same objects will repel each other, whereas some different objects attract. Introduce law of electrostatics – like charges repel, unlike charges attract. The questions to be asked are presented in the worksheet and slides, to be shown one after another after eliciting the wanted response (or asking the students to think about their responses if they rush to give a misconceived answer). For example, to determine that like charges repel, first determine if two same objects will develop the same charge when rubbed: **Are two of the same objects, rubbed with the same cloth, of the same charge?**, then ask students **What can you conclude about how these two objects of the same charge interacted?**.	Powerpoint, worksheet	Give students a chance to share their findings and discuss their theories and conclusions scientifically with the rest of the class, while fostering a vibrant and open environment for discussion and opinion. "Think-pair-share" lets quieter students share their views in private discussion before speaking up.

Time	Activities	Resources	Rationale
13 min	Charging by induction This section is more teacher-centric, driven by a series of demonstrations using the gold-leaf electroscope and metal spheres. Teacher will demonstrate charging one object by induction (grounding) and charging two objects by induction (separation). Done in small groups to allow students to see the results better, while others will be directed to the websites[4] that explain in detail some of the phenomena the students have seen thus far (e.g., the latter site gives explanations of the balloon-hair experiment). The actual demonstration will be carried out by the teacher between groups. First, demonstrate charging by induction by bringing a charged perspex or polythene rod to the gold leaf electroscope plate, noting how the gold leaf rises when the ruler touches the plate. Ask the students, **Why do you think the leaf rises by itself even though just one charge has been introduced?**, **Can you draw for me on a piece of paper what happens to the electrons in each step?**, to induce the idea of charging by induction. Show also induction using the metal spheres – first, charging the sphere by grounding it after bringing the charged rod near. Ask, **How can you use the equipment at hand to prove what charge it is?** Next, demonstrate charging the sphere by contact, and ask, **What do you think the charges on each are?**, **Can you draw the electron movements?**	Metal spheres, electroscope, websites	Using the metal spheres and the gold leaf electroscope, students are provided with a concrete demonstration of charging by induction, reinforced by self-learning from website. This would fulfil the objective of students having to learn methods of charging by induction.
10 min	Practical uses of static electricity Ask students to think of some practical uses of static electricity, hinting that the teacher had to use one to get all these worksheets out. Briefly introduce the mechanism behind the photocopier and paint-spraying (see slides for further detail).	Powerpoint	This portion provides concrete examples and practical usage for an otherwise abstract topic, and fulfils the final lesson objective.

[4] `http://www.physicsclassroom.com/mmedia/estatics/itsn.html` and `http://www.regentsprep.org/Regents/physics/phys03/aeleclab/default.htm`

Time	Activities	Resources	Rationale
5 min	Lesson closure Ask for any questions, and invite students to show their concept maps to the class. Show the completed concept map while going through briefly each item, summarising the key learning points from the day, and finally ask students to do their final worksheet ("worksheet 4") as homework to be submitted next lesson. Finally, as a lead-in to the next lesson, ask students to think about **why fuel-carrying trucks usually have a metal chain dangling from the metal body of the truck to the ground?**	Powerpoint, worksheet	Summarise the lesson, clear any misconceptions and end with an interesting question to ponder for the next lesson.

11 Reflection on Lesson Plan

This lesson plan is aimed at a mixed, mid-ability Secondary 4 Express class, with the necessary age and maturity to handle the change in pace from experiments to teacher-talk to multimedia. However, much setup and preparation work is necessary on the teacher's part before the lesson to ensure a smooth implementation. If executed effectively,this lesson plan should be able to engage students at every step of the way, gaining their interest at the very beginning with the set induction and holding it till the end.

12 Reflection on Microteaching

I felt that the microteaching portion of this lesson planning assignment went well, in that I was able to develop the concept clearly and with some interesting use of multimedia (e.g. Quicktime demonstration movie, Java applet, various animated graphics files). Nevertheless, one problem I might face in the future is that it took quite a while to search for all the multimedia resources that I ended up using, time that might not be so readily available when I begin teaching. Hopefully, with practice, some of this lesson planning comes more naturally.

Having taught before in various environments, I had received quite some practice in voice projection and picked up some teaching practice. That said, I still found myself a little bewildered at times when faced with all the prepared material with no apparent sign of where to go next during the lesson. Once again, I hope that with experience, this problem would fade away.

Finally on the microteaching, I thoroughly enjoyed watching my fellow trainee teachers' microteaching sessions, because of all the different and innovative styles they brought to the fold. With the added perspective of observing as a partially-trained teacher (instead of as a student or untrained teacher), these sessions have proven to be truly enriching.

13 Appendices

- Slides from Powerpoint presentation
- **Worksheet 1**: "Really Important Quiz" (to be torn up)
- **Worksheet 2**: "Concept Map"
- **Worksheet 3**:"Investigating the Law of Electrostatics"
- **Worksheet 4**: "Summary worksheet" (homework)