Senior secondary

Physical Science: Tutorial plans 1–15

Tutor handbook

Forum for African Women Educationalists in Malawi (FAWEMA)

"Supporting Girls and Women to Acquire Education for Development"

Keeping Girls in School scholarship programme
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‘Keeping Girls in School’ Scholarship Programme

Tutor's Folder MSCE Resources: 2014–15

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MSCE S1: Elements and Chemical Bonding: Tutorial 1

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- explain the difference between a pure substance and a mixture
- explain the difference between a element and a compound
- state the names and symbols of the first 20 elements.

2. Introduction to the course and outline of the purpose and structure of the tutorials (15 minutes)

3. Elements and chemical bonding: thought balloons (30 minutes)

This is a 'prepare for learning' activity. Ask the Scholars working alone to complete a thought balloon on elements and chemical bonding. Walkabout! When the thought balloons are ready, either pin them up on the walls, or if this is not possible, lay them on the desks or even find some free space on the floor for the posters. Allow the Scholars to freely circulate to see and discuss each other's thought balloons for the remaining 10 minutes of this session.

Pedagogic point: A thought balloon is an alternative to a semantic map and is a more open ended technique where the Scholars can record any past experiences, key words, pictures, opinions, feelings, questions they would like to ask about a particular issue, focus question or topic. Scholars place one 'thought' in each of the balloon's sections.

4. Pure substances and mixtures: peer share (20 minutes)

Start the activity by showing the Scholars a few examples of pure substances and a few examples of mixtures. Give the Scholars about 5 minutes to briefly review their lists of pure substances and mixtures in Unit S1 of the Scholar's MSCE Resources Folder. They can then spend the next 10 minutes discussing and comparing their lists with those another Scholar and together they can come to a shared understanding of the difference between a pure substance and a mixture.

Tip: as this activity starts with a demo, you will need to have prepared the samples of pure substances and mixtures in advance.

5. Elements and compounds: teaching (30minutes)

This is a Tutor-led section on elements and compounds (15 minutes). If at all possible demonstrate examples of both with real substances. The key teaching points to cover include:

a. In an element, all the small particles (atoms) in the substance are identical
b. The atoms in any element are different from the atoms of any other element
c. Compounds have more than one element in them and are created by chemical reactions
d. Elements are listed in the periodic table.

6. Elements and compounds: key words 'mingling' (30 minutes)

Remove all access to notes and books; allow the Scholars 5 minutes to complete the table below from memory with their first-guess definitions of the main key words discussed so far (see the table below for the main ones but you can add more key words if you like). Take the Scholars outside, or move to a place in the classroom where there is space for everybody to move around freely. Ask the Scholars to revisit their original definition by asking two other Scholars for their definitions in turn so that they end up with a third and hopefully correct final iteration of the definitions. Encourage the Scholars to speak to other Scholars they have not spoken to before, perhaps to other Scholars from outside their school group. You can do this by asking the Scholars to begin walking around randomly – when you shout 'Stop', they must talk to the Scholar nearest them. This activity works very well if you have music – instead of shouting 'Stop', you just switch the music off.

Key word	First definition	Second definition	Third and final definition
Pure substance			
Mixture			
Element			
Compound			

7. Elements and periodic table: Snap (30 minutes)

Allow the Scholars 5 minutes to revisit the work in Unit S1 relating to elements and the periodic table. Spend about 10 minutes checking that the Scholars have the correct understanding of the symbols used for elements and the basic arrangement of the periodic table.

Spend the remaining time allowing the Scholars to play a card game with the element cards they made for Activity 1 in Unit S1. In groups of three or four they can play Snap. Snap is very simple to play – after shuffling their cards each player places without looking at its face, their next card down on top of the pile in the middle, in turn. When two cards that are the same end up on top of the card pile the first one to shout 'Snap' wins the card pile. Play continues until one player has all the cards.

Pedagogic point: Playing games like Snap is a way of introducing fun while at the same time delivering scientific content. When they are playing the Scholars will be becoming familiar with the names and symbols of the first 20 elements.

Tip: You will have to instruct the Scholars to prepare the 20 elements cards at home and remind them to bring them to this tutorial.

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

MSCE S1: Elements and Chemical Bonding: Tutorial 2

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- name simple chemical compounds
- explain the properties of metals, non-metals and group one compounds
- describe the structure of an atom.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Compounds: teaching (30 minutes)

Spend 15 minutes explaining how compounds are named using the information in Unit S1 of the MSCE Resources Folder as your guide. Go through the answers to Activity 2, Part a and then give the Scholars another similar series of compound names to analyse and deconstruct to make sure that they are all quite happy with this process (10 minutes). Allow the Scholars 5 minutes to share what they have done for Activity 2, Part b.

Tip: In case they haven't been able to find some labels, make sure you have some to hand out.

4. Metals and non-metals and looking at compounds: drop-in session but 'C3B4ME' (30 minutes)

Allow the Scholars 30 minutes of study time to work through the information on 'Looking at elements: metals and non-metals' and on 'Looking at compounds' in Unit S1 again. Guide them to focus on Activities 3 and 4. If they have a problem or a question during this activity, before they can ask you (the Tutor), they must C3B4ME! In other words, they must approach three fellow Scholars in their cluster group to resolve the query/issue and only if none of the three Scholars can provide a satisfactory and correct answer may they then approach you.

This develops their independence and resilience rather than immediately and automatically relying on you as the Tutor and it is a good teaching strategy they can use with their own students (when they get to this stage). For those Scholars who finish quickly or have no problems, write some further examples on the board and allow Scholars to check each other's work.

5. Looking at elements: metals and non-metals and Looking at compounds: peer teaching (30 minutes)

There is an old saying which says that you don't really find out whether you understand something until you have to teach it – and this is the key idea behind this activity, which sees Scholars teaching each other. The Scholars have already worked in groups to recap the information on metals and non-metals and compounds in Unit S1. This self study is then followed by this activity where, working in pairs, the Scholars take turns to teach each other, without the use of notes, the main points about metals and non-metals and compounds (20 minutes). Ask one Scholar to deliver the content on metals and non-metals and the other Scholar in the pair has to deliver the information about compounds. After each presentation, the 'taught' Scholars should give feedback about at least one thing in the teaching session that she particularly liked or didn't understand before, but does now.

6. Atomic structure: modelling (30minutes)

Spend about 15 minutes checking that the Scholars are confident with the structure of an atom and the other information about electrons. You might also want to elaborate on the structure of the nucleus and talk about protons and neutrons at this stage. It might be helpful to redraw Figure 1 to show the nucleus containing protons and neutrons. Then divide the class up into three large groups –the proton group, the neutron group and the electron group. Model the first five or six elements on the periodic table by arranging the different groups of Scholars to physically demonstrate the arrangement of each of the atoms. So, for example, to demonstrate hydrogen, you would have one proton Scholar and one neutron Scholar in the middle representing the nucleus, with one electron Scholar running around her on the outside. For lithium, you would have three proton Scholars together with three neutron Scholars as the nucleus, and three electron Scholars 'orbiting' on the outside. If you have enough space, have the orbiting electrons as far out as possible to show that the electron orbits are actually very far away from the nucleus.

7. Thought balloon revisited (30minutes)

Spend about 15 minutes allowing the Scholars to revisit their original thought balloons from the previous tutorial – they can update them to reflect what they have learned in this tutorial. This might include adding answers, rephrasing the questions or even adding new questions. Allocate the remainder of the time in this session to a sharing and discussion of their responses – in pairs, school/random groups or as a whole class.

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

MSCE S1: Elements and Chemical Bonding: Tutorial 3

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- work out the electronic configuration for the first 20 elements
- explain ionic, covalent and metallic bonding.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Quick quiz (20 minutes)

Just to recap on everything that they have covered in the last two tutorials, give the Scholars a quick verbal quiz to test their recall and understanding of the material learned to date. Allow them to mark their own scripts. Using the marked scripts ask them to self diagnose the areas they are still struggling with. For those areas of weakness, tell the Scholars that they must go back over the work in the units until they are confident that they have a secure grasp of the material.

4. Electron shells: peer questions (30 minutes)

Spend about 10 minutes checking that the Scholars are confident with the structure of an atom and the other information about electrons in atoms from last tutorial, see Unit S1. Remind them about the models they created in the last tutorial. Go through the Scholars' answers to Activity 5 (5 minutes). Check their understanding of how to work out electron numbers from the periodic table by asking them to create, in pairs, a further series of questions with answers (perhaps about five questions and answers would suffice for the whole class, but to differentiate between Scholars who were finding this material straightforward, such Scholars could be challenged to create say 10 questions and answers in the same time period) similar to those in Activity 5 (10 minutes). Swop these questions between Scholar pairs and then re-swop to allow the Scholar pairs to mark the questions they set. Ask the Scholars to write brief feedback in the format of 'what you did well and things you need to go back and learn again' (10 minutes).

5. Electron configuration and ionic bonding: teaching (40 minutes)

As it is crucial that all Scholars fully understand the electronic configuration and ionic bonding it is suggested that this section is run as a standard Tutor-led activity, especially after the Scholars have been very active in the preceding sections. The accompanying material on the electron configurations is found in the unit and the information on ions follow straight on. You might want to go over the Scholars' answers to Activity 6.

6. Covalent bonding: peer teaching (35 minutes)

There is an old saying which says that you don't really find out whether you understand something until you have to teach it – and this is the key idea behind this activity, which sees Scholars teaching each other. Give the Scholars about 15 minutes to review individually the information on 'Sharing electrons'. This self study is then followed by this activity where, working in pairs and without the use of notes, the Scholars take turns to teach each other, the main points about covalent bonding (15 minutes). Round off this session with a whole class discussion to check that all the Scholars have the correct understanding of covalent bonding.

7. Bonding in metals: modelling (25minutes)

Spend about 5 minutes discussing bonding in metals (page 99). Remind the class how they modelled the structure of atoms in the last tutorial. Then divide the class up into two groups. Challenge the groups to be the first to model to your satisfaction, bonding in metals without the use of any notes or books. Discuss how useful creating models this way was to the Scholars' understanding. Remind them of other models they have created – how do these compare? Ask if there were any other ways in which the Scholars could model the diagrams/ideas in this particular unit. Ask them why scientists use models and what the advantages or disadvantages of different types of models could be.

As the Tutor, do take this opportunity, while the Scholars are all working, to sign off Unit S1 in each of their Scholar's MSCE Resources Folder.

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

The tasks should include completing Activity 2 of Unit S1 of the MSCE Resources.

MSCE S2: Forces and Motion: Tutorial 4

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- state the difference between distance and displacement
- explain the difference between speed, velocity and acceleration
- use their understanding of the above terms to solve problems.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Recap on forces: snowballing (30 minutes)

This is a recap activity to reinforce their basic knowledge of forces which makes use of Activity 1 of Unit S2 in the Scholar's MSCE Resources Folder. Give the Scholars 5 minutes to populate the table below with their answers to Activity 1. Leave the third column unlabelled at this stage and make sure the Scholars have lots of space at the bottom of the table to expand their tables downwards.

Example of a force	Classification: push, pull or turn?	
1.		
2.		
⋮		

Then give pairs of Scholars 5 minutes or so to merge their tables –the tables should expand slightly. Next, repeat the merging process by grouping two pairs and asking them to share table entries – this process of collecting ideas from other learners is called 'snowballing'. Continue with the snowballing process until almost all of the pairs have swopped table entries with each other or until 10 minutes have expired – whichever comes first.

The next task for the Scholars is to rank order their now larger tables from the largest forces to the smallest forces using the third column – this open-ended activity will require them to estimate the approximate sizes of all the force examples and start to give them some concept of size. Use the last 5 minutes to take whole class feedback on the activity; some trigger questions could include did the snowballing activity help them to come up with some more unusual forces of their own and how did they go about estimating the relative sizes of forces?

4. Distance/displacement: peer teaching (30 minutes)

Commence with a 5-minute think-pair-share activity on the differences between displacement and distance. Follow this up by asking Scholars in pairs to prepare a 3-minute demonstration of the differences between displacement and distance that they can, if selected, give to the rest of the group (10 minutes). As you only have 10 minutes for the demonstrations only three pairs will be able to present – one random way to select which learning pairs will demonstrate is to throw a small ball (carefully!) into the audience with your eyes closed – whoever catches the ball must present. This method avoids only the keener or more confident students volunteering and gives a chance to the less forthcoming students. Take the three presentations (10 minutes) and end with a summary of the difference between distance and displacement.

5. Forces and motion: key words iteration (40 minutes)

Give the Scholars about 10 minutes to select what they think are the key words from the entire unit on Forces and Motion. With the key words written down in their books in a table like the one below, their next task, working alone and without the texts or their other notes, is to see if they can write a definition for each key word (10 minutes). They can then spend the next 10 minutes discussing and sharing their definitions with those of another Scholar and together they can come to a new revised definition of each key word and also, as a pair, agree on what the key words should be! The remaining 10 minutes of this session can be spent discussing these second iterations of the key words and their definitions with the whole class to arrive at a third and final 'correct and official' list of key words and accompanying definitions that the whole class can agree on.

Key word	First definition	Second definition	Third and final definition
1			
2			
3			
⋮			

6. Velocity: worked example (20minutes)

As it is important to establish that all the Scholars understand and therefore are fully confident with the basic calculations required before they progress on to constructing graphs, this section concentrates on taking the Scholars step by step trough a worked example which highlights all of the salient problem solving skills they will face. Spend the full 20 minutes going carefully though the worked example in Unit S2, being sure to take questions from the Scholars as they arise and to deal with any misconceptions fully.

7. Problem solving: think-pair-share (30 minutes)

Tip. This activity requires that the Scholars have worked through the Activity 2 of Unit S2 beforehand, so ensure that it is set as part of the wrap up session of the preceding tutorial.

Allow the Scholars 5 minutes of private study time to consolidate what they have learned in the preceding section and to revisit their original answer to Activity 2 – encourage them to make any annotations or corrections they want to, to their answers during this time.

In pairs encourage them to share their answers/revisions to Activity 2 (5 minutes) and then have a quick 5-minute whole class discussion focusing on how the Scholars did on Activity 2 both before and after the teaching input. Give the Scholars further, similar style questions (10 minutes) to work on individually before you ask one or two Scholars to talk about how they went about solving the new problems (5 minutes) to the rest of the group.

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

MSCE S2: Forces and Motion: Tutorial 5

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- interpret velocity–time graphs to determine the total distance travelled and the acceleration.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Forces and motion: key words Splat (20 minutes)

This is a recap activity making use of the key words activity in the preceding tutorial. Give the Scholars 10 minutes to refresh their memories of the key words and their agreed definitions. Test this understanding by having a quick quiz in the form of Splat. Write each of the key words up on the board randomly and quite spread out from each: divide the class into two groups. Invite a representative from each group to the front to stand by the board. The Scholars do not have their notes for what comes next – they must recall the answers from memory. Read out loud the one definition of a key word on the board to the whole class – the first Scholar to splat, i.e. point to with her hand to the correct key word wins a point for her team. The Scholar who did not guess successfully returns to her team and is replaced with another Scholar from that team. Continue this game for a further 10 minutes – if you run out of key words ask the students to take your place in reading out definitions, without notes, for the teams to splat.

4. Graphs: poster activity (30 minutes)

In pairs, Scholars work to reduce the information on distance–time graphs in Unit S2 on to an A4 poster. Encourage the Scholars to be as creative as possible for what you are looking for is not only their ability to capture the key learning points from the material but their ability to summarise and represent the information in a visual and memorable way. Allow 20 minutes for this part of the activity.

Walkabout! When the posters are ready, either pin them up on the walls, or if this is not possible, lay them on the desks or even find some free space on the floor for the posters. Allow the Scholars to circulate freely to see and discuss each other's posters for the remaining 10 minutes of this session.

5. Calculating acceleration: collaborative problem solving (40 minutes)

Allow the Scholars to work alone on the material on changing speed or acceleration for 10 minutes. Then pair up confident Scholars with Scholars who are struggling (depending on numbers of struggling and confident Scholars you may have to go for small groups, rather than pairs). Give the pairs or groups a set of problems similar to the worked examples in Unit S2 or the practice questions to work through collaboratively (15 minutes). Complete the activity by asking each pair/group to come to the front and talk the class through their answer/solving process (15 minutes) – this will allow the other Scholars to mark their own answers and reinforce the learning for the presenting groups.

Tip: You will need to make sure that you have at least the same number of questions as you have groups.

6. Constant velocity: teaching (20 minutes)

This is a Tutor-led session on constant velocity and the various associated graphs in Unit S2. The key teaching point is to draw out the differences between the three graphs at the bottom of page 109.

7. Constant acceleration: how is this like…? and how is this not like….? (40 minutes)

Review the key teaching points on constant acceleration with the whole class. (15 minutes) Divide the class into school groups and ask each group to populate the table for constant acceleration with as many answers as they can think of. Allow about 15 minutes for this task.

How is constant acceleration like constant velocity?	How is constant acceleration not like constant velocity?

Round off the session with another walkabout session or a class Q & A session. (10 minutes) This activity stretches the Scholars to build meaning about motion in general by highlighting in detail the similarities and differences between constant acceleration and constant velocity. If the Scholars are finding making a start difficult, help them by doing the activity with another science topic as an exemplar.

As the Tutor, do take this opportunity, while the Scholars are all working, to sign off Unit S2 in each of their Scholar's MSCE Resources Folder.

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

MSCE S3: Periodic Table and Reactions: Tutorial 6

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- write word, symbol and balanced chemical equations
- interpret units for concentration of solutions.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Periodic table and reactions: thought balloons (30 minutes)

This is a 'prepare for learning' activity. Ask the Scholars to work alone to complete a thought balloon on all the content in Unit S3: Periodic Table and Reactions.

Walkabout! When the thought balloons are ready, either pin them up on the walls, or if this is not possible, lay them on the desks or even find some free space on the floor for the posters. Allow the Scholars to freely circulate to see and discuss each other's thought balloons for the remaining 10 minutes of this session.

Pedagogic point: A thought balloon is an alternative to semantic map and is a more open ended technique where the Scholars can record any past experiences, key words, pictures, opinions, feelings questions they would like to ask about a particular issue, focus question or topic. Scholars place one 'thought' in each of the balloon's sections.

4. Chemical reactions: 'deliberate mistakes' (40 minutes)

Scholars work alone to review the information on chemical reactions in Unit S3 for 5 minutes. Then, in pairs, they share their learning/understanding and write a short fact sheet on chemical reactions that contains three deliberate chemistry errors. (15 minutes) The Tutor then goes through a selection of the fact sheets with the whole group. The rest of the class has to find/locate the deliberate mistakes and correct them. (15 minutes) If you want to run it as a competition, then there could be a small prize or a round of clapping for the pair that gets the most undetected errors. Round off this session by summarising the key learning points on chemical reactions (5 minutes) on the board for the Scholars to note down.

5. Balancing equations: drop-in session but C3B4ME (30 minutes)

Allow the Scholars 30 minutes of private study time to work through the information on balancing equations. If they have a problem or a question during this activity, before they can ask you (the Tutor), they must C3B4ME! In other words, they must approach three fellow Scholars to resolve the query/issue and only if none of the three Scholars can provide a satisfactory and correct answer may they then approach you.

This develops their independence and resilience rather than immediately and automatically relying on you as the Tutor and it is a good teaching strategy they can use with their own students (when they get to this stage). For those Scholars who finish quickly, write some examples on the board and allow Scholars to check each other's work.

6. Concentration: peer teaching (30 minutes)

There is an old saying which says that you don't really find out whether you understand something until you have to teach it – and this is the key idea behind this activity, which sees Scholars teaching each other. Initially the Scholars work individually to recap the information on concentration in Unit S3. (10 minutes) This self study is then followed by an activity where, working in their school groups, the Scholars take turns to teach their peers, without the use of notes, the main points about concentration. (20 minutes) Make sure that where possible, each Scholar has a chance to deliver the information to the rest of the Scholars in her school group. After each presentation, the 'taught' Scholars should give feedback on one thing about the concentration presentation that she particularly liked or didn't understand before, but does now.

7. Periodic table and reactions: thought balloon revisited (20minutes)

Spend about 10 minutes allowing the Scholars to revisit their original thought balloons – they can update them to reflect what they have learned in the tutorial. This might include adding answers, rephrasing the questions or even adding new questions. Allocate the remainder of the time in this session to a sharing and discussion of their responses – in pairs, school/random groups or as a whole class.

8. Wrap up and set Scholars self-study tasks for the next fortnight 15 minutes)

MSCE S3: Periodic Table and Reactions: Tutorial 7

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- classify reactions as exothermic or endothermic
- draw the energy profile of a reaction and mark on the bond making and bond breaking
- describe metal displacement reactions.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Periodic table and reactions: brainstorm bingo (30 minutes)

This is a game that checks on the ideas that the Scholars have from the previous tutorial and hence reminds them of the importance of these ideas for their learning in this tutorial.

Working in pairs, the Scholars brainstorm a list of as many things they can remember from the last tutorial. (15 minutes) Read out a list of points or facts from the material – the pairs cross off those that are on their lists. The winners are the first pair to get to get 6 points and at this point they shout out 'Bingo!'.

4. Exothermic and endothermic reactions: postbox (50 minutes)

Allow the Scholars about 10 minutes to revisit their work individually on endothermic and exothermic reactions in Unit S3.

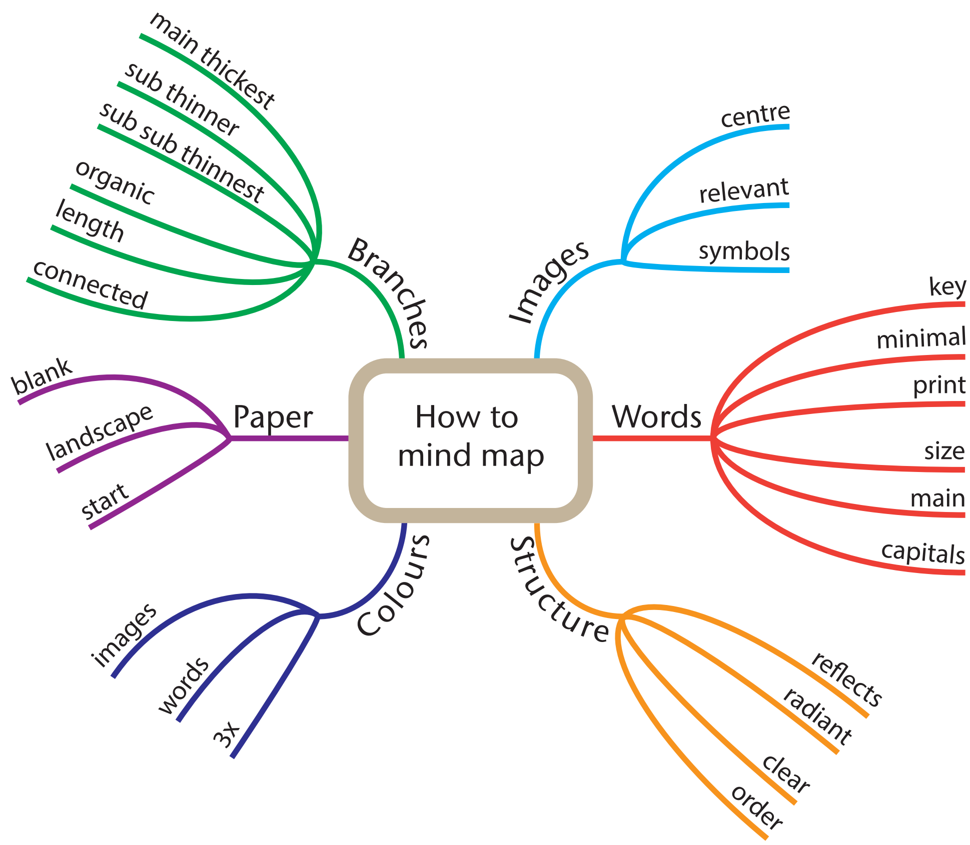
Place four empty postboxes at the corners of the classroom and give the Scholars some small squares of blank paper. Ask the Scholars a series of questions about exothermic and endothermic reactions – about five questions should be enough and make sure the questions are written on the board as well. The questions should be a mixture of closed and open ones and also should represent a range of difficulty on the topic. For example, a closed question could be 'In an exothermic reaction, is energy released?', and an example of an open-ended question could be 'How many examples of endothermic reactions can you name?' Ask the Scholars to write down their answers and after each question they post their answer in any one of the empty boxes – encourage them to move around the room at this stage so that they don't just use one box. When you have come to the end of the questions, group the Scholars together – you will need as many groups as you have boxes (allow 10 minutes for this part).

Each group opens one postbox. They read and categorise the answers and then prepare a 3-minute presentation to show the range of answers on the questions – this must also include the correction of any errors or misunderstandings they encounter. (15 minutes) Allow about 15 minutes in total for the final presentations (i.e. four groups each at 3 minutes plus swop over time).

5. Chemical reactions of metals: mind mapping (40 minutes)

This section allows the Scholars an opportunity to represent what they know about the chemical reactions of metals in a visual, and potentially more memorable way, on a mind map. Give the Scholars working individually about 15 minutes to review the information on the chemical reactions of metals. Quickly revise the use of the mind mapping technique using another topic e.g. waves. (5 minutes) In pairs the Scholars should then complete a mind map to show their understanding of the chemical reactions of metals. Start the map with the word METALS at the centre. Allow about 15 minutes for the Scholars to complete their mind maps and end the activity with 5 minutes of whole group feedback on how helpful the Scholars found the mind mapping exercise.

Pedagogic point: A mind map starts with one word that is the central or main idea to be explored. This is placed in the centre of the page. The Scholars then brainstorm connected ideas. The ideas are one or two words and are drawn coming from the original word or from a subsequent word. The map expands outwards with each branch having the potential to lead to further brainstorming. We are using the mind map as a graphic organiser to help the Scholars organise their thinking here but it can also be used to structure and visually represent more general discussions, or Q & A sessions. An example on the topic of mind mapping itself is shown below.



6. Periodic table and reactions: practice questions (30 minutes)

In this final section on Unit S3, allow the Scholars working in school groups, or any other grouping arrangement you feel is more appropriate, 30 minutes to discuss their responses to the practice questions. As the Tutor, do take this opportunity, while the Scholars are all working, to sign off Unit S3 in each of their Scholar's MSCE Resources Folder.

7. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

MCSE S4: Matter and Electricity: Tutorial 8

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- describe the kinetic theory model of solids, liquids and gases and use it to explain various effects such as diffusion, pressure and expansion.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Matter: poster activity (35 minutes)

In pairs, Scholars work to reduce the information on matter, in Unit S4, on to an A4 poster. Encourage the Scholars to be as creative as possible for what you are looking for is not only their ability to capture the key learning points from the material but their ability to summarise and represent the information in a visual and memorable way. Allow 20 minutes for this activity.

Walkabout! When the posters are ready, either pin them up on the walls, or if this is not possible, lay them on the desks or even find some free space on the floor for the posters. Allow the Scholars to freely circulate to see and discuss each other's posters for the remaining 15 minutes of this section.

4. Solids, liquids and gases: modelling (40 minutes)

Begin this section by working through the diagram and be sure to discuss the ideas about how solids, liquids and gases differ in terms of the temperature, molecular motions and molecular interactions (10 minutes). Divide the class up into three equally sized groups – a solid group, a liquid group and a gas group. Challenge the groups without the use of any notes or books to be the first to model to your satisfaction, the particular state of matter they have been allocated (10 minutes). Once you are happy that the three groups are modelling solids, liquids and gases accurately, then allow each group, in turn to demonstrate to the other two groups their state (10 minutes). Ask if there are any other ways in which the Scholars could model solids, liquids and gases – give the Scholars 10 minutes to think of other ways in which they could model the three states of matter.

5. Solids, liquids and gases: 'What am I?' (20 minutes)

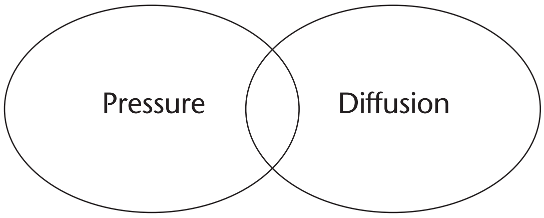
Revisit Activity 1 of Unit S4 with the whole class (5minutes). This session challenges the Scholars' understanding of solids, liquids and gases with the game of 'What am I?' where the Scholars have to try to guess what state of matter you are describing to them (15 minutes). Although there are only three states of matter to describe you can prolong the game by only giving partial descriptions and you can always ask students to take your place as the question master.

6. Diffusion and pressure: teaching (30 minutes)

It is suggested that this section is run as a standard Tutor-led activity, as the Scholars have been very active in constructing their own meaning in the preceding sessions. The accompanying material on diffusion and pressure is found in the unit. You might want to go over the Scholars' answers to Activity 3 of Unit S4 at this point in the tutorial.

7. Diffusion and pressure: Venn diagram to contrast and compare (35 minutes)

Divide the class into school groups. Ask each group to populate the Venn diagram below for diffusion and pressure with as many comments as they can think of (25 minutes).



Round off the session with another walkabout session or a class Q & A session (10 minutes). This activity stretches the Scholars to build meaning for pressure and diffusion by highlighting in detail the similarities and differences between them. If the Scholars are finding making a start difficult, help them by doing the activity with another science topic.

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

MCSE S4: Matter and Electricity: Tutorial 9

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- describe and explain the effects and uses of static electricity
- state the difference between series and parallel circuits.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Quick quiz (20minutes)

Just to recap on everything that they have covered in the last tutorial give the Scholars a quick verbal quiz to test their recall and understanding of the material learned to date. Allow them to mark their own scripts. Using the marked scripts ask them to self diagnose the areas they are still struggling with. For those areas of weakness, tell the Scholars that they must go back over the work in the units until they are confident that they have a secure grasp of the material.

4. Static electricity: demonstrations (30 minutes)

Demonstrate some of the simpler effects of static electricity to the Scholars (15 minutes). Some simple demonstrations include picking up small pieces of paper with a rubbed plastic comb; making a small stream of water from a tap deviate by holding a rubbed plastic rod next to it; making strands of hair move when a rubbed comb is brought close to them. Spend about 10 minutes checking that the Scholars are confident with ideas behind the creation of static electricity in Unit S4.

Tip: To successfully carry out the demonstrations on the day, you will have needed to decide what demos to do and to have organised the equipment and resources.

5. Introduction to current electricity: (40 minutes)

Scholars work alone to review the information on electrical current and series circuits (5 minutes). After sharing their learning/understanding as a pair, Scholars write a short fact sheet on electrical current and series circuits that contains three deliberate physics errors (15 minutes). The Tutor then goes through a selection of the fact sheets with the whole group. The rest of the class has to find/locate the deliberate mistakes and correct them (15 minutes). If you want to run it as a competition, there could be a small prize or a round of clapping for the pair that gets the most undetected errors. Round off this section by summarising the key learning points on electrical current and series circuits (5 minutes) on the board for the Scholars to note down.

6. Parallel circuits: drop-in session but C3B4ME (30 minutes)

Allow the Scholars 30 minutes of private study time to work through the information on parallel circuits. If they have a problem or a question during this activity, before they can ask you (the Tutor), they must C3B4ME! In other words, they must approach three fellow Scholars to resolve the query/issue and only if none of the three Scholars can provide a satisfactory and correct answer may they then approach you. This develops their independence and resilience rather than immediately and automatically relying on you as the Tutor and it is a good teaching strategy they can use with their own students (when they get to this stage). For those Scholars who finish quickly, write some examples on the board and allow Scholars to check each other's work.

7. Plus, Minus, Interesting (30 minutes)

This is a free-thinking, open-ended activity which allows the Scholars a chance to process all the information and accompanying learning they have encountered in this and the preceding tutorial and the related material in the unit. For the plus, minus, interesting exercise they need to discuss what was positive about what they they learnt, what was negative or difficult - and what was interesting. (20 minutes). Finally, let Scholars share their experiences including any tips, comments or difficulties they faced with their peers (5 minutes).

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

MCSE S4: Matter and Electricity: Tutorial 10

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- use Ohm's law
- carry out calculations to work out the running costs of different electrical devices
- know which materials are magnetic and a few uses of electromagnetism.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Matter and electricity: key words iteration (40 minutes)

Still working on S4, give the Scholars about 10 minutes to select what they think are the keys words for matter and electricity (do not include resistance), and write them in their books in a table like the one below. Their next task, working alone and without the texts or other notes, is to write a definition for each key word (10 minutes). They then spend the next 10 minutes discussing and sharing their definitions with those of another Scholar and together come to a new revised definition of each key word and also to agree, as a pair, on what the key words should be. The remaining 10 minutes of this section can be spent discussing these second iterations of the key words and their definitions with the whole class to arrive at a third and final 'correct and official' list of key words and accompanying definitions that the whole class can agree on.

Key word	First definition	Second definition	Third and final definition
1			
2			
3			

4. Resistance: you've found the answers, what were the questions? (30 minutes)

Let the Scholars work alone through the material on resistance (5minutes). The Scholars then process the information by creating as many questions as they possibly can that match the text (5 minutes). Pairs of Scholars share and discuss their questions to create a combined list (5 minutes). Take class feed-back on the combined lists of questions and quickly review the key teaching points about resistance (5 minutes).

Tip: If the Scholars are finding this activity too difficult because of the inclusion in the text of Ohm's law, instruct them to ignore the equation and the associated calculations in their processing.

Pedagogic point: *This is an activity which requires students to engage with information in the text by processing it in an alternative way to merely reading or note taking. Additionally, the Scholars generate something 'new' from the text, thereby developing their creative thinking skills.*

5. Ohm’s law and electrical power: teaching (30 minutes))

Because the Scholars need to practise Ohm’s Law and electrical power calculations, it is suggested that you teach this section of Unit S4 to the Scholars. Reinforce your teaching with plenty of worked examples similar to the ones in the unit: Example 1, Activity 6 and Example 2 and Activity 7. Ensure the Scholars’ understanding by giving them some further practice examples.

6. Magnetism: KWL procedure (30 minutes)

Spend about 10 minutes checking the understanding of the Scholars on the concept of magnetism. Allocate the remainder of the time in this session to a KWL procedure which covers basic magnetism, electro-magnetism and transformers. This is an open-ended activity which allows the Scholars to personally summarise their thinking and learning so far on magnetism, by asking them to consider ‘What do I know?’, ‘What do I want to know?’ and ‘What have I learned?’ They can represent the information in any way they want – in a table, as a drawing/poster, as a written list/paragraph (20 minutes). Complete the activity with some sharing and discussion of their responses, in pairs, school/random groups or as a whole class.

7. Plus, minus, interesting (30 minutes)

This is a free-thinking, open-ended activity which allows the Scholars a chance to process all the information and accompanying learning they have encountered in this and the preceding tutorial and the related material in the unit. Remind the Scholars that they have already done a PMI exercise on semiconductors in Tutorial 9 – your previous tutorial – let them review this PMI with their learning partners for about 5 minutes before you allow them to construct a PMI for this unit (20 minutes). Finally, let Scholars share their experiences including any tips, comments or difficulties they faced with their peers (5 minutes).

Pedagogic point: *The thinking associated with the creation of a KWL procedure will help the Scholars see their work as being about key ideas and concepts, not just about tasks done.*

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

As the Tutor, do take this opportunity, while the Scholars are all working, to sign off Unit S4 in each of their Scholar's MSCE Resources Folder.

MCSE S5: Organic Chemistry: Tutorial 11

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- explain the difference between and alkane and alkene
- name, draw and represent the molecular structure of the first ten primary alkanols.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Prefixes: mnemonics (30 minutes)

This is an engaging starter activity that will make sure that the Scholars have understood the basic knowledge on which all of the rest of the content of the unit depends as well as giving them a gentle introduction to what is a difficult and potentially confusing topic. Arrange the Scholars in school groups and challenge them to create either:

- a mnemonic, or
- a story/narrative

that helps them to remember the prefixes for the first ten hydrocarbons, 'meth' through to 'dec' in Unit S5.

An example of a mnemonic – to remember the order of the planets – My Very Easy Method Just Speeds Up Naming (the) Planets for Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune, Pluto.

An example of a story: if you want to remember these five words in this order: shoes, yellow, house, pencil, elephant, you could make a story like this: 'My shoes are yellow and in my house. Through the window I can see a pencil and in the yard there is an elephant'.

Once completed, share all the suggestions and if you want, have a vote for the one which is a) the most creative, b) the funniest, and c) the best for remembering the prefixes.

4. Alkanes quizzes: collaborative working (30 minutes)

Review/teach the key points of alkanes with the whole group and go through Activity 1 (10minutes) to make sure that the Scholars understand the basics. In school groups again, the Scholars then work to produce a 5-question quiz on alkanes, along with the correct answers that the other groups can do to test their understanding (10minutes). Spend the final 10 minutes allowing the groups to work through each other's quizzes on alkanes.

5. Alkenes: mind mapping (30 minutes)

Hydrocarbons can often be a confusing topic because the Scholars find the categories of hydrocarbons very difficult to differentiate between and this is exacerbated by vocabulary that appears almost identical, e.g. alkanes versus alkenes versus alkanols. This section allows the Scholars an opportunity to represent what they know about alkanes and alkenes in a visual, and potentially more memorable way, on a mind map. Give the Scholars working individually about 10 minutes to review the information on alkenes in Unit S5. Quickly demonstrate the use of the mind mapping technique using another topic, e.g. elements (5 minutes). In pairs, Scholars should then complete a mind map to show their understanding of alkenes and alkanes. Start the map with the word 'Hydrocarbons' at the centre. Allow about 10 minutes for the Scholars to complete their mind maps and end the activity with 5 minutes of whole group feedback on how helpful the Scholars found the mind mapping exercise.

Pedagogic point: *A mind map starts with one word that is the central or main idea to be explored. This is placed in the centre of the page. The Scholars then brainstorm connected ideas. The ideas are one or two words and are drawn coming from the original word or from a subsequent word. The map expands outwards with each branch having the potential to lead to further brainstorming. We are using the mind map as a graphic organiser to help the Scholars organise their thinking here but it can also be used to structure and visually represent more general discussions, or Q & A sessions. An example on the topic of mind mapping itself is shown below.*

Primary School Version of How to Mind Map - Source: BrainTraining4Kids.com

6. Alkanols: micro-teaching session (30 minutes)

To offer the Scholars a complete change of learning activity this section is presented as a traditional Tutor-led review of the materials on alkanols from Unit S5. Key teaching points to cover are covalent bonds, the functional group (OH), naming protocols and condensed and expanded structural formulae. Include a Q & A session at the end to check the progress of the Scholars.

7. Drop-in session but C3B4ME (30 minutes)

Allow the Scholars 30 minutes of private study time to consolidate what they have learned in this tutorial. Suggestions about what they might actually do in that time include finishing off /correcting activities and questions from the text/making some revision notes/doing another mind map. If they have a problem or a question during this activity, before they can ask you (the Tutor), they must C3B4ME! In other words, they must approach three fellow Scholars to resolve the query/issue and only if none of the three Scholars can provide a satisfactory and correct answer may they then approach you. This develops their independence and resilience rather than immediately and automatically relying on you as the Tutor and it is a good teaching strategy they can use with their own students (when they get to this stage).

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

MCSE S5: Organic Chemistry: Tutorial 12

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- define isomerism and give some examples of isomerism
- name, draw and represent the molecular structure of simple carboxylic acids
- give some examples of carboxylic acids.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Hydrocarbon modelling activity (30 minutes)

Write the names of about 10 hydrocarbons covered in the last tutorial on the board including alkenes, alkanes and alkanols. Divide the Scholars into two groups and then in each group ask them to be H, C or O atoms – make sure that there is some way of recognising the differences, e.g. an H atom Scholar could wear a scarf/hat while the O atom Scholars could have bare feet. Work through the list of hydrocarbons with the Scholars modelling the compounds by being the atoms and using their hands for the bonds. Make sure each group correctly models the compounds written on the board before moving on to the next. When the list is exhausted, ask each group to challenge the other group in turns with a model of a hydrocarbon that the other group must correctly name – and continue until you are happy that all the Scholars have a good understanding of the basic hydrocarbons.

Pedagogic point: *This kind of modelling allows Scholars to interact kinaesthetically with the chemistry and modelling more generally is a pedagogical technique that enables pupils to access/develop a higher order skills set.*

4. Isomers: (40 minutes)

Scholars work alone to review the information on isomers on page 274 (5 minutes). After sharing their learning/understanding in pairs, they write a short fact sheet on isomers that contains three deliberate chemistry errors (15 minutes). The Tutor then goes through a selection of the fact sheets with the whole group. The rest of the class has to find/locate the deliberate mistakes and correct them (15 minutes). If you want to run it as a competition, there could be a small prize or a round of clapping for the pair that gets the most undetected errors. Round off this section by summarising the key learning points on isomers (5 minutes) on the board for the Scholars to note down.

5. Carboxylic acids: whole class teaching (20 minutes)

As carboxylic acids are a complex topic, it is best that this topic is taught/reviewed with the whole class. Key teaching points to include are the COOH functional group, and its double bond, the properties of carboxylic acids as well as their uses and also emphasise the common examples that Scholars are likely to come across in everyday life.

6. Hydrocarbons: applying learning (40 minutes)

So that the Scholars can demonstrate their learning across the whole unit on basic organic chemistry this section is a question-led one, where the Scholars collaboratively work through a series of written questions in pairs (15 minutes). Choose a broad range of questions that test the Scholars across all the content in this unit (see the practice questions for this unit or better still, use old exam questions). Follow this up with a peer-marking exercise. Give the Scholars the answers/mark scheme and ask the Scholars, as well as marking their peers' work, to write two learning targets for the Scholars whose work they are marking. (15minutes). Reinforce the learning in this section in a 10-minute whole class discussion about the key learning points.

7. Hydrocarbons: 'speed dating' plenary (20 minutes)

This is a fun activity which will bring the tutorial to an energetic close while embedding the learning that has taken place during this final tutorial on Unit S5. You will need plenty of space for this, so consider going outside. Divide the Scholars into two equal teams, A and B. Arrange the two teams in two lines, with pairs of Scholars directly facing each other, about an arm's length apart in both directions. The Scholars from team A have 1 minute to tell their opposite number in team B as many facts as they can remember about the whole topic (no notes allowed) while the team B Scholar listens carefully. Then the roles are swapped and the team B Scholar repeats the telling/sharing process while the team A Scholar listens for one minute. The first person in the team A line then moves to join the team A line at the far end – this leaves a gap. The team A line shuffle up one place to fill the gap at the top, and now each team A Scholar should be facing a different team B Scholar. This time the team B Scholar takes 1 minute to tell their opposite team A Scholar all the facts as they can remember about the whole topic (no notes allowed still). Then the roles are swapped and the team A Scholar repeats the telling/sharing process while the team B Scholar listens. Again, the first person in the team A line moves to join the team A line at the far end leaving a gap. The team A line shuffle up one place to fill the gap at the top, each team A Scholar should be facing a new team B Scholar. Repeat this process until the 20 minutes has expired.

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

As the Tutor, do take this opportunity, while the Scholars are all working, to sign off Unit S5 in each of their Scholar's MSCE Resources Folder.

MCSE S6: Electricity and Magnetism: Tutorial 13

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- describe the role of electrostatics in everyday life
- calculate resistance in series and parallel circuits

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Electrostatics: poster activity (30 minutes)

Working in pairs, Scholars summarise the information on electrostatics, electrostatic induction and the rules of attraction and repulsion on to an A4 poster. Encourage the Scholars to be as creative as possible for what you are looking for is not only their ability to capture the key learning points from the material but their ability to summarise and represent the information in a visual and memorable way. Allow 20 minutes for this activity.

Walkabout! When the posters are ready, either pin them up on the walls, or if this is not possible, lay them on the desks or even find some free space on the floor for the posters. Allow the Scholars to freely circulate to see and discuss each other's posters for the remaining 10 minutes of this session.

4. Resistance: semantic map (30 minutes)

Begin this section by working through the thinking experiment on resistance in Unit S6 – ideally demonstrate it if possible, but if not then draw it on the board without any discussion. Do a think-pair-share activity next: pose the question from the experiment and give the Scholars 2 or 3 minutes thinking time to formulate their answer. Ask the Scholars to discuss their ideas with each other. Follow this with a Tutor-led discussion of resistance covering the main points as per the study guide. Test their understanding of concepts from Unit S4 voltage, current, Ohm's law, and add in resistance.
(10 minutes for all this.)

The main part of this section requires the pupils to complete a semantic map (20 minutes) which focuses on resistance.

Pedagogic point: *A semantic map has the central theme at the centre. Between 3 and 5 categories relevant to the central theme are placed around the map and the Scholars list in bullet points as many things as they know, think they know or believe about the 3 to 5 categories. So, there are no wrong answers on a semantic map. The semantic map is therefore a good tool for assessing what a learner knows at the start of a topic, but it can also be used to summarise learning part way through and document any misconceptions the student may have. The semantic map can be used as a working document and pupils can revisit it several times throughout the unit to capture their revised thinking. An example of a semantic map on basic electricity is shown below.*

5. Resistors in series: collaborative problem solving (40 minutes)

After the Scholars have worked alone through the material in resistors in series (10 minutes), pair up confident Scholars with Scholars who are struggling (depending on numbers of struggling and confident Scholars you may have to go for small groups, rather than pairs). Give the pairs or groups a set of problems similar to the worked example or the practice questions at the end of the unit to collaboratively work through (15 minutes). Complete the activity by asking each pair/group to come to front and talk the class through their answer/solving process (15 minutes) to one of the questions – this will allow the other Scholars to mark their own answers but reinforce the learning for the presenting groups.

Tip: You will need to make sure that you have at least the same number of questions as you have groups.

6. Resistors in parallel: how is this like… and how is this not like…? (20 minutes)

Remind the Scholars how to calculate resistors in parallel (10 minutes). Divide the class into school groups. Ask each group to populate the table for resistors in parallel with as many answers as they can think of.

How they are like resistors in series	How they are not like resistors in series

Round off the section with another walkabout session or a class Q & A session (5 minutes). This activity stretches the Scholars to build meaning about resistors in general by highlighting in detail the similarities and differences between resistors in series and resistors in parallel. If the Scholars are finding making a start difficult, help them by doing the activity with another science topic.

7. Plus, minus, interesting (30 minutes)

This is a free-thinking, open-ended activity which will allow the Scholars a chance to process all the information and accompanying learning they have encountered in the tutorial and in the accompanying unit on electricity. The Scholars have already done a PMI exercise on semi-conductors in a previous tutorial. Let them share and discuss their semi-conductor PMIs in pairs for about 5 minutes and then have a whole class discussion on how they found doing such an open-ended activity – let Scholars share their experiences including any tips, comments or difficulties they faced with their partners (5 minutes). Then allow the Scholars about 15 minutes to construct a PMI for the entire S6 unit.

8. Wrap up and set Scholars self-study tasks for the next fortnight (15 minutes)

As the Tutor, do take this opportunity, while the Scholars are all working, to sign off Unit S6 in each of their Scholar's MSCE Resources Folder.

MCSE S7: Waves and Radiation: Tutorial 14

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- describe a wave
- explain the characteristics of waves
- differentiate between transverse and longitudinal waves.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Waves: thought balloons (20 minutes)

This is a 'prepare for learning' activity. Ask the Scholars, working alone, to complete a thought balloon on waves. Walkabout! When the thought balloons are ready, either pin them up on the walls, or if this is not possible, lay them on the desks or even find some free space on the floor for the posters. Allow the Scholars to freely circulate to see and discuss each other's thought balloons for the remaining 10 minutes of this session.

Pedagogic point: *A thought balloon is an alternative to a semantic map and is a more open-ended technique where the Scholars can record any past experiences, key words, pictures, opinions, feelings questions they would like to ask about a particular issue, focus question or topic. Scholars place one thought in each of the balloon's sections. An example of a completed thought balloon is given below.*

4. Waves: key words iteration (40 minutes)

Give the Scholars about 10 minutes to select what they think are the key words from the following sections in Unit S7: 'Waves –the basics that you need to know' and 'How can we describe waves?' With the key words written down in their books in a table like the one below, their next task, working alone and without the texts or other notes, is to see if they can write a definition for each key word (10 minutes). They can then spend the next 10 minutes discussing and sharing their definitions with another Scholar and together they can come to a new revised definition of each key word and also, as a pair, to agree on what the key words should be! The remaining 10 minutes of this section can be spent discussing these second iterations of the key words and their definitions with the whole class to arrive at a third and final 'correct and official' list of key words and accompanying definitions that the whole class can agree on.

Key word	First definition	Second definition	Third and final definition
1			
2			
3			
⋮			

5. Transverse and longitudinal waves: teaching (30 minutes)

This is a Tutor-led session on transverse and longitudinal waves (15 minutes). If at all possible demonstrate the waves in Figures 1 and 2 in Unit S7 with ropes, chains or springs. The key teaching points to cover include:

a. there is energy transfer in all waves

b. the direction of energy transfer relative to the vibration determines the type of wave

c. examples of longitudinal and transverse waves.

Modelling: Where there is some free space, arrange the Scholars so that they can model the two types of waves themselves. The Scholars are the particles (lined up in a straight line for the longitudinal wave but there are multiple ways of arranging them for transverse waves): each wave vibration begins with a (gentle and careful) push at one end of the waves – the Scholars then should move accordingly to represent the flow of energy through the wave (10 minutes).

End this section with a quick game of 'What am I?' where the Scholars have to try to guess what type of wave, or wave key word (from the previous section) you are describing to them (5 minutes).

6. Characteristics of waves: teaching (30 minutes)

Initially the Scholars work individually to recap the information on the characteristics of waves in the unit (10 minutes). This self study is then followed by an activity where, working in school groups and without the use of notes,, the Scholars take turns to teach their peers the main characteristics of waves (20 minutes), making sure that they include explanations of the key terms (amplitude, wavelength, frequency). Make sure that, where possible, each Scholar has a chance to deliver the information to the rest of her Scholars in her school group. After each presentation, the 'taught' Scholars should give feedback about two things about the characteristics of waves that the Scholar needs to work on to improve her understanding of waves.

7. Frequency: KWL procedure (30 minutes)

Spend about 10 minutes checking the understanding of the Scholars on the concept of frequency. Allocate the remainder of the time in this session to a KWL procedure. This is an open-ended activity which allows the Scholars to personally summarise their thinking and learning so far on waves, by asking them to consider 'What do I Know?', 'What do I want to know?' and 'What have I learned?' They can represent the information in any way they want – in a table, as a drawing/poster, as a written list/paragraph (20 minutes). Complete the activity with some sharing and discussion of their responses – in pairs, school/random groups or as a whole class.

Pedagogic point: *The thinking associated with the creation of a KWL procedure will help the Scholars see their work on waves as a being about key ideas and concepts, not just about tasks done.*

MCSE S7: Waves and Radiation: Tutorial 15

1. Aims of the tutorial

By the end of this tutorial, Scholars will be able to:

- apply the wave equation in problem solving
- distinguish between a converging and diverging lens.

2. Recap questions on topics given for Scholars self-study at the end of the last tutorial (15 minutes)

3. Speed: where and why is it wrong? (30 minutes)

The first part of this section uses a rather unusual activity. Present the Scholars with the solutions to problems on speed that are wrong! The Scholars' job, working in pairs, is to locate the error and correct it, as the title suggests. Here are some examples of speed problem solutions that have one part and only one part wrong – the error is not carried forward. The errors are underlined; this is so that you can construct your own series of them for this activity. Five to ten problems will probably be enough for the Scholars to work on initially.

Problem 1	Problem 2	Problem 3
Speed = Distance x Time (should be Speed = Distance ÷ Time)	v = d/t	v = d/t
= 10 ÷ 5	v = <u>27 x 3 (should be 27/3)</u>	d = <u>t/v (should be v x t)</u>
= 2 m/s	v = 9 m/s	= 20 x 100
		=2000 m

After modelling the first one or two examples to the Scholars and explaining carefully what they need to do (5 minutes), give the Scholars your incorrectly solved problems on speed to work through (10 minutes).

If the Scholar pairs are making good progress through these problems then you can allow them 5 minutes to create some similar problems. The final part of the section can be devoted to Scholar pairs swapping their problems with those of other Scholar pairs, and correcting them (5 minutes). Close the session with a quick debrief (5 minutes).

Pedagogic point: *While this activity is pedagogically not quite officially in the realms of cognitive conflict – where Scholars are presented with situations that are in direct conflict with their established belief/knowledge system (e.g. why do a feather and an egg fall at the same rate?) – it will however require the Scholars to think very carefully about the all the processing steps that they apply to solve problems. By the end of this type of activity, the students should have a very solid understanding of the equation in question and the (mathematical) processing steps involved in the use of the equation.*

4. The wave equation: teaching (30 minutes)

As it is crucial that all Scholars fully understand the wave equation, it is suggested that this section is run as a standard Tutor-led teaching activity, especially after the Scholars have been very active in the preceding session. The accompanying material on the wave equation is found on page 404.

5. The wave equation: problem solving (30 minutes)

Having established the Scholars' understanding of the speed equation and the wave equation in the preceding sections, allow them the opportunity to demonstrate their understanding by letting them work through a traditional series of problems on waves. Use problems like the ones in Activity 4 or the practice questions. You can run this section in a variety of formats – with the Scholars working on their own, in pairs or in small groups of three or four. Use your judgement as their Tutor on the day as to which mode will support their learning most effectively.

6. Electromagnetic waves: you've found the answers, what were the questions? (20 minutes

When the Scholars have worked alone through the material on electro-magnetic waves (5minutes), they then process the information by creating as many questions as they possibly can that match the text (5 minutes). Scholars discuss and share their questions to create a combined list (5minutes). Take general class feedback on the combined list of questions and quickly review the key teaching points about EM waves (5 minutes).

Pedagogic point: *This is an activity which requires students to engage with information in the text by processing it in an alternative way to merely reading or taking notes. Additionally, the Scholars generate something new from the text, thereby developing their creative thinking skills.*

7. Lenses: how is this like… or how is this not like…? (40 minutes)

Revise the key learning points about lenses, including showing Scholars how to construct ray diagrams for diverging and converging lenses (25 minutes). Work towards the end of this final section by asking Scholars, working in small groups, to populate the table for lenses as fully as they can.

How converging lenses are like diverging lenses	How converging lenses are not like diverging lenses
1.	
2.	
3.	
⋮	

Round off the session with another walkabout session or a class Q & A session (5 minutes). This activity stretches the Scholars to build meaning about lenses in general by highlighting in detail the similarities and differences between the two types of lenses. If the Scholars are finding making a start difficult, help them by doing the activity with another science topic, or remind them that they did something similar in Tutorial 13.

8. Wrap up (15 minutes)

As the Tutor, do take this opportunity, while the Scholars are all working, to sign off Unit S7 in each of their Scholar's MSCE Resources Folder.

Forum for African Women Educationalists in Malawi (FAWEMA)

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