Secondary Science

Pair work: atoms and molecules, and chemical reactions

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Video resources

Some of the activities in this unit are accompanied by the following icon:  *. This indicates that you will find it helpful to view the TESS-India video resources for the specified pedagogic theme.*

The TESS-India video resources illustrate key pedagogic techniques in a range of classroom contexts in India. We hope they will inspire you to experiment with similar practices. They are intended to complement and enhance your experience of working through the text-based units, but are not integral to them should you be unable to access them.

TESS-India video resources may be viewed online or downloaded from the TESS-India website, http://www.tess-india.edu.in/). Alternatively, you may have access to these videos on a CD or memory card.

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All India - English

What this unit is about

This unit is about a simple teaching technique for encouraging students to talk about science. You can use it with Class IX or Class X students. The technique is pair work and is illustrated in the context of atoms and molecules, and chemical reactions.

Research shows (Mercer and Littleton, 2007) – and you probably know from your own experience – that talking about a problem or a new idea can be very helpful. Talking can help you to understand. Talk is an instrument for developing higher order cognitive activity, and it is the same for your students. But when students move from Class VIII to Class IX, they are usually expected to work silently on their own. The work they are expected to do is also considerably more demanding. However, as you know, students learn at different rates, and many find science in Class IX and Class X to be hard and unrewarding. Working and talking with a partner in structured activities will help to engage your students in science learning and support the co-construction of knowledge.

In this unit you will learn about some simple strategies for encouraging your students to talk about science problems and review their work with another student in the class. Talking about science and reviewing each other's work will help your students to understand difficult ideas. If they understand the work, they are more likely to apply the ideas in novel situations and will do better in the examination at the end of the year.

The teaching approaches in this unit involve students working in pairs, and apply to many topics in Classes IX and X. Resource 1 explores pair work in detail.

Video: Using pair work

http://tinyurl.com/video-usingpairwork

What you can learn in this unit

- The benefits of allowing your students to talk about science with a partner.
- How to plan and use pair work to promote learning.
- How to use peer review to help your students to learn science.

Why this approach is important

If you ask questions, your students will probably give answers. In many classrooms, however, the same students tend to answer questions and the answers are often very short. Not much talking about science goes on!

Vygotsky (1978) established that the construction of knowledge and understanding is predominantly a social process. Understanding appears first in the social space that students share, and then becomes internalised by individuals. The activities of talking around new ideas, exploring them through discussion, and asking for explanations and justifications, are all part of the process of building individual knowledge. Meaning is constructed as students talk among themselves, as well as discuss with the teacher; Vygotsky showed that language provides the tools for thought. Teachers can encourage students to describe and explain their ideas, and help students to feel unafraid of getting things wrong. There is research to show that spending time planning and using activities that focus on structured cooperative talk in students leads to higher scores in general logical processing.

By encouraging students to talk to each other in pairs, they get the benefits of talk, and it works with large classes. In this unit, you will learn about three possible approaches for activities to support structured student talking. You can find out more in Resource 2, 'Talk for learning'.

Video: Talk for learning

http://tinyurl.com/video-talkforlearning

Pause for thought

- When do your students get opportunities to talk in science lessons?
- How do you encourage them to talk about science ideas with other students?
- How do you organise for them to report their ideas to the whole class?

Through talk, we can combine our intellectual resources to find better solutions to problems than we can as individuals. Additionally, by using language to think together, students can also learn valuable ways of thinking independently. In this unit there are some techniques for organising productive talk with pairs of students. Other techniques – such as mind mapping, brainstorming and doing practical work – are also useful in supporting productive student science talk. All these techniques are covered in other units.

1 Technique: 'think–pair–share'

'Think–pair–share' is a powerful technique that provides the opportunity for students to learn with their classmates. The case study will show you how the technique works.

Think–pair–share involves setting a task for students to do on their own. The task could be some simple true/false questions, matching words with definitions, or putting a set of instructions into order. Once they have had about five minutes to do the questions on their own, students compare notes with a partner. In Case Study 1, the pairs share their answer with another pair (Figure 1).

Figure 1 Students are asked to work in pairs to solve a problem. They then compare their solution with another pair.

Case Study 1: A training session that uses the think–pair–share technique

Mr Singh attended a training session at the local DIET. Instead of sitting and listening to the trainer, the group were asked to take part in a number of activities. He then tried this activity with his students.

Last week I attended a training session at the DIET. It was much better than usual because we had the opportunity to try out the activities that we were being told about. The trainer drew nine diagrams on the blackboard [see Resource 3]. We had to label each diagram as an element, compound or a mixture. I was worried! I am a biology teacher and I could not remember much about this topic. The trainer encouraged us to guess if we weren't sure.

We then compared notes with the person next to us. The person next to me was Anju, a physicist, so she wasn't very sure either. I changed some of my answers and she changed some of hers, and eventually we agreed on the answers. Then we shared them with another pair. I realised that I had been correct about 'E' – I thought it was an element but couldn't explain why. Anju had convinced me that it was a compound because it contained molecules. Shanka, in the next group, explained that it was an element because all the atoms were the same. Finally, the four of us compared our results with another four and found that we agreed.

I realised that I had learnt quite a lot during the exercise as a result of talking to my colleagues. And nobody else in the class knew how I did at first, so I did not feel embarrassed about how little I knew!

A few days later, I was teaching chemical reactions to Class X. I asked them for the definition of an element. Only three people put their hands up and the first one I asked got it wrong, so I did the pair work exercise with them. It took a mere 15 minutes, and although we did elements, mixtures and compounds in Class IX, some of them did not do very well in the exam. I am sure they will find 'chemical reactions' easier now that they understand the underlying ideas. I watched them carefully and listened to the discussions. Susamma understood very well, but Rahanna struggled. I will make sure that they sit together when we do chemical formulas, so that Susamma can help Rahanna.

Pause for thought

- What is your reaction to this case study?
- How often do you discuss science ideas with your colleagues?

When using think–pair–share, you can ask your students to compare their answers with a partner, or you can do as Mr Singh did and ask them to compare with another pair. You can stop at four or continue until you have groups of eight or 16. The key is that the group has to agree on the right answers before it talks to another group. The benefit comes from giving your students the chance to talk and co-construct knowledge.

If you walk around while students are working, you will soon observe and hear who understands and who doesn't. You will know which students are likely to need support. You will also find that in some cases, students who got the answers wrong at first, have, as a result of talking to their classmates, change their ideas. This will give you chance to praise your students and increase their confidence.

Activity 1: Using think–pair–share

This activity will help you to prepare and carry out a think–pair–share exercise with your class. You can use it to consolidate understanding of writing chemical formulas.

First, think of chemicals with formulas that are complicated (i.e. involve brackets) or ones that, in your experience, students often get wrong (see Resource 4 for some ideas). Choose five of these chemicals and write their names on the blackboard.

Give your students five minutes to work out the formulas on the own. Then get each student to compare answers with their neighbour. If they do not agree, they each need to try and convince their neighbour that they have got the answer correct by explaining why they got that answer. When they agree on the answers, ask them to share with another pair. While they are working, move around the room and listen carefully to the conversations.

Finally, ask your students to stop their conversations. Choose students to share their answers with the whole class. If there are students who get the formulas wrong, ask them to explain their thinking and other students to explain the correct answers.

Pause for thought

Were you surprised, pleased or disappointed by how your students did?

Once you start to probe your students' understanding in this way, you may be disappointed to learn that they have not understood some of the things that you have taught. This does not mean that they can't understand. It means that you need to find other ways of helping them develop their understanding. Giving them a chance to have short discussions in pairs is a very good way of doing so.

2 Technique: solving problems

A good way to encourage your students to talk about science is to ask them to give explanations for their answers to problems, using questions that start with 'why' or 'how' rather than 'what'. For example, instead of asking them a closed question such as 'What type of chemical reaction is this?', you could ask: 'Why is this reaction classified as a double decomposition reaction?' The answer that they give will be longer and will tell you whether they have developed the skills and knowledge to classify reactions.

Working on solving problems in pairs is a good way for students to improve their thinking skills. By talking about the problem, they will develop their reasoning skills and gain confidence. It is easy for teachers to focus on whether a student has got the answer right or wrong, but it is important to pay attention to their thinking and reasoning. If students understand why a particular solution is correct, they are more likely to be able to apply their reasoning to new situations. This is difficult in a large class, but by using pair work you can give your students the opportunity to talk about their reasoning and develop these higher order skills.

Read Case Study 2, in which Mr Ransat uses this technique. Notice that he takes time for his students to respond appropriately to this type of tasks.

Case Study 2: Pair work in class

Mr Ransat was teaching chemical reactions to Class X.

This term I have been trying to get my students to talk about science. It is taking them some time to get used to the idea, as I have a reputation for being quite strict and in the past I have not allowed any talking in my class. I expected my students to work on their own. However, I have 70 students in the class and I am beginning to realise that although I can't help each one individually, they can learn a lot from each other if I give them the opportunity. By listening to their conversations, I now know who is finding the work hard and who understands.

Last week I gave them a problem to discuss. I wrote six word equations on the blackboard. I asked my students to rewrite each equation as a balanced chemical equation and to identify the type of reaction. I asked my students to work in pairs. One person did the first three and the other person did the second three. Then I asked them to compare answers. Each student had to explain their answers to their partner. They had to explain how they had made the equation balance and why they had classified the reaction as a particular type.

While they were working I moved around the room and listened to their discussions. I chose six students who gave clear explanations to explain the answer to the class.

I was pleased with the results. Everyone was actively involved – even though the room was noisy. In the past I might have given them ten or more questions to solve on their own and then would have gone through the answers. I probably didn't give them enough time to understand why a particular answer was wrong – the focus was always on the answer rather than the reason. I noticed Sanjay and Emrit were particularly animated. Sanjay was convinced that his one of his answers was right, but Emrit was able to explain that Sanjay had missed a bracket off $CaOH_2$ and why the bracket is needed. I don't think he will make that mistake again.

Activity 2: Problem solving in pairs

Write the following Grade X exam questions on the blackboard.

1. Choose from the following elements: ${}_{6}C$, ${}_{8}O$, ${}_{10}Ne$, ${}_{11}Na$ and ${}_{14}Si$.
   a) Which elements are in the same group?
   b) Which elements are in the same period?
2. Na, Mg and Al have one, two and three valence electrons respectively. Which has the largest atomic radius? Which is the most reactive?

The answer to Question 1(a) is C and Si and the answer to Question 1(b) is Na and Si. The answer to Question 2 is that sodium has the largest radius and sodium is the most reactive.

Ask your students to work in pairs to answer and to develop explanations for the answers. One student should explain the first question and the other student should explain the second question, so they both get a turn at explaining and listening. If they don't follow the reasoning, they should be encouraged to ask questions. This will help you to make sure that they really understand the problem.

Choose two students to explain the answers to the rest of the class. Finally ask someone to explain the link between the valency and the position in the Periodic Table. Once they understand this, remembering the valencies will be much easier.

Pause for thought

- How did your students respond to this activity?
- What did this tell you about their understanding of the Periodic Table?
- What will you do next to support students who are less confident in their understanding?
- Can you think of any other topics when you could use this technique?

If they are not used to talking about their work, it will take your students time to get used to this approach. You might find it helpful to explain to them why you are encouraging them to work like this. If they appreciate that you want them to understand where the answers come from, they will begin to take more responsibility for their learning and will have the confidence to ask you or their friends for help.

3 Technique: peer review

Research (Hattie, 2012) shows that one of the best ways to improve student achievement is to provide good feedback about what they need to do to improve and the next steps in their learning. You do this by marking their work. However, by encouraging students to review each other's work in pairs, they can get more feedback on their work and will be able to make more progress.

Pause for thought

- When you mark students' work, what sort of feedback do you usually give? What do you do if the student has made a mistake? Do you correct wrong answers? Do you give students time to read your feedback?
- Imagine that you had submitted an assignment. What sort of feedback would you like to receive?

Ideally, feedback should provide encouragement by indicating what has been done well, but also help to understand how to improve. Everyone likes to know what they have done well. It should also show them where they have gone wrong, indicate what they need to do to improve and include some questions to make them think. But not all of the feedback has to come from you. Students can learn a great deal by discussing their work with their peers: they learn evaluative skills as well as reinforce their knowledge of the science content.

It will take time for your students to learn how to evaluate other students' work and give feedback, and they will need practice. You will also need to establish some simple rules. For example, that when commenting on someone's work, you always say two positive things for every negative comment. Negative comments can be presented in a positive way: 'It would be even better if …' is more friendly than 'You should have …'.

In Case Study 3, Mrs Ranjam asks her students to mark some work. They all mark the same work so they can discuss the feedback.

Case Study 3: Peer assessment

Mrs Ranjam wanted to get her students involved in peer assessment, but she realised that they would need some practise.

I decided to give my Class X students some experience of marking work. We had just finished the chapter on chemical reactions, and I asked them to do the questions at the end of the chapter for homework. The next day, I got to school early and wrote the answers to some of the questions on the blackboard. But I made some deliberate mistakes. I said to my students, 'Now work in pairs to mark my work.' For each question I asked them to write down what was right, what was wrong and how it should be corrected. There was a great deal of lively discussion, especially when they found one of my mistakes.

While they were working, I walked round and listened to their discussions. I had to do quite a bit of prompting to make sure that they marked it thoroughly. Once they realised what I expected, they turned out to be strict markers!

When they had finished I asked students to write the correct answers on the blackboard and I asked them what feedback they would give about my answers. I asked them what I had done well, what I needed to improve and what mark they would have given my work. They particularly enjoyed doing this. At first some of them were reluctant to be critical, but Sushant said that I needed to try harder and set my work out more clearly, and they all laughed.

Then I gave them the chance to have another look at their own work. Some of them made quite a few corrections. This was fine, because the homework was not meant to be set as a test. I was happy that they had spotted some of their own mistakes, and I did not let them change anything unless they could explain why they wanted to change it.

Activity 3: Using peer assessment

Try this activity with a class when you next reach the end of a topic.

When you have finished a topic, set your students the homework task of devising ten revision questions (and, separately, the correct answers). Tell them to use the 'What have your learnt?' section at the end of the chapter to help them to pick out the important points.

The next day, ask them to work in pairs to complete each other's questions. Give them ten minutes to mark each other's work. For this sort of exercise, it is helpful for them to work with a friend – someone they like and trust.

Ask them to write down two things that their partner did well and one thing that they need to revise carefully.

Pause for thought

- How did this exercise help your students to learn?
- What did it tell you about their understanding of the topic?

It is helpful for students to know how their work will be judged. They are more likely to achieve highly if they know what is expected of them, and it will help them to take responsibility for their own learning.

4 Summary

Encouraging your students to talk about science in pairs will bring many benefits to your teaching. Working in this way will motivate your students and will develop their capacity to think and solve problems.

To get the full benefit from this approach, there are two key changes that you will need to make in your classroom, which you will be able to use in every topic. First, you will need to get used to there being more noise in your classroom. Second, you will need to be comfortable with allowing your students to change their own answers, like Mrs Ranjam did in Case Study 3. Students will be used to the idea that they should not copy other students work, and will often see homework as a sort of 'test'. But changing their answers because they realise that they have made a mistake is not the same as copying, and homework is a chance to learn. If a student realises that they have made a mistake, and most importantly understands why, they should be allowed to correct it themselves. The time to 'test' them is at the end of the topic, when they have had chance to revise the work.

Your students will need time to get used to working in this way, but when they do, you will see many benefits. The lessons will become more enjoyable, your students will become more confident and willing to take responsibility for their learning, and you will have a better idea about how they are doing – even in a large class.

Resources

Resource 1: Using pair work

In everyday situations people work alongside, speak and listen to others, and see what they do and how they do it. This is how people learn. As we talk to others, we discover new ideas and information. In classrooms, if everything is centred on the teacher, then most students do not get enough time to try out or demonstrate their learning or to ask questions. Some students may only give short answers and some may say nothing at all. In large classes, the situation is even worse, with only a small proportion of students saying anything at all.

Why use pair work?

Pair work is a natural way for students to talk and learn more. It gives them the chance to think and try out ideas and new language. It can provide a comfortable way for students to work through new skills and concepts, and works well in large classes.

Pair work is suitable for all ages and subjects. It is especially useful in multilingual, multi-grade classes, because pairs can be arranged to help each other. It works best when you plan specific tasks and establish routines to manage pairs to make sure that all of your students are included, learning and progressing. Once these routines are established, you will find that students quickly get used to working in pairs and enjoy learning this way.

Tasks for pair work

You can use a variety of pair work tasks depending on the intended outcome of the learning. The pair work task must be clear and appropriate so that working together helps learning more than working alone. By talking about their ideas, your students will automatically be thinking about and developing them further.

Pair work tasks could include:

- **'Think–pair–share':** Students think about a problem or issue themselves and then work in pairs to work out possible answers before sharing their answers with other students. This could be used for spelling, working through calculations, putting things in categories or in order, giving different viewpoints, pretending to be characters from a story, and so on.
- **Sharing information:** Half the class are given information on one aspect of a topic; the other half are given information on a different aspect of the topic. They then work in pairs to share their information in order to solve a problem or come to a decision.
- **Practising skills such as listening:** One student could read a story and the other ask questions; one student could read a passage in English, while the other tries to write it down; one student could describe a picture or diagram while the other student tries to draw it based on the description.
- **Following instructions:** One student could read instructions for the other student to complete a task.
- **Storytelling or role play:** Students could work in pairs to create a story or a piece of dialogue in a language that they are learning.

Managing pairs to include all

Pair work is about involving all. Since students are different, pairs must be managed so that everyone knows what they have to do, what they are learning and what your expectations are. To establish pair work routines in your classroom, you should do the following:

- Manage the pairs that the students work in. Sometimes students will work in friendship pairs; sometimes they will not. Make sure they understand that you will decide the pairs to help them maximise their learning.
- To create more of a challenge, sometimes you could pair students of mixed ability and different languages together so that they can help each other; at other times you could pair students working at the same level.
- Keep records so that you know your students' abilities and can pair them together accordingly.
- At the start, explain the benefits of pair work to the students, using examples from family and community contexts where people collaborate.
- Keep initial tasks brief and clear.
- Monitor the student pairs to make sure that they are working as you want.
- Give students roles or responsibilities in their pair, such as two characters from a story, or simple labels such as '1' and '2', or 'As' and 'Bs'). Do this before they move to face each other so that they listen.
- Make sure that students can turn or move easily to sit to face each other.

During pair work, tell students how much time they have for each task and give regular time checks. Praise pairs who help each other and stay on task. Give pairs time to settle and find their own solutions – it can be tempting to get involved too quickly before students have had time to think and show what they can do. Most students enjoy the atmosphere of everyone talking and working. As you move around the class observing and listening, make notes of who is comfortable together, be alert to anyone who is not included, and note any common errors, good ideas or summary points.

At the end of the task you have a role in making connections between what the students have developed. You may select some pairs to show their work, or you may summarise this for them. Students like to feel a sense of achievement when working together. You don't need to get every pair to report back – that would

take too much time – but select students who you know from your observations will be able to make a positive contribution that will help others to learn. This might be an opportunity for students who are usually timid about contributing to build their confidence.

If you have given students a problem to solve, you could give a model answer and then ask them to discuss in pairs how to improve their answer. This will help them to think about their own learning and to learn from their mistakes.

If you are new to pair work, it is important to make notes on any changes you want to make to the task, timing or combinations of pairs. This is important because this is how you will learn and how you will improve your teaching. Organising successful pair work is linked to clear instructions and good time management, as well as succinct summarising – this all takes practice.

Resource 2: Talk for learning

Why talk for learning is important

Talk is a part of human development that helps us to think, learn and make sense of the world. People use language as a tool for developing reasoning, knowledge and understanding. Therefore, encouraging students to talk as part of their learning experiences will mean that their educational progress is enhanced. Talking about the ideas being learnt means that:

- those ideas are explored
- reasoning is developed and organised
- as such, students learn more.

In a classroom there are different ways to use student talk, ranging from rote repetition to higher-order discussions.

Traditionally, teacher talk was dominant and was more valued than students' talk or knowledge. However, using talk for learning involves planning lessons so that students can talk more and learn more in a way that makes connections with their prior experience. It is much more than a question and answer session between the teacher and their students, in that the students' own language, ideas, reasoning and interests are given more time. Most of us want to talk to someone about a difficult issue or in order to find out something, and teachers can build on this instinct with well-planned activities.

Planning talk for learning activities in the classroom

Planning talking activities is not just for literacy and vocabulary lessons; it is also part of planning mathematics and science work and other topics. It can be planned into whole class, pair or groupwork, outdoor activities, role play-based activities, writing, reading, practical investigations, and creative work.

Even young students with limited literacy and numeracy skills can demonstrate higher-order thinking skills if the task is designed to build on their prior experience and is enjoyable. For example, students can make predictions about a story, an animal or a shape from photos, drawings or real objects. Students can list suggestions and possible solutions about problems to a puppet or character in a role play.

Plan the lesson around what you want the students to learn and think about, as well as what type of talk you want students to develop. Some types of talk are exploratory, for example: 'What could happen next?', 'Have we seen this before?', 'What could this be?' or 'Why do you think that is?' Other types of talk are more analytical, for example weighing up ideas, evidence or suggestions.

Try to make it interesting, enjoyable and possible for all students to participate in dialogue. Students need to be comfortable and feel safe in expressing views and exploring ideas without fear of ridicule or being made to feel they are getting it wrong.

Building on students' talk

Talk for learning gives teachers opportunities to:

- listen to what students say
- appreciate and build on students' ideas
- encourage the students to take it further.

Not all responses have to be written or formally assessed, because developing ideas through talk is a valuable part of learning. You should use their experiences and ideas as much as possible to make their learning feel relevant. The best student talk is exploratory, which means that the students explore and challenge one another's ideas so that they can become confident about their responses. Groups talking together should be encouraged not to just accept an answer, whoever gives it. You can model challenging thinking in a whole class setting through your use of probing questions like 'Why?', 'How did you decide that?' or 'Can you see any problems with that solution?' You can walk around the classroom listening to groups of students and extending their thinking by asking such questions.

Your students will be encouraged if their talk, ideas and experiences are valued and appreciated. Praise your students for their behaviour when talking, listening carefully, questioning one another, and learning not to interrupt. Be aware of members of the class who are marginalised and think about how you can ensure that they are included. It may take some time to establish ways of working that allow all students to participate fully.

Encourage students to ask questions themselves

Develop a climate in your classroom where good challenging questions are asked and where students' ideas are respected and praised. Students will not ask questions if they are afraid of how they will be received or if they think their ideas are not valued. Inviting students to ask the questions encourages them to show curiosity, asks them to think in a different way about their learning and helps you to understand their point of view.

You could plan some regular group or pair work, or perhaps a 'student question time' so that students can raise queries or ask for clarification. You could:

- entitle a section of your lesson 'Hands up if you have a question'
- put a student in the hot-seat and encourage the other students to question that student as if they were a character, e.g. Pythagoras or Mirabai
- play a 'Tell Me More' game in pairs or small groups
- give students a question grid with who/what/where/when/why questions to practise basic enquiry
- give the students some data (such as the data available from the World Data Bank, e.g. the percentage of children in full-time education or exclusive breastfeeding rates for different countries), and ask them to think of questions you could ask about this data
- design a question wall listing the students' questions of the week.

You may be pleasantly surprised at the level of interest and thinking that you see when students are freer to ask and answer questions that come from them. As students learn how to communicate more clearly and accurately, they not only increase their oral and written vocabulary, but they also develop new knowledge and skills.

Resource 3: Elements, compounds and mixtures

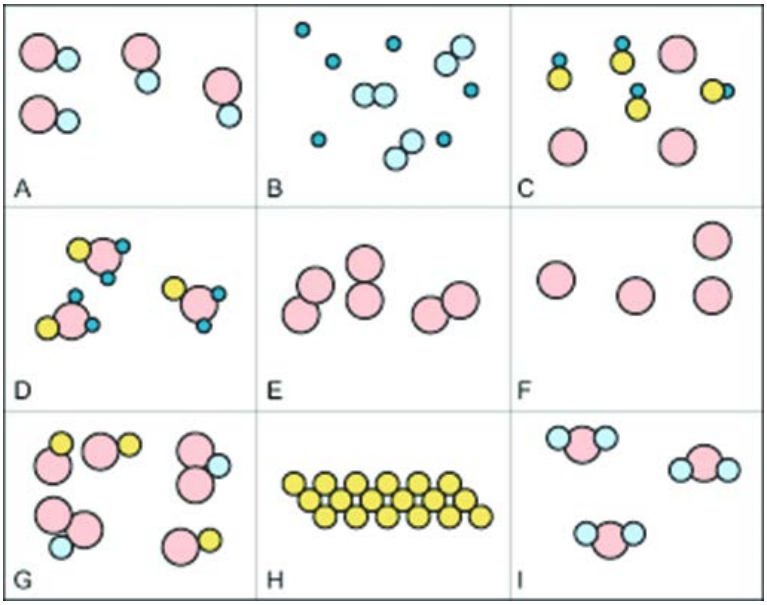

Figure R1.1 A selection of elements, compounds and mixtures.

Answers (for teacher's use)

- A: a compound
- B: a mixture of two elements
- C: a mixture of a compound and an element
- D: a compound
- E: an element
- F: an element
- G: a mixture of two compounds
- H: an element
- I: a compound

Resource 4: Chemical formulas

You could use examples such as:

- Sodium oxide Na_2O
- Calcium chloride $CaCl_2$
- Aluminium oxide Al_2O_3
- Iron (III) chloride $FeCl_3$
- Magnesium hydroxide $Mg(OH)_2$
- Ammonium sulphate $(NH_4)_2SO_4$
- Calcium phosphate $Ca_3(PO_4)_2$
- Magnesium nitrate $Mg(NO_3)_2$

Common mistakes that students make include:

- putting the number at the top: Na^2O
- using big numbers: Na2O
- missing out a bracket: $CaOH_2$.

It is also common for students to get the valancy wrong. They will need to learn the valencies of some atoms and groups. However, if you link the valancy to the position in the Periodic Table, then it will help them to understand why different atoms have different valencies and make it easier for students to remember the value. The rules are:

- Group 1 metals: +1
- Group 2 metals: +2
- Group 3 metals: +3
- Group 5 non-metals: −3
- Group 6 non-metals: −2
- Group 7 non-metals: −1

Additional resources

- Chemical reactions: https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiometry
- Balancing equations: http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/fundamentals/chemicalreactionsrev3.shtml
- Balancing symbol equations: http://www.creative-chemistry.org.uk/gcse/revision/equations/02.htm
- A video about balancing equations: https://www.youtube.com/watch?v=_B735turDoM
- A video about chemical reactions and equations suitable for Class X: https://www.youtube.com/watch?v=YKMWUeem1TI
- CBSE exam papers and questions: http://cbse-notes.blogspot.co.uk/2012/04/class-10-science-ch1-chemical-reactions.html

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