

Using games: the Periodic Table



Teacher Education
through School-based
Support in India
www.TESS-India.edu.in



<http://creativecommons.org/licenses/>




TESS-India (Teacher Education through School-based Support) aims to improve the classroom practices of elementary and secondary teachers in India through the provision of Open Educational Resources (OERs) to support teachers in developing student-centred, participatory approaches. The TESS-India OERs provide teachers with a companion to the school textbook. They offer activities for teachers to try out in their classrooms with their students, together with case studies showing how other teachers have taught the topic and linked resources to support teachers in developing their lesson plans and subject knowledge.

TESS-India OERs have been collaboratively written by Indian and international authors to address Indian curriculum and contexts and are available for online and print use (<http://www.tess-india.edu.in/>). The OERs are available in several versions, appropriate for each participating Indian state and users are invited to adapt and localise the OERs further to meet local needs and contexts.

TESS-India is led by The Open University UK and funded by UK aid from the UK government.

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.

Version 2.0 SS06v1
All India - English

Except for third party materials and otherwise stated, this content is made available under a Creative Commons Attribution-ShareAlike licence: <http://creativecommons.org/licenses/by-sa/3.0/>

What this unit is about

This unit explains how games can be used to teach your Class X students about the Periodic Table of Elements. The idea of using games in your lessons may seem unusual, especially in Class IX or X. However, educational games can be very useful teaching tools for teachers to know about and to use.

Through the excitement of being engaged in a game, students can become motivated to learn. Games can therefore help your students learn science more easily than normal teaching methods.

Games can also support the development of other important skills that your students need, such as working in a group, critical thinking, data analysis and observational skills. All these skills will help your students in other subjects and outside school, now and in later life.

Some of the games in this unit are classroom adaptations of well-known board games or popular TV game shows, which means they may have an added advantage of familiarity for your students.

What you can learn in this unit

- The benefits of using games with your students.
- How to use a range of games that can be adapted to any science topic.

Why this approach is important

The simple reason that games work so well in the classroom is because they have a competitive element to them. This challenge seems to bring out the best in most students, both girls and boys. Your students can be challenged against each other, for example in 'Splat' (see Case Study 1). Alternatively, the game can challenge the individual student.

Another reason why games are useful for you as a teacher is because your students have to demonstrate their learning in order to do well in the game. This can provide you with immediate feedback so that you can decide whether the science idea or concept needs discussion again in the whole class or perhaps with a few students. In the best games students often forget that they are learning or being assessed. Instead they become engrossed in the winning of the game itself. As you work through this unit, it would be helpful to remind yourself of different assessment techniques. For further information on assessing progress and performance, read Resource 1.



Video: Assessing progress and performance

<http://tinyurl.com/video-assessingprogress>

Classroom games range from the very simple to the more complex. This unit will work through the whole range, beginning with very simple games and progressing to some more complex ones. The final game illustrated is a complex game idea that you can try out for yourself.



Figure 1 Taking part in scientific games often gives your students the chance to get out of their places and move around the room. This is one of the advantages of this approach.

1 Very simple games

'Splat' is a word game that can be used to teach students about scientific vocabulary in a very animated but effective way. The main advantage of using 'Splat' is that it takes almost no preparation.

Case Study 1 is an account by Teacher Nehru of his experiences of using 'Splat' as his first classroom game. The rules of this version of 'Splat' are in Resource 2.

Case Study 1: 'Splat' – elements and the Periodic Table

Teacher Nehru uses Resource 2 on 'Splat' to end a lesson on the elements and the Periodic Table.

I had spent the whole lesson teaching my students about how the Periodic Table of Elements is arranged. It had been a long and intense lesson, but to my surprise I found that I had finished the work that I had planned early.

I had read about the game 'Splat' and decided to try it. As I had nothing else for my students to do other than more copying, I thought that I might as well take a risk and see what happened.

I filled the blackboard with lots of words: names of elements, symbols of elements, words about the Periodic Table and so on. It looked quite messy, actually – not at all like my usual tidy, neat and beautifully arranged blackboard writing.

I didn't tell my students what I was doing, and as the blackboard filled up with words to do with the Periodic Table and elements they watched me with growing curiosity. Towards the end of this I could see and hear that they were becoming unsettled, so I finished quickly.

I then held my arm out and said, 'Those of you on my right side are Team A, and those of you on my left side are Team B.' I explained the rules to them from Resource 1, asked them if they all understood and said that I hoped the best team would win.

The next five minutes were hectic and a little chaotic, but when the bell went for the end of the lesson I knew that playing the game had been well worth the noise. The risk-taking had paid off. My students had really enjoyed the game and they left very excited.

I had a brilliant time being the quiz master of 'Splat'. I would definitely recommend playing 'Splat' to any teacher who has a gap in their lesson to fill or wants to end the lesson on a high note!



Pause for thought

- What is your reaction to this case study?
- How might you use 'Splat' in your classroom?

Writing key words or phrases on the blackboard can be done very quickly, so it is always worth thinking about playing 'Splat' when you have any unexpected time to fill in a lesson. It also makes an excellent starter or concluding activity, and it gives you immediate feedback on your students' strengths and weaknesses with the topic.

'Splat' is a game that is very good for using with the whole of your class. There are many other simple games like 'Splat' that are quick and easy to arrange in the classroom but can also be used with pairs, small groups or the whole class, depending on your choice.

Another game that has this increased level of adaptability is 'What Am I?' This is a five-minute game, needs almost no extra material and can end and start quickly if need be. You will be surprised how quickly your students learn the rules for these types of games.

Activity 1: Playing 'What Am I?' with the Periodic Table

This activity is for you to do with your class. You will need a Post-it note or similar sticky paper for each member of your class.

1. Arrange your class into pairs.
2. Give each student one Post-it note (or something similar). Keeping the Post-it note hidden from their partner, ask your students to write the name of one group from the Periodic Table on it (or one scientist such as Newlands, or Mendeleev).
3. Ask the pairs to gently stick their Post-it note to their partner's forehead, but so that only they can see it. For the game to work, your students must not be able to see what is written on the Post-it note on their own forehead.
4. Each student must ask their partner a series of science questions to work out what periodic group or scientist they have stuck on their forehead.
5. As they play the game, move around the classrooms to listen to the range of conversations. Listen especially for areas where students are not sure about the science concepts and ideas.
6. Make notes of what your students know about the groups in the Periodic Table and what they do not know so well.
7. If your students are not familiar with this sort of game, you might model the game with one student at the front of the classroom before they start. This will help the game to go more smoothly.



Pause for thought

- Were you surprised, pleased or disappointed by how your students did in this activity?
- How can you use the information you have collected in planning for the next lessons on the Periodic Table?

2 Quizzes

A quiz is a game that needs a little more advance preparation than ones like 'Splat' and 'What Am I?' For a quiz to work well, the questions and answers need to be produced and checked beforehand.

The main advantage of using a quiz is that by providing the correct answers afterwards, your students can learn from any mistakes they make. You can easily adjust the challenge of the quiz by:

- giving your students more or less time
- giving them more or fewer questions
- changing the group size.

The most important thing to remember when planning a quiz is that all the questions need to be closed and have short answers. Closed questions are questions where there is only one definite right answer. This is to avoid any confusion for your students over other possible correct answers when they are doing the quiz. The questions themselves can be long (ideally not too long or complicated so that your students can access them quickly) but you want the student to be able to give a short rather than extended answer.

When you are planning quiz questions, also think of these four key factors:

- level of difficulty
- pace
- coverage of the topic
- variety.

So, in summary, good class quizzes have the following characteristics:

- All the questions can only be answered correctly with a brief and particular response.
- There should be a mixture of hard and easy questions.
- Each question doesn't take too long to answer.
- Each question concentrates on a different part of the science topic, but overall a sensible amount of science is tested.
- There are different types of questions, including 'true or false' questions and multiple choice questions.
- There are not too many questions in total, so that the quiz is quick and concise.

Activity 2: '10-4-10', planning a simple quiz on the trends in the Periodic Table

This activity will help you to prepare and carry out a short quiz on the trends in the modern Periodic Table with your class. The aim here is to create ten quiz questions that can be answered in ten minutes following the rules above – hence the name of the quiz, '10-4-10'.

Read the Class X textbook section on the trends in the modern Periodic Table. What kinds of questions does it ask? Do you think your students would be able to answer these questions well in a quiz situation?

Make a list of the questions in the textbook that you think could be easily adapted as good quiz questions. If possible, work with another science teacher to adapt the questions on your list into good quiz questions. Supplement your quiz with new questions of your own to make ten questions.

With your colleague, create the answer sheet for the quiz. Give the quiz to another colleague to test it out. Use the feedback from your second colleague to make any alterations to the questions.

Use your quiz with Class X. You could divide them into two teams and ask alternate questions, or you could set it up like a television quiz show.

Note carefully the questions that your students did not answer correctly. How will you improve their understanding in these areas?

3 Games that need props

Some games require the use of props – teaching aids that can be made cheaply with a little effort. Depending on the nature of the props, the planning and preparation of games like these is more time-consuming. Once you have made the props, you can re-use them with your classes next year, or you can use the props in a different way with the same class in later lessons.

The next case study illustrates the use of a sorting game which uses a series of element cards (see Resource 3).

Case Study 2: Teacher Pradeep uses element cards for teaching the classification structure of the Periodic Table

I had already used a quick quiz and played another game with my younger classes, and they had all taken part in both very enthusiastically. But I wanted to do a harder game with my older Class X who were studying the chapter on the periodic classification of elements in the textbook.

I wanted to recreate the process that Mendeleev had gone through when he sorted the elements into groups. When I saw some old men playing cards in the park on the way home from school I knew that I could do something similar if I made some cards with information about the elements, which my students could then sort into groups by hand.

I asked all my classes to collect and bring as much clean scrap cardboard as they could from home. After about three weeks I thought I had enough thin cardboard to create enough element cards for Class X. Because there were 60 students in the class and each group needed cards for the first 20 elements, I decided to create six large groups of ten students each for the sorting game lesson. Each group needed the cards for the first 20 elements, altogether making 200 cards!

It would have taken me much too long to create all the element cards myself, so in the lesson before, we all made the cards together. This included cutting the scrap card to the right size and, where necessary, covering the cards with white paper so that the element information could be written on it. It was a fun lesson, if a little noisy compared to normal. As they were all doing such a good job of making the element cards I decided to ignore the noise and giggling. I wouldn't do this normally! I asked for the following information on each element to be put on to the card and allocated different elements to different students:

- symbol
- atomic number
- electron arrangement
- mass number
- appearance

- state at room temperature.

Sanjay told me quietly at the end of the lesson that he had learnt more about the elements he was doing than he had in previous lessons because he had been learning them in a fun way. At the end of this lesson I collected in the cards and checked to make sure that they were all OK, and then arranged them for the next lesson.

In the actual lesson I gave the groups 20 minutes to devise a way of classifying the elements based on the information on the cards. 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 60 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. Playing games gives me great opportunities. While they are playing I get the chance to listen to their conversations, and I now know who is finding the work hard and who understands it.

After 20 minutes I said to them, 'Go and see how the other groups have classified their element cards.' At the end of the lesson I quickly gathered my students round the front. I explained how Mendeleev worked out the Periodic Table. I noticed lots of nodding heads. They now clearly understood the difficulties of classification better having done it for themselves.

I told them the properties of silicon and tin and then asked them to predict the properties of the element that would fit in between them. I was surprised how close they were able to get to the right answer. I then told them about the properties of germanium. I ended the lesson by explaining that a good chemist can use their knowledge of the Periodic Table to predict the properties of almost any element and that, as they had done this, they were becoming good chemists.

This lesson involves much preparation but it enables students to have a small glimpse of how scientists work and how scientific knowledge is constructed. This activity reinforces your students' learning about the Periodic Table so that they are more secure in their learning of this topic. An activity like this also offers you the opportunity to evaluate students' learning and to identify which students are less confident with their learning of this topic. Like this activity, many games involve groupwork, and you can try different ways of organising the groups. See the key resource 'Using groupwork' (<http://tinyurl.com/kr-usinggroupwork>) for more information.



Video: Using groupwork

<http://tinyurl.com/video-usinggroupwork>

4 Complex games

Games can take many shapes and forms. Educational games can be played in the real world, or in the virtual world, online or offline, on a mobile phone, tablet computer or other types of computer. They can be inspired by board games, books, videogames or even TV shows.

Adapting the format of a popular TV game show has instant appeal for many students. It demonstrates to students that you are 'current' and know what your students' interests are outside school. In other words, it can make you seem more human to your students and develop the student-teacher bond immensely!

Producing some games from scratch can be quite time-intensive, so working collaboratively with other teachers to adapt a TV game show format into a re-usable game to use with your classes is a good strategy

that will save you all time and hopefully be an enjoyable experience. Activity 3 enables you to undertake such an exercise in the context of the TV game show *Who Wants to be a Millionaire?*

Activity 3: *Who Wants to be a Science Millionaire?*

This activity will help you to prepare and test a complex game for your class.

Who Wants to be a Science Millionaire? is a quiz game mimicking the very popular and highly successful TV show *Who Wants to be a Millionaire?* Use Resource 4 to make a game entitled *Who Wants to be a Science Millionaire? – The Revision Episode*. If there is another science teacher in your school, try to do this with them.

All of the questions in the game you create should be science-based.

The learning aim of the game is that your students are able to effectively revise their three sciences – physics, chemistry and biology – for an upcoming summative assessment. You will need to think carefully about which specific classes you are aiming the game at, because this will influence both the material you include and the level and complexity of the questions you pose.

Test out your game on a small number of students. This is so that you know the questions work. It will also give you experience of the practicalities of running the game for real.

Plan where, in your future teaching sequences for the school year, you can use the game. Make a note of this in your planning documentation and don't forget to keep your game resources in a safe place until you get to this point in your teaching calendar.

After you have done this, consider the following questions and make a brief note of your answers:

- How valuable an experience was this for you in terms of working collaboratively with other teachers?
- What have you learnt about creating games from this exercise?
- What would you do differently next time?
- What impact do you expect this game to have on the quality or quantity of the revision of your target audience?



Pause for thought

Identify two techniques or strategies that you have learned in this unit that you might use in your classroom, and two ideas that you want to explore further.

5 Summary

Using games in your lessons will bring many benefits to your science teaching. Your students will learn the rules of each game you use very quickly. They will also easily adapt to the changes in classroom routines needed for the games to be successful. As they get used to this teaching method they will also begin to adapt the games and help you create new games.

The lessons will become more enjoyable and your students will become more motivated. Most importantly, they will also learn more science this way. You will also have a better idea about their learning, even in a large class.

When your students play games the noise levels will be higher than you are used to. But this will be 'good' noise as it means your students are actively learning.

Resources

Resource 1: Assessing progress and performance

Assessing students' learning has two purposes:

- **Summative assessment** looks back and makes a judgement on what has already been learnt. It is often conducted in the form of tests that are graded, telling students their attainment on the questions in that test. This also helps in reporting outcomes.
- **Formative assessment** (or assessment for learning) is quite different, being more informal and diagnostic in nature. Teachers use it as part of the learning process, for example questioning to check whether students have understood something. The outcomes of this assessment are then used to change the next learning experience. Monitoring and feedback are part of formative assessment.

Formative assessment enhances learning because in order to learn, most students must:

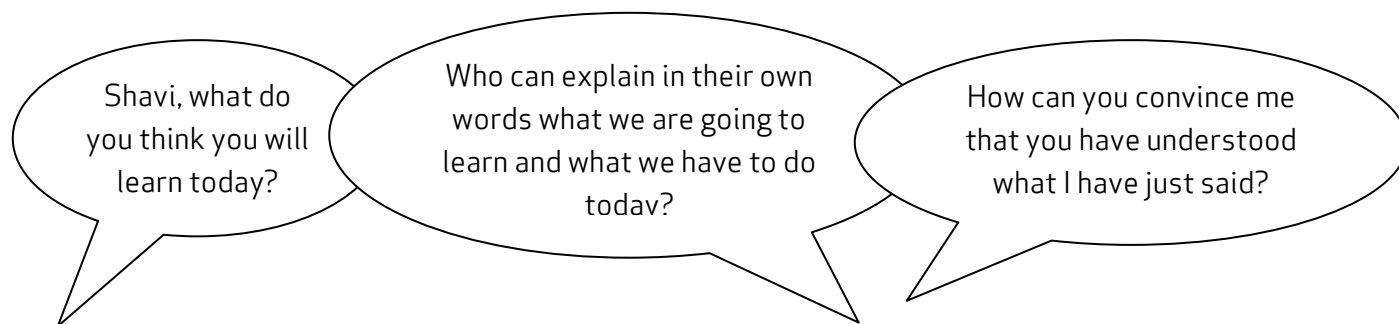
- understand what they are expected to learn
- know where they are now with that learning
- understand how they can make progress (that is, what to study and how to study)
- know when they have reached the goals and expected outcomes.

As a teacher, you will get the best out of your students if you attend to the four points above in every lesson. Thus assessment can be undertaken before, during and after instruction:

- **Before:** Assessing before the teaching begins can help you identify what the students know and can do prior to instruction. It determines the baseline and gives you a starting point for planning your teaching. Enhancing your understanding of what your students know reduces the chance of re-teaching the students something they have already mastered or omitting something they possibly should (but do not yet) know or understand.
- **During:** Assessing during classroom teaching involves checking if students are learning and improving. This will help you make adjustments in your teaching methodology, resources and activities. It will help you understand how the student is progressing towards the desired objective and how successful your teaching is.
- **After:** Assessment that occurs after teaching confirms what students have learnt and shows you who has learnt and who still needs support. This will allow you to assess the effectiveness of your teaching goal.

Before: being clear about what your students will learn

When you decide what the students must learn in a lesson or series of lessons, you need to share this with them. Carefully distinguish what the students are expected to learn from what you are asking them to do. Ask an open question that gives you the chance to assess whether they have really understood. For example:



Give the students a few seconds to think before they answer, or perhaps ask the students to first discuss their answers in pairs or small groups. When they tell you their answer, you will know whether they understand what it is they have to learn.

Before: knowing where students are in their learning

In order to help your students improve, both you and they need to know the current state of their knowledge and understanding. Once you have shared the intended learning outcomes or goals, you could do the following:

- Ask the students to work in pairs to make a mind map or list of what they already know about that topic, giving them enough time to complete it but not too long for those with few ideas. You should then review the mind maps or lists.
- Write the important vocabulary on the board and ask for volunteers to say what they know about each word. Then ask the rest of the class to put their thumbs up if they understand the word, thumbs down if they know very little or nothing, and thumbs horizontal if they know something.

Knowing where to start will mean that you can plan lessons that are relevant and constructive for your students. It is also important that your students are able to assess how well they are learning so that both you and they know what they need to learn next. Providing opportunities for your students to take charge of their own learning will help to make them life-long learners.

During: ensuring students' progress in learning

When you talk to students about their current progress, make sure that they find your feedback both useful and constructive. Do this by:

- helping students know their strengths and how they might further improve
- being clear about what needs further development
- being positive about how they might develop their learning, checking that they understand and feel able to use the advice.

You will also need to provide opportunities for students to improve their learning. This means that you may have to modify your lesson plans to close the gap between where your students are now in their learning and where you wish them to be. In order to do this you might have to:

- go back over some work that you thought they knew already
- group students according to needs, giving them differentiated tasks
- encourage students to decide for themselves which of several resources they need to study so that they can 'fill their own gap'

- use 'low entry, high ceiling' tasks so that all students can make progress – these are designed so that all students can start the task but the more able ones are not restricted and can progress to extend their learning.

By slowing the pace of lessons down, very often you can actually speed up learning because you give students the time and confidence to think and understand what they need to do to improve. By letting students talk about their work among themselves, and reflect on where the gaps are and how they might close them, you are providing them with ways to assess themselves.

After: collecting and interpreting evidence, and planning ahead

While teaching–learning is taking place and after setting a classwork or homework task, it is important to:

- find out how well your students are doing
- use this to inform your planning for the next lesson
- feed it back to students.

The four key states of assessment are discussed below.

Collecting information or evidence

Every student learns differently, at their own pace and style, both inside and outside the school. Therefore, you need to do two things while assessing students:

- Collect information from a variety of sources – from your own experience, the student, other students, other teachers, parents and community members.
- Assess students individually, in pairs and in groups, and promote self-assessment. Using different methods is important, as no single method can provide all the information you need. Different ways of collecting information about the students' learning and progress include observing, listening, discussing topics and themes, and reviewing written class and homework.

Recording

In all schools across India the most common form of recording is through the use of report card, but this may not allow you to record all aspects of a student's learning or behaviours. There are some simple ways of doing this that you may like to consider, such as:

- noting down what you observe while teaching–learning is going on in a diary/notebook/register
- keeping samples of students' work (written, art, craft, projects, poems, etc.) in a portfolio
- preparing every student's profile
- noting down any unusual incidents, changes, problems, strengths and learning evidences of students.

Interpreting the evidence

Once information and evidence have been collected and recorded, it is important to interpret it in order to form an understanding of how each student is learning and progressing. This requires careful reflection and analysis. You then need to act on your findings to improve learning, maybe through feedback to students or finding new resources, rearranging the groups, or repeating a learning point.

Planning for improvement

Assessment can help you to provide meaningful learning opportunities to every student by establishing specific and differentiated learning activities, giving attention to the students who need more help and challenging the students who are more advanced.

Resource 2: How to play 'Splat'

1. Divide your students into two equal-sized teams.
2. Write a series of key words, phrases or symbols on a particular science topic on the blackboard.
3. Take two contestants from each team and stand them facing each other next to the blackboard.
4. Read out a definition or a question that corresponds to one of the items on the blackboard.
5. The first contestant to tap the correct word with their hand is the winner.
6. The winner stays to challenge the next contender from the opposite team.
7. Each correct answer scores one point for their team.

The team with the most points at the end is the winner.

Resource 3: Element cards

<p>Hydrogen (H) Atomic number: 1 Mass number: 1 Electron arrangement: 1 Appearance: colourless, odourless State at room temperature: gas Reactivity: reactive; reacts explosively with oxygen</p>	<p>Helium (He) Atomic number: 2 Mass number: 4 Electron arrangement: 2 Appearance: colourless, odourless State at room temperature: gas Reactivity: completely unreactive</p>	<p>Lithium (Li) Atomic number: 3 Mass number: 7 Electron arrangement: 2,1 Appearance: soft, silvery metal State at room temperature: solid Reactivity: reactive; discolours in air, reacts with cold water, stored in oil</p>	<p>Beryllium (Be) Atomic number: 4 Mass number: 9 Electron arrangement: 2,2 Appearance: white, grey metal State at room temperature: solid Reactivity: does not appear reactive owing to a protective, layer of oxide</p>
<p>Boron (B) Atomic number: 5 Mass number: 11 Electron arrangement: 2,3 Appearance: brown, black State at room temperature: solid Reactivity: chemically inert; only reacts with hot, concentrated acids</p>	<p>Carbon (C) Atomic number: 6 Mass number: 12 Electron arrangement: 2,4 Appearance: dark grey slippery solid, black powder or glass-like gem stone (diamond) State at room temperature: solid Reactivity: reacts with air if heated</p>	<p>Nitrogen (N) Atomic number: 7 Mass number: 14 Electron arrangement: 2,5 Appearance: colourless, odourless State at room temperature: gas Reactivity: unreactive; reacts with oxygen if heated with a platinum catalyst</p>	<p>Oxygen (O) Atomic number: 8 Mass number: 16 Electron arrangement: 2,6 Appearance: colourless, odourless State at room temperature: Gas Reactivity: reactive; reacts with metals and non-metals – sometimes requires heat</p>

<p>Fluorine (F)</p> <p>Atomic number: 9</p> <p>Mass number: 19</p> <p>Electron arrangement: 2,7</p> <p>Appearance: pale yellow, pungent smell</p> <p>State at room temperature: gas</p> <p>Reactivity: very reactive; can etch glass</p>	<p>Neon (Ne)</p> <p>Atomic number: 10</p> <p>Mass number: 20</p> <p>Electron arrangement: 2,8</p> <p>Appearance: colourless, odourless</p> <p>State at room temperature: colourless, odourless</p> <p>Reactivity: completely unreactive</p>	<p>Sodium (Na)</p> <p>Atomic number: 11</p> <p>Mass number: 23</p> <p>Electron arrangement: 2,8,1</p> <p>Appearance: very soft, silvery metal</p> <p>State at room temperature: solid</p> <p>Reactivity: very reactive; stored in oil, tarnishes rapidly in air, reacts with water (melts)</p>	<p>Magnesium (Mg)</p> <p>Atomic number: 12</p> <p>Mass number: 24</p> <p>Electron arrangement: 2,8,2</p> <p>Appearance: silvery grey metal</p> <p>State at room temperature: solid (often kept as ribbon)</p> <p>Reactivity: reacts vigorously with air when heated, slowly with cold water, vigorously with steam</p>
<p>Aluminium (Al)</p> <p>Atomic number: 13</p> <p>Mass number: 27</p> <p>Electron arrangement: 2,8,3</p> <p>Appearance: shiny silver metal</p> <p>State at room temperature: solid</p> <p>Reactivity: tarnishes in air, forms a protective layer</p>	<p>Silicon (Si)</p> <p>Atomic number: 14</p> <p>Mass number: 28</p> <p>Electron arrangement: 2,8,4</p> <p>Appearance: grey, shiny, solid</p> <p>State at room temperature: solid</p> <p>Reactivity: unreactive</p>	<p>Phosphorous (P)</p> <p>Atomic number: 15</p> <p>Mass number: 31</p> <p>Electron arrangement: 2,8,5</p> <p>Appearance: Two forms: red phosphorous (powder) and white Phosphorous (pale grey solid – can be cut with a knife)</p> <p>State at room temperature: solid</p> <p>Reactivity: white phosphorous ignites in air and has to be stored in water; red phosphorous is unreactive</p>	<p>Sulphur (S)</p> <p>Atomic number: 16</p> <p>Mass number: 32</p> <p>Electron arrangement: 2,8,6</p> <p>Appearance: yellow</p> <p>State at room temperature: solid</p> <p>Reactivity: burns when heated in air; reacts with metals when heated</p>

<p>Chlorine (Cl) Atomic number: 17 Mass number: 35 or 37 Electron arrangement: 2,8,7 Appearance: green, yellowy, pungent smell. State at room temperature: gas Reactivity: reactive; reacts with metals, especially if heated</p>	<p>Argon (Ar) Atomic number: 18 Mass number: 40 Electron arrangement: 2,8,8 Appearance: colourless, odourless State at room temperature: gas Reactivity: completely unreactive</p>	<p>Potassium (K) Atomic number: 19 Mass number: 39 Electron arrangement: 2,8,8,1 Appearance: extremely soft, silvery metal State at room temperature: solid Reactivity: stored in oil, tarnishes in air, catches fire when it reacts with water</p>	<p>Calcium (Ca) Atomic number: 20 Mass number: 40 Electron arrangement: 2,8,8,2 Appearance: light grey metal State at room temperature: solid Reactivity: tarnishes in air, reacts with air on heating</p>
--	---	--	---

Resource 4: Information for *Who Wants to be a Science Millionaire?*

The real TV show *Who Wants to be a Millionaire?* has 15 questions. So that the game is not overly long in the classroom context, this is reduced to ten questions standing between your students and a (pretend!) million-dollar prize fund!

Each question is presented in a multiple choice format with one of the four choices being the only correct answer.

As the student progresses through the game, the questions become more difficult. Each question attracts a specific amount of money. The harder the question, the more money they win. Unfortunately for your students, unlike the TV show, they are only playing for prestige rather than real money.

Table R3.1 shows how much money each question is worth (using dollars). You can vary these amounts to suit your own classes.

Table R3.1 Value of each question in 'Who Wants to be a Millionaire?'

Question	1	2	3	4	5	6	7	8	9	10
Value in \$	50	500	1,000	10,000	50,000	1,00,000	2,50,000	5,00,000	7,50,000	10,00,000

There are two safe levels, one at \$1,000 and the other at \$2,50,000. Once reached, your students cannot win less than that (imaginary!) amount. They can quit the game at any time and collect their winnings.

If the student gets the answer wrong or cannot provide an answer, they are eliminated from the game and the next student steps in. The new student starts over from scratch with a new set of questions.

Your students have three 'lifelines' at their disposal if they get stuck. They can use each lifeline only once during the course of the game, so they must not squander them. The lifelines are:

- **Ask the audience:** Your other students are asked to put their hands up for the correct answer. The risk with this is that they may not know, or may suggest an incorrect answer on purpose.
- **50/50:** You as the teacher randomly remove two incorrect answers, leaving the correct answer and one incorrect answer.
- **Ask a friend:** The student can pick one classmate to suggest the correct answer.

Additional resources

- A Periodic Table resource pack containing multiple types of resources:
http://chemteacher.chemeddl.org/services/chemteacher/index.php?option=com_content&view=article&id=77 (accessed 20 May 2014)
- An interactive Periodic Table, including element images, descriptions, history and a voice clip. Other chemical data is linked as a PDF file:
http://www.rsc.org/chemsoc/visualelements/pages/pertable_fla.htm (accessed 20 May 2014)
- Resources relating to the Periodic Table, trends and bonding:
<http://www.khanacademy.org/science/chemistry/periodic-table-trends-bonding> (accessed 20 May 2014)
- 'The Elements', a song by Tom Lehrer. Many versions are available online, such as:
<http://www.youtube.com/watch?v=YIIUXHZR3ZA> (accessed 20 May 2014)

References/bibliography

Blum, H.T. and Yocom, D.J. (1996) 'A fun alternative: using instructional games to foster student learning', *Teaching Exceptional Children*, vol. 29, no. 2, pp. 60–63.

Card, O.S. (1985) *Ender's Game*. New York, NY: Dell. (A science fiction novel about a constructivist utopia based on games.)

Ellington, H., Addinall, E. and Percival, F. (1981) *Games and Simulations in Science Education*. London, UK: Kogan Page.

Gee, J.P. (2003a) 'High score education: games, not school, are teaching kids to think' (online), *Wired*, vol. 11, no. 5. Available from: <http://archive.wired.com/wired/archive/11.05/view.html?pg=1> (accessed 20 May 2014).

Gee, J.P. (2003b) *What Video Games Have to Teach Us about Learning and Literacy*. New York, NY: Palgrave.

Piaget, J. (1951) *Play, Dreams and Imitation in Childhood*. London, UK: Heinemann.

Randel, J.M., Morris, B.A., Wetzel, C.D. and Whitehill, B.V. (1992) 'The effectiveness of games for educational purposes: a review of recent research', *Simulation & Gaming*, vol. 23, pp. 261–76.

Acknowledgements

Except for third party materials and otherwise stated below, this content is made available under a Creative Commons Attribution-ShareAlike licence (<http://creativecommons.org/licenses/by-sa/3.0/>). The material acknowledged below is Proprietary and used under licence for this project, and not subject to the Creative Commons Licence. This means that this material may only be used unadapted within the TESS-India project and not in any subsequent OER versions. This includes the use of the TESS-India, OU and UKAID logos.

Grateful acknowledgement is made to the following sources for permission to reproduce the material in this unit:

Figure 1: TESS-India (<https://www.flickr.com/photos/98655236@N06/10817866213/in/photostream/>, <https://creativecommons.org/licenses/by-sa/2.0/>).

Every effort has been made to contact copyright owners. If any have been inadvertently overlooked the publishers will be pleased to make the necessary arrangements at the first opportunity.

Video (including video stills): thanks are extended to the teacher educators, headteachers, teachers and students across India who worked with The Open University in the productions.