MODULE: *Matter 1*

Module Teaching Guide

Learning objectives

The students will be able to:

- Understand that materials are made of tiny similar particles
- Understand about states of matter, and kinetic theory of matter.
- Know that atoms are the smallest particle that can exist on its own
- Understand that pure substances called elements have atoms that are all the same type.
- Know there are 118 elements currently known, of which 90 occur naturally
- Know that atoms combine to make new materials called compounds according to fixed rules of bonding
- Know that a group of atoms bonded together is a molecule
- Use the particle model to describe materials.
- Understand how particles are arranged in solids, liquids and gases
- Know terms to describe atoms and molecules.
- Know that the type of bonding between atoms and molecules determines many of the properties of matter
- Identify particle pictures of different states
- Understand that atoms are made of sub atomic particles
- Understand that compounds can be made of molecules or be a giant structure of atoms.
- Relate structure to properties of materials

Curriculum Links

Theme: Matter in nature

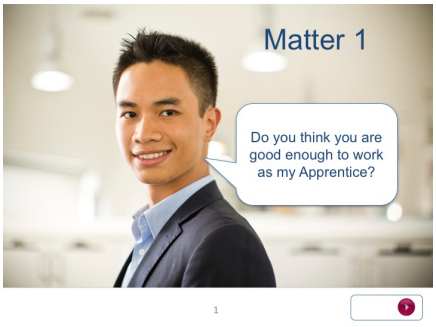
Essential pre-knowledge

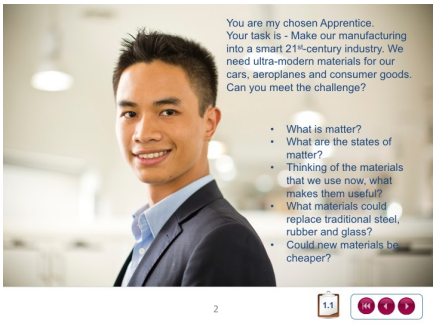
- Matter is composed of tiny particles
- These are arranged differently in solids, liquids and gases
- These particles are moving all the time – kinetic theory of matter
- As the temperature increases, the particles move faster
- Solids: particles vibrate in fixed positions
- Liquids: particles are in contact with each other, but wander through the whole bulk of the liquid
- Gases: particles are separated from each other and moving freely
- Melting: particles vibrate so much that they break the forces holding them in fixed positions
- Boiling: particle movement is so rapid that it overcomes the pressure of the atmosphere holding the particles together

Running the activity

Part 1 – Atoms and Bonding

Period 1



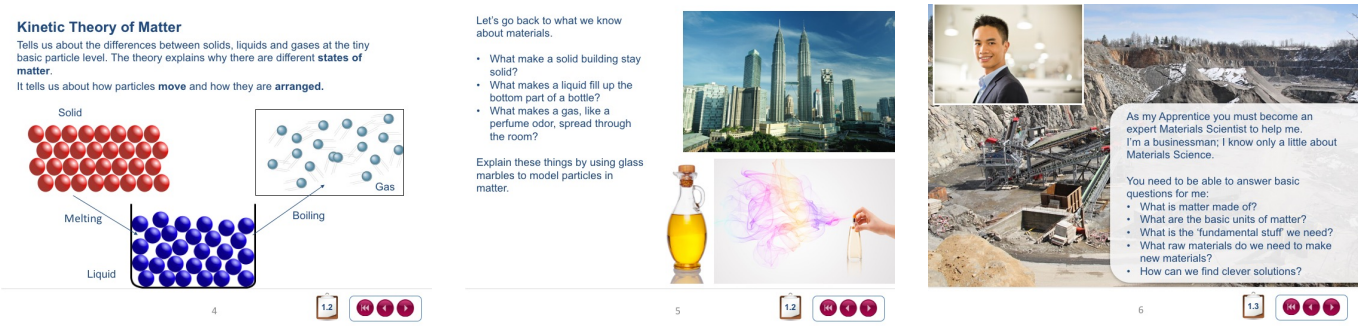


- Show slide 1 and remind students of the Apprentice Asia TV programme. Tell them this is the scenario and role they are going to adopt.
- Show slide 2 and emphasise the **challenge** nature of the activity. There will be a report to write to the 'boss' at the end of the episode, and they will be judged on their success. In this case the success criterion will be the quality of the information they have found out.

- Give out Activity Sheet 1.1. This has a similar stimulus to slide 2.
- Set the students the first task on Activity Sheet 1.1.

Students can work on the spider diagram individually or in groups. Tell the students to use a black pen for products, and a different colour for each different type of material e.g. blue for metals, green for plastics, brown for concrete and stone, purple for fabrics etc. They should add a material's properties in the same colour pen as the material.

This should be a quick activity, taking 10–15 minutes. The spider diagrams can be displayed on the classroom walls.



Show the students slide 4.

- Remind them of previous work on solids, liquids and gases, melting and boiling.
- Recap briefly the kinetic theory of matter for these states.
- Refresh their memory about movement and arrangements of particles according to the kinetic theory.

Give out Activity Sheet 1.2. Students should take about 20 minutes on this task.

After the task, hold a class discussion about the annotations they have added to their work.

Show the students slide 5.

Ask the questions on the slide to the students as a class discussion.

Ask students to explain the ice/ water/ steam system.

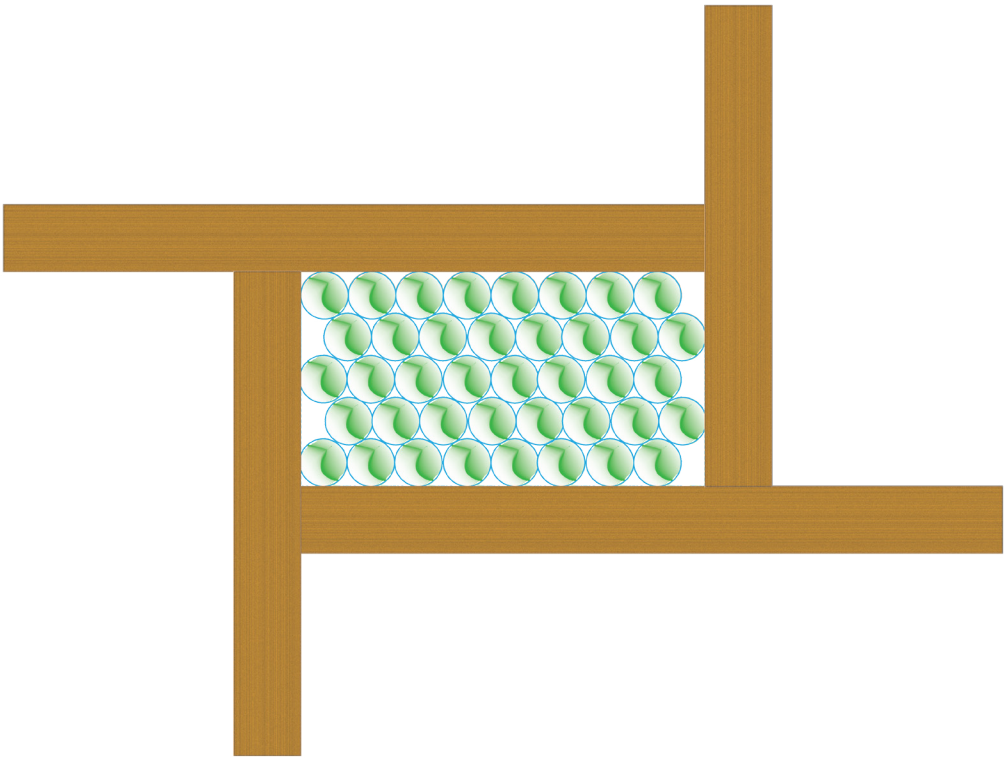
Ask the question: When $20cm^3$ of water is boiled away, how does it become $25{,}000cm^3$ of steam?

Ask questions about melting and boiling, and how particles are re-arranged in these changes of state. Investigate this with the practical activity below. If insufficient marbles are available for the whole class, you could do it as a demonstration.

Practical activity

Marbles in trays – practical activity

1. Take about 30 marbles and four pieces of wooden batten approximately 20cm long.
2. Arrange these on a tray, as shown below.



Explain to the students that this represents the arrangement of particles in a solid material.

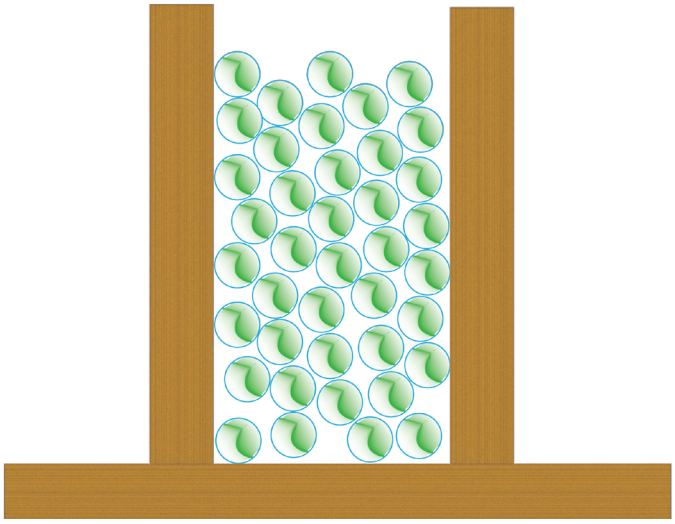
Question the students about what they should do to show the effect of rising temperature on the solid. Ask the students to demonstrate this.

Ask them how this affects the movement of the particles in the solid, even though the particles are never completely still.

Question the students about what will happen when the solid material gets hot enough to melt.

3. Re-arrange the model to show the arrangement of particles in a liquid.

   This is best done by putting one wooden batten under the tray the marbles are on, to give it a slight slope.



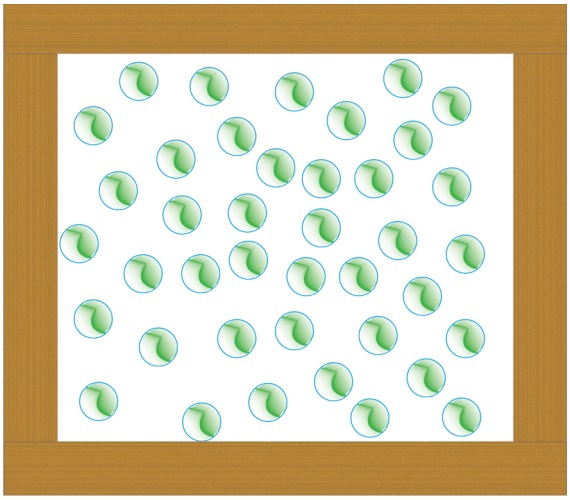
   Ask the students to show how the particles would move in a liquid.

   Question what would happen to faster-moving particles that reached the surface of the liquid.

   Question the students about what would change when the liquid boils.

4. Re-arrange the model, to show the arrangement of particles in a gas.

   This is best done by having the platform horizontal again.



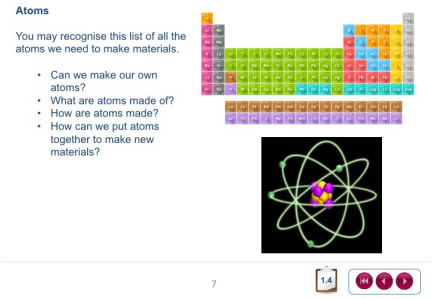
5. Ask the students to show how the particles could move in a gas.

   Ask the students to demonstrate the effect of gas pressure on the walls of the container by rolling marbles to bombard the wooden batten walls.

Optional practical demonstration: crushed can experiment.

See http://www.youtube.com/watch?v=QVayky_b-6U and http://scifun.chem.wisc.edu/homeexpts/COLLAPSE.html

Period 2



- Show slide 7 to introduce the topic of atoms.
- Give out Activity Sheet 1.3.
- Explore the use of the word ***atom*** in normal language. It can be given a variety of meanings.
- Explain the specific scientific meaning of the term. Explain carefully that atoms are not completely indestructible, but once an atom is broken up we cannot put it back together again with our current technology.
- Explain that all atoms were made in the intense gravity fields of stars, and that atoms heavier than iron (Fe) could only be created by the huge forces in a supernova explosion.

Explain that the Periodic Table is a:

- list of all the known elements
- list in order of weight (or atomic mass)
- list that has both element names and the atomic symbol

And that

- the atomic symbol is an international symbol, so it often does not relate to the name of the element in Malay or even in English
- in a chemical formula, the atomic symbol is often used to represent one atom of the element.

(This simplified explanation is appropriate for this age group, which does not need a detailed knowledge of chemical patterns of behaviour. That can come later.)

- Work through the text on Activity Sheet 1.3 with the students.
- Carefully explain the difference between atoms, molecules and ions.
- A useful definition of an ION for this purpose is ‘an atom or group of atoms that has reacted to form a compound.
- Explain giant structures of atoms or ions, in contrast to molecular structures in compounds.
- Get the students to answer the questions at the end of the sheet individually, or use the questions as the basis for a class discussion.

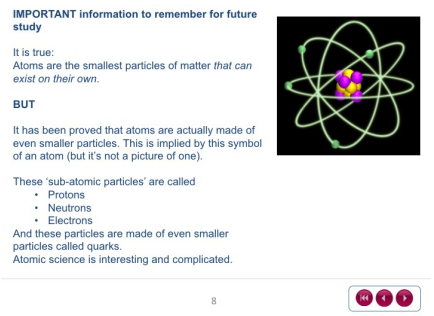
Give out Activity Sheet 1.4.

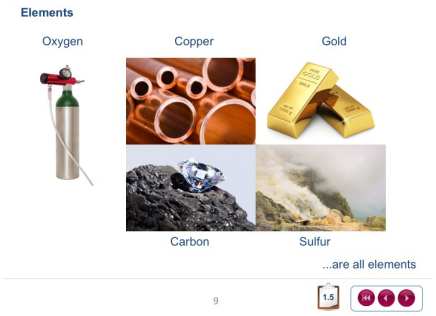
- Ask the students to read the definitions, which summarise the required learning.

As a plenary to the lesson, show slide 7 and go through the answers to its four bullet points.

- Show slide 8, and then carefully explain the notes in the box on Activity Sheet 1.4 about sub-atomic particles.
- A detailed knowledge of atomic structure is not required at this stage, but students will hear the terms proton, neutron and electron, so they will need a simple thinking model for atomic structure to fit this into.

Period 3





Show slide 8, and hand out Activity Sheets 1.5a and 1.5b.

Equipment: scissors

- Ask the students to cut up the four pages of Activity Sheet 1.5b to make a pack of 32 elements cards.
- These cards represent some of the more commonly known elements.
- Students will need access to reference books or the internet to complete the tasks on Activity Sheet 1.5a.
- The tasks are best completed in groups.

Answers

1.

a. *solids: Li, C, Na, Mg, Al, Si, P, S, K, Ca, Ti, Cr, Fe, Co, Ni, Cu, Zn, Ag, Sn, I, Au, Pb, U*

b. *Liquids: Br*

c. *Gases: H, He, N, O, F, Ne, Cl, Ar*

2.

a. *Li, Na, Mg, Al, K, Ca, Ti, Cr, Fe, Co, Ni, Cu, Zn, Ag, Sn, Au, Pb, U*

b. *H, He, C, N, O, F, Ne, Si, P, S, Cl, Ar, Br, I*

3.

a. *H, O*

b. *Na, Cl*

c. *Fe, C*

d. *Ca, C, O*

e. *Na, H, C, O*

f. *H, Cl*

g. *Ca, S, O*

h. *C, H*

i. *C, H, O*

j. *C, H, O, N*

4.

a. *9 of the 32 cards*

b. *C, H, O – 6 times each*

c. *There are many alternative answers: here are some examples*

He	*balloon gas*
Li	*low-sodium salt substitute*
F	*non-stick plastic coatings*
Ne	*display lighting tubes*
Mg	*indigestion tablets, Milk of Magnesia*
Al	*used to make aeroplanes*
Si	*sand and semiconductor materials*
Ar	*used to fill light bulbs*
K	*nitrate compound in gunpowder*
Ti	*very strong metal*
Cr	*used in stainless steel*
Co	*used in cooling glass*
Ni	*used for rechargeable batteries*
Cu	*electrical wiring*
Zn	*zinc oxide is an antiseptic*
Br	*used in sedatives*
Ag	*jewellery, antiseptic*

Sn *coating steel in tin cans*

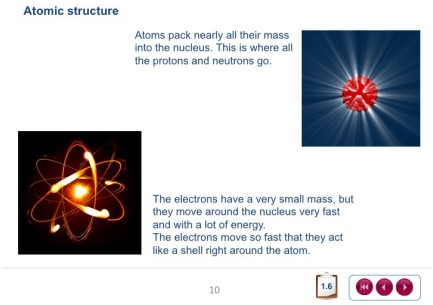
I *essential for a healthy diet*

Au *precious metal, jewellery, medicine, dentistry, glass-making, and a conductor in electronics*

Pb *in anti-corrosion paint*

U *nuclear fuel*

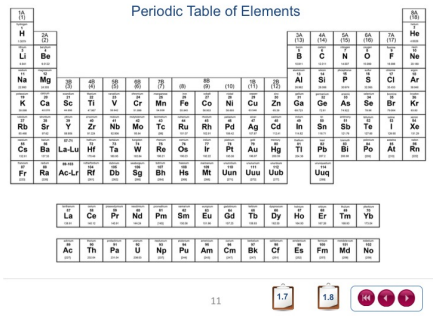
Go through the answers to any questions on Activity Sheet 1.5a that caused difficulty.



Show slide 10 and hand out Activity Sheet 1.6.

- Explain simply and briefly how atoms are put together from protons and neutrons to make the nucleus, with electrons orbiting the nucleus.
- Explain how the electrons appear to make a complete shell round the nucleus, by using the bicycle wheel analogy in the box on Activity Sheet 1.6.
- The important factor to emphasise in this is that the time taken for a collision between atoms is many, many times longer than the time it takes the electrons to orbit the nucleus.
- Ask the students to complete the summary task for Activity Sheet 1.6.

Lesson 4



- Show slide 11 as a stimulus.
- Ask students what they know about this chart, which is seen often in science laboratories.

Give out Activity Sheets 1.7 and 1.8.

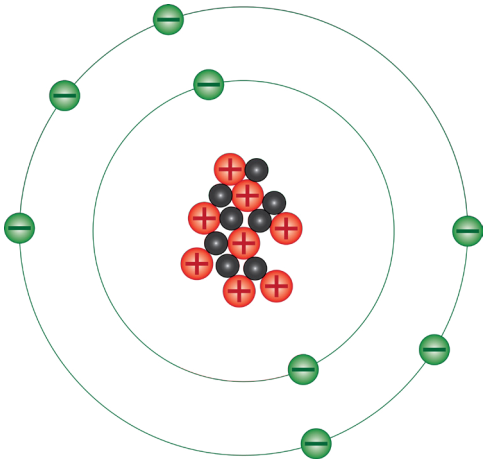
Work through this important idea:

- The chemical reactions of an element (that is, the way its atoms get rearranged when combined with other elements) depend on the number of protons in its nucleus.

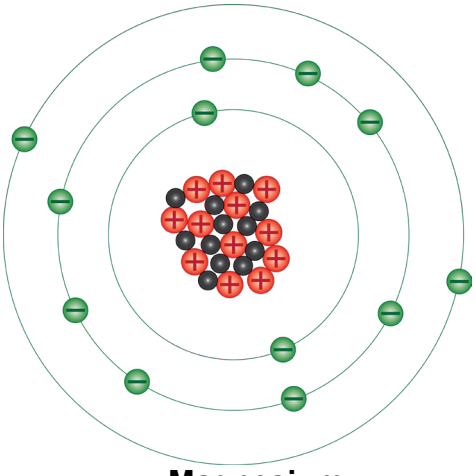
Next, the students explore how the electrons are arranged in an atom.

Use the drawing task on Activity Sheet 1.7 to reinforce a simple model of atomic structure.

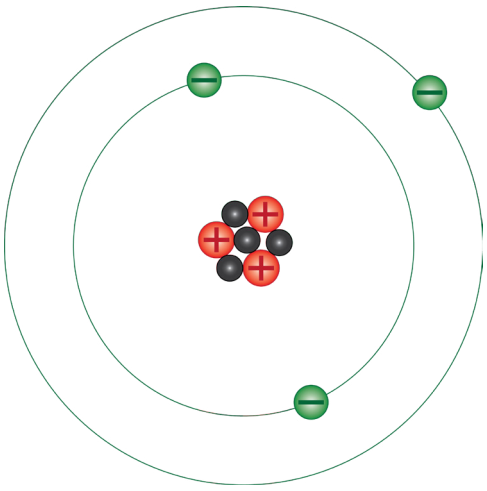
Answers to questions in the task:



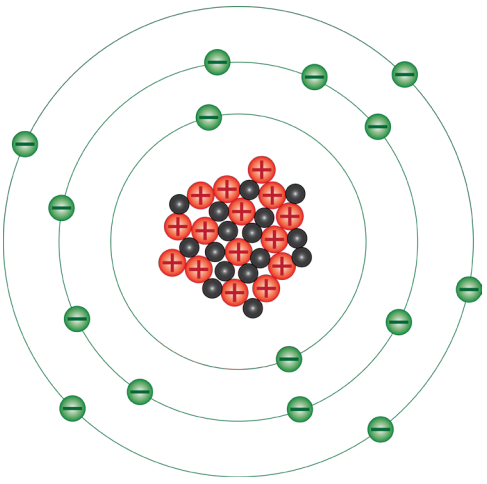
Oxygen



Magnesium



Lithium



Phosphorus

All those atoms are chemically reactive.

- Refresh the students concept of the Periodic Table as a list of elements in order of mass, and arranged according to their properties.
- Explain that 118 elements have been discovered so far, and atomic scientists may eventually find a way to make heavier atoms.

Part 2: Compounds and Bonding

Introduce this idea:

- 3 sub-atomic particles …
- make 118 elements …
- make millions of different compounds.

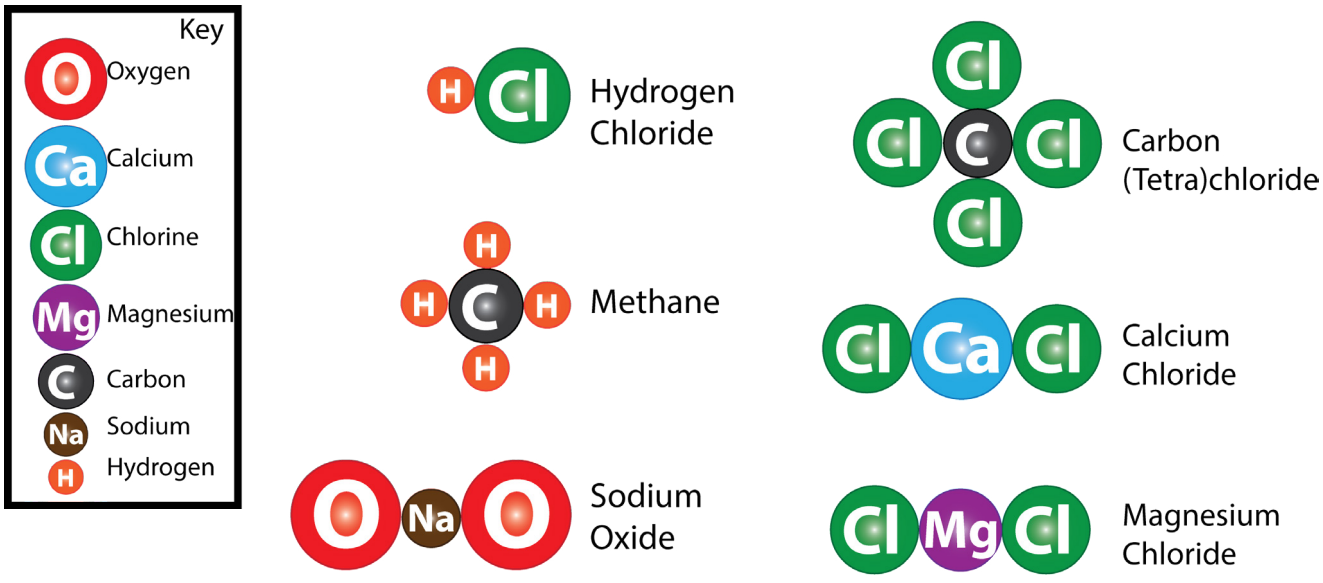
Emphasise that compounds are pure substances because all their molecules are the same as each other – but these identical molecules are made up of atoms of different types – usually a small number of different types.

Give out Activity Sheet 1.9.

Work through the text and ideas on Activity Sheet 1.9 as a class.

Allow the students to complete the task on Activity Sheet 1.9. They may need guidance.

Answers

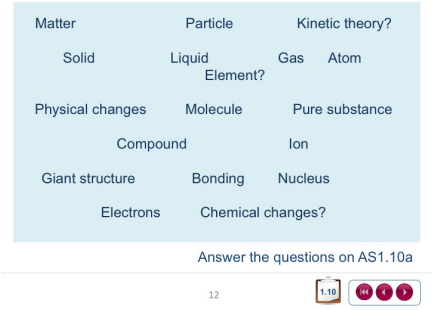


Work through the answers to Activity Sheet 1.9 as a plenary to the lesson.

Make sure that students understand these points:

- Different types of atoms combine to make new substances called compounds.
- Compounds usually have just small numbers of atoms combining with each other in a simple ratio.
- The way that atoms combine is decided by their chemical reactions and will be the subject of further study.
- Each type of atom has a ‘combining power’ that shows how many other atoms it can join onto.

Period 5



Show slide 12 as a prompt.

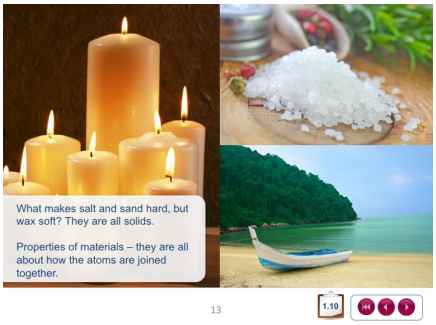
Give out Activity Sheet 1.10, which is a set of questions summarising the learning the students have achieved on this topic.

Students should work individually on answers to the questions.

After 30 minutes, stop the students and leave any remaining questions to be completed for homework.

There is an Activity Sheet 1.10: Questions/ quiz about atoms with answers that you can give to the students after they have completed the questions. This gives them an opportunity for self-evaluation.

Explore – Bonding

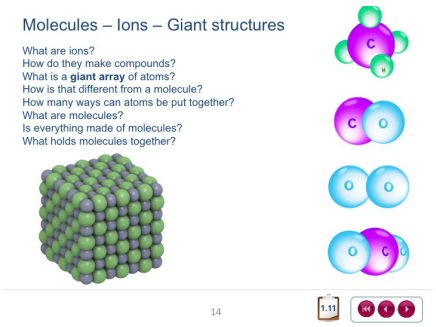


Show slide 13, and ask the question ‘Why are some solids soft and some very hard?’

Give out Activity Sheet 1.11.

Work through the text as far as the end of the Wax section, exploring these ideas:

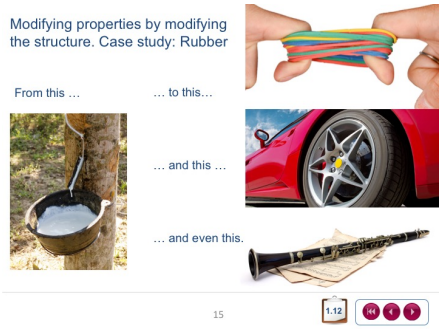
- Chemical reactions result in different types of particles in a solid
- The forces between the particles in a solid are therefore decided by the chemical reaction that produced the material
- The macro property (hardness) is a consequence of the nature of the particles produced in the chemical reaction



Then show slide 14, and introduce the idea that a Giant Array of ions or chemically linked atoms is an alternative to discrete single molecules of compounds.

Explain that in a compound made of giant arrays, the strong forces that bind the array’s atoms together give that substance very different properties from those with a molecular structure.

Period 6



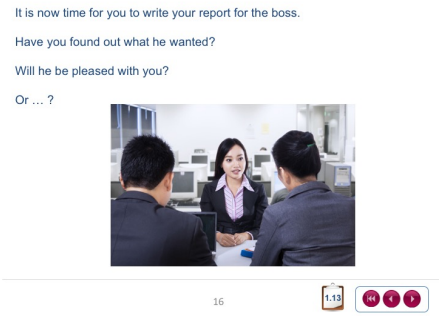
Show slide 15 and give out Activity Sheet 1.12.

The purpose of this task is to use the vulcanisation of rubber as a case study into how the properties of a material can be modified by chemical change.

These chemical changes modify the way the particles in the material are joined together, and hence modify the properties of the material.

The hardness of rubber can be modified from very soft and flexible to very hard and wear-resistant, by the amount of vulcanisation.

The case study is presented to the students on the Activity Sheet. The task requires the student to explain the process by transferring the information to diagram, annotating it.



Show slide 16 and hand out Activity Sheet 1.13.

Students are asked to prepare a report using what they have learned.

They will need to refer back to the individual brief on Activity Sheet 1.1.

Tell them to explain about atoms, elements, compounds, molecules, giant structures and ions.

They should explain how the nature and properties of substances are influenced by what atoms are available in the raw materials used to manufacture those substances.

Resources

Period 1

Learning resources

- PowerPoint presentation
- Prezi presentation
- Activity Sheet 1.1: Briefing
- Activity Sheet 1.2: Explaining the Kinetic theory of Matter

Equipment

Computer and projector

Per group

- Large sheet of white paper
- Marker pens in various colours
- Scissors
- Glue
- 30 glass marbles of similar size
- 4 pieces of wooden batten approx. 30cm long
- tray

Period 2

Learning resources

- PowerPoint presentation
- Prezi presentation
- Activity Sheet 1.3: About atoms
- Activity Sheet 1.4: Atom Words and Meanings

Equipment

- Computer and projector

Period 3

Learning resources

- Activity Sheet 1.5a: Elements cards activity
- Activity Sheet 1.5b: Elements cards
- Activity Sheet 1.6: Rules for making an atom

Equipment

Computer and projector

Per group

- Scissors

Period 4

Learning resources

- Activity Sheet 1.7: More about atoms
- Activity Sheet 1.8: Periodic Table
- Activity Sheet 1.9: Combining atoms to make compounds

Equipment

- Computer and projector

Period 5

Learning resources

- Activity Sheet 1.10: Questions/ quiz about atoms
- Activity Sheet 1.10: Questions/ quiz about atoms with answers
- Activity Sheet 1.11: Bonding and properties of materials

Equipment

- Computer and projector

Period 6

Learning resources

- Activity Sheet 1.12: Making Better Materials
- Activity Sheet 1.13: Report

Equipment

- Computer and projector

Safety

Not applicable

Preparation

You will need to prepare the wooden battens and marbles for each group

Interactive

Please refer to the Intervention Session Teaching Guide.

Alternative strategies

None