Chapter 3: The periodic table

Pages 65–88

Teacher notes

Introducing the chapter:

This chapter builds on prior knowledge of atomic theory and further explores connections in terms of how the structure of an atom determines its position on the periodic table and its properties. The history of the modern periodic table is explored as well as how our current understanding of the structure of atoms came to be. There is also a focus on atomic bonding, i.e the interaction between atoms to form molecules or molecular structures (ionic, covalent and metallic). Nanotechnology is also explored, in terms of the future implications of our knowledge of atomic theory and how this knowledge can be used to benefit our society.

Teacher notes

3.1 Scientists refine theories and models over time

Pages 66–69

Teaching tip: prior learning

Students may have investigated the history of the atom in year 9 and this should be revised when completing the history of the periodic table.

Additional activity: history of elements timeline

Science as a Human Endeavour is a strand of the Australian Curriculum that encourages students to understand that many scientific explanations are based on evidence and that science knowledge changes as new evidence becomes available. A sub-strand of this is developing an appreciation of the unique nature of science and scientific knowledge, including how current knowledge has developed over time through the actions of many people. The development of the periodic table as a result of the experimental evidence available at the time is an ideal opportunity to incorporate this strand into the course.

Each student can be allocated an element to research:

• name of element

• who first described it

• the date it was first described

• the properties of the element.

Each of these elements can then be added to a timeline of the periodic table that can reach across the room. Questions to ask the students include:

• Which elements were discovered first? (Gold, silver, copper, iron, lead, tin, mercury, sulfur and carbon.)

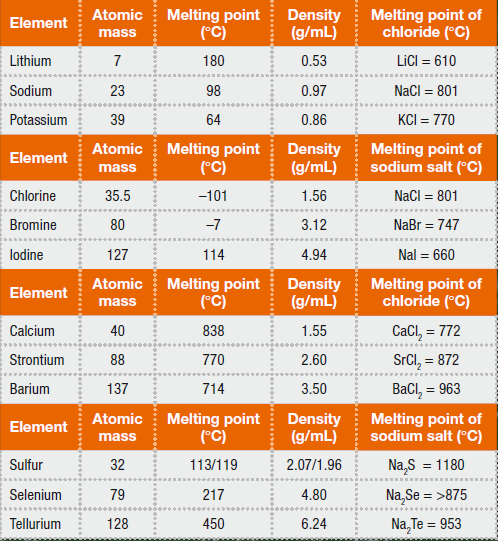
• Can you think of any reason these elements were the first to be discovered? (They occur in their natural state.)

• Was there any time when a large number of elements was discovered? Why? (Scientists working together or particle colliders.)

• What was the most recent element discovered?

Additional activity: Dobereiner’s triads

In 1817, Dobereiner found that many elements had similar properties and consequently arranged them in groups of three (triads) with increasing atomic weights. In 1863 A. E. Beguyer de Chancourtois arranged this list so that it was wrapped around a cylinder such that sets of elements that had similar properties lined up. This can be replicated by students using the properties in the table below. Make a set of cards with the symbol on one side and the properties on the other. Without looking at the periodic table, students can attempt to arrange the cards into similar properties. When they have their triads, they can arrange each triad into columns of increasing mass. When the cards are turned over, they should replicate the periodic table. Can students find any gaps?



Going further:

Many useful weblinks, videos and an interactive activity are available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Teacher notes

3.2 The structure of an atom determines its properties

Pages 70–73

Introducing the topic

Atomic structure, specifically electron configuration will determine how an element reacts to form a compound. It is essential that a working knowledge of how to read a periodic table and determine electron configuration is developed.

Teaching tip: prior learning

Students should have learnt how to calculate the number of protons, neutrons and electrons that an atom contains in year 9. Electron configuration should not be new to students either as it should have been introduced in year 9. Pretesting is essential to this topic as students will be at very different levels depending upon their understanding of their Year 9 Chemistry units.

Teaching tip: electron configuration

It should be pointed out to students that although the elements potassium and calcium can have nine and ten electrons, respectively, in their third electron shell (which holds a maximum of eighteen electrons), this electron shell is stable with eight electrons. Therefore, the remaining electrons will start to fill the fourth electron shell. Students often ask why this happens.

Each electron shell has a series of sub-shells. The Aufau principle states that an atom is built up by progressively adding electrons to the sub-shell that has the lowest energy state. Because the number of electrons in each sub-shell is limited, sometimes the energy needed to join a shell that already has a large number of similarly charged electrons is more than the energy needed to join a larger empty shell. For this reason an empty ‘higher’ sub-shell will start to fill before a lower energy sub-shell is completely full.

Teaching tip: information on the emission spectrum and electron shells

Many forensic science shows on television use spectroscopy to identify unknown substances. In fact, there are many different types of spectroscopy that can be used in chemistry. Some of these include the following.

• Absorption spectroscopy – tests for the amount of energy that was absorbed by the material. This can be done by measuring the energy that is able to be transmitted through the material. The difference between the energy going in and moving out is equivalent to the energy absorbed. Every compound will absorb different amounts of energy.

• Emission spectroscopy – this measures the amount of energy that is released by a material. It can be a spontaneous emission or induced by other energy sources, such as heat. The flame tests used previously are an example of emission spectroscopy.

• Reflection spectroscopy – this test examines how incident radiation is scattered or reflected by a material. Rutherford’s gold foil experiment is an example of reflection spectroscopy.

Additional activity: practise electron configuration and links to trends in the periodic table

Students gain a true understanding of electron configuration by practising drawing them. Get a blank periodic table and ask students to fill in each blank space with the elements electron configuration up to element 18 (argon). Then ask students if they can observe a trend in electron configuration: Periods have the same number of electron shells, Groups have the same number of outer shell (valence) electrons.

Ask students to now predict what the structure of potassium and calcium are based on the rules that they have just developed and fill in more of the blank periodic table.

Additional activity: electron configuration

Draw a target shape on a piece of paper. Smarties or counters can be used as electrons and placed on the circles to represent the electronic configurations of various elements.

Use wire or pipe-cleaners to make a series of circles of different sizes. Objects can then be placed at positions around the circles to represent electrons moving in their shells. These can be then made into mobiles that can hang around the room.

There are a number of apps that can be downloaded that ask students to suggest electron configurations.

Additional activity: ICT and graphing skills

It is useful for students to develop an understanding of the properties of the elements across the periodic table. ICT skills can also be developed by using Excel documents to:

• graph the boiling points of the first twenty elements against their atomic number

• graph the melting points of the first twenty elements against their atomic number

• graph the atomic radius for the first twenty elements against their atomic number.

A useful skill students need to develop is to describe the trends in these graphs. This is a learned skill, so it is important for students to be given guidelines.

1 Divide the graphs into sections according to the graph increasing or decreasing.

2 Label each section.

3 Describe each section using the axis and the limits.

For example, as we move across the first period (elements X to Y in section A of the graph) the boiling point of the elements increases. As we move across the second period (elements M to N in section C of the graph) the boiling points of the elements also increase at a faster/slower rate to that of the first period.

Additional activity: ‘what’s missing’ element cards

Understanding the predictive nature of the elements across the periodic table is important. An activity to emphasise this is to prepare cards with the properties of the first twenty elements (excluding the atomic numbers) and to present these to the students with one element missing. The students should be able to arrange the cards so that the gap in melting temperature/atomic weight/boiling point is noticeable.

Additional activity: draw a periodic table

Often students will be able to read a periodic table and be able to describe its general principles; however, they will have trouble relating the finer details of the construction of the table. A useful activity to do at the beginning of a class is to allow students time to draw a periodic table on a blank piece of paper. The first time students do this, most will be unable to draw the correct numbers of columns or periods. It will, however, provide a basis for their understanding during the class, especially if they are allowed to compare to the real table later. If this exercise is repeated a week later, the diagrams will become more recognisable and the students will be able to describe a greater number of its characteristics and the properties of the elements.

Additional activity: element words

How many names/words can the students write, using only the symbols of the periodic table, in five minutes?

Additional activity: round the world

Play a version of ‘round the world’ using the periodic table. One student stands behind another holding their periodic table. Ask them to find the atomic number of an element. The first student to answer stands behind the next student for the next question. The first student to make it all the way around the room (the world) is the winner.

Going further:

Many useful weblinks, videos and an interactive activity are available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Access the site, PhET – Build an atom, at the link below.

<https://phet.colorado.edu/en/simulation/build-an-atom>

Teacher notes

3.3 Groups in the periodic table have properties in common

Pages 74–75

Introducing the topic

This section explores the properties of metals, their behaviour and how they react. This is based on the structure of atoms already explored.

Teaching tip: prior learning

It is important to reinforce the general structure of an atom as well as its electron configuration and draw upon these when highlighting trends in the periodic table.

Students can be reminded of the experiment performed by Rutherford’s laboratory in which a stream of α-particles was fired at a thin sheet of gold foil. Most of the positive α-particles were able to move straight through the foil, indicating that most of an atom was made up of space. Some α-particles bounced back, suggesting the centre or nucleus of an atom is positively charged.

Teaching tip: grouping elements

Becoming familiar with the different parts of the periodic table is an important part of chemistry. Students should view the periodic table as a ‘cheat sheet’ in any chemistry test. The largest groups in the periodic table are the metals and non-metals. Understanding the properties of metals requires students to learn words such as lustrous, malleable and ductile. Using everyday examples will aid this. ‘Lustrous’ is a term used by shampoo manufacturers in describing the effect their product has on hair. Pearls are also seen as lustrous. ‘Malleable’ and ‘ductile’ can be demonstrated with fresh (very soft) Play-Doh. ‘Ductile’ is difficult to demonstrate; however, very soft Play-Doh will form a slight rope when it is rolled out then twisted slightly when pulled apart. ‘Malleable’ is easier to demonstrate using this method. A correlation can also be drawn between malleable or gullible people.

Teaching tip: group 1 and 2 metals and transition metals

Group 1 are the most reactive of the metals. It is often easiest for students to understand reactivity in terms of ‘explosiveness’. The metal at the bottom left-hand side of the periodic table, francium, is the most reactive of the group 1 metals. It does occur naturally; however, its 22 minute half-life makes it impractically radioactive. This metal, like all alkali metals, reacts explosively in water.

The most common demonstration of this is placing a small amount of sodium, another group 1 metal, in a large beaker of water. It is important that only a particle the size of a grain of rice be used. Phenolphthalein can be used to indicate the NaOH that will form as a result. A video of this reaction is available on the website for those who are more safety minded.

The elements to the right or above francium become progressively less reactive.

Group 2 metals are harder and denser than the group 1 metals. Although some react with water (calcium, strontium and barium), they are most commonly found as oxides. The further up the periodic table, the less reactive the element will be (i.e. it is quite easy to demonstrate that magnesium does not react in water).

It is often difficult at this level to explain the existence of the transition metals. Although students are aware of the existence of electron shells, the term ‘sub-shells’ is only used at more senior levels. It can be useful to hint at the various ‘layers’ of energy within the shells and that these fill in a specific order, affecting the properties of the element. An illustration of this is the different colours of the compounds formed by the transition metals or, alternatively, the differences between copper and gold.

Additional activity: brainstorming differences in reactivity

This activity can be used to introduce the idea of linking the properties of an element to the structure of the atom. Breaking the students into small groups, ask them to list the properties of a group of elements of the periodic table. It is useful for students to do this without any resources. Even if they cannot remember specific melting points or boiling points, they should be able to discuss this in terms of the other elements in the periodic table. For example, are the elements in group 3 more or less reactive than the elements in group 1? This will reinforce the properties they have already examined and give students the opportunity to ask ‘Why do the elements have different properties?’.

Additional activity: getting elements organised

Students with high levels of logical–mathematical intelligence will be able to categorise the properties of these elements easily. Other students may require more direction. Hints can be given to the students through a series of questions.

• How would you identify a metal from a non-metal by looking at it?

• What does the state of an element tell you about its melting point or boiling point?

• What are the properties of metals?

• Can you find the elements that are ductile/malleable/conduct electricity?

• Are some of the elements more reactive than others?

Students may find it easier to write out the elements and their properties on cards to physically rearrange them. Post-it notes on the board are a good way to demonstrate this.

Going further:

Many useful weblinks, videos and an interactive activity are available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

‘The Elements’ and ‘The Elements in Action’ apps are great for demonstrating the reactive properties of elements and the trends in elements on the periodic table.

Teacher notes

3.4 Non-metals have properties in common

Pages 76–77

Introducing the topic

This section explores the properties of non-metals, their behaviour and how they react. This is based on the structure of atoms already explored. They are essential to life and yet are very small in number.

Teaching tip: visualisation

The most reactive of the non-metals is fluorine. Non-metal elements further down the periodic table become less reactive. Fluorine has only one full electron shell and a second shell that is almost full. Because the incomplete shell is close to the nucleus, it is very attractive to any stray or loose electrons. This makes it highly likely to react with other elements.

Visual images are often important to students to help them remember what, to them, appear to be random pieces of information. A mental picture of fluorine with a halo overhead can help a student remember the term ‘halogen’. Helium or neon sitting on a throne looking down on all the other elements of the periodic table can help students remember that the noble gases are above any reactions. Ask students to come up with other images.

Additional activity: who am I?

Simple games can help students become more familiar with the locations of the elements. Two examples of this are given below. Can students come up with their own puzzle?

Who am I?

• I am lustrous, malleable and ductile.

• My boiling point is 677°C.

• My melting point is 27°C.

• I have one electron in my outer shell.

• I am highly radioactive and have a half-life of 22 minutes.

• I am the most reactive of the metals.

I am francium.

Who am I?

• I was first discovered by Sir William Ramsay in 1895.

• My melting point is −272°C and my boiling point is −269°C.

• I am colourless, odourless and non-toxic.

• I am a noble gas.

• My atomic number is 2.

• I am often used in balloons.

I am helium.

Going further:

Many useful weblinks, videos and an interactive activity are available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

‘The Elements’ and ‘The Elements in Action’ apps are great for demonstrating the reactive properties of elements and the trends in elements on the periodic table.

Teacher notes

3.5 Metal cations and non-metal anions combine to form ionic compounds

Pages 78–79

Introducing the topic

This topic explores ionic bonding. When metals and non-metals bond they do so ionically. These compounds are usually called salts and are essential in chemical reactions.

Teaching tip: prior learning

Allow students the opportunity to apply their knowledge of electron configuration here as well as their understanding of where the metals and non-metals lie on the periodic table.

Teaching tip: practice

Students often have difficulty with this concept and so it is best to give them as much opportunity as possible to practise as it is an essential VCE Chemistry concept.

Follow the ‘Gradual Release of Responsibility Model’. Sometimes referred to as ‘I do it, we do it, you do it,’ this model proposes a plan of instruction that includes demonstration, prompt, and practice.

Teaching tip: using electron configuration to form Ions

It is useful to repeat the activities from section 3.2 (pages 70–73), where the electronic configuration of an atom is created then electrons are added or removed to create a ‘full’ stable outer shell.

Some students may need to repeat activities several times to understand that when an electron is removed there are more positive protons than electrons remaining, and this leads to a positive ion. Conversely, if an electron is added, there are more negative electrons than protons, causing a negative ion to be formed.

Ionic compounds are usually created when a metal is combined with a non-metal. For example, sodium has one electron in its outer shell. It takes less energy for the sodium to lose one electron (and have a ‘full’ outer shell) than to gain seven electrons. Therefore, sodium will lose its outer electron and become positively charged. Conversely, the non-metal chlorine has seven electrons in its outer shell. It takes less energy to gain a single electron to complete its outer shell than to lose seven electrons. Therefore, chlorine will have a charge of −1 (one more electron than proton).

It is important to point out to students that the electrons are freely given (not borrowed).

Additional activity: the ‘cross down’ method of ionic formulae determination

For students with a strength in their mathematical reasoning skills, give them a list of ionic chemicals in written format. For example:

• Sodium Chloride

• Potassium Sulfide

• Magnesium Phosphate

• Beryllium Oxide

Students must then write the ions with their charges (give them the valency table below):

• Sodium Chloride Na1+ Cl1-

• Potassium Sulfide K1+ S2-

• Magnesium Phosphate Mg2+ PO43-

• Beryllium Oxide Be2+ O2-

They must then take the numbers (not the charges) and cross them down to the bottom of the other element, then follow the rules:

• Sodium Chloride: Na1+ Cl1- Na1Cl1

The 1’s are assumed = NaCl

• Potassium Sulfide: K1+ S2- K2S1

The 1 is assumed = K2S

• Magnesium Phosphate Mg2+ PO43- Mg3PO42

Brackets must be added otherwise you have 42 Oxygens = Mg3(PO4)2

• Beryllium Oxide Be2+ O2- Be2O2

The 2’s cancel (lowest ratio) = BeO

**Valencies**

**Cations**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Charge = +1** | | **Charge = +2** | | **Charge = +3** | | **Charge = +4** | |
| Hydrogen | H+ | Magnesium | Mg 2+ | Aluminium | Al 3+ | Tin [IV] | Sn 4+ | |
| Lithium | Li+ | Calcium | Ca 2+ | Chromium [III] | Cr 3+ | Lead [IV] | Pb 4+ | |
| Sodium | Na+ | Barium | Ba 2+ | Iron [III] | Fe 3+ |  |  | |
| Potassium | K+ | Iron [II] | Fe 2+ |  |  |  |  | |
| Caesium | Cs+ | Nickel | Ni 2+ |  |  |  |  | |
| Silver | Ag+ | Copper [II] | Cu 2+ |  |  |  |  | |
| Copper [I] | Cu+ | Zinc | Zn 2+ |  |  |  |  | |
| Ammonium | NH4+ | Tin [II] | Sn 2+ |  |  |  |  | |
|  |  | Lead [II] | Pb 2+ |  |  |  |  | |
|  |  | Manganese [II] | Mn 2+ |  |  |  |  | |
|  |  | Mercury [II] | Hg 2+ |  |  |  |  | |
|  |  | Berylium | Be2+ |  |  |  |  | |

**Anions**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Charge = -1** | | **Charge = -2** | | **Charge = -3** | |
| Hydride | H - | Oxide | O 2- | Nitride | N 3- |
| Fluoride | F - | Sulfide | S 2- | Phosphate | PO4 3- |
| Chloride | Cl - | Sulfate | SO4 2- | Phosphide | P3- |
| Bromide | Br - | Carbonate | CO3 2- |  |  |
| Iodide | I - | Sulfite | SO3 2- |  |  |
| Hydroxide | OH - | Dichromate | Cr2O7 2- |  |  |
| Nitrate | NO3 - | Chromate | CrO4 2- |  |  |
| Nitrite | NO2- | Hydrogen Phosphate | HPO4 2- |  |  |
| Hydrogen carbonate (bicarbonate) | HCO3 - | Peroxide | O22- |  |  |
| Hydrogen Sulfide | HS- |  |  |  |  |
| Hydrogen sulfate | HSO4 - |  |  |  |  |
| Chlorate | ClO3 - |  |  |  |  |
| Hydrogen sulfite | HSO3 - |  |  |  |  |
| Permanganate | MnO4 - |  |  |  |  |
| Acetate | CH3COO- |  |  |  |  |
| Dihydrogen Phosphate | H2PO4 - |  |  |  |  |

Additional activity: visual demonstration

This can be demonstrated with two pieces of A4 paper representing a metal and a non-metal.

• Write Na on one piece of paper and Cl on the other.

• Sodium (Na) is stable when it loses an electron. This can be represented by cutting a large triangle from the end of the paper labelled Na.

• Chlorine (Cl) is stable when it gains an electron. This can be represented by sticking the (electron) triangle from the Na to the side of the paper labelled Cl (try to match the position of the triangle stuck to the Cl with the cut section of the Na).

• Therefore, the two pieces of paper representing Na and Cl will fit back together and form an ionic compound.

Additional activity: visual demonstration extension

The visual demonstration from page 79 can be used to illustrate the balancing of the charges within an ionic molecule. This can often be prepared by the teacher before the class.

• Group 1 ions can be prepared with a single triangle cut out of the side.

• Group 2 ions can be prepared with two triangles cut out of the side.

• Group 16 ions should have two triangles sticking out of the side.

• Group 17 ions should have a single triangle sticking out of the side.

It may be useful to have the group 1 ions and group 17 ions half the thickness of the group 2 or 16 ions. This will enable a single group 2 ion to match triangles with two group 17 ions, forming a molecule such as CaCl2. (Two chloride ions with a single triangle cut out of each, matching with a calcium atom with two extra triangles sitting out from the side.)

Many students have difficulty understanding polyatomic ions. The demonstration above can help by making up some of the common ions using symbols. Students will then become used to seeing the various combinations and treating them as a single ion.

Teacher notes

3.6 Non-metals combine to form covalent compounds

Pages 80–81

Introducing the topic

Covalent compound are the basis of life as they are the family that organic compounds belong to. This includes all biomolecules and even medicines. It is important that we understand how these work to gain a full understanding of the earth as well as plant and animal functioning.

Teaching tip: prior learning

Allow students the opportunity to apply their knowledge of electron configuration here as well as their understanding of where the non-metals lie on the periodic table.

Teaching tip: organic chemistry

Students can be extended into organic chemistry. They can use their knowledge of electron configuration and covalent bonding (being a sharing of electrons) to create alkanes, alkenes and alkynes. Drawing and naming (IUPAC rules) is a great place to start and students may be extended into branched organic molecules and then functional groups.

Additional activity: molecular modelling

Give students a list of common covalent compounds and ask them to model their structures based on their knowledge of electron configuration (i.e. Carbon has four outer sell electrons and needs to gain four so it will have four bonds). They can be modelled with gummy lollies and toothpicks.

From here they can hypothesise about the structure of CO2 (if carbon needs four bond and Oxygen needs two, they are double bonded).

Students can also be extended into VCE organic chemistry.

Going further:

A useful weblink and an interactive activity are available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

Teacher notes

3.7 Metals form unique bonds

Pages 82–83

Introducing the topic

Metals are not often pure and are mixed with other metals to form alloys. Each metal or metal alloy has a specific purpose and is used in a variety of different ways based on this purpose. It is essential that we can understand the properties of metals so as to use them in an effective and scientifically accurate manner. For example, making cars that do not rust, the electroplating of tin cans, the use of steel etc.

Additional activity: modelling metallic bonding

As an assessment/activity or assignment, students create a model of metallic bonding. The task is outlined below:

|  |
| --- |
| Metals are amongst the most important elements for everyday life and occupy most of the periodic table. Metallic properties are the result of their special type of bonding – metallic bonding.  As scientists, we do not know for sure how a metal lattice operates but we do have theories and models to help us understand and predict metallic properties.  Your assignment is to use the metallic bonding model to create a physical model of a **metallic lattice** or **A poster** or a **video** or a **song** etc…Be Creative ☺ this can explain as many metallic properties as possible. Your assignment must answer the following questions.  Questions:  1 Why do metals conduct electricity well?  2 Why do metals conduct heat well?  3 Why are metals malleable and ductile?  4 Why do metals have high boiling temperatures?  5 Why are metals dense?  6 Why are metals lustrous?  Extra questions if you create a model  7 What limitations does YOUR model have-on top of the limitations the metallic bonding model has?  8 If you were to add different metals into your model, explain why your model would be harder and less malleable.  If you choose to make a model it shouldn’t be too much bigger than the size of a shoe box. You may use any materials you need to explain the properties of metals. An example is polystyrene balls of different sizes. Remember that sometimes simple is best. |

Additional activity: modelling electricity

Students may need to be reminded that electricity is the movement of electrons through an electrical circuit. Therefore, the flow of electrons is from the negative terminal to the positive terminal. It is important that students realise that it is not the one electron that moves around the circuit, but a progressive passing on of electrons between molecules. This can be demonstrated by giving all the students a series of counters (electrons) and asking them to create a pile of ‘electrons’ in front of themselves. The electrons start moving from the negative terminal. This is demonstrated by placing an extra counter on top of the pile in front of the first student. That student then picks up a counter (which may or may not be the same one as that given to him/her) and places it on the pile of the student next to them. A counter continues to be passed down the line until it reaches the positive terminal and completes the circuit. This should demonstrate the progressive movement of electrons around an electrical circuit.

Additional activity: relative electrical conductivity of metals

Early models of metals being positive ions in a ‘sea of electrons’ can be misleading for some students because it implies that the electrons are free from the attraction of the rest of the atom. There is also the difficulty of describing a metal as a ‘lattice of ions’ (sodium metal is written as Na not Na+). Therefore, the term ‘atoms with delocalised electrons’ is preferred because it allows for the movement of electrons between different atoms. Although the electrons are not fixed in one place, they move within a designated space and are therefore able to move between designated spaces when an electrical current is applied. When molten, the viscosity of the atoms interferes with the movement of the electrons, reducing the conductivity of the metal.

This movement of delocalised ions between the layers of metal atoms gives the metal atoms the ability to slide over each other. It is this structure that explains why metals are malleable and ductile.

Questions to ask include:

• Which metals have the highest electrical conductivity?

• Which metals have the lowest electrical conductivity?

• Which metals would make good insulators?

• Which metals are used most commonly in household wiring?

• Gold and silver are commonly used in the electrical circuits on silica chips in computers. Why?

• Why are gold and silver not used in normal household wiring?

Teacher notes

3.8 Nanotechnology involves the specific arrangement of atoms

Pages 84–85

Introducing the topic

Nanotechnology is essential in understanding current and future developments in Science. It deals with technology which is measured on a nanometer scale and is being developed for use in medicines, technologies and new scientific advances.

Introducing the concept of nano measurements can be difficult for some students. Using a common ruler with centimetres and millimetres can help. Ask the students to place their fingers either side of a millimetre. Ask them to imagine a nanometre is one millionth of a millimetre. The hydrogen atom is approximately 0.12 nanometres wide. This means approximately eight hydrogen atoms can fit in one nanometre. Nanotechnology involves understanding the properties of atoms well enough to be able to manipulate the way they are arranged.

For example, one of the first arrangements to be discovered is the buckminsterfullerene molecule (C60). This molecule has 60 carbon atoms arranged in a soccer ball shape. The molecule can be used to deliver drugs by placing small amounts of other molecules inside the ‘ball’.

Carbon nanotubes (which look like a tube of chicken wire with carbon atoms at the joins) behave more like individual molecules than the graphite sheets (the usual arrangement of carbon atoms). They come in a variety of diameters and lengths.

Additional activity: assignment assessment

Students present a poster on a nanotechnology of their choice:

Nanotechnology is a branch of science that refers to structures built from a few hundred atoms and are 1-100nm big. They show different properties to the same materials in bulk, partly because they also have a large surface area to volume ratio and their properties could lead to new developments in computers, building materials etc.

Task: To find out what nanotechnology is and what it is used for, you may ask:

1 What is nanotechnology?

2 Define the terms nanoparticle and nanocomposite.

3 Give a detailed explanation of one use of nanotechnology.

4 Describe some of the future uses of this technology.

5 Describe some of the ethical concerns over this technology.

You must outline:

• what your nanotechnology is.

• how the article is describing it

• what the uses are for this nanotechnology

• some of the science behind the nanotechnology

• some interesting facts

• any ethical problems with the technology

• anything else you think you might want to add.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Category | 4 – Very High | 3 – High | 2 – Medium | 1 – Low |
| Quality and accuracy of information included | Information is of a very high quality and is expressed accurately with regard to the chosen topic. | Information is of good quality and is expressed with regard to the chosen topic. | Information is of low quality and is expressed with regard to the chosen topic. | Information is of a poor quality and does not relate to the topic. |
| Have you properly addressed all questions? | Topic is addressed and all questions answered with at least 1 *paragraph* about each. | Topic is addressed and most questions answered with at least 1 *paragraph* about each. | Topic is addressed, and most questions answered with a few *sentences* about each. | Two or more questions were not addressed. |
| Coherent, and clearly expressed information | Information clearly relates to the main topic. It includes several supporting details and/or examples. | Information clearly relates to the main topic. It provides 1–2 supporting details and/or examples. | Information clearly relates to the main topic. No details and/or examples are given. | Information has little or nothing to do with the main topic. |
| Diagrams and Illustrations | Diagrams and illustrations are neat, accurate and add to the reader's understanding of the topic. | Diagrams and illustrations are accurate and add to the reader's understanding of the topic. | Diagrams and illustrations are neat and accurate and sometimes add to the reader's understanding of the topic. | Diagrams and illustrations are not accurate OR do not add to the reader's understanding of the topic. |
| Reference to other sources used | All sources (information and graphics) are accurately documented (in-text) in the bibliography. | All sources (information and graphics) are accurately documented (in-text), but a few are not in the bibliography. | All sources (information and graphics) are accurately documented (in-text), but many are not in the bibliography. | Some sources are not accurately documented (in-text) or in the bibliography./No bibliography. |
| Grammar, Spelling and Punctuation | No grammatical, spelling or punctuation errors | Almost no grammatical, spelling or punctuation errors | A few grammatical, spelling or punctuation errors | Many grammatical, spelling or punctuation errors |
| Overall mark | | | | \_\_\_\_\_\_\_\_\_\_\_\_\_/24 |

Additional activity: nanotechnology in the 21st century

**Students complete an** examination of the nature, applications, ethical aspects and personal experience of nanotechnology. They must provide a:

• Definition of nanotechnology   
4 pts A working definition of nanotechnology. The student is required to provide an adequate description of the nature of nanotechnology.

• Areas of application: Medical   
4 pts The student is required to provide ONE example of a medical application of nanotechnology. The description is clear, complete and appropriately referenced to a credible source.

• Area of application: Industrial   
4 pts The student is required to provide ONE example of an Industrial application of nanotechnology. The description is clear, complete and appropriately referenced to a credible source.

• Area of application: Environmental   
4 pts The student is required to provide ONE example of an environmental application of nanotechnology. The description is clear, complete and appropriately referenced to a credible source.

• Ethics of nanotechnology   
4 pts The student is required to research, and discuss, perceived advantages and disadvantages of nanotechnology applications.

• Personal experience of nanotechnology   
4 pts The student is required to discuss nanotechnology in the context of personal experience of products or applications of the technology.

• Bibliographic referencing.   
4 pts The student is required to use FOUR credible reference sources in addition to the class text. Referencing is an accepted style, or, approximates an appropriate form.