

Chapter 1 Substances

Overall learning outcomes

Students should learn:

- about chemical classification and be able to carry out investigations to identify elements, mixtures and compounds
- the properties of different materials and relate these to their uses.

Aims and purposes

This chapter will develop the learners' practical skills and knowledge of techniques through carrying out practical investigations. These include skills such as handling laboratory apparatus, following laboratory procedures and processes, recording and analysing data, risk assessments, communication skills, using correct symbols and scientific terminology.

This chapter covers the basics of chemistry and the associated skills that are in demand in industry. These topics include:

- basic chemical classification – elements, compounds and mixtures
- safe use of chemicals within a work setting.

This chapter requires the learner to approach many of the concepts through scientific investigation wherever possible.

The screenshot shows the chapter content page for Unit 1, Chapter 1: Substances. It includes a section titled 'Different materials' with a diagram of an eco-house and a list of 15 energy-saving devices. A 'Scenario' section describes a task where learners design an eco-house and identify materials. A 'Grading criteria for Substances' table is also visible, detailing requirements for different grades (P1, M1, D1, P2, M2) and listing assessment criteria like 'Identify different types of chemical substances' and 'Explain how the physical properties of chemicals relate to their uses'.

Links to other units in the BTEC Applied Science suite

Level 1	Level 2	Level 3
Making Scientific Observations and Measurements	Applications of Chemical Substances	Chemical Laboratory Techniques
Using Chemical Products	Chemical Analysis and Detection	Industrial Chemical Reactions

QCA links to KS3

This chapter builds on the following chemistry concepts covered in Key Stage 3:
7G Particles
8E Atoms and elements
8F Compounds and mixtures

Grading criteria

By working through this chapter, learners will be able to cover the requirements for the following criteria:
 Pass: P1 and P2
 Merit: M1 and M2
 Distinction: D1

Assignment overview

The first double spread provides a main scenario idea (eco-house designer) and an alternative scenario (crime scene investigator). Either scenario is fit for purpose. Learners are encouraged to have scenarios which are local to them. Therefore, these scenarios could be adapted to suit your local needs. These two scenarios give opportunities to talk about different substances with different uses in a context.

Work for P1 is essentially around correctly identifying elements, mixtures and compounds with M1 and D1 requiring the learner to describe/explain specific properties that lead to the classification.

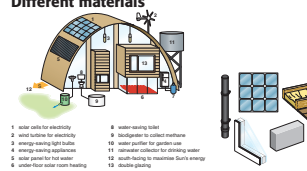
- For P1, learners must identify whether a substance is an element mixture or compound from its name and from knowledge of common substances.
- To achieve M1, learners will need to describe the differences between elements, mixtures and compounds. This could include drawing or recognising diagrammatic representations of elements, mixtures and compounds.
- To achieve P2, the learners would have to relate the uses of the chemicals to their physical properties. At least three chemicals should be studied.
- To achieve M2, learners would have to explain the uses of the chemicals in terms of their physical properties.
- The scope of D1 should be limited to three chemicals, chosen by the tutor to reflect the interests of the learners or local industry. Uses are to be in relation to physical properties.

Internet links

- www.ase.org.uk Association of Science Education
www.upd8.org.uk upd8 from Association of Science Education
www.schoolscience.co.uk School Science from ASE
www.sciencemuseum.org.uk/on-line Science Museum Online
www.bbc.co.uk/schools/gcsebitesize/science/edexcel/chemicalreactions BBC Bitesize Chemical Reactions
www.rsc.org Royal Society of Chemistry
www.webelements.com Web elements
www.vocationallearning.org.uk Learning and Skills Network
www.nebnpn.org National Education and Business Partnership Network

Unit 1 Chapter 1 Substances

Different materials



1 solar cells for electricity
2 windmill to generate electricity
3 energy-saving light bulbs
4 energy-saving appliances
5 solar panel for hot water
6 solar hot air for heating
7 heat-reflecting insulation
8 water-saving toilet
9 biodegradable carpet matting
10 water-purifier for green use
11 rainwater collector for drinking water
12 south-facing to maximise Sun's energy
13 double-glazing

Figure 1.1 An eco-house with energy-saving devices.

Figure 1.2

Scenario
 You are designing an eco-house of the future. You need to find the best materials to use to build the house, which will be eco-friendly and fit for purpose. In order to do this, you need to be able to identify different materials, describe their structures and investigate their properties. You will need to be able to identify your eco-house and show how and where all the materials will be used. Building materials from Figure 1.20 are either mixtures of chemical substances or pure chemical substances. All substances have properties that depend on the way the particles that make up the substance are held together. Pure substances can be elements or compounds. All of these substances are made up of tiny particles called atoms. It is the mixture and arrangement of these atoms that give the materials their properties. Builders choose materials for their properties, and for cheapness and availability. The property makes the material useful, e.g. bricks is hard wearing. The price and availability is a factor when there are many suitable materials, e.g. plastic and wood.

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Grading criteria for Substances

To achieve a pass grade you need to:	To achieve a merit grade you also need to:	To achieve a distinction you also need to:
P1 Identify characteristics of elements.	M1 Explain the difference between ions and neutral atoms.	D1 Explain the difference between elements and their properties.
P2 Explain a practical method used to identify the physical properties of elements.	M2 Explain how the physical properties of elements make them suitable for their uses.	

Scenario
 You are a crime scene investigator and have collected some unknown samples from the scene of a crime. You need to work out what the samples are as they could provide crucial clues and evidence. You need to investigate the properties of the unknown samples and compare them to known materials to find out what the samples are.

Keeping it local

- Visit local DIY or hardware stores to see what different materials there are and what they are used for.
- Do you have a water treatment plant nearby? You could visit it to see how clean water is obtained from dirty water.
- Do you live near a salt quarry? You could find out how pure salt is obtained from rock salt.

Careers

- Builder
- Designer
- Visitor or air quality assessor
- Architect
- Chemical analyst
- Crime scene investigator

Background knowledge

It is important that prior learning, mostly of the particle model and kinetic theory at KS3, should have taken place to enable learners to complete these objectives.

Objectives

Learners must be able to:

- recall the three states of matter
- recognise what changes of state happen at different temperatures
- say what state different materials will be in at different temperatures
- use particle pictures to represent the atoms in different materials
- describe the properties or characteristics of different materials
- describe the differences between different materials (metals and non-metals).

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Background science for the assignments

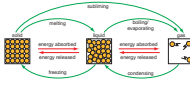


Figure 1.4 Solid, liquid and gas – how one state changes to another.

Materials are found as **solids**, **liquids** or **gases** at room temperature. Figure 1.4 shows the three states (solid, liquid or gas). The state that materials are in depends on their **melting** and **boiling** points. Different substances have different melting and boiling points depending on what they are made from.

Materials have different **properties**. For example, the properties of **metals** and **non-metal** materials are very different.

Do you remember?

Many of the properties of materials depend on the arrangement of the particles in them. In solids the particles are all touching their neighbours and are packed tightly together. But the particles themselves are moving – they vibrate a little in their fixed position. All the particles attract each other – the stronger the **attraction** the harder the solid will be.

As the solid gets hotter the particles vibrate faster until the particles have enough movement energy to break away from their fixed position. At this point the substance melts to become a liquid and the particles become a jumbled mass, still moving in close contact with each other.

Figure 1.5 A metal saucepan (left) and a wooden spoon (right).

The saucepan in Figure 1.5 is made of a metal. Its properties include: high melting point, conducts heat, malleable (can be hammered into shape), sonorous (makes a sound when you hit it). The spoon in Figure 1.5 is made from wood. Its properties include: insulator, brittle, floats, is neither malleable nor sonorous.

Key words: attraction, boiling, gas, liquid, melting, metal, non-metal, particles, property, solid

Substance activities

1 Look at the table of melting points and boiling points. Decide whether the materials are solids, liquids or gases at room temperature (20 °C).

Substance	Melting point (°C)	Boiling point (°C)
Iron	1538	2862
Aluminium	933	2542
Mercury	-38.8	356.7
Water	0	100
Carbon dioxide	-78	-87
Gas	-89	196

2 Describe the particle arrangement in a) solids, b) liquids and c) gases.

3 For each one, draw diagrams of the structure and describe how the particles move in each.

4 Look around the room and write down the names of ten different materials that you can see. Classify the materials as 'metal' or 'non-metal'.

5 Choose one metal and one non-metal from your list. Write down as many properties as you can think of for the two materials.

6 Describe how metals and non-metals are a) similar and b) different.

Did you know?

Water has a unique property. Cold water is less dense than liquid water and floats. This is because water expands when it freezes. This strange property causes burst pipes and sinks ships. It enabled the animals from which we evolved to survive the Ice Ages.




Figure 1.6 The Iceberg floats.

Answers to activities

- 1**
- | Name | State at room temperature |
|----------------|---------------------------|
| oxygen | gas |
| mercury | liquid |
| water | liquid |
| carbon dioxide | gas |
| salt | solid |
- 2**
- In solids the particles are close together and vibrate around a fixed point.
 - In a liquid some of the attraction between particles is overcome which allows the particles more freedom of movement and they wander past each other.
 - In a gas, attraction between particles is overwhelmed and the particles move freely throughout the container, normally in straight lines, colliding with each other and the sides of the container.
- 3**
- Typical answers would be:
non-metals – wood, plastic, glass, cardboard, etc.
metals – brass plumbing, steel clamp stand, aluminium window frame, etc.
 - Properties of metals are: shiny 'metallic' appearance; solids at room temperature (except mercury); high melting points; high densities; malleable; ductile; thermal conductors; electrical conductors.
Properties of non-metals are: dull; weak and brittle solids or gases at room temperature; low densities; poor thermal and electrical conductors.
- 4**
- Metals and non-metals can both be solid, hard, have a high melting point and high density.
 - Non-metals cannot be malleable, ductile, thermal conductors or electrical conductors.

Grading criteria

P1: Identify different types of chemical substance

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Elements, compounds, mixtures

Essential science for P1

An **element** is a substance which is only made of one type of **atom**. (An atom is the smallest **particle** that can exist on its own.) Elements are substances which cannot be broken down into anything simpler. Examples are iron, oxygen and carbon.

The **Periodic Table** contains a list of the elements known to humans. (You will learn more about the Periodic Table in the next chapter.)

Elements can undergo changes. These could be **physical changes**, such as melting or boiling, or **chemical changes** such as burning or rusting.



Figure 1.7 Iron is an element.



Figure 1.8 Rusting is a chemical change.



Figure 1.9 When iron melts it is a physical change.

When two or more elements are combined together you may have a **mixture** or a **compound**.

Rock salt is an example of a mixture. It contains salt and sand mixed together. However, it is quite easy to separate the salt from the sand.

Compounds are made when **chemical reactions** happen between elements. Pure water is an example of a compound. It contains hydrogen and oxygen that are chemically bonded together. In order to separate the hydrogen and oxygen in water there would need to be a chemical reaction (involving energy).

Key words: atom, chemical change, compound, element, mixture, particle, Periodic Table, physical change, reaction

Task

Visit local DIY stores with a whole range of materials. You need to decide which ones are elements, which are compounds and which are mixtures. Present your decisions as a 'Material' poster.

Make the grade

P1 For P1, you must successfully complete this task. Identify different types of chemical substances.

Your task:
Step 1: Classifying the materials
 Look at the materials from the DIY store. Make a table with three columns like the one below. Put each material in the correct column.

Element (and symbol)	Compound	Mixture

You may need to do some extra research if you do not know which column the material fits into.

Step 2: The poster
 Start your poster with definitions of the words element, compound and mixture.
 Check that you have classified the materials correctly, and then put this information onto your poster.
 When you have finished, show your teacher.

Tip: You might like to put pictures of the different materials onto your poster to improve its appearance.

Learning outcomes

Scientific knowledge & understanding

Learners must be able to:

- define elements as substances that contain only one type of atom
- define mixtures as substances that contain two or more elements that are not chemically joined together
- define compounds as substances that contain two or more elements that are chemically joined together
- make simple decisions about whether materials are elements, compounds or mixtures.

Skills

Learners must be able to:

- write definitions using key words
- organise and present information on a poster
- use resources such as the internet to help make classification decisions.

Suggested time for assignment task: 2 hours

Helpful tips

Suggested teaching activities prior to the assignment task:

- Use of visual aids (posters and/or models) and interactive activities.
- Provision of standard definitions for atom, element, mixture, compound; alongside simple diagrams to prevent early misconceptions.
- Simple practical to show chemical and physical change.
- Simple practical to demonstrate how mixtures can be separated.
- Practice internet search task (dependent on learners' prior skill level), to find pictures or facts about building materials.
- Elements could be introduced as substances which cannot be broken down into anything simpler. It would follow that the Periodic Table contains the names and symbols of all the elements. Mixtures can be separated by physical means whereas compounds need a chemical reaction involving energy to break them up into component parts.

Assistance/guidance during assignment task:

- Need to choose materials carefully to provide learners with opportunities to investigate and classify.
- Writing frame provided could be used either as method of collecting information, or as a prescribed layout for the final poster, depending on skill level.
- It may be necessary to provide learners with a range of suitable websites.
- Remind learners that they can also use the information learnt in lessons.

Opportunities for PLTS

Skill	Process
Creative thinkers	CT1 designing experiments to test their theories CT1, 2 exploring possibilities and asking questions to extend their own thinking when researching the Periodic Table
Team workers	TW1, 2, 3 working together on their experiments, dividing their roles during practical work, sharing and comparing results
Independent enquirers	IE1, 2, 4 obtaining data from different sources, making predictions about their experiments, recording results and evaluating their experiment
Self-managers	SM2 working towards goals, showing initiative, commitment and perseverance to complete tasks SM3 organising time and resources, prioritising time and resources throughout the unit to complete tasks SM4 anticipating and managing risks in the laboratory
Reflective learners	RL4 inviting feedback and dealing positively with praise or criticism following a practical activity RL6 communicating to others their learning about materials

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Elements, compounds, mixtures

Essential science for P1
An **element** is a substance which is only made of one type of **atom**. (An atom is the smallest **particle** that can exist on its own.) Elements are substances which cannot be broken down into anything simpler. Examples are iron, oxygen and carbon.
The **Periodic Table** contains a list of the elements known to humans. (You will learn more about the Periodic Table in the next chapter.)
Elements can undergo changes. These could be **physical changes**, such as melting or boiling, or **chemical changes** such as burning or rusting.



Figure 1.7 Iron is an element.



Figure 1.8 Rusting is a chemical change.



Figure 1.9 When iron melts it is a physical change.

When two or more elements are combined together you may have a **mixture** or a **compound**.
Rock salt is an example of a mixture. It contains salt and sand mixed together. However, it is quite easy to separate the salt from the sand.
Compounds are made when chemical **reactions** happen between elements. Pure water is an example of a compound. It contains hydrogen and oxygen that are chemically bonded together. In order to separate the hydrogen and oxygen in water there would need to be a chemical reaction involving energy.

Key words:
atoms, chemical change, compound, element, mixture, particle, Periodic Table, physical change, reaction

Task
Your local DIY store sells a whole range of materials. You need to decide which ones are elements, which are compounds and which are mixtures. Present your decisions as a 'Materials' poster.

For P1, you must successfully complete this task.
Identify different types of chemical substances.

Make the grade
P1

Figure 1.10 Do-it-Yourself materials - they are all made of elements, compounds and mixtures.

Your task:
Step 1. Classifying the materials
Look at the materials from the DIY store. Make a table with three columns like the one below. Put each material in the correct column.

Chemical symbol	Compound	Mixture

You may need to do some extra research if you do not know which column the material fits into.

Step 2. The poster
Start your poster with definitions of the words element, compound and mixture.
Check that you have classified the materials correctly, and then put this information onto your poster.
When you have finished, show your teacher.

Tip
You might like to put pictures of the different materials onto your poster to improve its appearance.

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Particles in elements, compounds and mixtures

Essential science for M1

We often represent particles as circles. Atoms are not really like circles – they are more like a fuzzy blob. Different sized and coloured circles represent different particles.

Here are some examples of particle pictures:

Figure 1.11

Iron is an element and so only contains atoms of iron. An element is a special case of a pure substance. Not only are all the particles the same, but all the atoms in all the particles are the same as well.

The iron and sulfur in Figure 1.11 is a mixture of two types of element (iron atoms and sulfur atoms) which are not chemically bonded together. The iron atoms and sulfur atoms can be easily separated using a magnet. Other mixtures can contain an element and a compound, e.g. oxygen and carbon dioxide, or two compounds, e.g. common salt and water.

Pure water contains two types of atom (hydrogen atoms and oxygen atoms) which are chemically bonded together. All the particles are identical (two hydrogen atoms plus one oxygen atom) so water is a pure substance and a compound.

Dirty water contains water molecules (compound) and other particles, so it is a mixture. Mixtures are not all dirty – air is a mixture, and orange juice is a mixture.

Key word:
Mixture

Task

Prepare a poster which describes the differences between some of the materials found at the DIY store.
Alternatively, you could develop the poster that you made for P1 to include descriptions of the materials.

Make the grade

M1 For M1, you must successfully complete this task:
Describe the differences between types of chemical substances.

Figure 1.12 Architects and engineers need to specify exactly what materials are used on the sites they draw up. This needs a high level of understanding of how materials work.

Your task:

Step 1: Choose
Choose at least two examples of each type of material (element, compound, mixture).

Step 2: Particle pictures
Draw a particle picture for each material.

Step 3: Sentences
Write a sentence to describe each material. Say how the materials are different from each other in terms of their atoms. When you have finished, show your teacher.

Helpful tips

Suggested teaching activities prior to the assignment task:

- Use of visual aids (posters and/or models) and interactive activities.
- Provision of standard definitions for atom, element, mixture, compound; alongside simple diagrams to prevent early misconceptions.
- Verbal activity to practice how to phrase the comparative descriptions.

Assistance/guidance during assignment task:

- Learners working at Merit level are expected to work with a greater level of autonomy, therefore requiring less teacher guidance during tasks. A simple worksheet could be provided to facilitate the collection of information, but not a writing frame which would provide a standard layout for the task. Learners should be reminded to use all information available (including classwork) and to reference work properly.

Learning outcomes

Scientific knowledge & understanding

Learners must be able to:

- use particle diagrams to represent the atoms in elements, compounds and mixtures
- describe how elements differ from mixtures and compounds
- describe how mixtures and compounds differ.

Grading criteria

M1: Describe the differences between types of chemical substances

Skills

Learners must be able to:

- organise and present information on a poster
- write comparisons of descriptions, using connectives such as 'however' to link statements, as opposed to writing separate descriptions of each material.

Suggested time for assignment task: 2 hours

Opportunities for PLTS

Skill	Process
Creative thinkers	CT4 questioning their own assumptions regarding materials
Team workers	TW1, 2, 3 working together on their experiments, dividing their roles during practical work, sharing and comparing results
Independent enquirers	IE3 looking at different points of view and coming to their own reasoned decisions about scientific phenomena
Self-managers	SM2 working towards goals, showing initiative, commitment and perseverance to complete tasks SM3 organising time and resources, prioritising time and resources throughout the unit to complete tasks
Reflective learners	RL6 communicating to others their learning about materials

To achieve higher levels (Merit or Distinction) learners should:

- use a consistent style in their particle model diagrams
- label the particles clearly
- draw the arrangement of particles in a solid carefully
- use consistent colours for the same atoms.

Grading criteria

P2: Carry out a practical investigation into the physical properties of chemicals

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Properties of materials

Essential science for P2

Different materials have different **properties** and **behave** in different ways. Examples of physical properties include:

- melting point (at what temperature does the material turn from solid to liquid?)
- boiling point (at what temperature does the material turn from liquid to gas?)
- thermal conductivity** (does the material let heat pass through?)
- electrical conductivity** (does the material let electricity pass through?)
- density** (is the material heavy for its size?)
- solubility** (does the material dissolve in water or other solutions?)
- viscosity** (is the liquid thick or runny?)

We can carry out different tests to find out about these properties. Some of these tests are shown in Figure 1.13.

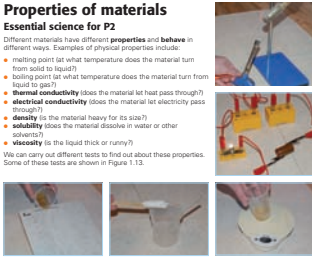


Figure 1.13

Key words: substances, density, electrical conductivity, property, solubility, thermal conductivity, viscosity

Table 1.1 Properties of some common materials

Melting	Crash helmets in falling water	Shiny metal sheets at a high temperature
Boiling	Liquid nitrogen boils at $-196\text{ }^{\circ}\text{C}$	
Thermal conduction (heat transfer)	Steel is a relatively poor conductor of heat	Plays in a poor conductor of heat
Electrical conduction	Copper conducts current well	Plastic is an insulator - it does not conduct at all
Density	Plastic foam is a low density material	Lead is a dense material
Solubility (for salt)	Sugar is very soluble in water	A very small amount of gold will dissolve when you make hot water
Viscosity (thickness of liquid)	Hot syrupy honey (syrupy) is a very runny liquid	Shiny metal is hard, but very stretchy

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Make the grade

P2: For P2, you must successfully complete this task.
Carry out a practical investigation into the physical properties of chemicals.

Task

You will be given four materials from the GYF store which you need to investigate. Finding the properties of these materials will enable you to decide how suitable they might be as building materials.

Your task:

You must carry out the tests to find the properties listed below and record your findings:

- melting point
- boiling point
- thermal conductivity
- electrical conductivity
- density
- solubility
- viscosity (all liquids only)

Step 1: Finding out
Follow the instruction sheets to carry out the tests on each material. You may need to use the internet or a textbook to find some of the information.

Step 2: Recording
Use a table (like the one shown below) to record your findings.

Figure 1.14 Some testing requires big machines.

Material	Melting point/ $^{\circ}\text{C}$	Boiling point/ $^{\circ}\text{C}$	Thermal conductivity (high/low)	Electrical conductivity (good/bad)	Density (g/cm ³)	Solubility (high/low)	Viscosity (high/low)	Notes
1								
2								
3								
4								

Step 3: Making connections
Show how the way each material is used relates to its physical properties.

When you have finished, show your teacher.

Helpful tips

Suggested teaching activities prior to the assignment task:

- Use of visual aids (posters and/or models) and interactive activities.
 - Provision of key terms and definitions.
- Assistance/guidance during assignment task:
- Writing frame provided could be used either as method of collecting information, or as a prescribed layout for the final poster, depending on skill level.
 - It may be necessary to provide learners with a range of suitable websites.
 - Remind learners that they can also use the information learnt in lessons.

Learning outcomes

Scientific knowledge & understanding

Learners must be able to:

- define the terms: melting point, boiling point, thermal conductivity, electrical conductivity, density, solubility, viscosity.

Skills

Learners must be able to:

- carry out simple practical activities (instructions may be provided) to investigate: melting point, boiling point, thermal conductivity, electrical conductivity, density, solubility (of solids) and viscosity (of liquids only)
- use the internet to find facts/information that cannot be illustrated in the classroom
- record information in a table, or other suitable format.

Suggested time for assignment task: 2 hours

Opportunities for PLTS

Skill	Process
Creative thinkers	CT1 designing experiments to test their theories CT1, 2 exploring possibilities and asking questions to extend their own thinking when researching the Periodic Table
Team workers	TW1, 2, 3 working together on their experiments, dividing their roles during practical work, sharing and comparing results
Independent enquirers	IE1, 2, 4 obtaining data from different sources, making predictions about their experiments, recording results and evaluating their experiment
Self-managers	SM2 working towards goals, showing initiative, commitment and perseverance to complete tasks SM3 organising time and resources, prioritising time and resources throughout the unit to complete tasks SM4 anticipating and managing risks in the laboratory
Reflective learners	RL4 inviting feedback and dealing positively with praise or criticism following a practical activity RL6 communicating to others their learning about materials

Grading criteria

M2: Explain how the physical properties of chemicals make them suitable for their uses

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Using materials

Essential science for M2

The uses of materials are directly related to their properties. In building you need to find the best materials. These will be the materials that have the most suitable properties. Here are some examples:

- Glass is used in windows because it is transparent (you can see through it).
- Polystyrene foam is not used to build walls as it is soft and easy to damage, but it is used as insulation inside walls as it is a very poor conductor of heat energy.
- Brick, stone, concrete blocks and cement are used to build walls because they are strong in compression, but none of these are used to make doors because you don't need doors to be strong like this.
- Doors are made out of wood or plastic because these materials are easy to shape, flexible and strong enough to be secure.

Iron

Melting point = 1538°C
Boiling point = 2862°C
High thermal conductivity
High electrical conductivity
Density = 7.874 g/cm³
Insoluble in water




Figure 1.15 This nail is made of iron.

Iron has many uses, for example in cookware (as shown in Figure 1.16). It has a high melting point, so it can be heated to high temperatures without melting. It is reasonably good at conducting heat, so heat will pass through it to the food. Iron is dense and strong so the cookware will not easily change its shape and will sit firmly on the heat, held by its own weight. Iron conducts electricity but this property is not relevant to its use in cookware. Iron is insoluble in water so can be washed and used to boil liquids without dissolving or reacting.

Key words:
materials, relevant, suitable




Figure 1.17 Be careful! Don't think 'material' means cloth; that's only one meaning of the word material.

Make the grade

M2 For M2, you must successfully complete this task.

Explain how the physical properties of chemicals make them suitable for their uses.

Task

Prepare a materials booklet to inform members of the public about the materials that you investigated in P2, what they are used for and why they are suitable for their uses.

Your task

Step 1: The uses
Find out what each material is used for. Try to find two different uses for each material.

Step 2: Linking uses to properties
For each use, decide which properties of the material are relevant. Explain how the properties of the material make it suitable for that use.

When you have finished, show your teacher.

Tip

- Try to find pictures of the materials being used to improve your presentation.
- You could make a booklet with one page per material or one page per use, or you could use your own ideas about how to present the information.

Helpful tips

Assistance/guidance during assignment task:
Learners working at Merit level are expected to work with a greater level of autonomy, therefore requiring less teacher guidance during tasks. A simple worksheet could be provided to facilitate the collection of information, but not a writing frame which would provide a standard layout for the task. Learners should be reminded to use all information available (including classwork) and to reference work properly.

Learning outcomes

Scientific knowledge & understanding

Learners must be able to:

- decide on a use for each material investigated in P2
- explain why (with reference to the physical properties) each material has its use.

Skills

Learners must be able to:

- use the internet to find facts/information that cannot be illustrated in the classroom
- present information in a suitable format.

Suggested time for assignment task: 3 hours

Opportunities for PLTS

Skill	Process
Creative thinkers	CT1, 2 exploring possibilities and asking questions to extend their own thinking when researching the uses of materials CT4 questioning their own assumptions regarding uses of materials
Independent enquirers	IE1 obtaining data from different sources,
Self-managers	SM2 working towards goals, showing initiative, commitment and perseverance to complete tasks SM3 organising time and resources, prioritising time and resources throughout the unit to complete tasks SM4 anticipating and managing risks in the laboratory
Reflective learners	RL4 inviting feedback and dealing positively with praise or criticism following a practical activity RL6 communicating to others their learning about materials

To achieve higher levels (Merit or Distinction) learners should:

- begin to relate the structure of the particles in the materials to their physical properties ready for distinction level.

Grading criteria

D1: Explain how the structure of different chemicals affects their properties

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Structures and properties

Essential science for D1

The properties of materials are related to their **structures**. When describing the structure of a material, we could be talking about whether it is a **solid, liquid or gas** at room temperature, and whether it is an element, compound or mixture. The structure of a substance is the microscopic arrangements of its particles, how they pack together, how strongly they hold onto each other and what the particles are.

Iron is very dense (compact). This is because its particles are packed tightly together (structure). Water is less dense than iron. This is because its molecules are not packed as tightly together. Properties of substances are observed by their microscopic structure but relate to the whole bulk of the substance, not just the individual particles.

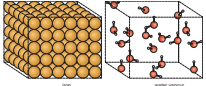


Figure 1.18 Iron is very dense; the particles are packed tightly together. Water vapour is not dense; the particles are spread out.

The boiling point of pure water is 100 °C. This means to how much heat energy is needed to separate the **molecules** of water. If there are any impurities in the water, the amount of energy needed will change, and therefore the boiling point will change. Finding the boiling point of water is a way to find out if the water is pure (a compound) or contaminated (a mixture).

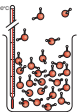


Figure 1.19 As water boils, particles spread further apart and escape as water vapour.

Key words: gas, liquid, molecule, solid, structure

15 Chapter 1 Substances

Make the grade

D1 For D1, you must successfully complete this task. Explain how the structure of different chemicals affects their properties.

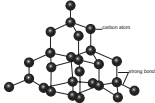


Figure 1.20 Diamond is a very hard substance. This is because it has a structure that holds the atoms together strongly in all directions. Diamond is not very dense because the individual atoms are not very heavy.

Task

Add pages to your materials booklet that you made for N2 about the structures of the materials.

Your task:

Step 1: Describing the structures
Draw particle pictures for each of the materials in your booklet and write sentences to describe the structure of each one. You may wish to do some additional research on the internet or from a textbook about the structures of the different materials.

Step 2: Explaining
For each material, explain how the structure affects its properties.

When you have finished, show your teacher.

Tip

You may wish to do this task as a separate section in your booklet.

Helpful tips

- Don't need details of types of bonding.
- Relates to physical properties not chemical properties.

Assistance/guidance during assignment task:

- Learners working at Distinction level are expected to work with a greater level of autonomy, therefore requiring little or no teacher guidance during tasks.

Learning outcomes

Scientific knowledge & understanding

Learners must be able to:

- recognise the different structures in different types of materials
- explain differences in the properties of materials using ideas about particles and their motion.
- use atomic and molecular structure to explain properties.

Skills

Learners must be able to:

- use the internet to find facts/information that cannot be illustrated in the classroom
- present information in a suitable format.

Suggested time for assignment task: 3 hours

Opportunities for PLTS

Skill	Process
Creative thinkers	CT1, 2 exploring possibilities and asking questions to extend their own thinking when researching the structures of the materials CT4 questioning their own assumptions regarding the structures of materials
Team workers	TW1, 2, 3 working together on their experiments, dividing their roles during practical work, sharing and comparing results
Independent enquirers	IE1 obtaining data from different sources
Self-managers	SM2 working towards goals, showing initiative, commitment and perseverance to complete tasks SM3 organising time and resources, prioritising time and resources throughout the unit to complete tasks
Reflective learners	RL4 inviting feedback and dealing positively with praise or criticism following a practical activity RL6 communicating to others their learning about materials