9 From models to materials

Teaching plan

Sub-chapter	Approximate number of learning hours	Learning content	Resources
9.1 Bonding and electro-negativity	1–2	Bonding is best described as a continuum between the ionic, covalent and metallic models, and can be represented by a bonding triangle. Use electronegativity values to place substances in a bonding triangle. Relate the position of a compound in the bonding triangle to its properties.	**Coursebook** Section 9.1 Test your understanding Question 1 **Workbook** Exercise 9.1 **Teacher's resource** End of Chapter 9 test questions
9.2 Alloys	2–3	Alloys are mixtures of a metal and other metals or non-metals. They have enhanced properties. Explanation of the properties of alloys in terms of non-directional bonding.	**Coursebook** Section 9.2 Test your understanding Question 1 **Workbook** Exercise 9.2 **Teacher's resource** PowerPoint 9, slide 3
9.3 Polymers	2–3	Polymers are long-chain covalently bonded molecules made from sub-units called monomers. Description of the common properties of plastics in terms of their structure. Addition polymers form by the breaking of a double bond in each monomer. Representation of the repeating unit of an addition polymer from given monomer structures.	**Coursebook** Section 9.3 **Workbook** Exercise 9.3 **Teacher's resource** Worksheet 9.1 End of Chapter 9 test questions PowerPoint 9, slides 3–6

Sub-chapter	Approximate number of learning hours	Learning content	Resources
9.4 Condensation Polymers		Condensation polymers form by the reaction between functional groups in each monomer with the release of a small molecule. Condensation polymers form by the reaction between functional groups in each monomer with the release of a small molecule. Understand that biological macromolecules form by condensation polymerization and breakdown by hydrolysis. Representation of the repeating unit of polyamides and polyesters from given monomer structures.	

BACKGROUND KNOWLEDGE

- The chapter on bonding needs to have been covered before this chapter.
- Students should have prior knowledge of some simple organic molecules (alkanes, alkenes, alcohols).

Syllabus overview

- Students will understand the bonding in alloys and how it differs from pure metals. At Higher Level students will understand that there is a bonding triangle based on its electronegativities and be able to relate the positions of compounds in the bonding triangle to their properties.
- Students will then understand how different polymers are made and what they are used for.
- At Higher Level the students will focus on condensation polymers and understand how these are formed and how they break down by hydrolysis.

9.1 Bonding and electronegativity

LEARNING PLAN

Learning objectives	Success criteria
Understand the continuum between ionic, covalent and metallic bonding	Students can explain that there is a continuum between ionic, covalent and metallic bonding.
Use electronegativity values to place substances in a bonding triangle	Students will be able to use electronegativity values to place substances in a bonding triangle.
Relate the position of a compound in the bonding triangle to its properties	Students can relate the position of a compound in the bonding triangle to its properties.

Common misconceptions

Misconceptions	How to identify	How to overcome
Students get confused by which molecules / compounds have which type of bonding	Through homework's and tests.	Create flashcards with different molecules / compounds and work out the type of bonding and explain it.

Starter ideas

1 Review Bonding

Resources: Different molecules and compounds on the board

Description and purpose: Students can think back to prior learning to see if they can remember which molecules / compounds have which type of bonding

What to do next: Students can then think about how to explain the bonding present and could look at more complicated molecules / compounds such as ammonium nitrate

Main teaching ideas

1 The bonding triangle (30 minutes)

Resources: Diagram of the bonding triangle, electronegativity values. Both could be from the data book.

Description and purpose: Students will use the electronegativity values of different elements to decide on which type of bonding best describes the compound formed. The students can discuss their ideas with each other and with the whole class.

› **Differentiation ideas:**

Support: Give students the periodic table and get them to highlight the elements with high electronegativities in one colour and low electronegativities in a different colour. They can annotate the periodic table to show which elements are most likely to be ionic and which ones are most likely to be covalent.

Stretch and challenge: Students can be given more complicated molecules and be asked to describe the types of bonding in them.

Plenary ideas

1 Student presentations (40 minutes)

Resources: Computers, poster-making equipment.

Description and purpose: Students take one section of Bonding and spend some time reviewing it and then presenting their work to the class. This could be done on computers or by making posters. Feedback from the class is welcomed. This will give the students the opportunity to revise some of the material and learn from their peers.

› **Language focus:** Opportunity to use key terms and apply them successfully.

2 Bonding triangle (15 minutes)

Resources: Bonding triangle

Description and purpose: Give students different compounds and see if they can work out what sort of bonding is present (ionic, covalent, metallic) using the bonding triangle. This will help them understand how electronegativities of atoms affect the bonding.

9.2 Alloys

LEARNING PLAN

Learning objectives	Success criteria
Understand the term alloy	Students can explain the term alloy.
Explain the properties of alloys	Students can explain the properties of alloys in terms of metallic bonding.

Common misconceptions

Misconceptions	How to identify	How to overcome
Students think that alloys are covalent or ionic bonding.	During the starter activity.	Explanation of how alloys are bonded together. Reflection throughout the topic.
Students think that bonding is split into 3 distinct types.	Discuss the bonding triangle with the students and highlight molecules / compounds that do not fit.	Students given examples of compounds that do not fit the common Ionic or covalent definitions and explain them using the bonding triangle.

Starter ideas

1 Different types of bonding (10 minutes)

Resources: Different compounds on the board, including alloys like steel.

Description and purpose: Students decide what type of bonding is present in each compound.

What to do next: Students can design a flow chart to show how to determine which bonding is present in different molecules / compounds.

Main teaching ideas

1 Properties of alloys (25 minutes)

Resources: Different metal alloys.

Description and purpose: Students can see different alloys and why they are used for different purposes. The teacher explains the bonding in alloys. Students will then be able to explain the properties of the alloys and link to their uses. Students could expand on the history of alloys to show why they have been used for certain purposes in the past.

Differentiation ideas:

Support: Mix and match metal, property, and use. Students can then put the right metal with the right property and use.

Stretch and challenge: Students could look at smart metals, and new materials, and see how their properties and uses match their bonding.

2 What are alloys used for? (50 minutes)

Resources: Computer room.

Description and purpose: Students could research one particular alloy, looking at how it is made, the history of this alloy and what it is used for and why, and present their findings to the class.

Differentiation ideas:

Support: Students could be given an alloy to research or they could be given some guiding questions.

Stretch and challenge: Students could be asked to explain the bonding in the different alloys and link this to their properties and uses.

Plenary ideas

1 Assessing learning objectives (10 minutes)

Resources: Learning objectives on the board.

Description and purpose: Students assess how well they understand each of the learning objectives from the lesson. The teacher can then use this information to plan lessons in the future to ensure that all students have a good grasp of the content covered.

9.3 Polymers and 9.4 Condensation polymers

LEARNING PLAN

Learning objectives	Success criteria
Understand the term polymer	Students can explain the term polymer.
Explain the properties of polymers (plastics) in terms of structure and bonding	Students can explain the properties of polymers (plastics) in terms of structure and bonding.
Explain how addition polymers are formed	Students can explain how addition polymers are formed.
Deduce the structure of the repeating unit and equations for the formation of addition polymers	Students can deduce the structure of the repeating unit and equations for the formation of addition polymers.
Explain how condensation polymers are formed	Students can explain how condensation polymers are formed.
Deduce the structure of the repeating unit of a condensation polymer	Students deduce the structure of the repeating unit of a condensation polymer.
Understand that biological macromolecules form by condensation polymerisation and breakdown by hydrolysis	Students explain that biological macromolecules form by condensation polymerisation and breakdown by hydrolysis.

Common misconceptions

Misconceptions	How to identify	How to overcome
For addition polymers, students do not understand which bonds are broken and which ones are formed.	Recap during the plenary to see what they draw. Homework could also identify this misconception.	Use models and diagrams to show students that the double bond is broken and the monomers join using the carbons that previously formed the double bond.
Students do not understand that the shapes (squares/circles) represent a carbon chain in a polymer.	Questioning of the students throughout the lesson.	Show the molecules with both the carbon chain and the shapes, so the students can see what is inside the shapes.
Students get confused by the different organic groups and names.	Through homework and tests.	Revision of names and functional groups is required. Drawing out the molecules and naming them will help. Students could use flash cards for this.

Starter ideas

1 Organic molecules (20 minutes)

Resources: Molymod kits

Description and purpose: Students make models of different alkanes and alkenes. This is revision from their previous learning, and the teacher can assess how much prior knowledge each student has. Students can see that alkenes have a double bond and alkanes have a single bond.

2 Dicarboxylic acids, diamines, and diols (10mins)

Resources: Molymod kits

Description and purpose: Students can build models, using the Molymod kits, for the dicarboxylic acids, diamines, and diols. Students will understand the structure and bonding of the starting materials when making condensation polymers. The teacher can help students with the structures and use this to build upon the student's prior knowledge.

What to do next: Students can think about what bonds are broken when these molecules are joined to form condensation polymers. They can use the models to try and make the repeating unit of the polymer.

Main teaching ideas

1 Addition polymers (40 minutes)

Resources: Molymod kits

Description and purpose: Students can use the Molymod kits to make two ethene molecules and think about how they could be joined. The teacher can then go through the formation of addition polymers, showing the breaking of the double bond to form a single bond and a long chain.

Differentiation ideas:

Support: Visual aids and diagrams could be used to help students understand the formation of addition polymers.

Stretch and challenge: Students given different addition polymers and asked to work out what the monomers are and write out equations for the formation of these addition polymers.

2 Deducing polymers and monomers (35 minutes)

Resources: Examples of different monomers and polymers. Molymod kits.

Description and purpose: Students are asked to work out what polymers are formed from certain monomers and then what monomers are used to make certain polymers.

› **Differentiation ideas:**

Support: Students could use the Molymod kits to help them understand which bonds are breaking in the monomer and which bonds are formed.

Stretch and challenge: Students could be given the chain of a polymer and be asked to deduce the repeating unit and the monomer from which it is formed.

3 Making nylon (35 minutes)

Resources: Chemicals and apparatus required to make nylon.

› **Description and purpose:** This can be a demonstration or a class practical for students to see how a polymer can be made.

Safety: Teachers will need to assess the practical and write their own risk assessment for this.

› **Differentiation ideas:**

Support: Scaffolded question about making condensation polymers.

Stretch and challenge: Students are given some different condensation polymers and must work out how they could be made.

Plenary ideas

1 Mini-whiteboard recap (15 minutes)

Resources: Mini-whiteboards.

Description and purpose: Students are given different monomers, polymers, and repeating units to draw.

› **Assessment ideas:** The teacher can assess the students' understanding of the topic from their drawings.

2 Student presentations (40mins)

Resources: Computers, making poster equipment.

Description and purpose: Students take one section each from the unit and spend some time reviewing it and then presenting their work to the class. This could be done on computers or by posters. Feedback from the class is welcomed. This will give the students the opportunity to revise some of the material and learn from their peers.

› **Language focus:** *opportunity to use key terms and apply them successfully*

Assessment ideas

- End of unit test, covering all the chapters.

Homework ideas

› **Language focus:** Students could research and write an essay on what polymers are used for. They could explore the history of polymers and think about how they will be used in the future.

Reflection

- Students do an end of unit test; they then get the opportunity to go through the mark scheme and annotate their papers to see which areas they didn't fully understand. They can then make a revision list based on this information and spend some time going through this list to ensure that they have a better grasp of the content.

Links to digital resources

- A practical method for students to use to make nylon
- A video showing the polymerisation of ethene

CROSS-CURRICULAR LINKS

- Design technology: Looking at different materials and their properties.