





> 6 The ionic model

Teaching plan

Sub-chapter	Approximate number of learning hours	Learning content	Resources
6.1 Ionic and covalent bonding 6.2 Formation of ions	1–2	Positive ions (cations) form by metals losing valence electrons. Negative ions (anions) form by non-metals gaining electrons. The number of electrons lost or gained is determined by the electron configuration of the atom.	Coursebook Sections 6.1 and 6.2 Test your understanding questions Workbook Exercise 6.1
6.3 The formation of ionic compounds	1–2	The ionic bond is due to electrostatic attraction between oppositely charged ions. Deduction of the formula and name of an ionic compound from its component ions, including polyatomic ions.	Coursebook Section 6.3 Test your understanding questions Workbook Exercise 6.3 Teacher's resource  PowerPoint 6, slide 2
6.4 Ionic bonding and the structure of ionic compounds 6.5 Physical properties of ionic compounds 6.6 Lattice enthalpy and strength of ionic bonding	1–2	Under normal conditions, ionic compounds are usually solids with lattice structures. Explanation of the physical properties of ionic compounds (volatility, electrical conductivity and solubility) in terms of their structure.	Coursebook Sections 6.4–6.6 Exam-style questions Workbook Exercise 6.4 Exam-style questions Teacher's resource  PowerPoint 6, slides 3–5  Worksheet 6.1  End of Chapter 6 test

BACKGROUND KNOWLEDGE

- Understanding of Unit 1: The nature of matter.
- Understand the terms atoms, ions, electrons.
- Understand electronic configurations of atoms.
- Understand that different materials have different properties.

Syllabus overview

- The beginning of the chapter consolidates the students' knowledge of atoms and ions from Unit 1. Deeper explanations of how ions are formed are covered and students will be expected to work out the charges on the ions formed using the periodic table. There are some common positive and negative ions that students will be expected to know which are difficult to work out from the periodic table. These are listed in the tables within the chapter (Tables 6.7 and 6.8).
- The formation of an ionic bond is described and explained, and students are expected to know the definition of an ionic bond. Students are then taught how to work out the formulas of ionic compounds from positive and negative ions. There is plenty of opportunity to practice this in the questions given within the chapter.
- The chapter also focuses on the structure of ionic compounds and shows the simple 3D structure of an ionic compound.
- The properties of ionic compounds are discussed and explained using the theory mentioned previously in the chapter.

6.1 Ionic and covalent bonding and

6.2 Formation of ions

LEARNING PLAN	
Learning objectives	Success criteria
Understand the formation of anions and cations	Students can understand the formation of anions and cations.
Deduce the charges on ions from their position in the periodic table	Students can deduce the charges on ions from their position in the periodic table.
Know the charges of commonly encountered ions	Students can recall the charges of commonly encountered ions.

Common misconceptions

Misconceptions	How to identify	How to overcome
Students use the wrong signs for the charge of the ions.	Check students' work, test them during the lessons.	Reinforce that electrons have a negative charge and, if they are lost from an atom, the ion becomes positive. If they gain electrons, then the ion becomes positive.
Student get certain ions confused, e.g., sulfate and sulfide ions.	Practice working out ion charges and check their understanding. Write homework and quizzes to identify this.	Highlight that ions ending with -ate have oxygen attached; ions that end in -ide are only those elements.

Starter ideas

1 Recap prior knowledge from pre-IB bonding topics on the formation of ions (15 minutes)

Resources: Students are provided with a few metal and non-metal ions.

Description and purpose: Ask students what they understand about the formation of ions from their previous learning. They can then work out the ions formed from some simple (Groups 1 and 2 and 16 and 17) atoms and put the correct charge on them.

What to do next: If the majority of students can work out the charges of the ions, you can move on to practice with more examples of different atoms. If some students have not done chemistry as a specialised subject before, then you will need to explain the concepts of the loss and gain of electrons and the formation of ions.

Main teaching ideas

1 Deducing the charges of ions from their position in the periodic table (25 minutes)

Resources: All students will need a periodic table.

Description and purpose: This exercise gives students practice on how to use the periodic table to work out the charge of an ion from its group number. Students can work out charges of ions from the transition block using the roman numerals given. Some other commonly encountered ions that are difficult to work out from the periodic table should be given to the students (NH_4^+ , OH^- , NO_3^- , HCO_3^- , CO_3^{2-} , SO_4^{2-} and PO_4^{3-}).

> Differentiation ideas

Support: Different atoms and ions are given with easy to challenging questions. The teacher can position themselves with the students who require more assistance.

Stretch and challenge: Students can think ahead and come up with the formulas of some ionic compounds.

Plenary ideas

1 Ion bingo

Resources: A table of atoms and ions as follows:

Magnesium	Iron(III)	Iodide	Oxide
Sulfate	Ammonium	Aluminium	Nitrate
Nitride	Copper(II)	Sulfide	Bromide

Description and purpose: This exercise gives students an opportunity to apply their knowledge to work out the formulas and charges for ions from the periodic table and the knowledge they have learnt during the lesson.

6.3 The formation of ionic compounds

LEARNING PLAN

Learning objectives

Deduce the formulas of ionic compounds
Understand ionic bonding

Success criteria

Students can work out formulas of ionic compounds from the names of the ionic compound and the ions using a periodic table.
Students understand what an ionic bond is and can explain how it works.

Common misconceptions

Misconceptions	How to identify	How to overcome
Students get the wrong ions in compounds, e.g., magnesium sulfate and magnesium sulfide.	Practice writing out ionic compounds and check their understanding. Write homework and quizzes to identify this.	Highlight that ions that end in -ate have oxygen attached; ions that end in -ide are only those elements.
Students get confused with the terminology, not using the correct words when describing ionic bonding.	Students explanations and definitions of ionic bonding can be assessed.	Highlight that ionic bonding needs ions so that should be used in the explanations not atoms/molecules/particles.

Starter ideas

1 Ions and ionic compounds (10 minutes)

Resources: Mini-whiteboards.

Description and purpose: Ask students to come up with the ions from some atoms and write out on a mini-whiteboard to check.

What to do next: This activity allows teachers to recap knowledge from the previous lesson. This gives students the confidence that they understand ions, which is important moving through this topic. If there are common misunderstandings, teachers can pick these up and go through them again to make sure everyone has a solid understanding.

Main teaching ideas

1 Work out the formulas of ionic compounds, given the ions, atoms or names of the compound (25 minutes)

Resources: Sheet given showing the formulas of common positive and negative ions.

Description and purpose: Explain the formation of ions and the transfer of electrons from the positive ion to the negative ion. Give them the definition of an ionic bond and highlight the terminology required. Explain that ionic compounds have no overall charge, and then give them some simple ions (Na^+ and Cl^- , Mg^{2+} and Br^-) to work out what the formula for the ionic compound would be.

➤ Differentiation ideas

Support: Start with easy ionic compounds, so students can understand the basics of the formation of an ionic compound.

Stretch and challenge: Give harder ionic compounds to work out.

Plenary ideas

2 Work out the formulas of ionic compounds (10 minutes)

Resources: A periodic table and mini-whiteboards.

Description and purpose: Students are given some different names of ionic compounds, and they have to write out the formula of the ionic compound on the mini-whiteboard and hold it up so the teacher can see if they understand the content covered. This exercise gives students an opportunity to apply their knowledge and give the teacher the opportunity to assess their knowledge.

6.4 Ionic bonding and the structure of ionic compounds; 6.5 Physical properties of ionic compounds and 6.6 Lattice enthalpy and strength of ionic bonding

LEARNING PLAN

Learning objectives	Success criteria
Describe the structure of ionic compounds	Students understand that ionic structures are a giant 3D lattice made up of alternating charged ions.
Explain the properties of ionic compounds in terms of structure and bonding	Students should be able to explain the different properties of an ionic compound using the structure and bonding.
Discuss the connection between the lattice enthalpy and the strength of ionic bonding	Students understand the connection between the lattice enthalpy and the strength of ionic bonding

Common misconceptions

Misconception	How to identify	How to overcome
Students don't always understand that ionic compounds are giant ionic lattices with lots of ions.	Questions asking students to explain the structure and properties of ionic compounds.	Although simple diagrams only show a few ions, reinforce that these lattices are giant and have lots of ions. Show larger models to the students.

Starter ideas

1 Recap the formation of ionic compounds (10 minutes)

Resources: Fill in sheet to show their understanding of the previous topic.

Description and purpose: Students complete the sheet to show their understanding of the previous lesson. Go through the answers, so students can correct their own work.

What to do next: This activity allows teachers to recap knowledge from the previous lesson. By learning from errors, students can understand the concepts. If there are common misunderstandings, teachers should go back and re-teach part of the previous lesson.

Main teaching ideas

1 Structure of an ionic compound (10 minutes)

Resources: Pictures of different 3D models of ionic compounds.

Description and purpose: Explanation of the structure of an ionic compound (NaCl is commonly used). Students should draw this out and understand the main points, including that it is three dimensional; has alternating charged ions, which should be labelled, and that it is a giant lattice structure.

2 Properties of ionic compounds (20 minutes)

Resources: Pictures of different 3D models of ionic compounds.

Description and purpose: Students should understand why ionic compounds have certain properties (high melting points and boiling points, dissolve in water, conduct electricity when molten or in solution, don't conduct electricity when solid). The teacher should talk about the link between lattice enthalpy and the strength of the ionic bond. Students are put into groups, and they are given these properties and they come up with ideas, based on what they have learnt, as to the reason for each property in an ionic compound.

> Differentiation ideas

Support: Group work encourages more discussions and allows teachers to give verbal support accordingly. Teachers could split the groups into ability and spend more time with those that need extra support.

Stretch and challenge: Students can be asked why MgO has a higher melting point than NaCl based on what they have learned in this chapter.

> **Language focus:** Students write out flash cards for the content covered in this chapter. Students should review these flash cards and check their level of understanding of each one. If they don't understand anything or have some questions, they can then bring these to the teacher so they can help.

Plenary ideas

1 Exam-style questions (15 minutes)

Resources: Exam-style questions; could use the questions from the coursebook.

Description and purpose: This exercise gives students an opportunity to practice questions they would see in the exam. The teacher would also be able to assess the students' knowledge on the subject.

Assessment ideas

- Assessment opportunities throughout the chapter, mini-whiteboard work, exam-style questions.
- The group work set on properties of ionic compounds can be shared with other groups, and they can add comments and make improvements to give peer assessment.

Homework ideas

- Build a 3D model of an ionic compound (LiF).
- Questions from the coursebook chapter.

Links to digital resources

- Chemistry terminology: For good explanations of the different topics in IB chemistry, search the internet for the words '[chemguide](#)' or 'Helping you to understand chemistry'
- Atoms and [ionic structures](#): Use the atomic structure and bonding page on chemguide to go through the ionic model section

CROSS-CURRICULAR LINKS

- Physics: Materials used in engineering/structures.
- TOK: Using models to understand scientific theory.