Accompagnement personnalisé — Première S

IONIC BONDING AND STRUCTURE

DESCRIPTIF DE L'ACTIVITE DESTINE AU PROFESSEUR

Compétences exigibles du B.O.	***Préambule du programme du cycle terminal de la voie S :*** […] en devant présenter la démarche suivie et les résultats obtenus, l'élève est amené à une activité de communication écrite et orale susceptible de le faire progresser dans la maîtrise des compétences langagières, orales et écrites, dans la langue française, mais aussi en langue étrangère, notamment en anglais, langue de communication internationale dans le domaine scientifique. […]
	Programme de première S : Cohésion et transformations de la matière (Solide ionique. Interaction électrostatique ; loi de Coulomb).
Déroulement de l'activité	Cette activité de **soutien** est prévue pour une durée d'une heure en séance d'accompagnement personnalisé, en première S. ***Déroulement :*** • Le document est donné aux élèves qui en prennent connaissance. • Selon les difficultés rencontrées, le professeur leur remet, si besoin, une fiche « coup de pouce » permettant de pallier les difficultés de compréhension liées au vocabulaire. • A la fin de la séance, il est préconisé de distribuer l'une des deux fiches pour s'assurer que l'ensemble des élèves s'est approprié l'activité.
Compétences évaluées	Compétences linguistiques : • compréhension écrite de la langue anglaise ; • expression écrite. En plus des compétences linguistiques, cette activité permet de travailler les compétences de la démarche scientifique : • s'approprier (APP) • analyser (ANA)
Remarques	Cette activité peut se décliner selon trois niveaux de compétences : • niveau 1 : une fiche « coup de pouce » permet de donner le vocabulaire nouveau (ou qui pose problème) directement en français (fiche 1). • niveau 2 : le vocabulaire nouveau est introduit sous forme écrite par le biais de fiche « coup de pouce » proposant les définitions en anglais (fiche 2). • niveau 3 : le vocabulaire nouveau (ou qui pose problème) est explicité oralement par l'enseignant.
Auteurs	Séverine Leget – Lycée Marceau – Chartres Delphine Pailler – Lycée Paul-Louis Courier – Tours Florence Trouillet – Lycée Claude de France – Romorantin

IONIC BONDING AND STRUCTURE

Compétences travaillées (capacités et attitudes) :

- **APP :** mobiliser ses connaissances ; extraire des informations utiles.
- **ANA** : exploiter des informations ; adopter une démarche explicative.

INTRODUCTION

Ionic bonds are usually found in compounds that contain metals combined with non-metals. For example, consider what happens when sodium and chlorine combine to make sodium chloride:

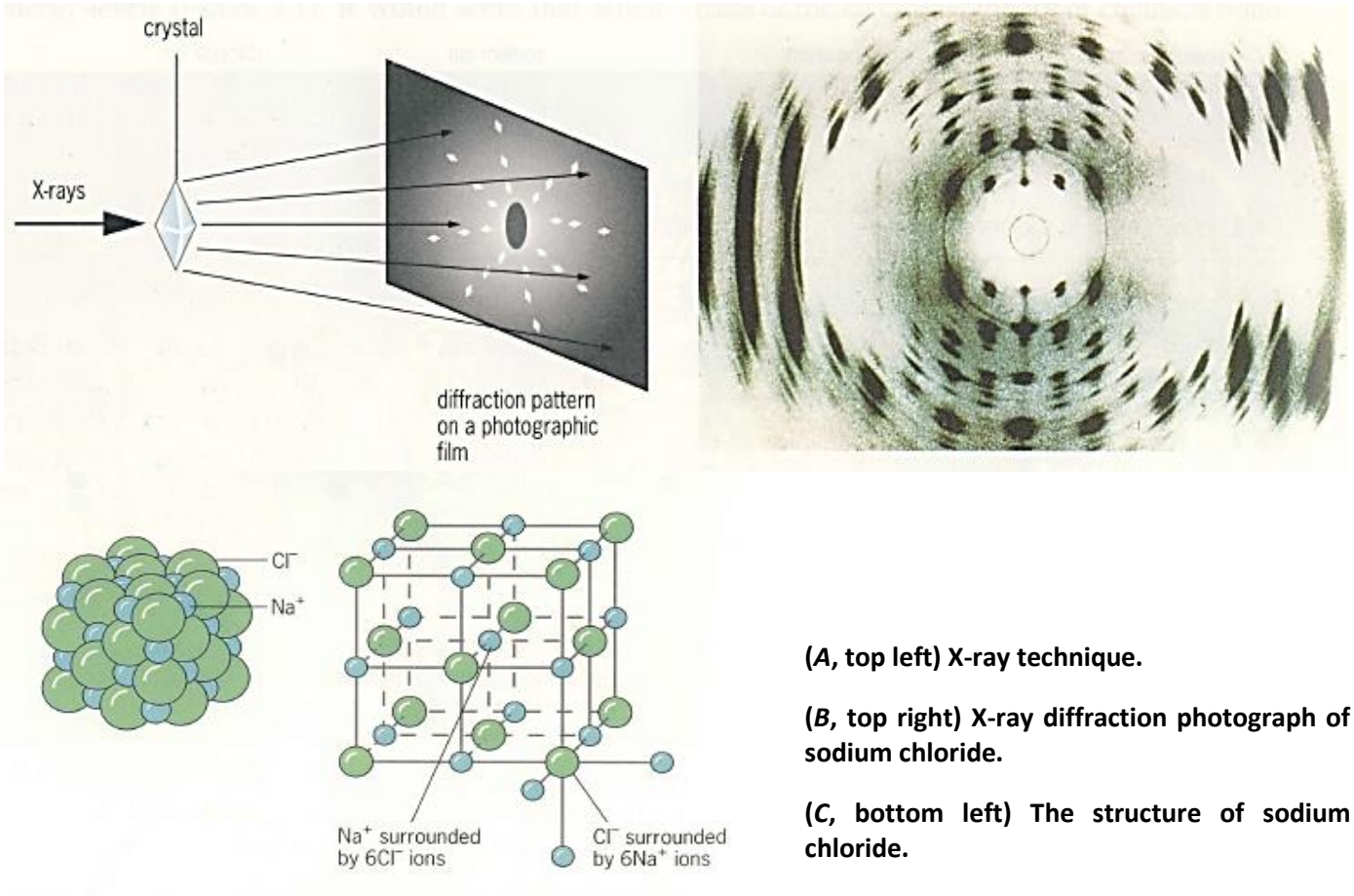
sodium + chlorine → sodium chloride

The charges on the sodium and chlorine ions are equal but opposite. They balance each other and the resulting formula for sodium chloride is NaCl. These oppositely charged ions attract each other and are pulled, or bonded, to one another by strong electrostatic forces. This type of bonding is called "ionic bonding".

IONIC STRUCTURES

The ions are packed together in a regular arrangement called a lattice. Within a lattice, oppositely charged ions attract one another strongly.

Diffraction is a phenomenon which occurs when a wave encounters an obstacle whose dimension is roughly similar to its wavelength. Scientists, using X-ray diffraction, have obtained photographs which indicate the way in which the ions are arranged. *Figure A* shows the structure of sodium chloride as determinate by the X-ray diffraction technique. The study of crystals using X-ray diffraction was pioneered by Sir William Bragg and his son Sir Laurence Bragg in 1912.



(*A*, top left) X-ray technique.

(*B*, top right) X-ray diffraction photograph of sodium chloride.

(*C*, bottom left) The structure of sodium chloride.

When X-rays are passed through a crystal of sodium chloride, for example, you get a pattern of spots called a diffraction pattern (*Figure B*). This pattern can be recorded on photographic film and used to work out how the ions or atoms are arranged in the crystal. Crystals give particular diffraction patterns depending on their structure, and this makes X-ray diffraction a particularly powerful technique in the investigation of crystal structures.

Figure C shows only a tiny part of a small crystal of sodium chloride. Many millions of sodium ions and chloride ions would be arranged in this way in a crystal of sodium chloride to make up the giant ionic structure.

Properties of ionic compounds:

- Ionic structures are solid at room temperature and have high melting and boiling points.
- They usually cannot conduct electricity when solid.
- They mainly dissolve in water.
- They usually conduct electricity when in the molten state or in aqueous solution.

QUESTIONS

(a) What are X-rays? Compare the wavelengths of visible light and X-rays? ……..

……

(b) Diffraction occurs with visible light too (such as a laser beam), consequently, could you explain why scientists use X-ray in this case?

……

……

(c) "Ionic compounds usually cannot conduct electricity when solid". Why?

……

……

(d) Using your 1S course, briefly explain the process leading to the dissolution of ionic crystal in water.

……

……

(e) Fill in the blanks: *"In aqueous solution, the forces of attraction between the ……. are ……., and the ions are …….. to move."*
Thus, what can you deduce about the property of this solution?

……

……

(f) Using the information thereafter, write the formulae of the following ionic compounds:

Iron(II) chloride	
Calcium phosphate	
Iron(III) chloride	
Silver oxide	
	CaO
	$MgCl_2$
	KCl

ANSWERS

(a) What are X-rays? (APP)
X-rays are a form of electromagnetic radiation. Their wavelength is in the range of 10 to 0.01 nanometers, corresponding to frequencies in the range 3×10^{16} Hz to 3×10^{19} Hz.

(b) Diffraction occurs with visible light too (such as a laser beam), consequently, could you explain why scientists use X-ray in this case? (ANA)
They have a much shorter wave-length than light, that's why it's possible to use them to study extremely small structures.

(c) "Ionic compounds usually cannot conduct electricity when solid". Why? (APP)
When solid, they cannot conduct electricity because their ions are not free to move.

(d) Using your 1S course, briefly explain the process leading to the dissolution of ionic crystal in water. (APP)
This phenomenon occurs in three steps: dissociation, solvation, dispersion. The part of the molecule of water which is charged negatively is attracted by sodium ions, and the opposite part is attracted by chloride ions.

(e) Fill in the blanks: *"In aqueous solution, the forces of attraction between the ions are broken, and the ions are free to move."* (APP)
This allows an electric current to be passed through the molten sodium chloride.

(f) Using the information thereafter, write the formulae of the following ionic compounds: (ANA)

Iron(II) chloride	$FeCl_2$
Calcium phosphate	$Ca_3(Po_4)_2$
Iron(III) chloride	$FeCl_3$
Silver oxide	Ag_2O
Calcium oxide	CaO
Magnesium chloride	$MgCl_2$
Potassium chloride	KCl

USEFUL VOCABULARY - LEVEL 1

Metal ions	Lithium Sodium Potassium Silver Copper (I)	Li^+ Na^+ K^+ Ag^+ Cu^+	Magnesium Calcium Copper (II) Zinc Iron (II) Lead Barium	Mg^{2+} Ca^{2+} Cu^{2+} Zn^{2+} Fe^{2+} Pb^{2+} Ba^{2+}	Aluminum Iron (III)	Al^{3+} Fe^{3+}
Non-metal ions	Fluoride Chloride Bromide Hydrogen	F^- Cl^- Br^- H^+	Oxide Sulphide	O^{2-} S^{2-}		
Polyatomic ions	Hydroxyde Nitrate Ammonium Hydrogencarbonate	HO^- NO_3^- NH_4^+ HCO_3^-	Carbonate Sulphate	CO_3^{2-} SO_4^{2-}	Phosphate	PO_4^{3-}

compound	composé (ici, un solide ionique)
to pull	tirer
a lattice	une maille
to be pioneered	avoir été le premier à développer cette technique
a pattern	une figure
surrounded by	entouré de
to work out	résoudre, comprendre
melting point	température de fusion
boiling point	température d'ébullition
at room temperature	température ambiante
molten	liquéfié

USEFUL VOCABULARY - LEVEL 2

Metal ions	Lithium Sodium Potassium Silver Copper (I)	Li^+ Na^+ K^+ Ag^+ Cu^+	Magnesium Calcium Copper (II) Zinc Iron (II) Lead Barium	Mg^{2+} Ca^{2+} Cu^{2+} Zn^{2+} Fe^{2+} Pb^{2+} Ba^{2+}	Aluminum Iron (III)	Al^{3+} Fe^{3+}
Non-metal ions	Fluoride Chloride Bromide Hydrogen	F^- Cl^- Br^- H^+	Oxide Sulphide	O^{2-} S^{2-}		
Polyatomic ions	Hydroxyde Nitrate Ammonium Hydrogencarbonate	HO^- NO_3^- NH_4^+ HCO_3^-	Carbonate Sulphate	CO_3^{2-} SO_4^{2-}	Phosphate	PO_4^{3-}

compound	a substance formed by a chemical reaction of two or more elements in fixed amounts relative to each other. *Common salt is a compound of sodium and chlorine.*
to pull	to use a force to move something towards yourself. *I pulled on the rope to make sure that it was secure.*
a lattice	a regular repeated arrangement of atoms in a crystal (a regular shape that some mineral form when they become solid).
to be pioneered	to be one of the first to develop a technique.
a pattern	an arrangement of shapes, colors, as a design. *A shirt with a floral pattern on it.*
surrounded by	to be or to go all around something. *The garden is surrounded by a high wall.*
to work out	to solve something. *I can't work out how to do this.*
melting point	the temperature at which a substance will melt.
boiling point	the temperature where bubbles rise to the surface and the liquid changes to a gas.
at room temperature	the temperature of the lab.
molten	made liquid by very great heat (used about metal or rock).