

THE STRUCTURE OF IONIC COMPOUNDS

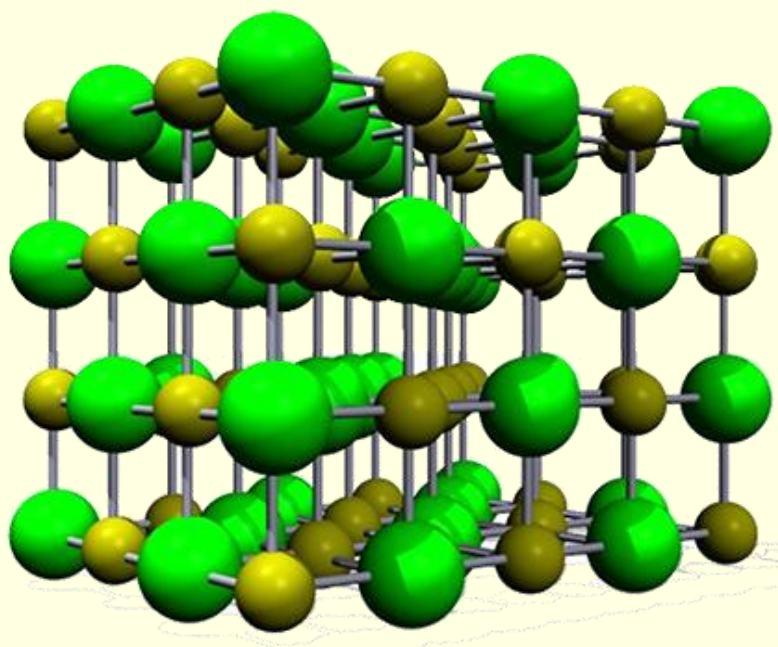
IONIC LATTICES

Answer all the questions below and then check your answers.

1. What charge do metal ions have? Why do they have this charge?
2. What charge do non-metal ions have? Why do they have this charge?
3. What is an ionic bond?

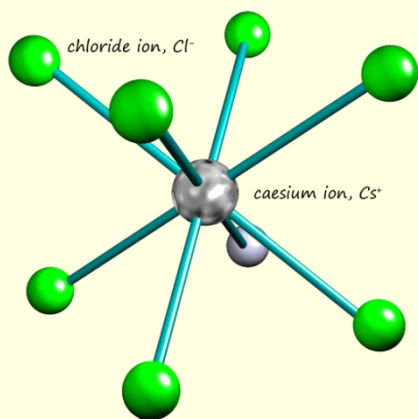
4. The diagram opposite shows the structure of a sodium chloride crystal.

- a. What type of structure do ionic compounds have?
- b. Why can this structure be described as crystalline?
- c. Why could it also be said to be a cubic lattice?

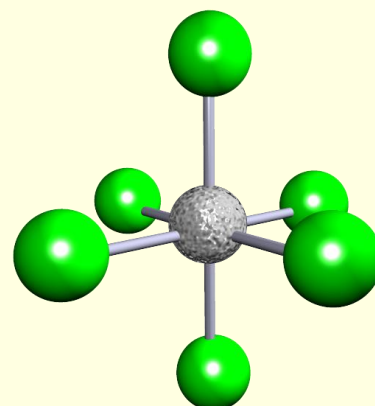


d. The images below can be used to show the co-ordination numbers in the sodium chloride (NaCl) and the caesium chloride (CsCl) ionic lattices.

Caesium chloride cell



sodium chloride cell



i. What is the co-ordination number for sodium and caesium in the cell diagrams shown above?

Formulae

Use the table below to help you answer the following questions.

Metal ion	formula	Non-metal ion	formula
Lithium	Li^+	fluoride	F^-
Sodium	Na^+	Chloride	Cl^-
Potassium	K^+	Bromide	Br^-
Magnesium	Mg^{2+}	Oxide	O^{2-}
Calcium	Ca^{2+}	Sulfide	S^{2-}
Aluminium	Al^{3+}	phosphide	P^{3-}

Ionic compounds are electrically **neutral**, this means that the overall charges from the ions need to balance and cancel each other out.

Example. What is the formula for calcium bromide?

Well calcium ions are Ca^{2+} and bromide ions are Br^- . Since the metal calcium ions have a 2^+ charge we will need two bromide ions to cancel out this charge. So the formula for calcium bromide will be CaBr_2 .

2. Work out the formula for the following ionic compounds:

- a. calcium oxide b. magnesium chloride c. aluminium oxide
d. lithium sulfide e. sodium phosphide

3. Formula of compounds containing group ions (polyatomic ions)

Use the table below to help you answer the following questions

Polyatomic ion	formula
sulfate	SO_4^{2-}
nitrate	NO_3^-
hydroxide	OH^-
carbonate	CO_3^{2-}
ammonium	NH_4^+
phosphate	PO_4^{3-}

2. Work out the formula for the following ionic compounds:

- a. calcium hydroxide b. magnesium carbonate c. calcium nitrate
d. potassium sulfate e. ammonium carbonate f. lithium phosphate

Ionic compounds

Answers

1. What charge do metal ions have? Why do they have this charge?

Metal ions have a positive charge, they lose electrons when they react so end up with more positive protons than negative electrons.

2. What charge do non-metal ions have? Why do they have this charge?

Non-metal ions have a negative charge, they gain electrons when they react so end up with more negative electrons than positive protons.

3. What is an ionic bond?

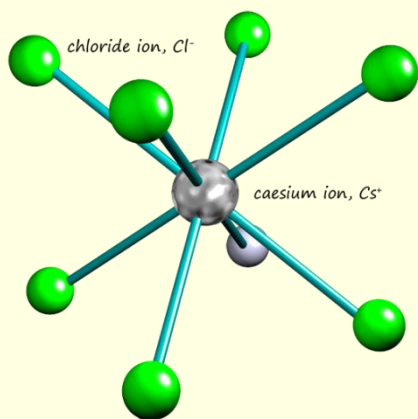
Electrostatic attraction of positive metal ions for negatively charged non-metal ions

4. The diagram opposite shows the structure of a sodium chloride crystal.

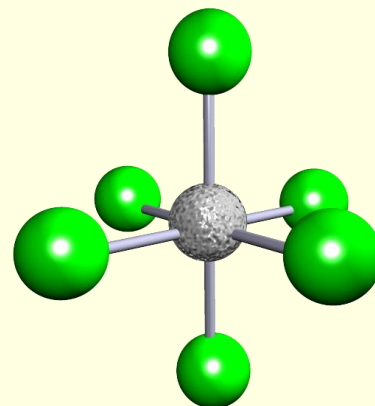
- What type of structure do ionic compounds have? *Giant ionic lattice*
- Why can this structure be described as crystalline? *Crystalline structures are ordered ones, ionic lattices are very ordered structures with the ions arranged in a regular repeating way.*
- Why could it also be said to be a cubic lattice? *Shape is cubic, the shape of the repeating cell in the lattice is a cube/cubic.*

d. The images below can be used to show the co-ordination numbers in the NaCl and the CsCl lattice.

Caesium chloride cell



sodium chloride cell



i. What is the co-ordination number for sodium and caesium in the cell diagrams shown above? *Caesium has 8 chloride ions around it so its co-ordination number is 8, while sodium has 6 chloride ions around it so its co-ordination number is 6.*

Formulae

Use the table below to help you answer the following questions.

Metal ion	formula	Non-metal ion	formula
Lithium	Li ⁺	fluoride	F ⁻
Sodium	Na ⁺	Chloride	Cl ⁻
Potassium	K ⁺	Bromide	Br ⁻
Magnesium	Mg ²⁺	Oxide	O ²⁻
Calcium	Ca ²⁺	Sulfide	S ²⁻
Aluminium	Al ³⁺	phosphide	P ³⁻

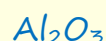
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Example. What is the formula for calcium bromide?

Well calcium ions are Ca^{2+} and bromide ions are Br^- . Since the metal calcium ions have a 2^+ charge we will need two bromide ions to cancel out this charge. So the formula for calcium bromide will be CaBr_2 .

2. Work out the formula for the following ionic compounds:

a. calcium oxide b. magnesium chloride c. aluminium oxide



d. lithium sulfide e. sodium phosphide



3. Formula of compounds containing group ions (polyatomic ions)

Use the table below to help you answer the following questions

Polyatomic ion	formula
sulfate	SO_4^{2-}
nitrate	NO_3^-
hydroxide	OH^-
carbonate	CO_3^{2-}
ammonium	NH_4^+
phosphate	PO_4^{3-}

2. Work out the formula for the following ionic compounds:

a. calcium hydroxide



b. magnesium carbonate



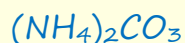
c. calcium nitrate



d. potassium sulfate



e. ammonium carbonate



f. lithium phosphate



Note: Brackets are needed with some formula, for example Ca(OH)_2 , this formula tells us there is 1 calcium ion and 2 hydroxide ions. Without the bracket being present we have:

CaOH_2 , this formula tells us there is 1 calcium ions, 1 oxygen and 1 hydrogen, which is not what we want. This is incorrect for the formula of calcium hydroxide.