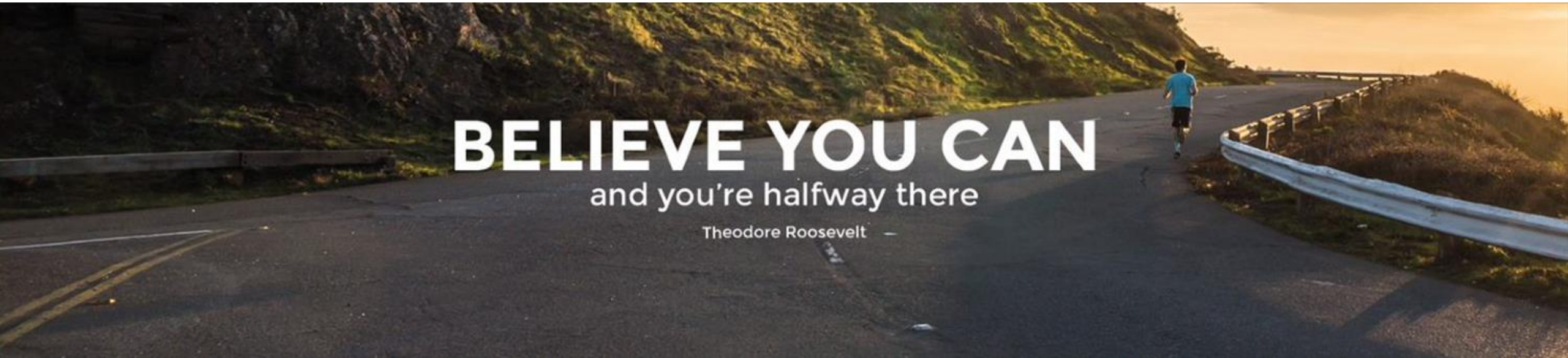


EB Education Revision Guide



How to work with Ionic Bonding: Part 1

What is an ion?

How are ions formed?

Atoms bond to get full 'outer' shells of electrons. They react with other atoms to try to achieve a full outer shell.

Some atoms will lose or gain electrons in order to get a full outer shell (or a **stable electronic structure**).

When atoms lose, or gain, electrons they become IONS.

Ions are charged particles.

Negative ions (**anions**) form when atoms gain electrons. This is because they have more electrons than protons.

Positive ions (**cations**) form when atoms lose electrons. This is because they have more protons than electrons.

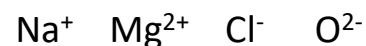
The number of electrons lost or gained is the same as the charge in the ion:

If 1 electron is lost, the charge is 1+

If 3 electrons are gained the charge is 3-

Common ions.

Ions can be formed from singular atoms that become charged.



They can also be formed from groups of multiple atoms that become charged.

Nitrate	NO_3^-
Sulphate	SO_4^{2-}
Hydroxide	OH^-
Hydrogen carbonate	HCO_3^-
Phosphate	PO_4^{3-}
Ammonium	NH_4^+
Carbonate	CO_3^{2-}

TOP TIP:
You should learn the formula and charge of all these ions.

Making ions

What charge will the ion have?

You can work out how many electrons an atom will lose or gain, by looking at which group they are in, in the Periodic Table.

Group 1 elements will all form 1+ ions. This is because they have 1 electron in their outer shell, so they lose 1 electron to get a full outer shell.

Group 2 elements will form 2+ ions. They have 2 electrons in the outer shell, so they lose 2 electrons to get a full outer shell.

Group 6 elements will form 2- ions, This is because they have 6 electrons in the outer shell, so they gain 2 electrons to get a full outer shell.

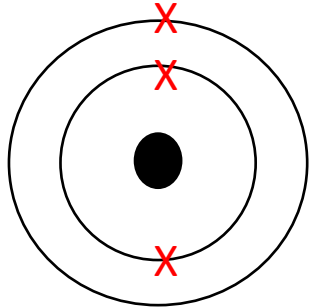
Group 7 elements will form 1- ions. This is because they have 7 electrons in the outer shell, so they gain 1 electron to get a full outer shell.

Na	Sodium: 2, 8, 1	Lose 1 (2,8) ⁺
Mg	Magnesium: 2,8,2	Lose 2 (2,8) ²⁺
Cl	Chlorine: 2,8,7	Gain 1 (2,8,8) ⁻
O	Oxygen: 2,6	Gain 2 (2,8) ²⁻

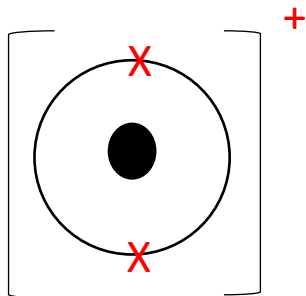
Ion formation

How to show ion formation in a diagram.

Lithium atom
No. of protons = 3
No. of electrons = 3
Overall charge is neutral.

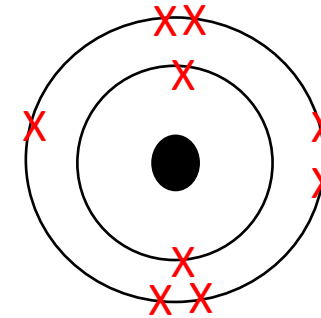


Lithium ion
No. of protons = 3
No. of electrons = 2
Overall charge is positive (+1)

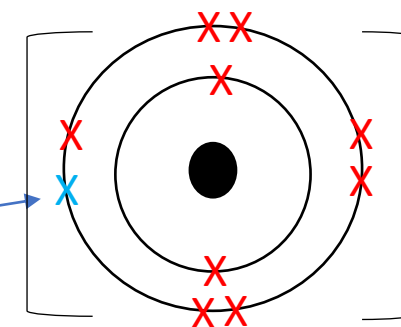


TOP TIP:
When you are drawing ionic diagrams – you need to add brackets and the charge.

Fluorine atom
No. of protons = 9
No. of electrons = 9
Overall charge is neutral.



Fluorine ion
No. of protons = 9
No. of electrons = 10
Overall charge is negative (-1)



It has gained an electron

Metals **lose electrons** to achieve a full outer shell. They form an ion. Ions are atoms with a charge (+ or -). **Metals form positive ions.**

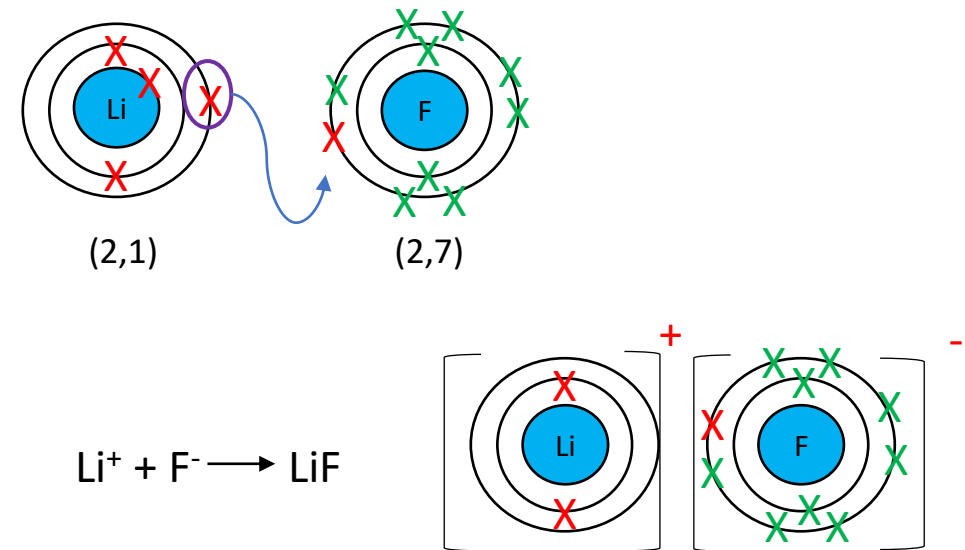
Non-metals **gain electrons** to achieve a full outer shell. They form an ion. Ions are atoms with a charge (+ or -). **Non-metals form negative ions.**

Ionic bonding

What is an ionic bond?

When a metal and a non-metal react together an ionic bond is formed:

- The metal atom loses electrons and forms a positive ion (cation)
- The non-metal atom gains the electrons from the metal atom and forms a negative ion (anion)
- The ions have opposite charges, and so are strongly attracted to each other by **electrostatic forces**
- This is an **ionic bond**



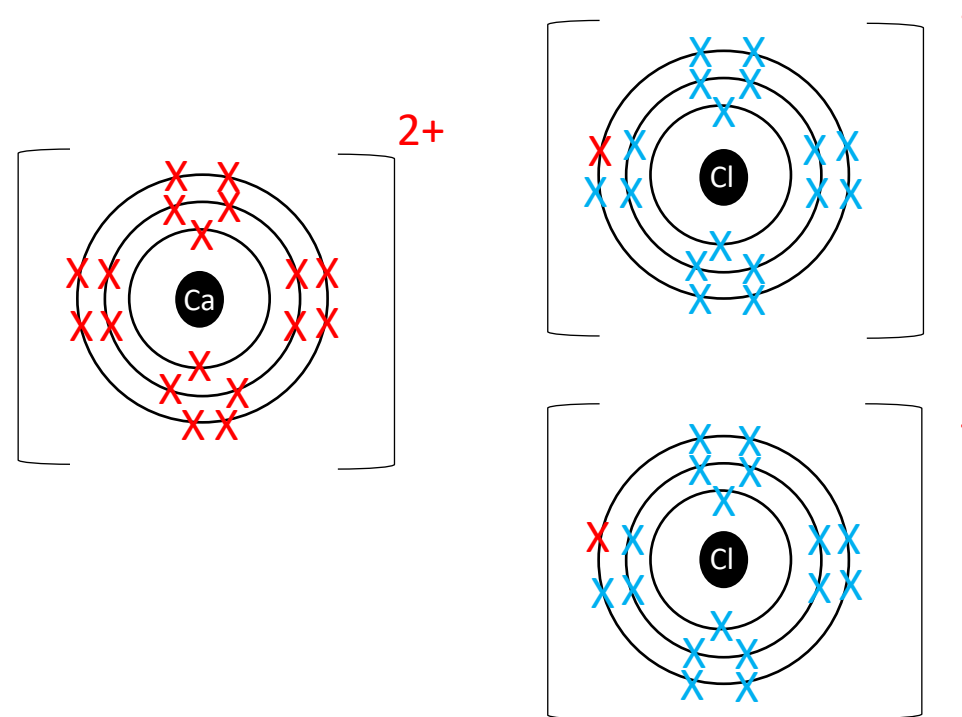
Ionic bonding

You always need to make sure the charges are balanced.

Calcium will lose its two outer electrons and become a Ca^{2+} ion

Two chlorine atoms will pick up one electron each, and become two Cl^- ions

This will form calcium chloride CaCl_2



Your turn

1. Ionic compounds contain ions.

Below is a table showing the number of electrons, protons and neutrons in four particles.

Particle	Electrons	Neutrons	Protons
A	10	14	12
B	16	16	16
C	18	18	16
D	9	10	9

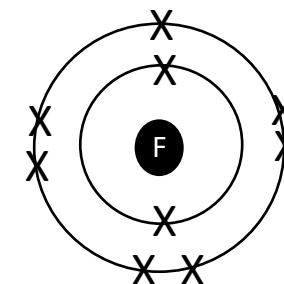
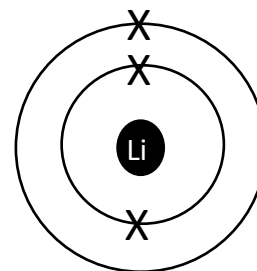
a) Explain which particle is a negative ion.

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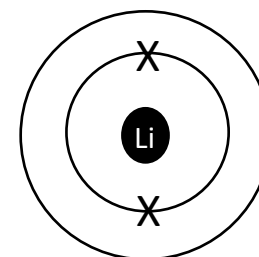
b) Lithium fluoride is an ionic compound.

It consists of lithium cations and fluoride anions.

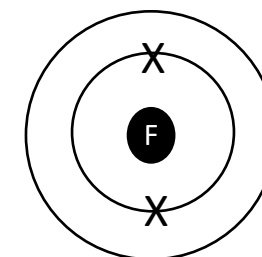
The electronic configurations of a lithium atom and a fluorine atom are shown below.



Complete the diagram below to show the electronic configurations and charges of the ions in lithium fluoride.



charge on ion



charge on ion

Your turn

2 a) The names and formulae of three ions are shown in the table below.

Name of ion	Formula of ion
Nitrate	NO_3^-
Phosphate	PO_4^{3-}
Calcium	Ca^{2+}

What is the formula of calcium nitrate?

- A: CaNO_3
- B: Ca_2NO_3
- C: Ca_3NO_2
- D: $\text{Ca}(\text{NO}_3)_2$

b) How many oxygen atoms are there in $\text{Ca}_3(\text{PO}_4)_2$

.....

c) The table below provides information about the elements, sodium and sulphur.

	Sodium	Sulphur
Atomic symbol	Na	S
Number of electrons in one atom	11	16
Metal or non-metal	Metal	Non-metal

Sodium sulphide is an ionic compound.

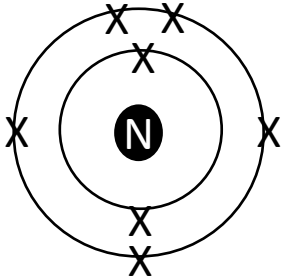
Describe how sodium atoms react with sulphur atoms to form sodium sulphide in terms of electron transfer. You should include the charges on the ions formed.

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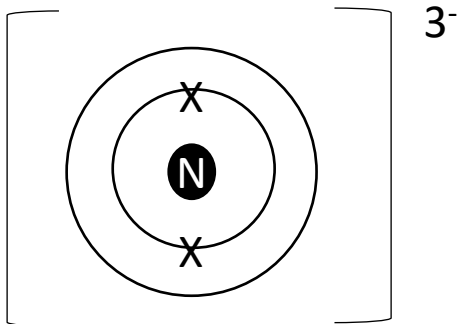


Your turn

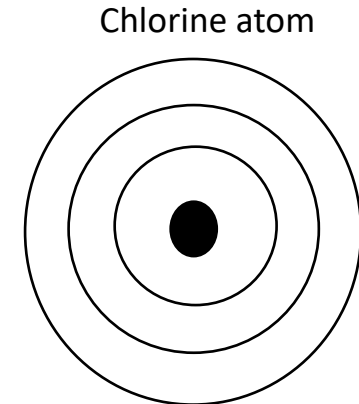
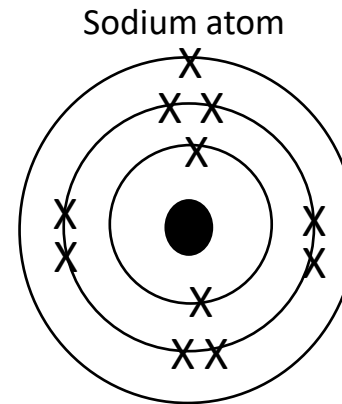
3. The diagram below show the electronic structure of a nitrogen atom.



Complete the diagram below to show the electronic structure of a nitride ion (N^{3-})



4a) Sodium reacts with chlorine to produce sodium chloride. The electronic structure of a sodium atom is shown below. Complete the diagram for the electronic structure of a chlorine atom.



Your turn

b) Explain how a sodium atom changes into a sodium ion when it reacts with chlorine to form sodium chloride.

.....
.....
.....
.....

Answers

1. Ionic compounds contain ions.

Below is a table showing the number of electrons, protons and neutrons in four particles.

Particle	Electrons	Neutrons	Protons
A	10	14	12
B	16	16	16
C	18	18	16
D	9	10	9

a) Explain which particle is a negative ion.

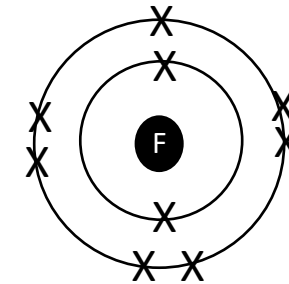
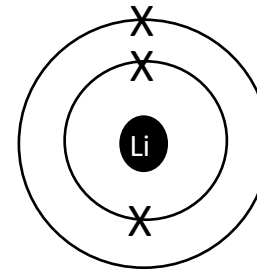
C is a negative ion.

This is because there are 16 protons, but 18 electrons. So it will have a 2- charge.

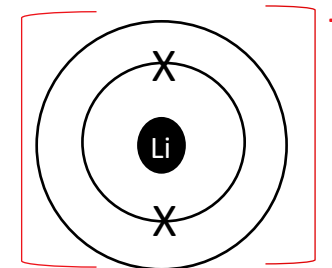
b) Lithium fluoride is an ionic compound.

It consists of lithium cations and fluoride anions.

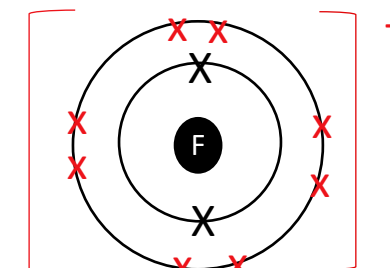
The electronic configurations of a lithium atom and a fluorine atom are shown below.



Complete the diagram below to show the electronic configurations and charges of the ions in lithium fluoride.



charge on ion $1+$



charge on ion $1-$

Your turn

2 a) The names and formulae of three ions are shown in the table below.

Name of ion	Formula of ion
Nitrate	NO_3^-
Phosphate	PO_4^{3-}
Calcium	Ca^{2+}

What is the formula of calcium nitrate?

- A: CaNO_3
- B: Ca_2NO_3
- C: Ca_3NO_2
- D: $\text{Ca}(\text{NO}_3)_2$ X

b) How many oxygen atoms are there in $\text{Ca}_3(\text{PO}_4)_2$

8

c) The table below provides information about the elements, sodium and sulphur.

	Sodium	Sulphur
Atomic symbol	Na	S
Number of electrons in one atom	11	16
Metal or non-metal	Metal	Non-metal

Sodium sulphide is an ionic compound.

Describe how sodium atoms react with sulphur atoms to form sodium sulphide in terms of electron transfer. You should include the charges on the ions formed.

Sodium has the electronic structure 2,8,1 so it has 1 electron in the outer shell.

Sulphur has the electronic structure 2, 8, 6 so it has 6 electrons in the outer shell.

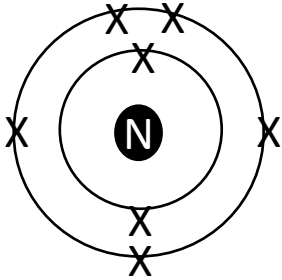
Two sodium atoms will lose their outer electron and become Na^+ ions.

One sulphur atom will gain these 2 electrons and become a S^{2-} ion

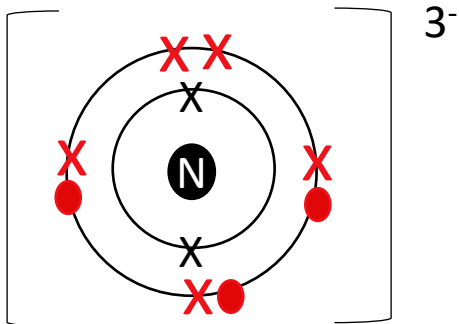
The two Na ions will be attracted to the S ion and become Na_2S

Your turn

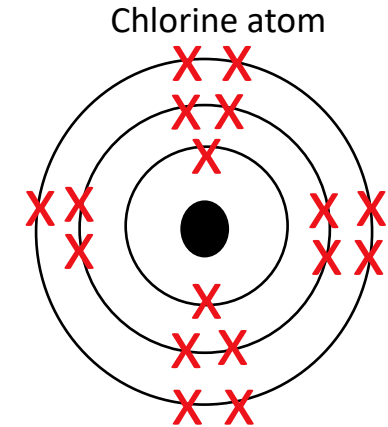
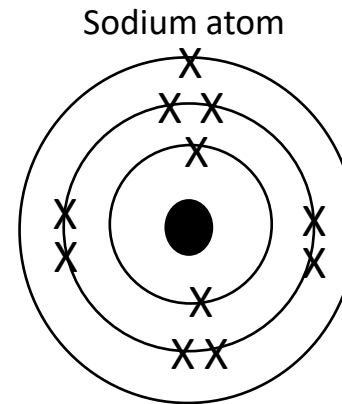
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4a) Sodium reacts with chlorine to produce sodium chloride. The electronic structure of a sodium atom is shown below. Complete the diagram for the electronic structure of a chlorine atom.



Your turn

b) Explain how a sodium atom changes into a sodium ion when it reacts with chlorine to form sodium chloride.

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It loses its outer electron, and becomes an ion with a 1+ charge
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