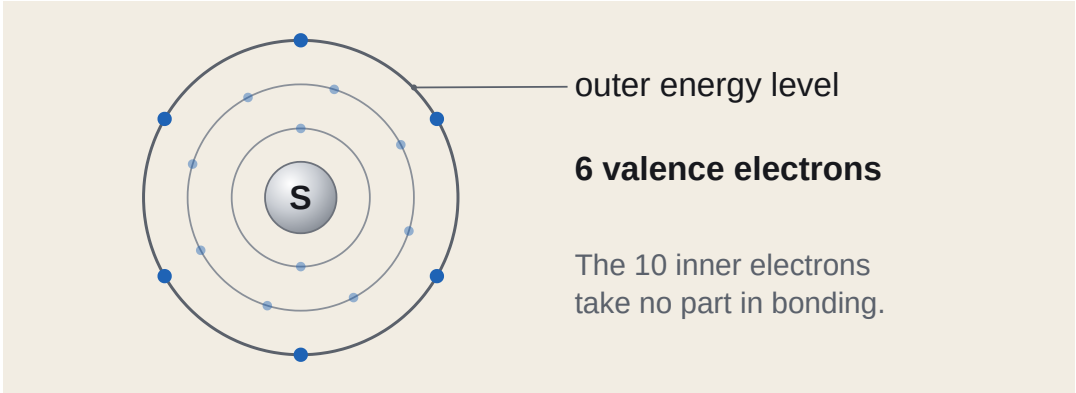
A2 · Valence electrons and electron dot diagrams for atoms · Completed notes

Goals: Find the number of valence electrons of an atom from its group number. Draw the electron dot diagram of an atom. Tell bonding electrons from lone pairs, and state the octet rule.

These are the completed notes. The blanks are filled in and each question is worked.

Slide 1 of 6 · Valence electrons

In lesson A1 you used group numbers to find ion charges. Today you use them to count outer electrons. Atoms join to each other with their outer electrons.



Key ideas

Electrons are in layers. Each layer is an **energy level**.

The electrons in the outer level are the **valence electrons**.

Only valence electrons take part in **bonding**.

For groups 13 to 18, the **last digit** gives the number of valence electrons.

Example

Phosphorus is in group 15. How many valence electrons does it have?

1. For groups 13 to 18, use the last digit.
2. The last digit of 15 is 5.
3. Phosphorus has 5 valence electrons.

Try it

Calcium is in group 2. Bromine is in group 17. How many valence electrons does each have?

1. For groups 1 and 2, the count is the group number. Calcium has 2.
2. For group 17, use the last digit. Bromine has 7.

Slide 2 of 6 · Drawing an electron dot diagram

On the last slide you counted valence electrons. Drawing every energy level is slow. A dot diagram shows only the valence electrons.



phosphorus
5 dots



sulfur
6 dots



chlorine
7 dots



argon
8 dots

Key ideas

An **electron dot diagram** shows the valence electrons of an atom as dots.

The **symbol** stands for the nucleus and the inner electrons.

Put one dot on each of the **four** sides first.

A fifth dot must share a side and make a **pair**.

Example

Draw the electron dot diagram for chlorine. How many pairs and single dots does it have?

1. Chlorine is in group 17, so it has 7 valence electrons.
2. Four single dots go on first. Three more dots make pairs.
3. Chlorine has three pairs and one single dot.

Try it

Draw the electron dot diagram for nitrogen, in group 15. How many pairs and single dots does it have?

1. Nitrogen has 5 valence electrons.
2. Four single dots go on first. One more dot makes a pair.
3. Nitrogen has one pair and three single dots.

Slide 3 of 6 · Method: how to draw the electron dot diagram of an atom

You just drew eight dot diagrams. Each time you did the same four things. Here they are as steps.

1. **Find** the group number.
2. **Count** the valence electrons.
3. **Place** one dot on each side, up to four.
4. **Pair** the rest, one side at a time.



Check: the dots equal the valence electrons, and 8 is the most.

Used again in: lessons A3 to A8

Key ideas

Step 1: find the **group** number.

Step 2: **count** the valence electrons.

Step 3: **place** one dot on each side, up to four.

Step 4: **pair** the rest, one side at a time.

Example

Use the four steps to draw the electron dot diagram of oxygen.

1. Step 1: oxygen is in group 16.
2. Step 2: the last digit is 6, so it has 6 valence electrons.
3. Step 3: four single dots go on first.
4. Step 4: two more dots make two pairs. Oxygen has two pairs and two single dots.

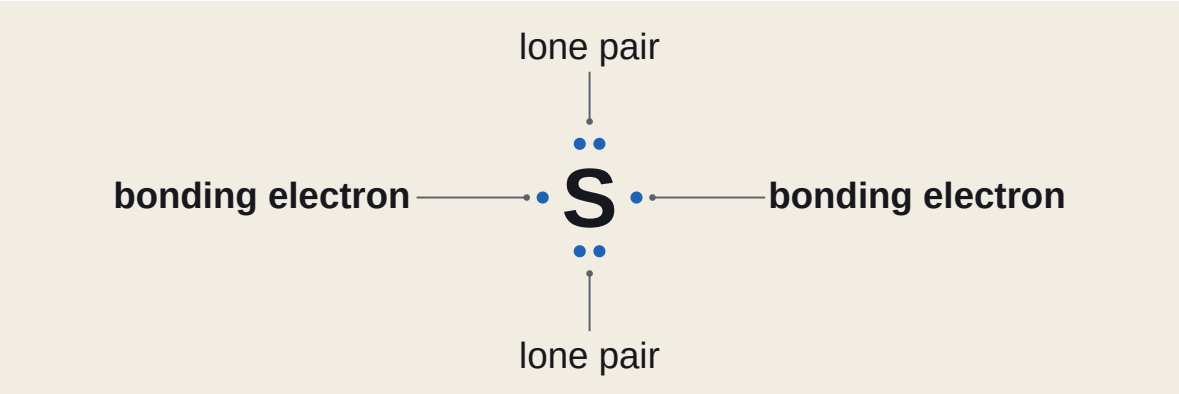
Try it

Use the four steps to draw the electron dot diagram of aluminium.

1. Step 1: aluminium is in group 13.
2. Step 2: the last digit is 3, so it has 3 valence electrons.
3. Step 3: three single dots go on three sides.
4. Step 4: no dots are left to pair. Aluminium has three single dots.

Slide 4 of 6 · Bonding electrons and lone pairs

Your diagrams have single dots and pairs of dots. The two kinds behave differently. Each kind has a name.



Key ideas

A single dot is a **bonding electron**. It can be shared with another atom.

Two dots together are a **lone pair**. A lone pair is not shared.

Hydrogen and helium hold only **2** electrons in their outer level.

Example

Sulfur has 6 valence electrons. How many bonding electrons and lone pairs does it have?

1. Four dots go on singly. Two more dots make two pairs.
2. That leaves two single dots.
3. Sulfur has two bonding electrons and two lone pairs.

Try it

Phosphorus has 5 valence electrons. How many bonding electrons and lone pairs does it have?

1. Four dots go on singly. One more dot makes one pair.
2. That leaves three single dots.
3. Phosphorus has three bonding electrons and one lone pair.

Slide 5 of 6 · A full outer level is stable

On the last slide, helium had a full level and no bonding electrons. A whole group of elements is like that. Their diagrams show why they do not bond.



chlorine has 7
It needs 1 more.



sulfur has 6
It needs 2 more.



hydrogen has 1
It needs 1 to reach 2.

Key ideas

The noble gases are in group **18**. They almost never react.

An atom with a full outer level is **stable**.

For most atoms, full means **8** valence electrons. This is the **octet rule**.

Example

Chlorine has 7 valence electrons. How many more does it need to be stable?

1. The octet rule says full means 8.
2. 8 − 7 = 1.
3. Chlorine needs 1 more electron.

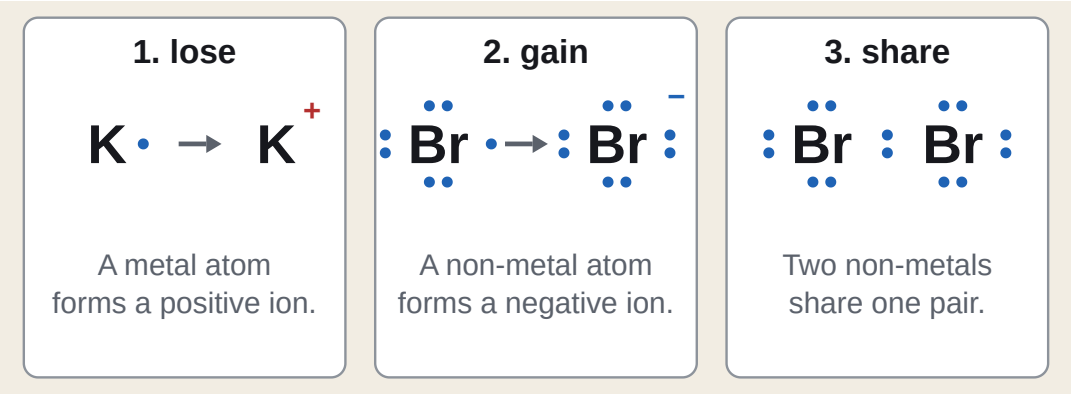
Try it

Oxygen has 6 valence electrons. How many more does it need to be stable?

1. The octet rule says full means 8.
2. 8 − 6 = 2.
3. Oxygen needs 2 more electrons.

Slide 6 of 6 · Three ways to fill the outer level

On the last slide, a full outer level made an atom stable. An atom without one can change to get one. There are three ways.



Key ideas

An atom can **lose** electrons. Metals do this and become positive ions.

An atom can **gain** electrons. Non-metals do this when they meet a metal.

Two non-metals **share** electrons.

Example

Potassium has 1 valence electron. Which of the three ways does it use, and what ion forms?

1. Potassium is a metal, so it loses electrons.
2. It loses its 1 valence electron.
3. The ion is K^+.

Try it

Fluorine has 7 valence electrons. Which way does it use when it meets a metal, and what ion forms?

1. Fluorine is a non-metal, so it gains electrons.
2. It gains 1 electron to reach 8.
3. The ion is F^-.