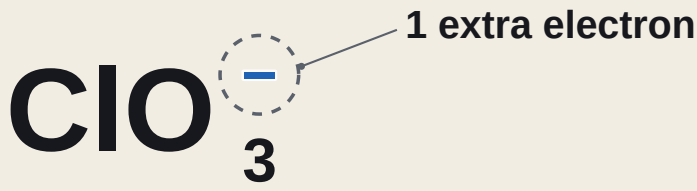
A8 · Electron dot diagrams for polyatomic ions · Notes

Goals: Explain why bonding capacity cannot build a polyatomic ion. Count the valence electrons of a molecule or an ion, using the charge. Draw the electron dot diagram of a polyatomic ion in five steps.

Name: _____ Date: _____

Slide 1 of 6 · When bonding capacity is not enough

In lessons A5 and A6, bonding capacity built every molecule. In A1 you also met ions made of several atoms. Bonding capacity cannot build those.



Chlorine forms 1 bond, but here it is joined to 3 atoms.

Key ideas

A polyatomic ion is a group of atoms with a _____.

The chlorate ion has a charge of 1−, so it has 1 _____.

_____ does not work for an ion.

Example

The nitrate ion is NO_3^-. How many extra electrons does it have?

Try it

The sulfate ion is SO_4^{2-}. How many extra electrons does it have?

Slide 2 of 6 · The five steps, on a molecule

The last slide said a new method is needed. Test it first on $COCl_2$, the molecule from lesson A6. The answer should match.

1

Atom	Each	How many	Electrons
C	4	1	4
O	6	1	6
Cl	7	2	14
total			24

2



3 bonds use 6.

Key ideas

Step 1: _____ the valence electrons.

Step 2: _____. Join each outer atom to the middle atom.

Step 3: _____ the outer atoms with lone pairs.

Step 5: _____ a lone pair in if the middle atom has only 6.

Example

How many valence electrons are in carbon dioxide, CO_2? Show your count.

Try it

How many valence electrons are in nitrogen trifluoride, NF_3? Show your count.

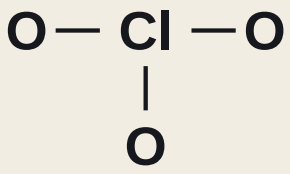
Slide 3 of 6 · A negative ion

The five steps worked on a molecule. Now use them on the chlorate ion from slide 1. A negative charge changes only step 1.

1

Atom	Each	How many	Electrons
Cl	7	1	7
O	6	3	18
charge −			+ 1
total			26

2



3 bonds use 6.

Key ideas

For a negative ion, _____ electrons for the charge.

Put the finished diagram in _____.

Write the charge outside, at the _____.

Example

How many valence electrons are in the hydroxide ion, OH^-? Show your count.

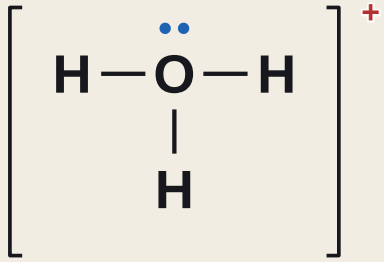
Try it

How many valence electrons are in the nitrate ion, NO_3^-? Show your count.

Slide 4 of 6 · A positive ion

On the last slide, a negative charge added electrons in step 1. A positive charge also changes only step 1. It takes electrons away.

Atom	Each	How many	Electrons
H	1	3	3
O	6	1	6
charge +			− 1
total			8



Key ideas

For a positive ion, _____ electrons for the charge.

Hydrogen is never the _____.

In H_3O^+ the total is _____ valence electrons.

Example

How many valence electrons are in the ammonium ion, NH_4^+? Where do they go?

Try it

How many valence electrons are in the phosphonium ion, PH_4^+? Show your count.

Slide 5 of 6 · Method: how to draw the electron dot diagram of a polyatomic ion

You have now used the five steps on a molecule and four ions. Here are the five steps on one card.

1. **Count** the valence electrons. Adjust for the charge.
2. **Connect** the middle atom to each outer atom.
3. **Fill** the outer atoms to 8. Hydrogen has 2.
4. **Put** left-over electrons on the middle atom.
5. **Move** a lone pair in if the middle has under 8.



Check: electrons drawn equal electrons counted.

Used again in: lesson A9

Key ideas

Step 1: _____. Step 2: _____.

Step 3: _____ the outer atoms.

Step 4: put what is _____ on the middle atom.

Step 5: _____ a pair in, if the middle atom is short.

Example

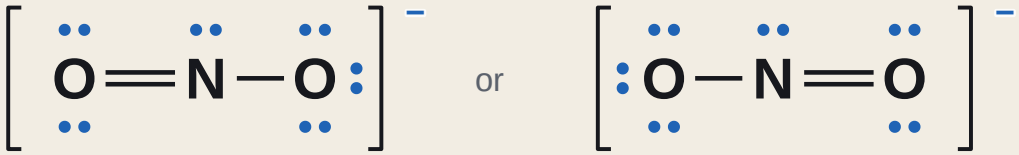
Use the five steps on the carbonate ion, CO_3^{2-}.

Try it

Use the five steps on the hydroxide ion, OH^-.

Slide 6 of 6 · More than one right answer

On slide 2, step 5 moved a lone pair in from oxygen. No other atom could give one. Sometimes step 5 gives you a choice.



correct **correct**

Key ideas

The nitrite ion has _____ valence electrons.

After steps 1 to 4, nitrogen has only _____.

The pair can come from _____ of the oxygen atoms.

Example

In the carbonate ion, CO_3^{2-}, a lone pair must move in from an oxygen atom. How many correct drawings are there?

Try it

Why are both drawings of the nitrite ion correct?