A8 · Electron dot diagrams for polyatomic ions · Practice key

This is the worked key. Every practice question is worked step by step.

Worked examples

Read these first. There is one for each kind of question in this lesson.

Example 1 · Draw the electron dot diagram of a negative ion

Use the five steps on the sulfite ion, SO_3^{2-}.

1. Count the valence electrons, and adjust for the charge: 6 + 18 + 2 = 26.
2. Connect the middle atom to each outer atom: sulfur is in the middle. The 3 bonds use 6.
3. Fill the outer atoms to 8: each oxygen gets 3 lone pairs. That uses 18.
4. Put left-over electrons on the middle atom: 26 − 6 − 18 = 2, so sulfur gets 1 lone pair.
5. Move a lone pair in if the middle has under 8: sulfur has 6 + 2 = 8, so no pair moves.
6. Check: the electrons drawn, 26, equal the electrons counted.

Answer: Sulfur in the middle with 3 single bonds and 1 lone pair, in square brackets with 2− outside.

Example 2 · Move a lone pair in

Use the five steps on sulfur dioxide, SO_2. Sulfur is the middle atom.

1. Count the valence electrons: 6 + 12 = 18.
2. Connect the middle atom to each outer atom: the 2 bonds use 4.
3. Fill the outer atoms to 8: each oxygen gets 3 lone pairs. That uses 12.
4. Put left-over electrons on the middle atom: 18 − 4 − 12 = 2, so sulfur gets 1 lone pair.
5. Move a lone pair in if the middle has under 8: sulfur has 4 + 2 = 6. A lone pair moves in from one oxygen.
6. The two oxygen atoms are the same, so the pair can come from either one.

Answer: Sulfur has 1 single bond, 1 double bond and 1 lone pair. Both drawings are correct.

Practice

Questions 1 to 4 are easy. Questions 5 to 8 are medium. Questions 9 and 10 are harder.

EASY

1. The phosphate ion is PO_4^{3-}. How many extra electrons does its charge add?

1. Its charge is 3−.
2. So it has 3 extra electrons.

EASY

2. The ammonium ion is NH_4^+. In step 1, does its charge add electrons or take them away? Say how many.

1. A positive charge takes electrons away.
2. The charge is 1+, so take away 1.

EASY

3. How many valence electrons are in the sulfate ion, SO_4^{2-}? Show your count.

1. Sulfur has 6. Each oxygen has 6, and there are 4.
2. Add 2 electrons for the charge 2−.
3. 6 + 24 + 2 = 32 valence electrons.

EASY

4. Where do the square brackets and the charge go on the finished diagram of an ion?

1. Put the whole diagram in square brackets.
2. Write the charge outside, at the top right.

MEDIUM

5. Use the five steps on the hydrogen sulfide ion, HS^-.

1. Step 1: 1 + 6 + 1 = 8.
2. Step 2: one bond joins H and S. It uses 2.
3. Step 3: hydrogen is full with 2. Sulfur gets 3 lone pairs. That uses 6.
4. Step 4: 8 − 2 − 6 = 0, so none are left over.
5. Step 5: sulfur has 8, so no pair moves. Add brackets and 1−.

MEDIUM

6. Use the five steps on the bromate ion, BrO_3^-.

1. Step 1: 7 + 18 + 1 = 26.
2. Step 2: bromine is in the middle. The 3 bonds use 6.
3. Step 3: each oxygen gets 3 lone pairs. That uses 18.
4. Step 4: 26 − 6 − 18 = 2, so bromine gets 1 lone pair.
5. Step 5: bromine has 8, so no pair moves. Add brackets and 1−.

MEDIUM

7. Use the five steps on the amide ion, NH_2^-.

1. Step 1: 5 + 2 + 1 = 8.
2. Step 2: nitrogen is in the middle. The 2 bonds use 4.
3. Step 3: each hydrogen is full with 2.
4. Step 4: 8 − 4 = 4 left over, so nitrogen gets 2 lone pairs.
5. Step 5: nitrogen has 8, so no pair moves. Add brackets and 1−.

MEDIUM

8. Use the five steps on the peroxide ion, O_2^{2-}.

1. Step 1: 6 + 6 + 2 = 14.
2. Step 2: one bond joins the two oxygen atoms. It uses 2.
3. Step 3: each oxygen gets 3 lone pairs. That uses 12.
4. Step 4: 14 − 2 − 12 = 0, so none are left over.
5. Step 5: each oxygen has 8, so no pair moves. Add brackets and 2−.

HARDER

9. Use the five steps on the nitrate ion, NO_3^-. Then say how many correct drawings there are.

1. Step 1: 5 + 18 + 1 = 24.
2. Step 2: nitrogen is in the middle. The 3 bonds use 6.
3. Step 3: each oxygen gets 3 lone pairs. That uses 18.
4. Step 4: 24 − 6 − 18 = 0, so none are left over. Nitrogen has only 6.
5. Step 5: move a lone pair in from one oxygen. Add brackets and 1−.
6. The 3 oxygen atoms are the same, so there are 3 correct drawings.

HARDER

10. A student counts 19 valence electrons for the chlorite ion, ClO_2^-. Find the mistake. Then give the correct total.

1. Chlorine has 7. Two oxygen atoms have 12. That is 19.
2. The student forgot the charge.
3. The charge 1− adds 1 electron. The total is 20.