B1 · Electron transfer and redox

Student notes - complete the underlined spaces | Notes 1/3

Follow the electrons, explain charge changes, write half-reactions and name what each agent makes possible.

Name: _____ Date: _____

1. One transfer and what it does to charge

Start with the moving electron

Redox is all about electrons moving from one particle to another. Here, one electron moves from A to B. A _____ it and B _____ it. A reaction that moves electrons like this is called an oxidation–reduction reaction, or redox for short.

_____ means loss of electrons, so A is oxidized. _____ means gain of electrons, so B is reduced. The electron B gains is the same electron A lost, so the two changes always happen together.

On the diploma: decide loss or gain of electrons first. Then choose "oxidized" or "reduced". The letters A and B just label particles. They are not element symbols.

Watch: Reduction is gain, oxidation is loss (Tyler DeWitt, “Introduction to Oxidation Reduction (Redox) Reactions”, 0:41)

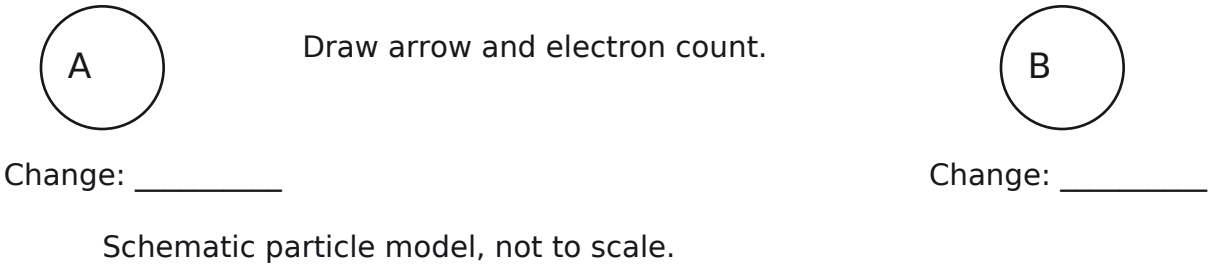
Why the charge changes

An electron carries _____ charge. Adding a negative amount makes the charge value _____. That is why gaining electrons is called reduction: the charge is reduced.

For example, 0 + (-1) = _____, and +3 + (-1) = _____. The +2 ion is still positive, but its charge went down. So a positive product can still be a reduction. Removing a negative electron makes the charge _____.

A neutral atom has equal positive and negative charge. The nucleus stays the same in these changes, so only the electrons move. When you are given particle counts, charge number = _____.

Watch: Why gaining electrons is called reduction (Tyler DeWitt, “Introduction to Oxidation Reduction (Redox) Reactions”, 2:02)



Schematic particle model, not to scale.

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2. Read the particles and the reaction

Particle words and notation

First, the words. An _____ is a nucleus with electrons around it. An _____ is a particle with a net charge, and it can be one atom or a bonded group. A _____ is a small bonded group of atoms. NaCl(s) is different: it builds a big ionic lattice, not separate molecules.

Now the symbols. A coefficient is the big number in front, and it counts _____. A subscript is the small lower number, and it counts _____. A superscript is the small raised number, and it gives the _____. So $2Cl^-$ means _____, but Cl_2 is one neutral molecule with _____.

The letters in brackets tell you the state. (s) means _____, (l) means _____, (g) means _____, and (aq) means _____.

On the diploma: read every number in a formula before you count anything. A coefficient, a subscript and a charge look alike but do three different jobs.

A simple shell model

Valence electrons are the ones in the _____. We are given Na as 2,8,1 and Cl as 2,8,7. When Na gives one electron to Cl, Na^+ becomes _____ and Cl^- becomes _____. The proton counts stay _____, because only electrons move.

Full outer shells help explain why Na^+ and Cl^- are common ions. But a full shell does not prove a reaction will happen. What matters is the energy change of the _____.

Keep one real reaction in view

Take $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$. Sodium metal and chlorine gas start out neutral. Each Na gives away _____. The Cl_2 molecule has two Cl atoms, and each takes one electron, so together they take in _____.

The Na^+ and Cl^- ions that form attract each other and build an ionic _____, a repeating pattern of ions. Two +1 and two -1 balance, so the solid is neutral overall. The formula NaCl shows the _____. It does not mean a separate NaCl molecule exists.

On the diploma: always compare the particles before and after the reaction.

Watch: Sodium and chlorine make sodium chloride (Tyler DeWitt, “Introduction to Oxidation Reduction (Redox) Reactions”, 3:45)

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3. Half-reactions, agents and changed examples

Two halves of the same sodium/chlorine story

A half-reaction shows only one half of a redox reaction. Reduction: Cl_2 + _____ → $2Cl^-$. The electrons go on the left because chlorine _____. Check it: two Cl on each side, and the total charge is _____ on each side.

Oxidation: $2Na \rightarrow 2Na^+$ + _____. The electrons go on the right because sodium _____. The right side is +2 - 2 = _____, which matches the neutral left side.

Now add the two halves. The same $2e^-$ sits on _____, so it cancels. The electrons are not destroyed. They move from sodium to chlorine. What is left is $2Na + Cl_2 \rightarrow 2Na^+ + 2Cl^-$, and those ions form NaCl(s).

On the diploma: in a reduction half-reaction the electrons are reactants. In an oxidation half-reaction they are products.

Watch: Writing a half-reaction (Tyler DeWitt, “Introduction to Oxidation Reduction (Redox) Reactions”, 7:41)

Watch: Two half-reactions make the whole reaction (Tyler DeWitt, “Introduction to Oxidation Reduction (Redox) Reactions”, 10:45)

Watch: Oxidation and reduction always happen together (Tyler DeWitt, “Introduction to Oxidation Reduction (Redox) Reactions”, 11:14)

Agent names describe the partner’s change

An agent is a substance that makes a change happen in another substance. Na supplies the electrons, so chlorine can be _____. That makes Na the _____, even though Na itself is oxidized.

Cl_2 accepts the electrons, so sodium can be _____. That makes Cl_2 the _____, even though Cl_2 itself is reduced. The two kinds of name answer two questions: what happens to this substance, and what does it do to its partner?

On the diploma: name the agents from the starting reactants, such as Cl_2, not from the product ions such as Cl^-. The reducing agent is the substance that is oxidized.

Watch: What an agent is (Tyler DeWitt, “Oxidizing Agents and Reducing Agents”, 0:57)

Watch: Which agent is which (Tyler DeWitt, “Oxidizing Agents and Reducing Agents”, 4:54)

Watch: Name the whole compound, not just one atom (Tyler DeWitt, “Oxidizing Agents and Reducing Agents”, 11:01)

Change one feature, keep the reasoning

Now start with NaCl that already exists. Solid NaCl already holds Na^+ and Cl^- ions. Dissolving it only separates ions that already have charges. Na stays +1 and Cl stays

-1, so no electrons move and this is _____.

Seeing charge symbols in an equation does not mean redox. Compare each particle before and after, not just the charge marks.

Now try $Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$. Mg gives _____ to _____. So Mg is the _____ and Cu^{2+} is the _____. The oxidizing agent starts positive here, but the same loss and gain reasoning still works.

On the diploma: draw the electron arrow first. Then name the agents from the reactants, Mg and Cu^{2+}, not from the products.

Watch: Charges and ions do not make a reaction redox (Tyler DeWitt, “The Oxidation Reduction Question that Tricks Everyone!”, 0:21)

Watch: The charges never change, so no electrons move (Tyler DeWitt, “The Oxidation Reduction Question that Tricks Everyone!”, 1:22)

Watch: The same reaction starting neutral is redox (Tyler DeWitt, “The Oxidation Reduction Question that Tricks Everyone!”, 3:07)

Watch: Finding the agents in an equation (Tyler DeWitt, “Oxidizing Agents and Reducing Agents”, 6:21)

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State symbols: (s) solid, (aq) dissolved in water, (l) liquid, (g) gas. Use the supplied reaction and conditions. B4 values name the Alberta Chemistry 30 Data Booklet table where used.

B1-P01 · Easy · A neutral magnesium atom has 12 protons and 12 electrons. It loses two electrons. How many electrons does it have now? What is its charge? Was it oxidized or reduced?

B1-P02 · Easy · A Cu^{2+} ion has 29 protons and 27 electrons. It gains two electrons. How many electrons does it have now? What is its charge? Was it oxidized or reduced?

B1-P03 · Easy · Complete $Fe^{2+} \rightarrow Fe^{3+}$ + ___ with electrons. Is this an oxidation or a reduction? Check the charge on each side.

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B1-P04 · Easy · Complete Ag^{+} + ___ → Ag with electrons. Name the oxidizing agent and check the charge on each side.

B1-P05 · Medium · Given Mg(s) + Cu^{2+}(aq) → Mg^{2+}(aq) + Cu(s), name what is oxidized, what is reduced, the reducing agent and the oxidizing agent. Explain the agent names.

Optional start: First draw an arrow from the reactant that gives electrons to the reactant that takes them.

B1-P06 · Medium · Given Zn(s) + 2Ag^{+}(aq) → Zn^{2+}(aq) + 2Ag(s). Write the oxidation half-reaction and the reduction half-reaction for the amounts shown. Check that the electrons match.

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B1-P07 · Medium · Given $Fe^{3+}(aq) + e^{-} \rightarrow Fe^{2+}(aq)$. A student says this cannot be a reduction because the product is positive. Correct the student. Use the electron and the charge.

B1-P08 · Medium · Compare $KCl(s) \rightarrow K^{+}(aq) + Cl^{-}(aq)$ with $2K(s) + Cl_2(g) \rightarrow 2KCl(s)$. Which one is redox? Explain what happens to the charges in each.

B1-P09 · Challenging · A question says: three Cu^{2+} ions each gain two electrons. Aluminium atoms each lose three electrons to become Al^{3+}. How many Al atoms are needed? Write the balanced net equation and name both agents.

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B1-P10 · Challenging · A student writes the half-reaction $Zn \rightarrow Zn^{2+} + e^{-}$. Which check finds the mistake? Fix it. Explain why changing Zn^{2+} to Zn^{+} is not a correct fix.

B1-P11 · Challenging · A beaker holds Fe^{2+} and Ag^{+}. The reaction $Fe^{2+} + Ag^{+} \rightarrow Fe^{3+} + Ag$ happens. Draw or describe the arrow that shows the electron moving. A student says “both are positive, so neither can give an electron”. Explain why that is wrong.

B1-P12 · Challenging · Zinc is put in blue copper(II) sulfate solution. A reddish solid forms on the zinc and the blue colour fades. Give one observation and one explanation in terms of particles. Use $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$ to explain both changes. What happens to the sulfate ion?