B1 · Electron transfer and redox

Student notes - follow the slides, fill the blanks, work the questions

Goals: Explain oxidation and reduction as electrons lost and gained. Name what is oxidized, what is reduced, and both agents. Tell a redox reaction from ions that only separate.

Name: _____ Date: _____

Slide 1 of 12 · One electron transfer has two sides

In a redox reaction, an electron moves from one particle to another. Redox is short for _____.

Oxidation means _____ of electrons. The particle that loses the electron is _____.

Reduction means _____ of electrons. The particle that gains the electron is _____.

Oxidation and reduction always happen _____, because the electron that one particle loses is the same electron the other particle _____.

Example. A particle model shows one electron moving from atom A to atom B. What happens to each atom? Use the words oxidized and reduced.

Work:

Answer: _____

Try it. An electron moves from particle X to particle Y. Which particle is oxidized, which is reduced, and how many electrons moved?

Work:

Answer: _____

Sketch (draw and label the diagram):

Slide 2 of 12 · Why gaining electrons reduces charge

A neutral atom has protons, which are _____, and electrons, which are _____. Their charges cancel, so the total is _____.

One electron has a charge of _____. Gaining an electron adds a negative amount, so the total charge goes _____. That is why gaining electrons is called _____.

Losing an electron removes a negative amount, so the total charge goes _____. A neutral atom that loses one electron becomes _____.

OIL RIG: Oxidation Is _____ of electrons; Reduction Is _____ of electrons.

Example. An ion with charge 3+ gains one electron. What is its new charge, and is it oxidized or reduced?

Work:

Answer: _____

Try it. A neutral atom loses two electrons. What is its new charge, and is it oxidized or reduced?

Work:

Answer: _____

Sketch (draw and label the diagram):

Slide 3 of 12 · Read particles, formulas and states

An _____ has a nucleus and electrons. An _____ is a particle with a charge, because its positive and negative charges do not balance.

A big number in front of a formula counts _____: 2Na means two sodium atoms. A small lower number counts _____ inside one formula: Cl_2 has two chlorine atoms.

The letters in brackets give the state: (s) is _____, (l) is _____, (g) is _____ and (aq) means _____.

In the shell model, Na is 2,8,1. Each number is the electrons in one shell. The last number is the _____ electrons, which sit in the outer shell.

Example. Given $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$. How many sodium atoms and how many chlorine atoms are on the left side?

Work:

Answer: _____

Try it. Chlorine is 2,8,7. How many valence electrons does it have, and what ion forms if it gains one electron?

Work:

Answer: _____

Slide 4 of 12 · Sodium chloride: before, transfer, after

Sodium metal is made of _____ Na atoms. Chlorine gas is made of neutral Cl_2 _____. Neither one contains ions.

In the reaction $2Na + Cl_2 \rightarrow 2NaCl$, each sodium atom gives up _____ electron and becomes Na^+. Each chlorine atom gains _____ electron and becomes Cl^-.

Two sodium atoms lose 2 electrons and two chlorine atoms gain 2 electrons. The electrons lost _____ the electrons gained.

Opposite charges _____, so the ions pull together into a repeating pattern called a _____. The solid is neutral overall.

Example. Given $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$. How do the neutral starting atoms become the ions in the solid?

Work:

Answer: _____

Try it. How many sodium ions and how many chloride ions are in the product of $2Na + Cl_2 \rightarrow 2NaCl$, and what is the total charge of the product?

Work:

Answer: _____

Sketch (draw and label the diagram):

Slide 5 of 12 · Name what happens to each reactant

Look at each reactant separately. Sodium goes from neutral Na to _____. An electron leaves sodium, so sodium is _____.

Chlorine goes from neutral Cl_2 to _____. Electrons enter chlorine, so chlorine is _____.

Oxidation and reduction always happen _____: one cannot happen without the other.

In $2Na + Cl_2 \rightarrow 2NaCl$, the _____ electrons lost equal the _____ electrons gained.

Example. Use the sodium and chlorine reaction. Which reactant is oxidized, and which is reduced?

Work:

Answer: _____

Try it. In $2Na + Cl_2 \rightarrow 2NaCl$, how many electrons are lost in total, and how many are gained in total?

Work:

Answer: _____

Sketch (draw and label the diagram):

Slide 6 of 12 · Write the two halves of the story

A half-reaction shows only one half of the electron transfer. The symbol e^- is _____.

In a reduction half-reaction the electrons are on the _____ (reactant) side: $Cl_2 + 2e^- \rightarrow$ _____.

In an oxidation half-reaction the electrons are on the _____ (product) side: $2Na \rightarrow 2Na^+ +$ _____.

Add the two halves and cancel the _____, because they appear on opposite sides: $2Na + Cl_2 \rightarrow 2Na^+ + 2Cl^-$.

Example. Write the reduction half-reaction for Cl_2 forming Cl^-, and the oxidation half-reaction for Na forming Na^+, using the equation $2Na + Cl_2 \rightarrow 2Na^+ + 2Cl^-$.

Work:

Answer: _____

Try it. Write the oxidation half-reaction for one zinc atom forming Zn^{2+}. Where do the electrons go in the equation?

Work:

Answer: _____

Slide 7 of 12 · An agent is named for its effect on the partner

An oxidizing agent _____ oxidation of the other reactant. It does this by _____ electrons, so the oxidizing agent is itself reduced.

A reducing agent causes _____ of the other reactant. It does this by _____ electrons, so the reducing agent is itself oxidized.

There are two names for each reactant. Its own change is oxidized or reduced. Its effect on the _____ is the agent name.

In $2Na + Cl_2 \rightarrow 2NaCl$, sodium is oxidized, so sodium is the _____ agent. Chlorine is reduced, so chlorine is the _____ agent.

Example. Sodium gives electrons and chlorine receives them. Why is sodium called the reducing agent even though it is oxidized?

Work:

Answer: _____

Try it. In $2Na + Cl_2 \rightarrow 2NaCl$, name the oxidizing agent and say what it does to the other reactant.

Work:

Answer: _____

Slide 8 of 12 · Method: how to name an electron transfer

Step 1. Write the _____ for each particle, from start to end.

Step 2. Find the _____. The particle that loses electrons is _____.

Step 3. Find the _____. The particle that gains electrons is _____.

Step 4. Name the agents. The oxidizing agent is what is _____. The reducing agent is what is _____.

Step 5. Write two _____. Electrons are on the product side for oxidation and on the reactant side for reduction.

Check: the electrons _____ must equal the electrons _____.

Example. Use the method on $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$. Name the electron transfer, the agents and the two halves.

Work:

Answer: _____

Try it. Use the method on $Mg(s) + Cl_2(g) \rightarrow MgCl_2(s)$. Name what is oxidized, what is reduced and the oxidizing agent.

Work:

Answer: _____

Slide 9 of 12 · Ions present does not mean electrons transferred

Forming NaCl from its elements is a _____ reaction. Neutral Na and Cl_2 change into ions by electron _____.

Dissolving NaCl in water is different. The solid already contains _____, and the dissolved ions are the same ions.

In dissolving, ions _____, but no electrons are transferred. So dissolving is _____ a redox reaction.

To test for redox, ask whether any particle _____ electrons.

Example. Compare making NaCl from its elements with dissolving NaCl that already exists. What changes in each process?

Work:

Answer: _____

Try it. Given $KNO_3(s) \rightarrow K^+(aq) + NO_3^-(aq)$. Is this redox? Explain in one sentence.

Work:

Answer: _____

Slide 10 of 12 · Same idea, different starting particles

The electron-transfer idea works for any reactants. In $Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$, the reactants are Mg atoms and _____ ions.

First decide which reactant _____ electrons. Mg goes from 0 to 2+, so it loses _____ electrons and is oxidized.

Cu^{2+} goes from 2+ to 0, so it _____ 2 electrons and is reduced.

The agents follow: Mg is the _____ agent and Cu^{2+} is the _____ agent.

Example. Given $Mg(s) + Cu^{2+}(aq) \rightarrow Mg^{2+}(aq) + Cu(s)$. First draw the electron arrow. Then name the changes and both agents.

Work:

Answer: _____

Try it. Given $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$. Name what is oxidized, what is reduced and both agents.

Work:

Answer: _____

Sketch (draw and label the diagram):

Slide 11 of 12 · Use an electron record instead of an equation

Sometimes the question gives an electron record, not an equation. Read the electron _____ for each particle.

If a particle keeps its nucleus and its electron count goes _____, it is oxidized and is the reducing agent.

If its electron count goes _____, it is reduced and is the _____ agent.

The electrons lost by one particle _____ the electrons gained by the other.

Example. A question says: P keeps its nucleus and loses two electrons. Q keeps its nucleus and gains those two electrons. Name both agent roles and explain one.

Work:

Answer: _____

Try it. A question says: R keeps its nucleus and its electron count goes from 18 to 15. S gains those electrons. Name what happens to R and S, and the agents.

Work:

Answer: _____

Sketch (draw and label the diagram):

Slide 12 of 12 · Carry the explanation into oxidation numbers

Follow the electron _____ first. Loss of electrons is _____. Gain of electrons is _____.

The agent name describes the effect on the _____: the reducing agent is oxidized, and the oxidizing agent is _____.

For simple ions we tracked the actual _____.

For molecules, _____ do the same counting. B2 teaches them.

Example. How do electron transfer, charge changes, half-reactions and agent names describe one connected idea? Use Na and Cl_2 in your answer.

Work:

Answer: _____

Try it. In one sentence, say which three words describe electron loss, electron gain and the effect on a partner.

Work:

Answer: _____

B1 · Practice

Electron transfer and redox | Questions 1-2 of 7

1. Given: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^{-}$. Is zinc oxidized or reduced? Explain the change in charge.

Work:

Final answer (with unit): _____

2. Given: $2Al(s) + 3Cu^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Cu(s)$. Name both agents. How many electrons move in the reaction as written?

Work:

Final answer (with unit): _____

B1 · Practice

Electron transfer and redox | Questions 3-4 of 7

3. Given: $NaNO_3(s) \rightarrow Na^+(aq) + NO_3^-(aq)$. The solid already contains Na^+ and NO_3^- ions. Is this a redox reaction? Explain.

Work:

Final answer (with unit): _____

4. Given: $Sn^{2+}(aq) + 2Fe^{3+}(aq) \rightarrow Sn^{4+}(aq) + 2Fe^{2+}(aq)$. Draw the arrow that shows which way the electrons move. Name both agents.

Work:

Final answer (with unit): _____

B1 · Practice

Electron transfer and redox | Questions 5-6 of 7

5. Given: a particle keeps 12 protons while its number of electrons changes from 10 to 12. Give its charge at the start and at the end. Is it oxidized or reduced?

Work:

Final answer (with unit): _____

6. A student says: “Cu^{2+} becomes Cu, so copper loses its positive charge by losing electrons.” Find the mistake and write the correct statement.

Work:

Final answer (with unit): _____

B1 · Practice

Electron transfer and redox | Questions 7-7 of 7

7. Challenge: Given: $Mg(s) + 2Ag^{+}(aq) \rightarrow Mg^{2+}(aq) + 2Ag(s)$. Write the oxidation half-reaction and the reduction half-reaction. Then state how many electrons 3 Mg atoms transfer in total.

Work:

Final answer (with unit): _____