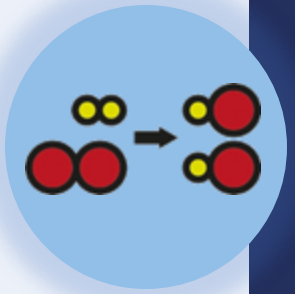
Writing Half Equations

Answer the questions below.

1. Define oxidation in terms of electrons.
   Oxidation is the loss of electrons
2. Define reduction in terms of electrons.
   Reduction is the gain of electrons
3. True or false? A more reactive metal is more likely to form positive ions.
   True
4. Sodium atoms (Na) are oxidised to Na^+ ions in a reaction. Why is this an oxidation reaction?
   This is an oxidation reaction because the sodium atom lost an electron.
5. Complete the general word equation to show the product of a reaction between a metal and oxygen. Metal + oxygen →
   Metal + oxygen → metal oxide



Do Now

Writing Half Equations

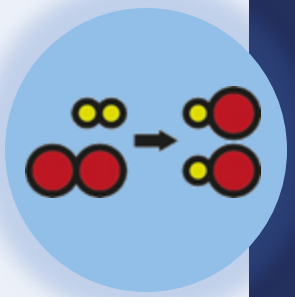
Do Now:

1. Define oxidation in terms of electrons.
2. Define reduction in terms of electrons.
3. True or false? A more reactive metal is more likely to form positive ions.
4. Sodium atoms (Na) are oxidised to Na^+ ions in a reaction. Why is this an oxidation reaction?
5. Complete the general word equation to show the product of a reaction between a metal and oxygen. Metal + oxygen →

Drill:

1. State the formula for a chloride ion.
2. Rewrite this ionic equation so that it is correct:

$$H^+_{(aq)} + Cl^-_{(aq)} + K^+_{(aq)} + OH^-_{(aq)} \rightarrow K^+_{(aq)} + Cl^-_{(aq)} + H_2O_{(l)}$$



Do Now

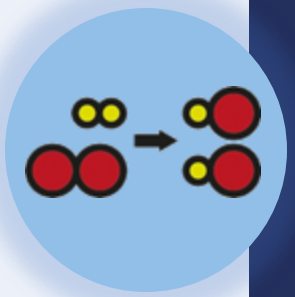
Writing Half Equations

Read Now:

Researchers at the University of Maryland in the US have found that a battery can be made from chitosan, a material in crab and shrimp shells, and zinc. The battery is rechargeable. The benefits of the battery include that it is safe, can be recharged up to 10,000 times, and it can be safely recycled. Scientists hope that this material could be an alternative to lithium-ion batteries. These are the batteries which we use in our phones, small and large appliances, smart watches, electric vehicles and in many other devices. Unfortunately, lithium-ion batteries contain polypropylene and polycarbonate which take hundreds of years to degrade. The amount of chitosan powder that would be needed to make a coin-sized battery would cost just 0.00015 p.

1. What is chitosan?
2. List 3 benefits of a battery made from chitosan.
3. Where do we use lithium-ion batteries?
4. State a disadvantage of lithium-ion batteries.
5. How much would it cost to purchase enough chitosan make a coin sized battery?

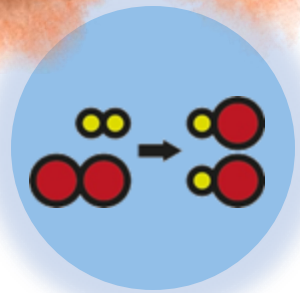
Do Now



(HT) Writing Half Equations

C4.2.5

Science Mastery

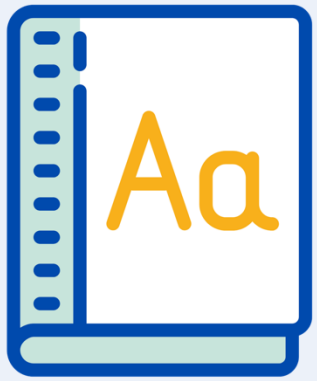


Lesson Objectives

Following this lesson, students will be able to:

- Split an ionic equation into two half equations
- Identify the species which are oxidised and reduced.

Key Words:



half equation

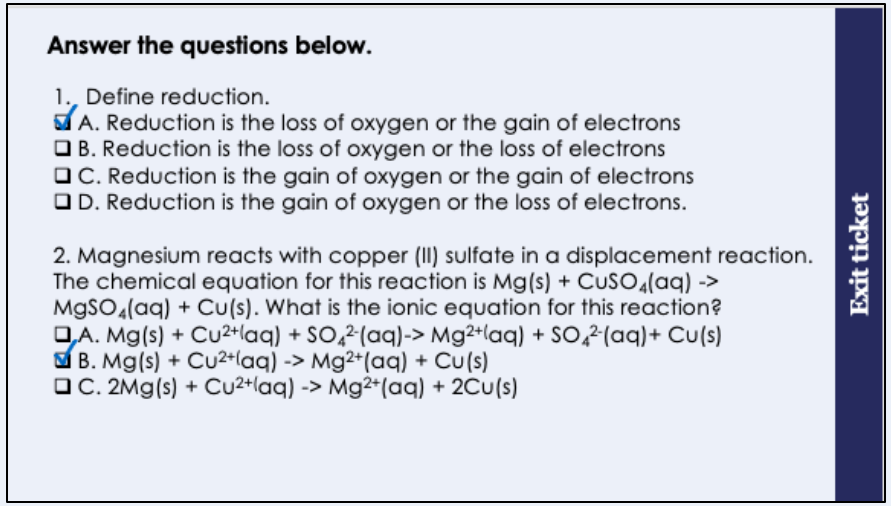
electron

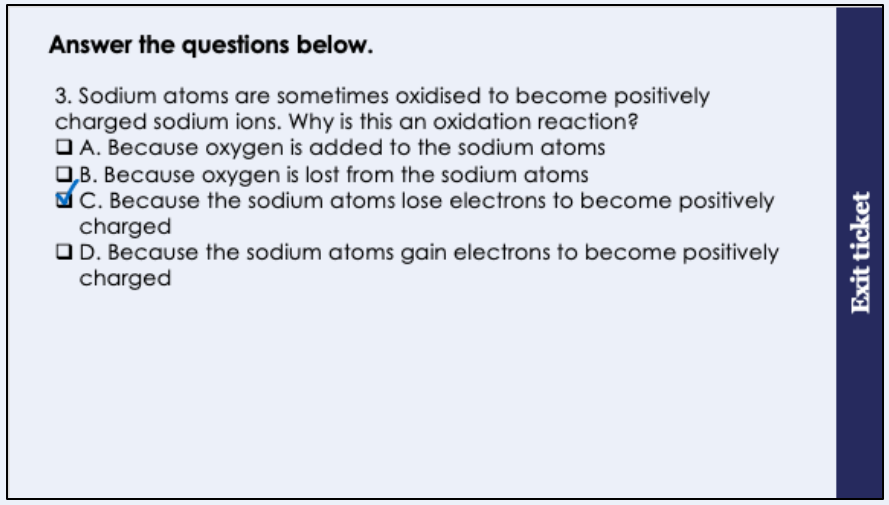
redox

This is the fix-it portion of the lesson

The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the previous lesson's exit ticket.

- The teacher should customise this slide as needed, to facilitate
  - **reteach**, **explanation, demonstration** or **modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
  - **practise** answering specific questions or of key skills.
  - **redrafting** or **improving** previous work.





Fix-it

What does an ionic equation show?

$$Mg_{(s)} + Cu^{2+}_{(aq)} \rightarrow Mg^{2+}_{(aq)} + Cu_{(s)}$$

- Magnesium **atoms** lose 2 electrons to become positively charged **ions**
- This loss of electrons is called **oxidation**

Oxidation is the loss of electrons

- Copper **ions** gain 2 electrons to become neutral **atoms**
- This gain of electrons is called **reduction**

Reduction is the gain of electrons

A redox reaction is one in which oxidation and reduction take place at the same time

Half Equations

We can separate an ionic equation into two **half equations**.

$$Mg_{(s)} + Cu^{2+}_{(aq)} \rightarrow Mg^{2+}_{(aq)} + Cu_{(s)}$$

1. Magnesium

2. $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)}$

3. $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)}$
1 atom 1 ion

4. $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)}$
Charge: 0 Charge: 2+

5. $\mathbf{Mg_{(s)} \rightarrow Mg^{2+}_{(aq)} + 2e^-}$
Charge: 0 Charge: 0

1. Copper

2. $Cu^{2+}_{(aq)} \rightarrow Cu_{(s)}$

3. $Cu^{2+}_{(aq)} \rightarrow Cu_{(s)}$
1 ion 1 atom

4. $Cu^{2+}_{(aq)} \rightarrow Cu_{(s)}$
Charge: 2+ Charge: 0

5. $\mathbf{Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}}$
Charge: 0 Charge: 0

Steps for writing half equations:

1. **Pick one element** that's on both sides of the equation
2. Write down **reactant → product**, copying from the equation exactly
3. **Balance the atoms and ions**
4. **Add up the charges** on both sides
5. **Balance the charges** with electrons

What does a half equation tell us?

$$Mg_{(s)} \rightarrow Mg^{2+}_{(aq)} + 2e^-$$

- Magnesium **atoms** lose 2 electrons to become positively charged **ions**
- This loss of electrons is called **oxidation**

Oxidation is the loss of electrons

$$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$$

- Copper **ions** gain 2 electrons to become neutral **atoms**
- This gain of electrons is called **reduction**

Reduction is the gain of electrons

Is this correct?

$$Cl_2 + e^- \rightarrow 2Cl^-$$

Talk Task

Drill

1. What happens to metal atoms in order for them to form ions?
2. What happens to Group 6 elements in order for them to form ions?
3. How many electrons will a beryllium atom lose in order to form an ion?
4. What is the charge on a chloride ion
5. Write down the formula for a nitrate ion
6. Write a half equation that shows the following: a lithium atom loses one electron to become a lithium ion with the formula Li^+
7. Write a half equation that shows the following: a fluoride ion with the formula F^- loses an electron to form a fluorine atom.
8. Rewrite the following half equation, adding in the state symbols: $Na^+ + e^- \rightarrow Na$
9. For the half equation in question 8, state whether sodium ion is oxidised or reduced.
10. Explain your answer to question 9.

Check for understanding

Drill answers

1. Metal atoms lose electrons to form ions
2. Group 6 elements gain 2 electrons to form ions
3. A beryllium atom will lose 2 electrons to form an ion
4. A chloride ion has the formula Cl^-, so it has a -1 charge
5. A nitrate ion has the formula NO_3^-
6. $Li_{(s)} \rightarrow Li^+_{(aq)} + e^-$
7. $F^-_{(aq)} + e^- \rightarrow F_{(s)}$
8. $Na^+_{(aq)} + e^- \rightarrow Na_{(s)}$
9. The sodium ion is reduced
10. The sodium ion is reduced because it gains electrons to form a sodium atom

Check for understanding

I: Writing half equations

The ionic equation for a reaction is as follows:

$$Fe_{(s)} + Cu^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow Fe^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} + Cu_{(s)}$$

Use this ionic equation to write two half equations.

$$Fe_{(s)} + Cu^{2+}_{(aq)} \rightarrow Fe^{2+}_{(aq)} + Cu_{(s)}$$

1. Iron

2. $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)}$

3. $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)}$
   1 atom 1 ion

4. $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)}$
   Charge: 0 Charge: 2+

5. $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2e^-$
   Charge: 0 Charge: 0

1. Copper

2. $Cu^{2+}_{(aq)} \rightarrow Cu_{(s)}$

3. $Cu^{2+}_{(aq)} \rightarrow Cu_{(s)}$
   1 ion 1 atom

4. $Cu^{2+}_{(aq)} \rightarrow Cu_{(s)}$
   Charge: 2+ Charge: 0

5. $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$
   Charge: 0 Charge: 0

Steps for writing half equations:

1. **Pick one element** that's on both sides of the equation
2. Write down **reactant → product**, copying from the equation exactly
3. **Balance the atoms and ions**
4. **Add up the charges** on both sides
5. **Balance the charges** with electrons

Apply

We: Writing half equations

The ionic equation for a reaction is as follows:

$Br_{2(s)} + 2Na^+_{(aq)} + 2I^-_{(aq)} \rightarrow 2Na^+_{(aq)} + 2Br^-_{(aq)} + I_{2(s)}$

Use this ionic equation to write two half equations.

$Br_{2(s)} + 2I^-_{(aq)} \rightarrow 2Br^-_{(aq)} + I_{2(s)}$

1. Bromine

2. $Br_{2(s)} \rightarrow 2Br^-_{(aq)}$

3. $Br_{2\,(s)} \rightarrow 2Br^-_{(aq)}$
   2 atoms 2 ions

4. $Br_{2\,(s)} \rightarrow 2Br^-_{aq)}$
   Charge: 0 Charge: -2

5. $Br_{2\,(s)} + 2e^- \rightarrow 2Br^-_{(aq)}$
   Charge: -2 Charge: -2

1. Iodine

2. $2I^-_{(aq)} \rightarrow I_{2\,(s)}$

3. $2I^-_{(aq)} \rightarrow I_{2\,(s)}$
   2 ions 2 atoms

4. $2I^-_{(aq)} \rightarrow I_{2\,(s)}$
   Charge: -2 Charge: 0

5. $2I^-_{(aq)} \rightarrow I_{2(s)} + 2e^-$
   Charge: -2 Charge: -2

Steps for writing half equations:

1. **Pick one element** that's on both sides of the equation
2. Write down **reactant → product**, copying from the equation exactly
3. **Balance the atoms and ions**
4. **Add up the charges** on both sides
5. **Balance the charges** with electrons

Apply

You: Writing half equations

The ionic equation for a reaction is as follows:

$Cl_{2(aq)} + 2K^+_{(aq)} + 2Br^-_{(aq)} \rightarrow 2K^+_{(aq)} + 2Cl^-_{(aq)} + Br_{2(aq)}$

Use this ionic equation to write two half equations.

$Cl_{2(aq)} + 2Br^-_{(aq)} \rightarrow 2Cl^-_{(aq)} + Br_{2(aq)}$

1. Bromine

2. $2Br^-_{(aq)} \rightarrow Br_{2(aq)}$

3. $2Br^-_{(aq)} \rightarrow Br_{2(aq)}$
   2 ions 2 atoms

4. $2Br^-_{(aq)} \rightarrow Br_{2(aq)}$
   Charge: -2 Charge: 0

5. $2Br^-_{(aq)} \rightarrow Br_{2(aq)} + 2e^-$
   Charge: -2 Charge: -2

1. Chlorine

2. $Cl_{2(aq)} \rightarrow 2Cl^-_{(aq)}$

3. $Cl_{2(aq)} \rightarrow 2Cl^-_{(aq)}$
   2 atoms 2 ions

4. $Cl_{2(aq)} \rightarrow 2Cl^-_{(aq)}$
   Charge: 0 Charge: -2

5. $Cl_{2(aq)} + 2e^- \rightarrow 2Cl^-_{(aq)}$
   Charge: -2 Charge: -2

Steps for writing half equations:

1. **Pick one element** that's on both sides of the equation
2. Write down **reactant** → **product**, copying from the equation exactly
3. **Balance the atoms and ions**
4. **Add up the charges** on both sides
5. **Balance the charges** with electrons

Apply

Answer the questions below.

1. The reaction between magnesium and copper (II) sulfate can be represented by the following ionic equation:

$$Mg_{(s)} + Cu^{2+}_{(aq)} \rightarrow Mg^{2+}_{(aq)} + Cu_{(s)}$$

Which answer correctly splits this ionic equation into two half equations?

- ☑ A. $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)} + 2e^-$ $\quad Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$
- ☐ B. $Mg_{(s)} + 2e^- \rightarrow Mg^{2+}_{(aq)}$ $\quad Cu^{2+}_{(aq)} \rightarrow Cu_{(s)} + 2e^-$
- ☐ C. $Mg_{(s)} \rightarrow Mg^{2+}_{(aq)}$ $\quad Cu^{2+}_{(aq)} \rightarrow Cu_{(s)}$

2. What is a redox reaction?

- ☐ A. A redox reaction is one which oxidation or reduction take place
- ☐ B. A redox reaction is one in which oxidation and reduction take place
- ☑ C. A redox reaction is one in which oxidation and reduction take place at the same time

Exit ticket

Answer the question below.

3. Complete the half equation to show the oxidation of a potassium atom.

$$K_{(s)} \rightarrow$$

- ❑ A. $K^{2+}_{(aq)} + 2e^-$
- ❑ B. $K^{+}_{(s)} + e^-$
- ☑ C. $K^{+}_{(aq)} + e^-$

Exit ticket

Feedback

Lesson C4.2.5	
What was good about this lesson?	What can we do to improve this lesson?

Send us your feedback by clicking this link
or by emailing sciencemastery@arkonline.org
Thank you!