

SI Chemistry - Full Discipline Demo

Oxidation-Reduction Activity Series

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Chemistry - Full Discipline Demo
Course	SI Chemistry - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

⚡ Oxidation		Represents the charge an atom would have if electrons were completely transferred	1	
⚡ Oxidation number				
⚡ Oxidation-reduction		The loss of electrons by a substance undergoing a chemical reaction	2	
⚡ Oxidizing agent	▶	Donates electrons	3	
⚡ Reducing agent		Accepts electrons	4	
⚡ Reduction		Reaction occurring when electrons are transferred from one reactant to another	5	
		The gain of electrons by a substance undergoing a chemical reaction	6	

Correct answers:

- 1 Oxidation number 2 Oxidation 3 Reducing agent
4 Oxidizing agent 5 Oxidation-reduction 6 Reduction

Identify the statements as true or false.

⚡ An activity series is a list of metals from most easily oxidized to least easily oxidized.	
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Correct answers:

1

In a single displacement reaction, an element reacts with a compound and part of the compound is released to become a free element.

An activity series is a list of metals from most easily oxidized to least easily oxidized.

2

Atoms move from lower energy to higher energy locations during a chemical reaction.

Spectator ions are both oxidized and reduced during a chemical reaction.

Exploration

The oxidation number represents the charge an atom would have if electrons were completely transferred.

☒ True



☐ False

Oxidation is the ____ of electrons by a substance undergoing a chemical reaction. Reduction is the ____ of electrons by a substance undergoing a chemical reaction.

☒ loss; gain



☐ gain; loss

☐ gain; gain

☐ loss; loss

MgCl₂ is composed of ____ magnesium ion(s) and ____ chloride ion(s).

☐ 2; 1

☒ 1; 2



☐ 1; 1

☐ 2; 2

Chromium is more active than gold.

☒ True



☐ False

Exercise 1

Define oxidation, reduction, and oxidation number. Describe how oxidation and reduction affect the oxidation number of an element.

Oxidation- when an element loses electrons.
Reduction- when an element gains electrons.
Oxidation number- the charge an element would have if electrons were fully transferred.
Oxidation causes an increase in the oxidation number and reduction causes a decrease in the oxidation number.

Define oxidizing agent, reducing agent, and spectator ion.

The oxidizing agent accepts electrons and the reducing agent donates electrons. A spectator ion neither donates nor accepts electrons.

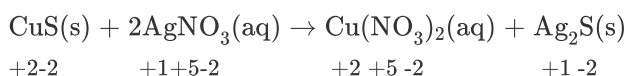
In the reaction of copper and silver nitrate, a new substance appeared in the test tube. Describe the physical appearance of the substance and identify its chemical formula.

The physical substance that appeared was pure silver. It looked drab and silver-gray colored; it appeared fluffy and accumulated on the outside of the copper pieces. The chemical symbol (or formula) for pure silver is Ag.

Given an activity series in which the most active metals are at the top of the list and the least active metals are at the bottom of the list, would copper be listed above silver or would silver be listed above copper? Support your answer with data from Data Table 1.

Copper would be listed above silver because copper has a greater ease of oxidation. As shown in Data Table 1, copper is oxidized by silver.

Solid copper sulfide and silver nitrate react to form copper (II) nitrate and solid silver sulfide. Write a balanced chemical equation that describes the reaction. Identify the oxidation number of each element in the reaction. (You do not need to include the total contribution of charge.) Is this reaction a redox reaction or a non-redox reaction? Explain your answer.



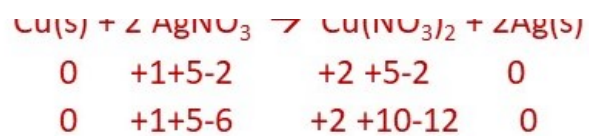
The reaction is non-redox reaction because the oxidation numbers of the elements do not change, and therefore no electrons are donated or accepted. (A redox reaction is defined as a reaction in which electrons are transferred.)

Data Table 1: Redox Reaction of Copper and Silver Nitrate
(SAMPLE ANSWER BELOW)

Initial Observations before Beginning	<i>AgNO₃ is a clear, colorless liquid; Cu is a shiny, copper – colored metal</i>
Observations	<i>Small crystals form on the copper and begin to blacken</i>
Observations after 30 min	<i>The solution is slightly blue – green. A silver solid has formed around the</i>
Element that is Oxidized	<i>Copper</i>
Element that is Reduced	<i>Silver</i>
Spectator Ion	<i>Nitrate</i>
Oxidizing Agent	<i>Silver ion</i>
Reducing Agent	<i>Copper</i>

Photo 1: Chemical Equation for Redox of Copper and Silver Nitrate. Note: Copper has a +2 oxidation number in the products. Silver has its expected oxidation number on the reactants side.
(SAMPLE ANSWER BELOW)





Exercise 2

List each of the metals tested in Exercise 2. Indicate the oxidation number when each element is pure and the oxidation number when each element is in a compound.

Copper: pure copper = 0; copper in compound = +2
Lead: pure lead = 0; lead in compound = +2
Zinc: pure zinc = 0; zinc in compound = +2

Which of the metals in Exercise 2 was the strongest oxidizing agent? Was there an instance when this metal also acted as a reducing agent? Explain your answer using data from Data Table 3.

Copper was the strongest oxidizing agent. The chemical equations in Data Table 2 show that copper tends to accept electrons from the other metals. There is no instance where copper acts as a reducing agent to donate electrons.

Which of the metals in Exercise 2 was the strongest reducing agent? Was there an instance when this metal also acted as an oxidizing agent? Explain your answer using data from Data Table 3.

Zinc was the strongest reducing agent. The chemical equations in Data Table 2 show that zinc tends to donate electrons to the other metals. There is no instance where zinc acts as an oxidizing agent to accept electrons.

How does ease of oxidation correlate with activity? Do highly active metals tend to donate electrons or accept electrons from other metals?

Highly active metals have a high ease of oxidation and less active metals have a lesser ease of oxidation. Highly active metals are more likely to donate electrons.

Create an activity series for copper, lead, and zinc. Place the most active metal at the top of the list.

Zinc
Lead
Copper

Data Table 2: Redox Reactions of Copper, Lead, and Zinc
(SAMPLE ANSWER BELOW)

Solid Metal	Well ID	Solution	Immediate Observation	30 Minute Observation
Cu	A1	Pb(NO ₃) ₂	No change	No change
Cu	A2	Zn(NO ₃) ₂	No change	No change
Pb	B1	CuSO ₄	Metal is slightly darker color	Metal is a darker color
Pb	B2	Zn(NO ₃) ₂	No change	No change
Zn	C1	CuSO ₄	Metal is a darker color	Solid coating covering entire metal, appears rust colored and looks somewhat spiky or fluffy
Zn	C2	Pb(NO ₃) ₂	Instant formation of darker coating	Soft dark silver coating appears on all surfaces of the metal

Data Table 3: Potential Redox Reactions and Chemical Equations
(SAMPLE ANSWER BELOW)

Metal and Metallic Solution	Reaction Occurred?
Cu + Pb(NO ₃) ₂	<i>No reaction</i>
Cu + Zn(NO ₃) ₂	<i>No reaction</i>
Pb + CuSO ₄	<i>Yes</i>
Pb + Zn(NO ₃) ₂	<i>No reaction</i>
Zn + CuSO ₄	<i>Yes</i>
Zn + Pb(NO ₃) ₂	<i>Yes</i>

Photo 2: Chemical Equations and Redox Numbers for Reactions
(SAMPLE ANSWER BELOW)



0 +2+6-2 +2+6-2 0

0 +2+6-8 +2+6-8 0



0 +2+6-2 +2+6-2 0

0 +2+6-8 +2+6-8 0



0 +2+5-2 +2+5-2 0

0 +2+10-12 +2+10-12 0

Competency Review

The oxidation number is often referred to as the ____.

- ☐ redox factor
- ☒ oxidation state ✓
- ☐ spectator ion
- ☐ reducing factor

A redox reaction occurs when electrons are transferred from one element to another.

- ☒ True ✓
- ☐ False

Oxidation and reduction may occur alone in a chemical reaction.

- ☐ True
- ☒ False ✓

When a substance is in its elemental form (existing alone without bonds to other elements), the oxidation number is ____.

- ☒ 0 ✓
- ☐ 1
- ☐ 2
- ☐ 3

The sum of the oxidation numbers within a formula is equal to the overall charge of the formula.

- ☒ True ✓
- ☐ False

A spectator ion is ____ during a chemical reaction.

- ☐ oxidized
- ☐ reduced
- ☐ both oxidized and reduced
- ☒ neither oxidized nor reduced

✓

During an oxidation-reduction experiment, why is it important to observe the reaction after 30 minutes?

- ☐ The solution and solid look different after 30 minutes than when the reaction begins.
- ☐ The reaction requires time to complete.
- ☐ Silver continues to precipitate for 30 minutes.
- ☒ All of the above

✓

In the redox reaction of silver nitrate (AgNO_3) and solid copper (Cu), the silver acts as a(n) ____.

- ☒ oxidizing agent
- ☐ reducing agent
- ☐ spectator ion
- ☐ All of the above

✓

If during an experiment zinc was found to be more reactive than lead or copper, zinc would be considered the strongest ____.

- ☐ oxidizing agent
- ☒ reducing agent
- ☐ spectator ion
- ☐ All of the above

✓

Extension Questions

Redox reactions occur in many everyday experiences. Three examples of common redox reactions that everyone is familiar with are outlined below. Write the chemical equation for each of these reactions and identify the oxidizing agent and the reducing agent.

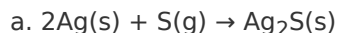
Note: If needed, consult a web source to determine the reaction.

a. When silver jewelry or silverware tarnishes, it is reacting with S in the air to undergo a redox reaction.

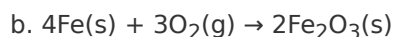
b. When someone leaves a screwdriver sitting outside and it rusts, the iron in the screwdriver underwent a redox reaction.

c. The process of photosynthesis, which causes green plants to react with sunlight to form oxygen, is an example of a redox reaction.

(SAMPLE ANSWER BELOW)



Ag = reducing agent, S = oxidizing agent



Fe = reducing agent, O_2 = oxidizing agent.

Note: The formation of rust actually can be more complicated and involve reaction with OH^- ions and form several different iron oxides.



CO_2 = oxidizing agent, H_2O = reducing agent