

SI Chemistry - Full Discipline Demo

Chemical Reactions

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

Categorize each change as physical change or chemical change.

⚡ A butane lighter produces a flame	⚡ A screwdriver left outside in the rain rusts
⚡ Barium hydroxide mixed with ammonium chloride becomes colder	
⚡ Rubbing alcohol evaporates	⚡ Silver tarnishes upon exposure to the air
⚡ Sugar dissolves in water	⚡ Water boils

Physical Change	Chemical Change
1	2

Correct answers:

1 Sugar dissolves in water Water boils Rubbing alcohol evaporates

2 A butane lighter produces a flame

Silver tarnishes upon exposure to the air

Barium hydroxide mixed with ammonium chloride becomes colder

A screwdriver left outside in the rain rusts

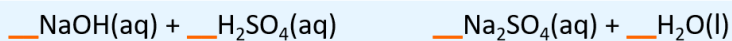
Identify the coefficients that balance each chemical equation.



1



2



3



4

⚡ 2, 1, 1, 2

⚡ 1, 2, 1, 1

⚡ 1, 1, 1, 2

⚡ 1, 5, 3, 4

Correct answers:

1 1, 5, 3, 4 2 1, 2, 1, 1 3 2, 1, 1, 2 4 1, 1, 1, 2

Classify each chemical reaction.

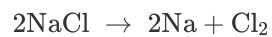
⚡ Combination

⚡ Decomposition

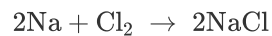
⚡ Double displacement

⚡ Single displacement

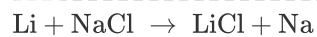
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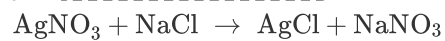
2



3



4



Correct answers:

- 1 Decomposition 2 Combination 3 Single displacement
4 Double displacement

Arrange the metals from least active to most active.

Li - Lithium
K - Potassium
Ba - Barium
Sr - Strontium
Ca - Calcium
Na - Sodium
Mg - Magnesium
Al - Aluminum
Mn - Manganese
Zn - Zinc
Cr - Chromium
Fe - Iron
Cd - Cadmium
Co - Cobalt
Ni - Nickel
Sn - Tin
Pb - Lead
H₂ - Hydrogen
Cu - Copper
Ag - Silver
Hg - Mercury
Au - Gold

≡ Calcium

1 **Correct answer:** Lead

≡ Lead

2 **Correct answer:** Zinc

≡ Magnesium

3 **Correct answer:** Magnesium

≡ Potassium

4 **Correct answer:** Calcium

≡ Zinc

5 **Correct answer:** Potassium

Exploration

A chemical reaction occurs when the atoms of substances interact with one another, rearranging to form new chemical substances.

- ☒ True ✓
- ☐ False

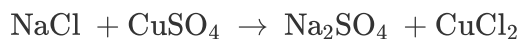
In the chemical reaction $8\text{Fe} + \text{S}_8$ yields 8FeS , Fe is a ____, while FeS is a ____.

- ☒ reactant; product ✓
- ☐ product; reactant
- ☐ Both Fe and FeS are reactants.
- ☐ Both Fe and FeS are products.

Chemical changes include bread molding, putting hydrogen peroxide on a cut, and boiling water.

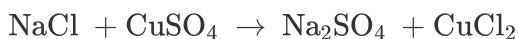
- ☐ True
- ☒ False ✓

How many NaCl are required to balance the equation?



- ☐ 1
- ☒ 2 ✓
- ☐ 3
- ☐ 4

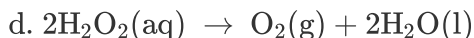
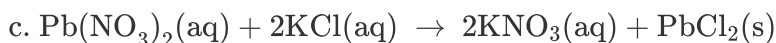
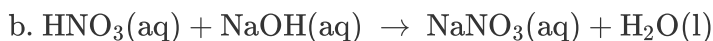
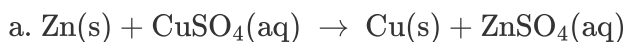
How many NaCl are required to balance the equation?



- ☐ 1
- ☒ 2
- ☐ 3
- ☐ 4

✓

Classify each reaction as decomposition, combination, single displacement, double displacement, or acid-base neutralization.



- ☐ a. double displacement; b. decomposition; c. single displacement; d. acid-base neutralization
- ☐ a. acid-base neutralization; b. decomposition; c. double displacement; d. single displacement
- ☐ a. acid-base neutralization; b. single displacement; c. double displacement; d. decomposition
- ☒ a. single displacement; b. acid-base neutralization; c. double displacement; d. decomposition

✓

List metals from least active to most active.

- ☐ Ag < Al < Cu < K < Mg < Zn
- ☐ Cu < K < Ag < Al < Mg < Zn
- ☒ Ag < Cu < Zn < Al < Mg < K
- ☐ Zn < Ag < Cu < K < Al < Mg

✓

_____ describe(s) why an event occurred.

- ☐ Observations and conclusions
- ☐ An observation
- ☒ A conclusion

✓

Indicators of chemical reactions include changes in color and the formation of a precipitate or gas.

- ☒ True
- ☐ False

✓

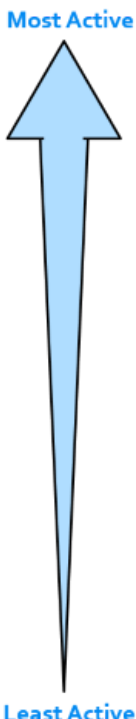
Exercise 1

Which of the reactants in Data Table 1 showed evidence of a chemical reaction with the aluminum foil? Use your observations to explain your answer.

AgNO₃ generated a silver-colored precipitate on the foil and also pits. There was a production of bubbles in this reaction which indicated a gas product.
CuSO₄ created a copper-colored precipitate of the foil and also pits. There was a production of bubbles in this reaction which indicated a gas product.
Pb(NO₃)₂ generated a grey precipitate on the foil and also pits. There was a production of bubbles in this reaction which indicated a gas product.
CaCl₂ produced no reaction. CaCl₂ left no visible signs on the foil, just an evaporated mark which rinsed away.

List the metals found in each of the four reactants in Data Table 1. Indicate the metal or metals that are more active than aluminum. (See the activity series below.)

Li - Lithium	
K - Potassium	
Ba - Barium	
Sr - Strontium	
Ca - Calcium	
Na - Sodium	
Mg - Magnesium	
Al - Aluminum	
Mn - Manganese	
Zn - Zinc	
Cr - Chromium	
Fe - Iron	
Cd - Cadmium	
Co - Cobalt	
Ni - Nickel	
Sn - Tin	
Pb - Lead	
H ₂ - Hydrogen	
Cu - Copper	
Ag - Silver	
Hg - Mercury	
Au - Gold	



Ag, Cu, Ca, Pb
More active: Calcium
Less active: Silver, Copper, and Lead

Use the activity series to determine whether aluminum would replace the metals in the chemical compounds listed in Data Table 1. Does the activity series' ability to predict whether or not a reaction will occur agree with your observations?

The activity series indicates that Al replaces Ag of AgNO₃. This agrees with the observed reaction.

The activity series indicates that Al replaces Cu of CuSO_4 . This agrees with the observed reaction.
 The activity series indicates that Al DOES NOT replace Ca of CaCl_2 . Al is less reactive than Ca and no reaction occurs. No reaction was observed.
 The activity series indicates that Al replaces Pb of $\text{Pb}(\text{NO}_3)_2$. This agrees with the observed reaction.

What are the potential sources of error that might cause disagreement between the activity series' prediction of reactions and your observations of reactions?

The solutions added to the aluminum were aqueous and some oxidation (rusting) of aluminum may have occurred. The aluminum foil used may not have been 100% pure and other metals or compounds may have been present.

Write a balanced equation for the reaction between silver nitrate and aluminum. What type of reaction is this?

$3\text{AgNO}_3(\text{aq}) + \text{Al}(\text{s}) \rightarrow \text{Al}(\text{NO}_3)_3(\text{aq}) + 3\text{Ag}(\text{s})$
 This reaction is a single displacement reaction.

Data Table 1: Observations of Chemical Reactions with Aluminium Foil
 (SAMPLE ANSWER BELOW)

	AgNO_3	CuSO_4	CaCl_2	$\text{Pb}(\text{NO}_3)_2$
Start Time	Student answers will vary			
Initial Appearance of Chemical	Very faint pink/brown color, clear	Pale blue, clear	Clear and colorless	Clear and colorless
Initial Appearance of Foil	Looks like a drop of water on normal, clean foil	Looks like a drop of light blue water on normal, clean foil	Looks like a drop of water on normal, clean foil	Looks like a drop of water on normal, clean foil
Observations after 5 Minutes	Bubbles form, silver-colored precipitate begins forming	Bubbles form, copper-colored precipitate begins forming	Appears as before	Bubbles form, dark grey precipitate begins forming
Observations after 3 Hours	Dried mass of silver-colored crystals	Dried mass of copper-colored crystals	Dried faint white crystals	Dried mass of dark grey crystals

Appearance of Foil after Rinsing	Foil has numerous pits and is eroded in places.	Foil has numerous pits.	No visible evidence of chemical	Foil has numerous pits.
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Exercise 2

Reviewing Data Table 2, what were the visual cues that chemical reactions occurred?

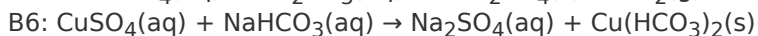
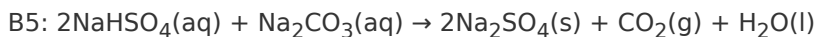
Change in color, formation of gas bubbles, formation of solid/precipitate.

Define a single displacement reaction and a double displacement reaction. Describe the similarities and differences between a single displacement reaction and a double displacement reaction.

In a displacement reaction, one chemical element displaces another in a chemical compound. There are two types of displacement reactions, single displacement and double displacement. In a single-displacement reaction, an uncombined element displaces an element in the compound. In a double-displacement reaction, two sets of atoms are displaced. The reactions are similar because because a new compound is formed in both. The reactions are different because one reactant of the single-displacement reaction is a pure substance not bonded within a compound, while both reactants of the double-displacement reaction are compounds.

Data Table 2 contains nine double displacement reactions. Write a balanced chemical equation for five of those reactions.

A1: $\text{NaHCO}_3(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{H}_2\text{CO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) + \text{NaCl}(\text{aq})$
A3: $2\text{KI}(\text{aq}) + \text{Pb}(\text{NO}_3)_2(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + 2\text{KNO}_3(\text{aq})$
A6: $\text{NaOH}(\text{aq}) + \text{AgNO}_3(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq}) + \text{AgOH}(\text{s})$
B1: $\text{AgNO}_3(\text{aq}) + \text{NH}_4\text{OH}(\text{aq}) \rightarrow \text{AgOH}(\text{s}) + \text{NH}_4\text{NO}_3(\text{aq})$
B2: $2\text{NH}_4\text{OH}(\text{aq}) + \text{CuSO}_4(\text{aq}) \rightarrow (\text{NH}_4)_2\text{SO}_4(\text{aq}) + \text{Cu}(\text{OH})_2(\text{s})$
B3: $\text{Pb}(\text{NO}_3)_2(\text{aq}) + \text{CaCl}_2(\text{aq}) \rightarrow \text{Ca}(\text{NO}_3)_2(\text{aq}) + \text{PbCl}_2(\text{s})$
B4: $\text{CaCl}_2(\text{aq}) + 2\text{NaHSO}_4(\text{aq}) \rightarrow \text{Ca}(\text{HSO}_4)_2(\text{s}) + 2\text{NaCl}(\text{aq})$



Which reactions produced a precipitate? Describe the observations when answering this question.

A3: The color becomes yellow and a cloudy precipitate forms

A6: A brown colored solution with brown, cloudy/milky precipitate is formed

B1: Forms white precipitate

B2: Dark blue precipitate

B3: Milky White Solution

B4: Almost appears oily when drops are added; clear, colorless solution; slowly forms a solid that settles.

B6: A white powder and a turquoise solution

Which reactions produced a color change? Describe the change in color for each of these reactions. (For example, the reactants were clear and colorless and the product was a bright pink solution.)

A2: The color is black/blue

A3: The color becomes yellow and a cloudy precipitate forms

A4: The color observed is bright pink.

A6: A brown colored solution with brown, cloudy/milky precipitate is formed

B1: Colorless, then brown/red

B2: Dark blue precipitate

B3: Milky White Solution

B6: A white powder and a turquoise solution

C1: dark green solution

C2: dark pink solution

Data Table 2: Reaction Observations
(SAMPLE ANSWER BELOW)

Well	Chemical #1 (4 drops)	Chemical #1 Appearance	Chemical #2 (4 drops)	Chemical #2 Appearance	Observations	Chemical Change (Yes/No)
A1	NaHCO ₃ Sodium Bicarbonate	Clear solution	HCl Hydrochloric Acid	Clear solution	Bubbles are formed	Yes
A2	IKI indicator	Brown solution	Starch	Colorless solution	The color is black/blue	Yes
A3	KI Potassium Iodide	Colorless solution	Pb(NO ₃) ₂ Lead(II) Nitrate	Colorless solution	The color becomes yellow and a cloudy precipitate forms	Yes
A4	NaOH Sodium Hydroxide	Colorless solution	C ₂₀ H ₁₄ O ₄ Phenolphthalein	Colorless solution	The color observed is bright pink	Yes
A5	HCl Hydrochloric Acid	Colorless solution	C ₂₀ H ₁₄ O ₄ Phenolphthalein	Colorless solution	Colorless Solution	No
A6	NaOH Sodium Hydroxide	Colorless solution	AgNO ₃ Silver(II) Nitrate	Colorless solution	A brown colored solution with brown, cloudy/milky precipitate is formed	Yes
B1	AgNO ₃ Silver Nitrate	Colorless solution	NH ₄ OH Aqueous Ammonia	Colorless solution	Observation 1: Forms white precipitate + Absorb in paper towel and expose to sunlight Observation 2: Colorless, then brown/red	Yes
B2	NH ₄ OH Aqueous Ammonia	Colorless solution	CuSO ₄ Copper(II) Sulfate	Blue Solution	Dark blue precipitate	Yes
B3	Pb(NO ₃) ₂ Lead Nitrate	Colorless solution	CaCl ₂ Calcium Chloride	Colorless solution	Milky White Solution	Yes
B4	NaHSO ₄ Sodium Bisulfate	Colorless solution	CaCl ₂ Calcium Chloride	Colorless solution	Almost appears oily when drops are added; clear, colorless solution; slowly forms a solid that settles.	Yes
B5	NaHSO ₄ Sodium Bisulfate	Colorless solution	Na ₂ CO ₃ Sodium Carbonate	Colorless solution	Tiny bubbles in clear, colorless solution	Yes
B6	CuSO ₄ Copper(II) Sulfate	Pale blue solution	NaHCO ₃ Sodium Bicarbonate	Colorless solution	A white powder and a turquoise solution	Yes
C1	Blue Dye #1	dark blue	HCl Hydrochloric	colorless solution	dark green solution	Yes

			Acid			
C2	Na ₂ CO ₃ Sodium Carbonate	colorless solution	C ₂₀ H ₁₄ O ₄ Phenolphthalein	colorless solution	dark pink solution	Yes

Competency Review

During a chemical reaction, atoms of chemicals ____.

- ☐ interact with one another
- ☐ rearrange to form new substances
- ☒ both interact with one another and rearrange to form new substances

✓

During a chemical reaction, ____ will yield ____.

- ☒ reactants; products
- ☐ products; reactants

✓

____ is NOT necessarily the result of a chemical reaction.

- ☐ A hard-boiled egg
- ☐ A fire
- ☒ Steam
- ☐ A rusted shovel

✓

A ____ is a change in the form or state of a substance.

- ☐ chemical change
- ☒ physical change
- ☐ reaction

✓

Choose the correct coefficients for the following reaction: ____ H_2 + ____ N_2 yields 2NH_3 .

- ☐ 2; 3
- ☐ 3; 2
- ☒ 3; 1
- ☐ 1; 2

____ is a combination reaction.

- ☐ 2NaCl yields $2\text{Na} + \text{Cl}_2$
- ☐ $\text{Li} + \text{NaCl}$ yields $\text{LiCl} + \text{Na}$
- ☒ $2\text{Na} + \text{Cl}_2$ yields 2NaCl

An activity series consists of ____ ordered by ____.

- ☐ compounds; activity
- ☐ elements; size
- ☒ elements; activity
- ☐ compounds; size

Observations are a descriptions of what happened and why.

- ☐ True
- ☒ False

A change in color can indicate a chemical reaction.

- ☒ True
- ☐ False

If a clear liquid is mixed with a green liquid and no noticeable changes are observed, the most appropriate observation would be ____.

- ☐ no reaction occurred
- ☒ the result was a green liquid and no observable changes occurred
- ☐ the clear reactant turned green

If two liquids are combined and a precipitate forms, it is likely that a chemical reaction has occurred.

- ☒ True
- ☐ False

When H_2SO_4 is mixed with NaOH , an acid-base neutralization reaction proceeds, and ____ is one of the products. Hint: Write the balanced equation before attempting to select an answer.

- ☐ H_3O
- ☒ Na_2SO_4
- ☐ Na_2S
- ☐ NaSO_3

List the coefficients for the reaction: $\text{C}_{10}\text{H}_8 + \text{O}_2$ yields $\text{CO}_2 + \text{H}_2\text{O}$.

- ☐ 1, 8, 6, 2
- ☒ 1, 12, 10, 4
- ☐ 1, 4, 6, 8
- ☐ 1, 10, 12, 8

Aluminum replacing a less active metal in a compound is classified as a ____ reaction.

- ☐ decomposition
- ☒ single displacement ✓
- ☐ combination
- ☐ double displacement
- ☐ neutralization

Chemical changes always occur very quickly, like explosions.

- ☐ True
- ☒ False ✓

Extension Questions

Give three examples each of physical and chemical changes you observed in the last 24 hours. Explain why you classified each example as physical or chemical. (SAMPLE ANSWER BELOW)

Three chemical changes and three physical changes must be listed in your answer. After each, an explanation must be included as to why the change is categorized as physical or chemical. For example, making ice cubes is a physical change because the water molecules only change from liquid to solid, while vehicle exhausts are the result of chemical changes because the fuel is broken down into carbon dioxide, water vapor, and other gases.