SI Chemistry - Full Discipline Demo

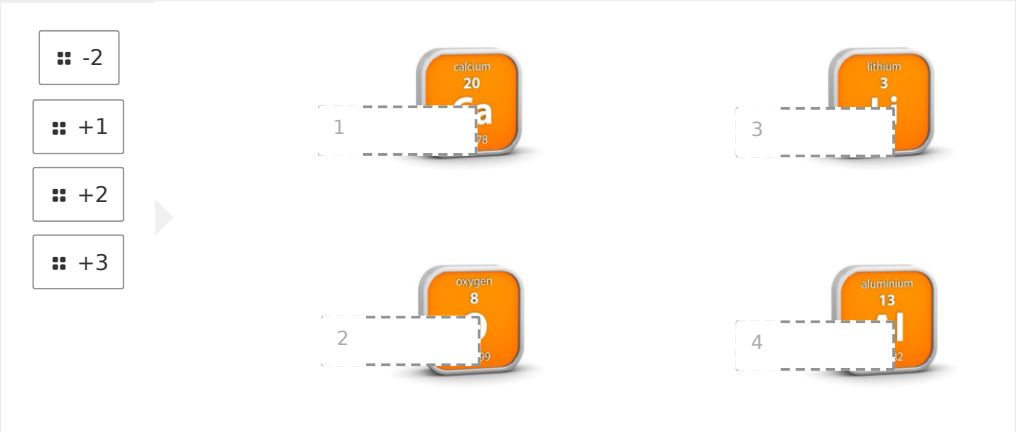
Anions, Cations, and Ionic Reactions

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

Label each element with the charge of the ion that it tends to form.



Correct answers:

1 +2 2 -2 3 +1 4 +3

Match each term with the best description.

Cation | Group | Ion | Metal | Negative | Positive

Elements with similar chemical properties are found in a(n) 1 on the periodic table.

An element that is malleable and ductile is likely to be a(n) 2.

When an atom loses electrons, it forms a positively-charged particle called a(n) 3.

4 is the term used for any charged particle.

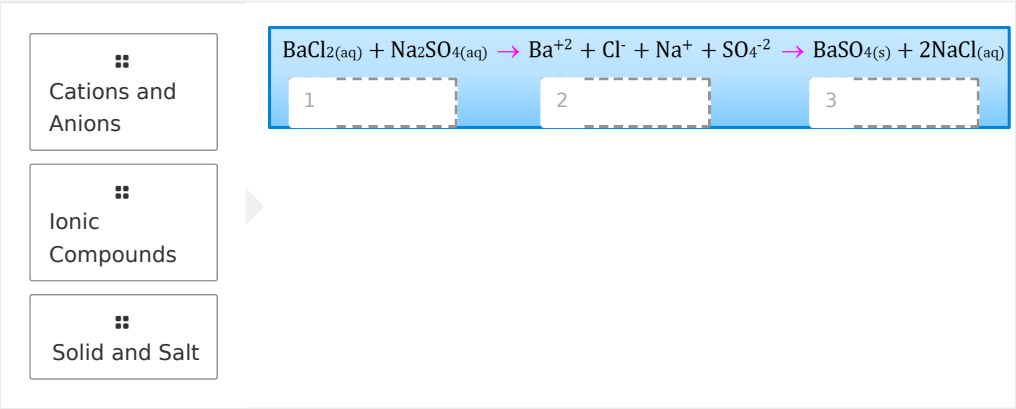
Metals tend to form ions with a(n) 5 charge.

Anions are particles with a(n) 6 charge.

Correct answers:

1 Group 2 Metal 3 Cation 4 Ion 5 Positive 6 Negative

Label the components of the double displacement reaction.



Correct answers:

1 Ionic Compounds 2 Cations and Anions 3 Solid and Salt

Exploration

A cation is an element that _____ one or more electrons to form _____ ions.

- loses; positive ✔
- loses; negative
- gains; positive
- gains; negative

Group 2 on the periodic table of elements includes alkaline earth metals that readily form ions with a _____ charge.

- +1
- +2 ✔
- +4
- -1
- -2
- -4

A hallmark of many ionic compounds is their ability to dissolve in water through a process called _____.

- anion mixing
- cation mixing
- hydration ✔
- humidification
- reactivation

Ionic compounds are chemical compounds in which the anion and cation are held together by strong electrostatic attractions in a lattice structure.

- True ✔
- False

A double displacement reaction occurs when _____.

- two anions form an ionic bond
- the reactants, a salt and a solid, share ions
- the anions and cations of ionic compounds switch places ✔
- hydration replaces two cations

In an ionic reaction, spectator ions are not involved in the production of _____.

- a precipitate
- a gas
- water
- All of the above ✔

Confirmation tests are _____.

- qualitative tests to identify anions and cations in unknowns ✔
- quantitative tests to identify anions and cations in unknowns
- always performed with hydrochloric acid

Exercise 1

What was the identity of the anion in Unknown #103? Explain how you used the observations recorded in Data Table 1 to reach this conclusion.

The identity of the anion in Unknown #103 was carbonate. The observation that a precipitate formed upon addition of silver nitrate, followed by the evolution of gas bubbles (CO_2) upon addition of the hydrochloric acid allowed me to identify the unknown as carbonate.

What was the identity of the anion in Unknown #104? Explain how you used the observations recorded in Data Table 1 to reach this conclusion.

The identity of the anion in Unknown #104 was sulfide. The observation that a dark brown precipitate was formed upon
addition of silver nitrate allowed me to identify the unknown as sulfide.

Write the chemical equation for the ionic reaction between Na_2S and $AgNO_3$.

$Na_2S(aq) + 2\ AgNO_3(aq) \rightarrow Ag_2S(s) + 2\ NaNO_3(aq)$

Write the chemical equation for ionic reaction between NaBr and $AgNO_3$.

$NaBr(aq) + AgNO_3(aq) \rightarrow AgBr(s) + NaNO_3(aq)$

Date Table 1: Anion Confirmation Tests
(SAMPLE ANSWER BELOW)

Chemical	Anion	Observations: Addition of $AgNO_3$	Observations: Addition of HCl
NaBr	Bromide	Formation of a yellow-white precipitate	No observable change
Na_2CO_3	Carbonate	Formation of a white precipitate	Formation of gas bubbles
NaCl	Chloride	Formation of a bright white precipitate	No observable change
NaI	Iodide	Formation of a bright yellow precipitate	No observable change
Na_2SO_4	Sulfate	No observable change	Formation of a bright white precipitate
Na_2S	Sulfide	Formation of a dark brown precipitate	
Unknown #103	Carbonate	Formation of a white precipitate	Formation of gas bubbles
Unknown #104	Sulfide	Formation of a dark brown precipitate	No observable change

Exercise 2

What was the identity of the cation in Unknown #105? Explain how you used the observations recorded in Data Table 2 to reach this conclusion.

The identity of the cation in Unknown #105 was copper. The green-colored flame that appeared when the Unknown was
placed into the flame allowed for this conclusion.

If you were asked to confirm the identity of an unknown chemical such as lithium sulfide (Li_2S), describe the tests that you would use to confirm the identity. Use your results in both Exercise 1 and Exercise 2 to describe the observations in both the cation and anion tests that would allow the unknown to be confirmed as lithium sulfide.

If I were asked to confirm the identity of an unknown chemical that is suspected to be Lithium Sulfide, I would first add to the
unknown silver nitrate. If a brown precipitate was formed, then it would appear the unknown anion is sulfide. I would then place a pea-sized amount of the unknown into the flame and look for a red colored flame. If the flame did appear red then it would appear that the unknown cation was lithium.

Data Table 2: Cation Flame Tests
(SAMPLE ANSWER BELOW)

Chemical	Cation	Observations: Flame Test
KI	Potassium	Creates a violet/purple-colored flame
$CaCl_2$	Calcium	Creates an orange-colored flame
LiOH	Lithium	Creates a red-colored flame
NaCl	Sodium	Creates a yellow-colored flame
$Cu(NO_3)_2$	Copper	Creates a green-colored flame
Unknown #105	Copper	Creates a green-colored flame
Unknown #106	Potassium	Creates a violet/purple-colored flame
Unknown #107	Calcium	Creates an orange-colored flame

Data Table 3: Complete Chemical Identification
(SAMPLE ANSWER BELOW)

Chemical	Cation	Anion Test Observations	Anion	Complete Chemical Name and Formula
Unknown #106	Potassium	Upon addition of silver nitrate, a bright-yellow precipitate was formed. Upon addition of hydrochloric acid, there was no evidence of bubble formation.	Iodide	Potassium Iodide KI
Unknown #107	Calcium	Upon addition of silver nitrate, a bright-white precipitate was formed. Upon addition of hydrochloric acid, there was no evidence of bubble formation.	Chloride	Calcium Chloride CaCl2

Competency Review

When an element _____ one or more electrons, it becomes a negatively charged particle called a(n) _____.

- gains; anion ✔
- gains; cation
- loses; anion
- loses; cation

A bromide ion has a charge of _____.

- -2
- -1 ✔
- 0
- +1
- +2

Group 1 of the periodic table of elements includes alkali metals that readily form ions with a _____ charge.

- -2
- -1
- 0
- +1 ✔
- +2

A double displacement reaction can generate products, including a precipitate, a gas, or a salt and water.

- True ✔
- False

In an ionic compound, the _____ is listed first, followed by the _____.

- cation; anion ✔
- anion; cation
- salt; water
- water; salt

In the compound NaCl, chlorine is the _____.

- anion ✔
- cation
- spectator ion

When NaI and $AgNO_3$ are mixed, _____.

- no reaction occurs
- a reaction occurs, as indicated by a precipitate ✔

How might a scientist identify the anion of an unknown substance?

- Perform flame tests.
- Perform a series of reactions with known substances and compare these to reactions with the unknown. ✔
- Write formulas for chemical compounds and label the charges of the anions and cations.

How might a scientist identify the cation of an unknown substance?

- Perform flame tests. ✔
- Perform a series of reactions with known substances and compare these to reactions with the unknown.
- Write formulas for chemical compounds and label the charges of the anions and cations.

An effective way to identify the anion and cation of an unknown ionic compound is to perfom confirmation tests using both flame tests and known reactions.

- [x] True
- [ ] False

Extension Questions

A solution containing an ionic compound is subjected to the anion and cation confirmation tests performed in this experiment, providing the following results:

- **Addition of silver nitrate: a bright yellow precipitate formed.**
- **Flame test: a purple color was observed.**

Identify the ionic compound and write the chemical reaction that occurs when the ionic compound interacts with the silver nitrate. Identify the spectator ions.

(SAMPLE ANSWER BELOW)

$\mathrm{KI(aq) + AgNO_3(aq) \rightarrow K^+I^- + Ag^+NO_3^- \rightarrow AgI(s) + KNO_3(aq)}$

K^+ and NO_3^- are spectator ions