

Chemical Analysis

Level: S.3

Subject: Chemistry

Topic: Chemical Analysis

Introduction:

This set of ELA materials in Chemistry was developed for a group of 40 S3 students voluntarily participating in an after-school English Enhancement Course. The materials, consisting of a lesson plan, PowerPoint slides and worksheets, are designed for a one-hour lesson to review various tests for chemical analysis. The content of the ELA lesson is a re-organization of the topic “Chemical Analysis” covered through the medium of Chinese in S2 and S3 (1st term) science classes. Through the ELA, students learn how to describe chemical tests in English and solve problems with the tests.

ELA Lesson Plan – Chemical Analysis

- Description: This ELA covers the tests for chemical analysis mentioned in Section 7.1, Unit 7 and Section 10.3, Unit 10 of the CDC Science syllabus, as well as in Section 1 of the CDC S.4 – 5 Chemistry syllabus. The suggested activities integrate the different chemical tests which students have learned using Chinese as the medium of instruction and require them to apply their knowledge and understanding in ‘Chemical Analysis’. A series of writing tasks is provided to give students’ the opportunity to practice writing about science in English. At the end of the ELA, a class exercise with problem-solving questions is provided to consolidate students’ learning.
- Content Objectives: After completing the activity, students should be able to:
- understand the procedure of some tests for chemical analysis,
 - know the results of some chemical tests,
 - identify unknown substances from test results.
- Language Objectives: After completing the activity, students should be able to:
- understand and use the English terms related to chemical analyses (e.g., *chemical analysis, chemistry, process, identify, sample, composition, compound, flame test, flame colour, sodium chloride, potassium chloride, calcium chloride, lithium chloride, lilac, pale purple, brick red,*
 - understand and use the correct English expressions for discussing the key ideas, e.g.,
 - *Chemical analysis is an important part of chemistry. It is a process to identify a sample or to find its composition.*
 - *The flame test is a chemical test for metals and metal compounds. When heated strongly, some metals and metal compounds produce light of special colours. The flame test is based on this principle.*
 - use the imperative or the passive voice to describe the procedure of some tests for chemical analysis, e.g.,
 1. *Clean a platinum wire with concentrated hydrochloric acid.*
 2. *Dip the clean wire into a crushed sample to be tested.*
 3. *Heat the sample on the wire strongly in a non-luminous flame.*
 4. *Observe the colour of the flame at the wire.*
 - use a IF clause to state the unknown substances identified from test results, e.g.,
 - *If a ‘pop’ sound is heard when a burning splint is put in a gas, the gas is hydrogen.*
 - *If the colour of the flame is lilac, the sample contains potassium. The flame colour of a metallic compound*

depends mainly on the metallic element composing it.

- *If dry cobalt chloride paper turns from blue to red, water is present in the sample.*
 - *If anhydrous copper (II) sulphate powder turns from white to blue, water is present in the sample.*
 - *If the glowing splint relights in a gas, the gas is oxygen.*
 - *If limewater turns from colourless to milky white, the gas is carbon dioxide.*
 - *If hydrogencarbonate indicator turns from red to yellow, the gas is carbon dioxide*
 - *If limewater turns from colourless to milky white, the gas is carbon dioxide and the sample contains carbonates.*
- write a short description to show how to identify calcium carbonate powder, e.g.,

A flame test can be used to test for calcium. Some sample powder is put into a non-luminous flame. Then, the colour of the flame produced by the sample is observed. If the colour is brick red, the sample powder contains calcium.

The presence of carbonates can be tested with dilute acid and limewater. Some sample powder is added into a dilute acid (e.g. dilute hydrochloric acid). If a gas is produced, it is tested by limewater. If limewater turns from colourless to milky white, the gas is carbon dioxide and the sample contains carbonates.

- Activities:
1. Reviewing tests for Chemical Analysis – whole – class activity with individual work (40 - 45 min)
 2. Exercise – individual work (15 - 20 min)

- Materials:
- 1 set of PowerPoint slides [Set1: *Chemical Analysis (teacher version)*]
 - 2 worksheets (WS1: *Chemical Analysis*, WS2: *Chemical Analysis slides* (A student version of the PowerPoint slides))
 - 1 class exercise
 - Apparatus for demonstration:
 - 2 stoppered boiling tube filled with oxygen
 - 1 stoppered boiling tube filled with hydrogen
 - Several wooden splints
 - 1 box of matches

Remark: Some spare boiling tubes filled with oxygen and hydrogen may be prepared.

Steps:

1. The teacher should start by stating the learning objectives of the lesson and explaining how it relates to what students are learning in their junior form science classes.
2. The teacher should then use the first slide of PowerPoint Set 1 to introduce the purposes of Chemical Analysis, highlighting the key phrases (*find the composition of a sample, identify a sample*) and asking students to note them on Worksheet 2 (WS2 – the students' version of the PowerPoint slides)..

Refer to Teacher's note (TN1)

Reviewing the flame test

3. The teacher goes through Slides 2 and 3 of PowerPoint Set 1 to review the flame test, using the flame test for potassium as an example, highlighting the key words and phrases (*platinum wire, non-luminous flame, lilac, potassium*) and asking students to note them on WS2.
4. The teacher then asks students to complete the Description in Item 1 of Worksheet 1 (WS1) with the key words and phrases.
5. In checking the answers, teachers should read aloud the description to be completed and ask students to provide the words and phrases to complete the blanks. After checking the answers, the teacher can ask a student or the whole class to read the completed description once.

Refer to Teacher's note (TN2)

6. The teacher can then play a video clip showing other examples of flame tests by clicking "Demo" in Slide 3 of the PowerPoint presentation and ask students to complete the table in Item 1 of WS1 after watching it.

Refer to Teacher's note (TN3)

7. After checking the answers, the teacher should guide students to generalize from the results of the flame tests that the colour of the flame of a compound depends mainly on the metallic element composing it. Then, discuss the differences between a description and a set of procedure for a test – i.e. the first describes the stages of the test, while the second provides instructions for carrying out the test.

Reviewing the tests for water

8. Using Slide 4 of PowerPoint Set 1, the teacher then reviews the tests for water. An animation can be shown to demonstrate the use of anhydrous copper (II) sulphate to test for water by clicking "Demo" in Slide 4 of the presentation. The teacher should highlight the key phrases (*dry cobalt chloride paper, anhydrous copper (II) sulphate*) and ask students to note them on WS2.
9. The teacher then asks students to complete the Description in Item 2 of WS1 with the key phrases, encouraging them to follow the sentence pattern of the answer in (a) in answering (b).
10. The answers can be checked following the procedure described in point 5 above.

Reviewing the tests for oxygen with a student demonstration

11. The teacher should then use Slides 5 and 6 of PowerPoint Set 1 to review the tests for oxygen, highlighting the key words and phrases (*glowing splint, relight, burning splint, burn more brightly*) and asking students to note them on WS2.
12. The teacher should nominate a student to demonstrate the tests in front of the class and ask the student to describe the test results in English using the key words and phrases.
13. The teacher should discuss with the class the test to be used if they wish to see a more prominent result. Students should then complete the Description in Item 3 of WS1 with the key words and phrases used for describing the preferred test and the teacher can check the answers using the established procedure.

Reviewing the test for hydrogen with a student demonstration (or a video demonstration)

14. The teacher should use Slide 7 of PowerPoint Set 1 to review the test for hydrogen, highlighting the key phrase (*'pop' sound*) and asking students to note it on WS2.
15. A student should be nominated to demonstrate the test in front of the class. (Alternatively, a video clip demonstrating the test for hydrogen can be played by clicking "Demo" in Slide 7). The student should be asked to describe the test results in English using the key phrase.
16. Students should be asked to complete the Description in Item 4 of WS1 with the key phrase, and encouraged to follow the sentence pattern used in the description of the test for oxygen.
17. The answers can be checked in the established way.

Reviewing the tests for carbon dioxide

18. In the same way, the teacher uses Slide 8 of PowerPoint Set 1 to review the tests for carbon dioxide, highlighting the key words and phrases (*limewater, hydrogencarbonate indicator, milky white*) and asking students to note them on WS2.
19. Students should be asked to complete the Description in Item 5 of WS1 with the information given in Slide 8 and encouraged to follow the sentence pattern of the answers in Item 2 before the answer are checked.

Reviewing the test for carbonate ion

20. The teacher then uses Slide 9 of PowerPoint Set 1 to review the test for carbonate ion, highlighting the key phrase (*dilute hydrochloric acid*) and asking students to note it on WS2.
21. Students are asked to complete the Description and the Procedure in Item 6 of WS1 with the information given in Slide 9 and Item 5 (Tests for carbon dioxide) and the answers checked as before.

Reviewing the test for chloride ion

22. The teacher then uses Slide 10 of PowerPoint Set 1 to review the test for chloride ion, playing a video clip to demonstrate the test by clicking “Demo” in Slide 10. As before, the teacher should highlight the key words and phrases (*nitric acid, silver nitrate, white precipitate*) and ask students to note them on WS2.

Refer to Teacher’s note (TN4)

23. The teacher then asks students to complete the Description in Item 7 of WS1 with the key words and phrases and encourages them to follow the sentence pattern of the answers in previous items.
24. The answers can then be checked.

Classwork exercise – individual work (15 - 20 min)

25. The teacher should explain Question 1 and work out Sample A with the students as an example.
26. The students should be asked to work out the answers for Samples B and C.
27. After checking the answers, as a way of doing so, some students can be invited to report their answers and give justifications for them.
28. The teacher should explain Question 2, reminding students that no ONE test can provide enough information for identifying calcium carbonate.
29. The teacher then encourages students to discuss the question with their neighbours and write their answers with the aid of diagrams.
30. The teacher should spend time checking students’ work as they write and when they have finished, invite some students to read their descriptions to the class and give explanation as necessary.

Teacher’s notes

TN1: The procedure of highlighting the key words or phrases for students to note them on WS2 is a common step followed in the revision of each test in these materials.

TN2: This procedure helps to engage all students in listening and reading a complete description of a test. The same procedure is repeated in checking the answers for each test.

TN3: The ‘Demo’ links to a video clip showing the flame test for sodium, potassium and lithium chloride. For the calcium chloride flame test, an image can be found at <http://www.dkimages.com/discover/DKIMAGES/Discover/Home/Science/Physics-and-Chemistry/Experiments/General/General-277.html>

TN4: Teachers may ask students

1. What chemicals are used in the test?
2. Is the test done safely? Why and why not?

(Safety precautions such as wearing gloves and transferring solution with a dropper are missing.)

S3 Chemical Analysis

Chemical analysis is an important part of chemistry. It is a process to identify a sample or to find its composition.

1. The flame test – a chemical test for metals and metal compounds

When heated strongly, some metals and metal compounds produce light of special colours. The flame test is based on this principle.

Description

In a flame test, a sample is put into a _____ flame. Then, the _____ of the flame produced by the sample is observed.

For example, if the _____ of the flame is _____, the sample contains _____.

Compound	Flame colour
Sodium chloride	
Potassium chloride	lilac / pale purple
Calcium chloride	
Lithium chloride	

Note: Although all the metallic compounds above are chlorides, they show different colours in the flame test. This implies that the flame colour of a metallic compound depends mainly on the _____ composing it.

Procedure

1. Clean a platinum wire with concentrated hydrochloric acid.
2. Dip the clean wire into a crushed sample to be tested.
3. Heat the sample on the wire strongly in a non-luminous flame.
4. Observe the colour of the flame at the wire.

2. Test for water

Water is a colourless liquid. There are many other liquids which are colourless too.

Description

To tell whether a given sample contains water, the sample can be tested by dry cobalt chloride paper or anhydrous copper (II) sulphate powder.

- a) Dry cobalt chloride paper

If the cobalt chloride paper turns from _____ to _____, water is present in the sample.

- b) Anhydrous copper (II) sulphate powder

If _____, _____.

3. Test for oxygen

Oxygen supports burning (combustion). It allows substances to burn in it. Substances burn faster in pure oxygen than in air.

Description

We can use a _____ splint to test for oxygen. If the _____ splint _____ in a gas, the gas is oxygen.

1. Test for hydrogen

Hydrogen is a colourless gas. It reacts violently with oxygen to form water. It is the lightest gas and almost insoluble in water.

Description

We can use _____

4. Test for carbon dioxide

Carbon dioxide is a colourless gas. It reacts with limewater (calcium hydroxide solution) and hydrogencarbonate indicator (Bicarbonate indicator).

Description

Passing a gas through limewater or hydrogencarbonate indicator can test whether it is carbon dioxide.

a) Limewater

If _____, _____.

b) Hydrogencarbonate indicator

_____.

5. Test for carbonates

Many carbonates react with dilute acids to produce carbon dioxide.

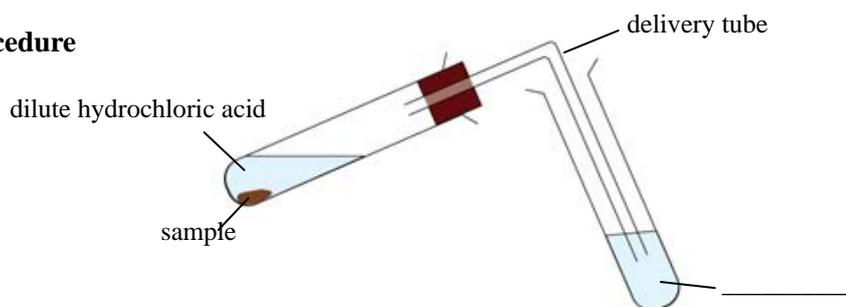
Description

A sample is added into a dilute acid and the gas produced is tested by _____.

If _____, _____.

_____.

Procedure



1. Add some _____ to the sample in a test tube.
2. Quickly stopper the tube with a rubber stopper carrying a _____. Pass any gas produced into _____.
3. Observe any change in the _____.

6. Test for chlorides

Chlorides are present in sea water. They react with silver nitrate to produce white precipitate.

Description

Adding _____ to a sample can test whether the sample contains _____.

If _____, _____.

Exercise

1. Given the results of the following tests, suggest what samples A, B and C are.

	Sample A	Sample B	Sample C
Flame test	Lilac flame	brick red flame	golden yellow flame
Add acidified silver nitrate to the solution	No precipitate is formed	A white precipitate is formed	No precipitate is formed
Add hydrochloric acid to the powder	Bubbles evolved	No observable change	Bubbles evolved

What are samples A, B and C ?

2. With the aid of diagrams, briefly describe how to identify calcium carbonate powder.

Chemical analysis is an important part of chemistry. It is a process to identify a sample or to find its composition.

2. The flame test – a chemical test for metals and metal compounds

When heated strongly, some metals and metal compounds produce light of special colours,. The flame test is based on this principle.

Description

In a flame test, a sample is put into a non-luminous flame. Then, the colour of the flame produced by the sample is observed.

For example, if the colour of the flame is lilac, the sample contains potassium.

Compound	Flame colour
Sodium chloride	yellow
Potassium chloride	lilac / pale purple
Calcium chloride	brick red
Lithium chloride	red

Note: Although all the metallic compounds above are chlorides, they show different colours in the flame test. This implies that the flame colour of a metallic compound depends mainly on the metallic element composing it.

Procedure

- Clean a platinum wire with concentrated hydrochloric acid.
- Dip the clean wire into a crushed sample to be tested.
- Heat the sample on the wire strongly in a non-luminous flame.
- Observe the colour of the flame at the wire.

3. Test for water

Water is a colourless liquid. There are many other liquids which are colourless too.

Description

To tell whether a given sample contains water, the sample can be tested by dry cobalt chloride paper or anhydrous copper (II) sulphate powder.

a) Dry cobalt chloride paper

If the cobalt chloride paper turns from blue to red, water is present in the sample.

b) Anhydrous copper (II) sulphate powder

If anhydrous copper (II) sulphate powder turns from white to blue, water is present in the sample.

4. Test for oxygen

Oxygen supports burning (combustion). It allows substances to burn in it. Substances burn faster in pure oxygen than in air.

Description

We can use a glowing splint to test for oxygen. If the glowing splint relights in a gas, the gas is oxygen.

5. Test for hydrogen

Hydrogen is a colourless gas. It reacts violently with oxygen to form water. It is the lightest gas and almost insoluble in water.

Description

We can use a burning splint to test for hydrogen. If a pop sound is heard when a burning splint is put in a gas, the gas is hydrogen.

6. Test for carbon dioxide

Carbon dioxide is a colourless gas. It reacts with limewater (calcium hydroxide solution) and hydrogencarbonate indicator (Bicarbonate indicator).

Description

Passing a gas through limewater or hydrogencarbonate indicator can test whether it is carbon dioxide.

a) Limewater

If limewater turns from colourless to milky white, the gas is carbon dioxide.

b) Hydrogencarbonate indicator

If hydrogencarbonate indicator turns from red to yellow, the gas is carbon dioxide.

7. Test for carbonates

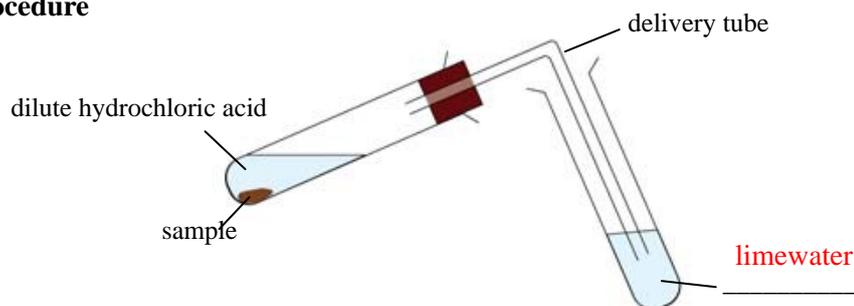
Many carbonates react with dilute acids to produce carbon dioxide.

Description

A sample is added into a dilute acid and the gas produced is tested by limewater.

If limewater turns from colourless to milky white, the gas is carbon dioxide and the sample contains carbonates.

Procedure



1. Add some dilute hydrochloric acid to the sample in a test tube.
2. Quickly stopper the tube with a rubber stopper carrying a delivery tube. Pass any gas produced into limewater.
3. Observe any change in the colour of the limewater.

8. Test for chlorides

Chlorides are present in sea water. They react with silver nitrate to produce white precipitate.

Description

Adding silver nitrate to a sample can test whether the sample contains chlorides.

If white precipitate is formed, the sample contains chlorides.

Exercise

1. Given the results of the following tests, suggest what samples A, B and C are.

	Sample A	Sample B	Sample C
Flame test	Lilac flame	brick red flame	golden yellow flame
Add acidified silver nitrate to the solution	No precipitate is formed	A white precipitate is formed	No precipitate is formed
Add hydrochloric acid to the powder	Bubbles evolved	No observable change	Bubbles evolved

What are samples A, B and C ?

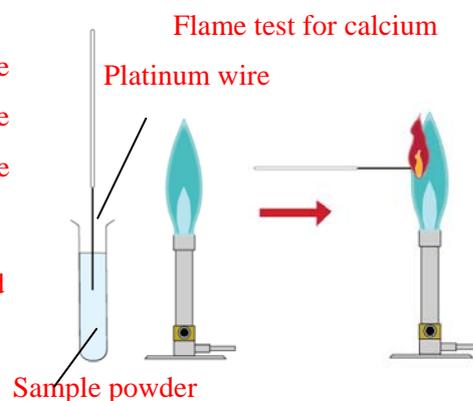
Sample A is potassium carbonate. Sample B is calcium chloride.

Sample C is sodium carbonate.

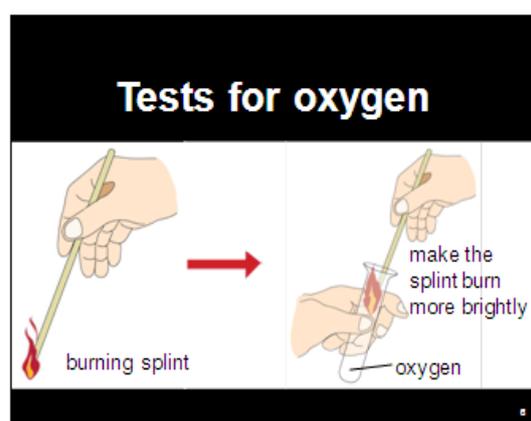
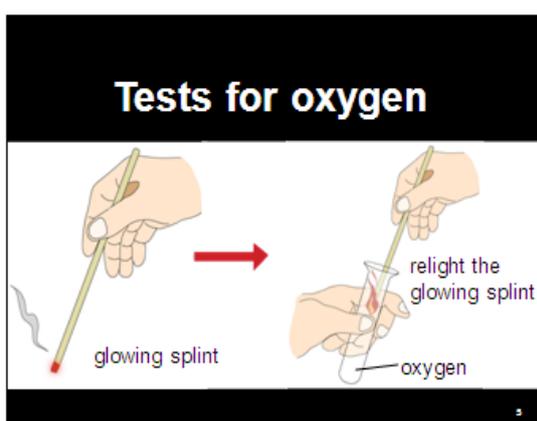
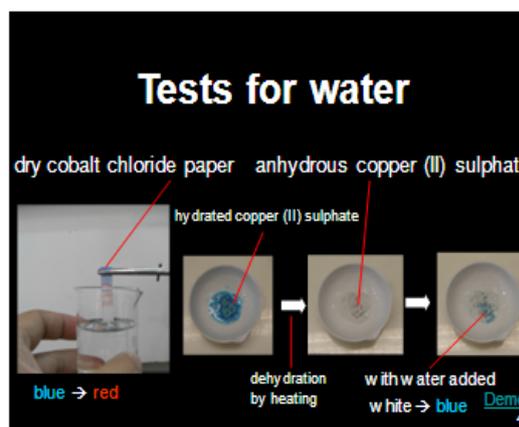
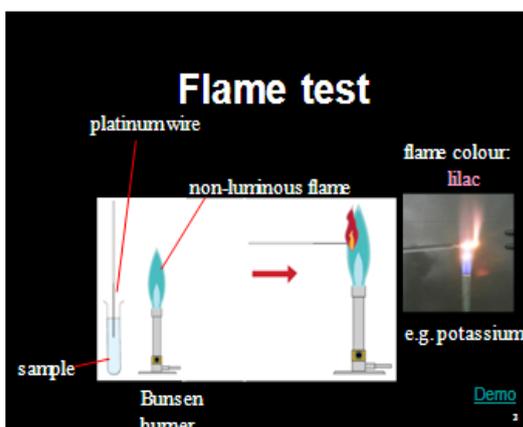
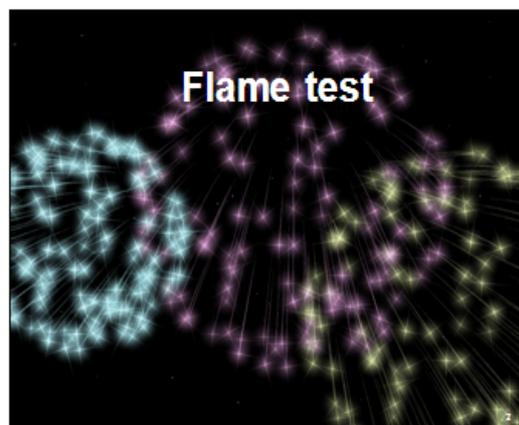
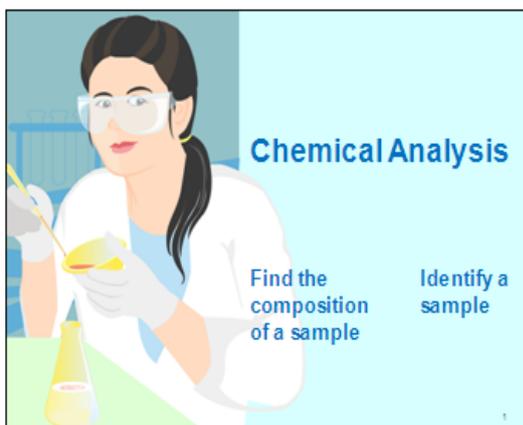
2. With the aid of diagrams, briefly describe how to identify calcium carbonate powder.

A flame test can be used to test for calcium. Some sample powder is put into a non-luminous flame. Then, the colour of the flame produced by the sample is observed. If the colour is brick red, the sample powder contains calcium.

The presence of carbonates can be tested with dilute acid and limewater. Some sample powder is added into a dilute acid (e.g. dilute hydrochloric acid). If a gas is produced, it is tested by limewater. If limewater turns from colourless to milky white, the gas is carbon dioxide and the sample contains carbonates.



PowerPoint Slides Set 1 Chemical Analysis (Teacher version)



Test for hydrogen

pop

burning splint

hydrogen

[Demo](#)

7

Tests for carbon dioxide

limewater

limewater

carbon dioxide

shake gently

colourless → milky white

hydrogencarbonate indicator

hydrogencarbonate indicator

carbon dioxide

shake gently

red → yellow

8

Test for carbonates

dilute hydrochloric acid

sample

delivery tube

limewater

9

Test for chlorides

nitric acid

sample with chlorides

silver nitrate

white precipitate

[Demo](#)

10

化學分析 Chemical Analysis

找出樣本成分 辨別樣本

1

焰色試驗 Flame test

焰色試驗 Flame test

潔淨的鉑金屬線

無光焰 (藍色火焰)

本生燈

樣本

焰色為遠紫色

例：鉀

示範 3

水的試驗方法 Tests for water

乾燥的氯化鈷試紙

無水硫酸銅

含水硫酸銅

加熱脫水

沾水後

藍 → 紅

白 → 藍 示範 4

氧的試驗方法

Tests for oxygen

帶星火的木條

令木條重燃

氧

5

氧的試驗方法

Tests for oxygen

燃燒中的木條

令木條更劇烈地燃亮

氧

6

氫的試驗方法

Test for hydrogen

燃燒中的木條

氫

7

二氧化碳的試驗方法

Tests for carbon dioxide

石灰水

碳酸氫鹽指示劑

二氧化碳

輕輕地搖動

無色 → 乳白色

紅 → 黃

8

氯化物的試驗方法 Test for chlorides

硝酸

硝酸銀

白色沉澱物

含氯化物的樣本

10

碳酸鹽的試驗方法 Test for carbonates

稀鹽酸

樣本

導管

石灰水

9