

Silicate Garden



Chemistry

Science

Grade 10-12

Chemistry Lab

Individual or teams of 2

DESCRIPTION

Small colorful gardens can be created by adding crystals of various salts to a sodium silicate solution. In this exercise, students will have an opportunity to create these tiny gardens.

LEARNING OUTCOMES

Students will:

- learn the chemistry involved in stalagmite formation

READINESS ACTIVITIES

Teachers should:

- check the availability of the salt crystals required for the exercise

MATERIALS

- commercial sodium silicate solution (water glass)
- distilled water
- crystals of hydrated forms (see instructions)
- small jars or vials, covered or uncovered

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Science involved

When crystals of various salts are added to a sodium silicate solution, colorful plant-like extensions grow from the surface of each crystal. There is actually a lot of chemistry involved in the process. As the salts dissolve, the metal ions combine with silicate ions and form membranes of **insoluble** silicates around the crystals. The inside of the membranes contains lower water concentrations and higher salt concentrations than the outside, so water passes inward by **osmosis**. This causes breaks in the membrane and formation of more membrane surface. The metal dissolves in the water and expands forming **stalagmites**. Growth occurs in an upward direction.

Salt Crystals

These are the best crystals for silicate gardens. Beside the name of each crystal is the color of extension that grows from it.

aluminum(III) chloride (AlCl_3) - white
cobalt(II) chloride (CoCl_2) - dark blue
chromium(III) chloride (CrCl_3) - dark green
copper(II) chloride (CuCl_2) - light blue-green
iron(III) chloride (FeCl_3) - yellow
tin chloride (SnCl_4) - white

iron(II) sulfate (FeSO_4) - grayish white
nickel(II) sulfate (NiSO_4) - green
aluminum(III) nitrate [$\text{Al}(\text{NO}_3)_3$] - white
cobalt(II) nitrate [$\text{Co}(\text{NO}_3)_2$] - dark blue
nickel(II) chloride (NiCl_2) - light green
chromium(III) nitrate [$\text{Cr}(\text{NO}_3)_3$] - dark
green

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Caution

Some of the compounds in this lab are very dangerous when not handled properly. For example:

Aluminum chloride is caustic and can cause burns to the skin

Chromium nitrate is a cancer-suspect agent. Avoid contact or inhalation

Copper compounds are harmful if taken internally. Dust from these compounds can irritate mucous membranes

Nickel salts or solutions can irritate the eyes upon contact. The compounds are toxic if ingested. Nickel salts are suspected carcinogens

Tin(IV) chloride is corrosive and can cause burns to the skin on prolonged contact

Water glass is a strongly alkaline solution and is caustic to skin and mucous membranes

Please handle all materials with care

Procedure

1. Pour the sodium silicate into the vials or jars. It might be a good idea to dilute with distilled water.
2. Choose a variety of different types of crystals to allow the garden to be as colorful as possible. *Handle all compounds with care.*
3. Drop the crystals of the salts into the solution and distribute them evenly on the bottom of the beaker.
4. The reaction should start to occur almost immediately. Allow it to continue for several days without disturbing the vial.

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5. The color of each column is determined by the identity of the salt crystal. Once the garden has grown, the cap can be taken off, allowing the solution to evaporate leaving the crystal garden.
6. Dispose of the garden by flushing down the drain with water.

Glossary of Terms

insoluble	not capable of being dissolved in some liquid
osmosis	tendency of liquids to pass through a porous membrane or partition that separates them
stalagmites	a cone of carbonate of lime which gradually forms a column

Information from

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References

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