Teacher and Technician sheet

In this practical students will:

- Set up the practical enquiry for growing crystal gardens, ensuring that the experiment is fair.
- Report on the size, colour and rate of growth for the different crystals.
- Use their scientific knowledge and understanding to explain the results of the experiment.

Introduction for Teachers:

This is a nice experiment and an old one. Many a teacher will probably remember making a crystal garden. Yet it continues to fascinate young students. The chemistry can be a little difficult for primary level but using the garden and seeds analogy is a good one to enable a simple explanation to be attempted. For secondary level they should be able to understand some of the chemistry involved.

It can be introduced as a 'fun' lesson or be used at a science club session. The best discussions take place after they have done the experiment and the students can observe the growth of the crystals. The students need to be warned that the growth is not immediate and it takes about a week to see the full effects but during the lesson they may see some growth.

The jars should be moved as little as possible once the chemicals are placed into them.

Curriculum Range:

It is applicable for upper primary and lower secondary dependent upon the chemical used. . It links with:

- Setting up simple practical enquiries, comparative and fair tests;
- Reporting on findings from enquiries and observations, including oral and written explanations, displays or presentations of results and conclusions;
- Using straightforward scientific evidence to answer questions or to support their findings;
- Ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience;
- Use appropriate techniques, apparatus, and materials during laboratory work, paying attention to health and safety;
- Make and record observations using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements;
- Present observations using appropriate methods;
- Interpret observations and identify patterns using those observations to draw conclusions;

- Present reasoned explanations, including explaining data in relation to predictions and hypotheses;
- Learn about the concept of dissolving of metal salts to form silicates.

Hazard warnings:

Potassium aluminium sulfate is of NO SIGNIFICANT HAZARD

Sodium silicate solution is of NO SIGNIFICANT HAZARD (but it is sensible to wear eye protection given its alkaline nature)

Iron aluminium sulphate is a SKIN AND EYE IRRITANT.

Iron(II) sulphate, copper(II) sulphate, and calcium nitrate are IRRITANTS (CATEGORY 2) and Harmful if swallowed (ACUTE TOXINS CATEGORY 4)

Iron(III) chloride and Zinc sulphate are also harmful if swallowed (ACUTE TOXINS CATEGORY 4). Zinc sulphate causes EYE DAMAGE (CATEGORY 1 and iron(III) chloride is CORROSIVE TO SKIN AND EYES (CATEGORY 1B)

Manganese sulphate is a specific target organ toxin on repeated exposure (Category 2) affecting the brain in particular. (*The small amount and short potential exposure here suggests that is not an issue.*)

Nickel and cobalt compounds are CARCINOGENIC and SENSITISERS (and more). They should not be used by pupils of this age. If it is required, the teacher can set up a demonstration garden with these,

Eye protection should be worn. Given that the solids are only being handled with forceps, there is no need for gloves; the silicate solution is only an irritant – though pupils with sensitive skin might be better off wearing gloves.

Equipment:

- Eye protection
- Large glass jar with lid (e.g. an empty, cleaned coffee jar)
- Glass rod
- Forceps

Chemicals:

- Water glass (about 250 cm^3)(**Irritant** solution)

- Water best to use deionised water but if unavailable tap water will give some effects (about 300 cm^3)
- 2 large crystals of the following (see hazard warnings)
- iron(II) sulfate (Harmful & irritant)
- copper(II) sulfate (Harmful & irritant)
- calcium nitrate (Oxidising, harmful & Irritant)
- manganese(II) sulfate (Specific target Organ Toxin on Repeated Exposure & Dangerous for the Environment)
- iron aluminium sulfate (Irritant)
- potassium aluminium sulfate (Low hazard)
- iron(III) chloride (Harmful / Corrosive)
- zinc sulfate (Harmful, Eye Damage & Dangerous for the Environment)
- nickel sulfate (Harmful, Irritant Carcinogen, Mutagen, Reproductive Toxin, Skin sensitiser, Respiratory sensitiser, Specific target Organ Toxin on Repeated Exposure & dangerous for the Environment)
- cobalt chloride (Harmful, Carcinogen, Mutagen, Reproductive Toxin, Skin sensitiser, Respiratory sensitiser, Dangerous for the Environment)

Technical Notes:

Provide a 8% solution of sodium silicate in water. This works well by producing results both within the lesson and over time. With older students different dilutions could be tried and the results compared

Powders of the chemicals can be used if crystals are unavailable. The powder can be carefully dropped against the side of the jar just above the water line. If any floats on the surface it can be nudged under the water to drop to the bottom of the jar. The powders still produce an interesting array of crystal tendrils.

Label the jar of water glass solution **IRRITANT**.

Avoid using glass beakers for this practical if you can because the chemicals will be very difficult to clean off the glassware afterwards.

Although many of these chemicals are damaging to the environment, the amounts used are so small as to be not significant. The solution can be washed to waste in the foul water drain with copious quantities of cold water.

Results:

A strong water glass solution will grow a crystal formation more quickly than a weak one.

Crystals of chemicals will produce further growths of crystals on the original one over time, chemical powders grow tendrils.

Although cobalt chloride and nickel sulphate produce colourful crystals (magenta/purple and green/blue respectively) a very good and colourful chemical garden can be created with the less toxic chemicals.

The chemical garden chemicals will produce the following colours of crystals (excluding those mentioned above): green, blue, white, orange/brown, brown.

Taking the work further:

Students could experiment with different strength solutions of sodium silicate.

Sodium silicate solution is highly alkaline and therefore it may be best for younger students to only test dilutions of the solution that have already been provided for them.