# “Test tube geology” and “Mining for metals” Introduce a scientific writing heuristic

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**Presentation Outline**

Scientific Writing Heuristic (SWH)

- Background
- Use in chemistry

Prepare for Test Tube Geology Lab (Teacher Notes)

- Place in curriculum
- Pre-Lab
- Guiding students in data collection and recording

Begin Test Tube Geology Lab (SWH 1-3)

Discuss and Analyze Lab Results (SWH 4-7) (Teacher Notes)

- Guiding students in claim, evidence, scientific communication, reflection

Continue Test Tube Geology Lab (SWH 3)

Analyze Test Tube Geology Lab (SWH 4-7)

- Create a claim and support with evidence
- Scientific communication
- Reflection

Prepare for Mining for Metals Lab (Teacher Notes)

- Place in curriculum
- Pre-Lab
- Guiding students in separation of mixture

Perform Mining for Metals Lab (SWH 1-3)

Analyze Mining for Metals Lab (SWH 4-7)

- Create a claim and support with evidence
- Scientific communication
- Reflection – Personal Particulate Model

Wrap Up

Works Cited

Hand, Brian, et al. *Negotiating science: the critical role of argument in student inquiry, grades 5-10*. Portsmouth, NH: Heinemann, 2009. Print.

Cortez, James A., Dick Powell, and Ed Mellon. "Test Tube Geology: A Slowly Developing Redox System for Class Study." *Journal of Chemical Education* 65.4 (1988): 350-351. Print.

Name _____ Hour _____ Date _____

Chemistry

Test Tube Geology

**SWH 1 – Pre-Lab**

Read the lab handout on the back of this sheet and complete the following questions and actions.

1. What do you think – How does geology relate to chemistry?
2. In the materials section, what is the group of letters and numbers after the chemical name (i.e. $CuSO_4$) called?
3. Underline each place in the procedure where an observation (qualitative data) will be made. Create an observation table that you can use during the lab.
4. Circle each place in the procedure where a measurement (quantitative data) will be made. Create a data table that you can use during the lab.
5. Is there part of the procedure that is implied – something that you should do before step 2? Add that to the procedure (perhaps step 1.5).
6. Make a labeled sketch of what you think the test tube will look like after step 7.
7. Make a list of some of the specific factors you could change in the procedure that might affect the outcome. After discussing with your lab group, circle the one factor you will change.
8. Complete the experimental design for this lab. Each lab table will do 1 experimental trial and 1 control trial. Therefore, we will have up to 7 control trials in each class. Each lab table will choose its own experimental question so there may only be 1 experimental trial for each experimental question.

| | |
|---|---|
| Experimental Question: What affect does changing _____ have on the outcome of the test tube geology lab? (*This is a very general experimental question, but we have to start somewhere!*) | |
| Hypothesis: It will be very difficult to make a good hypothesis since you probably have no idea of what is going to happen. | |
| Independent Variable: | |
| Dependent Variable: | |
| Constants: | |
| Experimental Trial: | Number of Trials: |
| Control Trial: | Number of Trials: |

9. Use the materials section of the lab handout to fill in the **chemical names** on the safety and disposal handout.
10. ORL Rat $LD_{50}$ is the amount of chemical that has a 50% chance of killing a rat with a body mass of 1 kg. For instance, Fe has an $LD_{50}$ of 30 g/kg. That means 30 grams of iron has a 50% chance of killing a 1 kg rat.
    The other $LD_{50}$ values are in mg of chemical per kg of body mass.
    a. $CuSO_4$: How many grams is 300 mg?
    b. NaCl: How many grams is 3000 mg?
    c. Which chemical requires the least mass to kill a 1 kg rat?

Test Tube Geology

**Introduction**

The earth we live on has the atmosphere (air), hydrosphere (water), and lithosphere (land). The biosphere encompasses all of the places where life exists – birds in the air, fish in the water, and humans on the land. All of these parts of earth are connected by biogeochemical cycles that change and move matter throughout the planet.

In this experiment we will be focusing on a very simple system that involves only a few substances to see if any changes occur when the substances are placed near one another. This experiment will help you to master a few very important learning goals:

1. design and carry out an experiment
2. make thorough and complete observations (qualitative data)
3. create and defend a scientific argument

**Experimental Design**

See front.

**Materials**

| | | |
|---|---|---|
| copper (II) sulfate, $CuSO_4$ | nails (ungalvanized), Fe | other materials as needed |
| sodium chloride, NaCl | water (distilled), $H_2O$ | |

**Equipment**

| | | |
|---|---|---|
| electronic balance | weighing boat (2) | paper towel or filter paper |
| large test tube (2) | scoopula (2) | stopper |
| test tube rack | wash bottle | other equipment as needed |

**Safety and Disposal**

See attached sheet.

**SWH 2 – Procedure**

Half of the table will do follow the procedure below. The other half of the table will change one factor and keep the rest of the factors the same.

*NOTE:* Record observations of all materials used in this experiment. You may enhance your written observations with photos.

1. Label the top of the test tube with your hour, table, and initials. Use ballpoint pen or permanent marker.
2. Tare a weighing boat on the electronic balance. Use a scoopula to measure approximately 3 grams of copper (II) sulfate into the weighing boat. Record the exact mass in your data table. Transfer the chemical to the test tube.
3. Place a small circle of filter paper or paper towel on top of the copper (II) sulfate layer.
4. Tare a weighing boat on the electronic balance. Use a scoopula to measure approximately 1.5 grams of sodium chloride into the weighing boat. Record the exact mass in your data table. Transfer the chemical to the test tube.
5. Place a small circle of filter paper or paper towel on top of the sodium chloride layer.
6. Use the wash bottle to carefully and slowly add water to the test tube until the level of water is about 2 cm above the level of the sodium chloride.
7. Place 1 or 2 nails into the test tube. Be careful not to puncture the filter paper.
8. Put the stopper on the test tube and place the test tube in the rack.
9. Continue making observations.

Clearly state how the procedure was changed to test the one factor that you varied.

Table _____

Test Tube Geology
Independent Variables

| Hour | Specific Change to Procedure (ex. mass of $CuSO_4$ increased to 6 g) |
|---|---|
| 1 | |
| 2 | |
| 4 | |
| 7 | |
| 8 | |

Table _____

Test Tube Geology
Independent Variables

| Hour | Specific Change to Procedure (ex. mass of $CuSO_4$ increased to 6 g) |
|---|---|
| 1 | |
| 2 | |
| 4 | |
| 7 | |
| 8 | |

| | Safety | Disposal |
|---|---|---|
| Chemical Name and Formula | MSDS (Flinn) | Flinn Catalog Method |
| **Name**: | **Section 3 – Hazards Identification**:<br>Skin and respiratory irritant; moderately toxic by ingestion and inhalation. | **Pure**:<br>26 A – landfill |
| | **Section 5 – Fire Fighting Measures**:<br>Nonflammable, noncombustible solid. However, sulfur trioxide can be produced at temperatures above 653 $^{o}$C. | |
| | **Section 10 – Stability and Reactivity**:<br>Avoid contact with finely powdered metals and heat. Will corrode steel. | |
| | **Section 11 – Toxicological Information**: | |
| **Formula**:<br>$CuSO_4$ | **Acute Effects**:<br>Toxic, severe eye irritant, and gastrointestinal disturbances. | **Solution**:<br>26B – drain |
| | **Chronic Effects**:<br>Possible mutagen. | |
| | **Target Organs**:<br>Liver, kidneys, and blood. | |
| | **ORL RAT $LD_{50}$**:<br>300 mg/kg | |
| **Name**: | **Section 3 – Hazards Identification**:<br>Very slightly toxic by ingestion. Dust may cause minor irritation to mucous membranes upon inhalation. | **Pure**:<br>26 A – landfill |
| | **Section 5 – Fire Fighting Measures**:<br>Noncombustible solid. When heated to decomposition, emits toxic fumes of Cl and $Na_2O$. | |
| | **Section 10 – Stability and Reactivity**:<br>Reacts violently with bromine trifluoride and lithium. Avoid contact with strong oxidizers, acids, bromine. | |
| | **Section 11 – Toxicological Information**: | |
| **Formula**:<br>NaCl | **Acute Effects**:<br>Irritant, dehydration | **Solution**:<br>26B – drain |
| | **Chronic Effects**:<br>N.A. | |
| | **Target Organs**:<br>Investigated as a mutagen, reproductive effecter. | |
| | **ORL RAT $LD_{50}$**:<br>3000 mg/kg | |

| | Safety | Disposal |
|---|---|---|
| Chemical Name and Formula | MSDS (Flinn) | Flinn Catalog Method |
| **Name**: | **Section 3 – Hazards Identification**:<br>Substance is not considered hazardous. Flammable solid in dust form. | **Pure**:<br>26 A – landfill |
| | **Section 5 – Fire Fighting Measures**:<br>Finely divided iron can be flammable. | |
| | **Section 10 – Stability and Reactivity**:<br>Avoid contact with acids, moisture, strong oxidizing agents, halogens, phosphorus, and oxygen. | |
| | **Section 11 – Toxicological Information**: | |
| **Formula**:<br>Fe | **Acute Effects**:<br>Harmful dust. | **Solution**:<br>NA |
| | **Chronic Effects**:<br>N.A. | |
| | **Target Organs**:<br>N.A. | |
| | **ORL RAT $LD_{50}$**:<br>30 g/kg | |
| **Name**: | **Section 3 – Hazards Identification**:<br>Substance is not considered hazardous. | **Pure**:<br>26 B – drain |
| | **Section 5 – Fire Fighting Measures**:<br>Noncombustible liquid. | |
| | **Section 10 – Stability and Reactivity**:<br>N.A. | |
| | **Section 11 – Toxicological Information**: | |
| **Formula**:<br>$H_2O$ | **Acute Effects**:<br>N.A. | **Solution**:<br>NA |
| | **Chronic Effects**:<br>N.A. | |
| | **Target Organs**:<br>N.A. | |
| | **ORL RAT $LD_{50}$**:<br>>90 g/kg (adapted from: http://www.sciencelab.com/msds.php?msdsId=9927321) | |

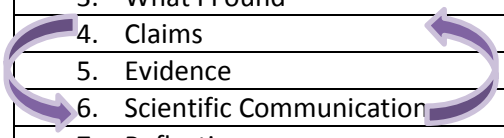
Name _____ Hour _____ Date _____

Chemistry

Test Tube Geology SWH

**SWH Template**

| | |
|---|---|
| 1. Beginning Idea(s) | What was my experimental question? (part of experimental design template) |
| 2. Tests I Did | Summarize experimental design and procedure. |
| 3. What I Found | Qualitative (observations) and quantitative (measurements) data |
| 4. Claims | What can you infer from the data? |
| 5. Evidence | Justify your claims by using specific data. |
| 6. Scientific Communication | How do your claims and ideas compare to your peers? To experts? |
| 7. Reflection | How have your ideas changed? What new questions arose from this investigation? |



**SWH 1 Experimental Design**

Include your neatly written or typed experimental design form.

***Type*** the rest of the SWH. Save paper. Single space, use margins of no greater than 0.75 inches, normal size font…

**SWH 2 Procedure**

Summarize your experimental procedure in no more than 3 sentences. Use 3rd person, present tense. Be concise!

**SWH 3 Data: Observations and Measurements**

Organize your observations and measurements to make them clear and understandable. Attach your original data (qualitative and quantitative) tables to your SWH.

**SWH 4 Claim**

Make a specific inference related to the experimental question based on the information your group collected.

**SWH 5 Evidence**

What data (observations or measurements) support your claim? You can also include photographic evidence that you specifically describe. Just including photos without explaining the evidence contained is not acceptable.

**SWH 6 Scientific Communication**

What does the class say? Compare your results (control and experimental) to groups who changed the same variable that you did (can be from different hours). If you are the only one who did a particular experiment just compare your control trials to other groups. Make sure to identify the groups that you compared to.

**SWH 4-6 Repeat as needed…**

Is your claim still supported? Can you think of other reasons for what you observed? Did discussion with other group(s) clarify your thinking?

**SWH 7 Reflection**

Answer the following questions with specificity.

Why did you decide to change the factor that you did?
What were my ideas prior to the SWH? What were my ideas after the SWH?
How have my ideas changed? What caused my ideas to change?
If you could redo this investigation, what things would you do differently to help it run smoother?
What are two questions that you have after doing this investigation?

Name _____ Hour _____ Date _____

Chemistry

Mining for Metal

Put your answers on another sheet of paper except for the table in SWH 1 and the particulate model in SWH 7.

**SWH 1 – Beginning Ideas**

In the Test Tube Geology lab, you used 4 chemicals: copper (II) sulfate, sodium chloride, water and iron (nails) in your control test tube. Given the formula, identify each as a pure substance or mixture (BEFORE COMBINING), an element or compound, and particle type (atom, molecule, formula unit). Circle the name of the ELEMENT that is a metal.

| Name | Symbol | Formula | Pure | Mixture | Element | Compound | Atom | Molecule | Formula Unit |
|---|---|---|---|---|---|---|---|---|---|
| copper (II) sulfate | | $CuSO_4$ | | | | | | | |
| sodium chloride | | NaCl | | | | | | | |
| water | | $H_2O$ | | | | | | | |
| iron | Fe | | | | | | | | |

After combining all of the substances in the test tube, did you have a pure substance or a mixture on Day 1? Why?

Do you have a pure substance or a mixture now? What is your evidence?

**SWH 2 – Tests I Did**

You will need to separate the shiny, reddish-brown substance from the rest of the stuff in the test tube. How can you do that? Write down some ideas on another sheet of paper. You may use any equipment from your drawer as well as other equipment provided.

All liquids can go down the drain, all solids except the shiny, reddish-brown substance can go in the kitty litter bucket.

When you have separated the shiny, reddish-brown substance you are going to try to classify and identify it.

- Metal or non-metal – what are some properties of metals that you know from prior experience?
- React with nitric acid
    1. Place approximately 0.5 g of the shiny, reddish-brown substance into your test tube and bring it to the hood.
    2. Use the dispenser to add the nitric acid. The color of the resultant liquid can be used to identify the substance! Do not remove the test tube or nitric acid from the hood until the reaction is finished!

       copper + nitric acid → blue liquid
       iron + nitric acid → yellow/orange liquid
       sodium + nitric acid → colorless liquid

    3. Dispose of the liquid in the container in the hood.

**SWH 3 – What I Found**

Record your data on another sheet of paper.

**SWH 4 – Claim**

Make a claim about the identity of the shiny, reddish-brown substance and where it came from.

**SWH 5 – Evidence**

Support your claim with specific data. Label and identify any random or systematic errors that may affect the lab outcome and evidence you are presenting.

**SWH 6 – Scientific Communication**

How do your claims and ideas compare to your peers? To experts? For the "experts" find a resource that describes some characteristics of the substance you think you had. Cite your source. Possible sources include www.webelements.com or other online periodic tables.

**SWH 7 – Reflection**

1. Draw a particulate model showing the substances in your test tube on Day 1. Make different shapes to represent each particle of each substance: copper (II) sulfate (2 shapes), sodium chloride (2 shapes), water (2 shapes), nail (1 shape). The thin lines represent filter paper. Draw a particulate model to show how the test tube looked today. Consider the following: are the original substances still present? Have any new substances formed? If there have been changes, where did the original chemicals go and the new chemicals come from? Include a legend and a written description.

2. What were your ideas about matter in SWH 1? What are your ideas now? How have your ideas changed? What caused them to change? What are two questions that you have after doing this investigation?