Key: Yellow highlight = required component

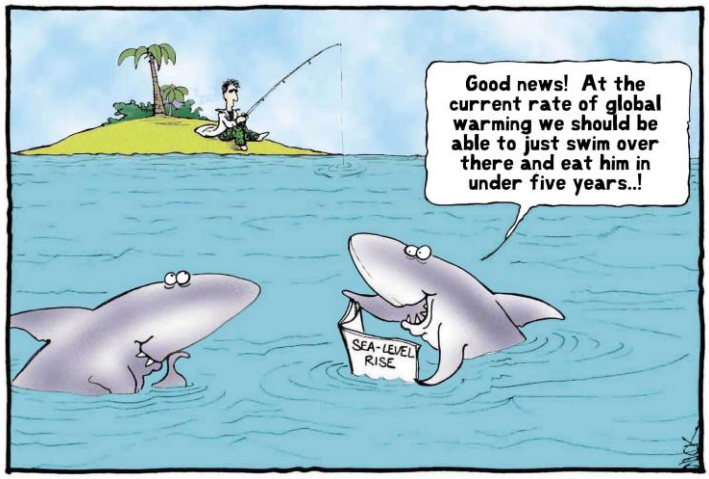
Synthesis of SIFSIX-3-Zn

Subject Area(s) **Biology, Chemistry**

Associated Unit **Biochemistry**

Lesson Title **Synthesis of SIFSIX-3-Zn**

Header



Grade Level **Freshman (9th & 10th)**

Lesson # 1

Lesson Dependency

Time Required: Two class periods

Summary: Students will be synthesizing a simple MOF (Metal organic framework) that can store our greenhouse gas, CO2. Students will use red cabbage as an indicator to decipher pH range.

Engineering Connection

Students will be synthesizing and they will be testing mixtures (MOF) for pH levels using specific techniques and methods related to chemical engineering.

Engineering Category

Relating science and/or math concept(s) to engineering

Keywords

Synthesis, MOF (metal organic framework), Meniscus, Indicator, pH

Educational Standards (List 2-4)

State STEM Standard (required)

Benchmark SC.912.L.17.10 Diagram and explain the biogeochemical cycles of an ecosystem including carbon.

ITEEA Standard

STL J. The rate of technological development and diffusion is increasing rapidly

NGSS Standard

K-ESS3-3 Earth and Human Activity

CCSS Standard

RST 9-10.1 support analyst of science and technical text.

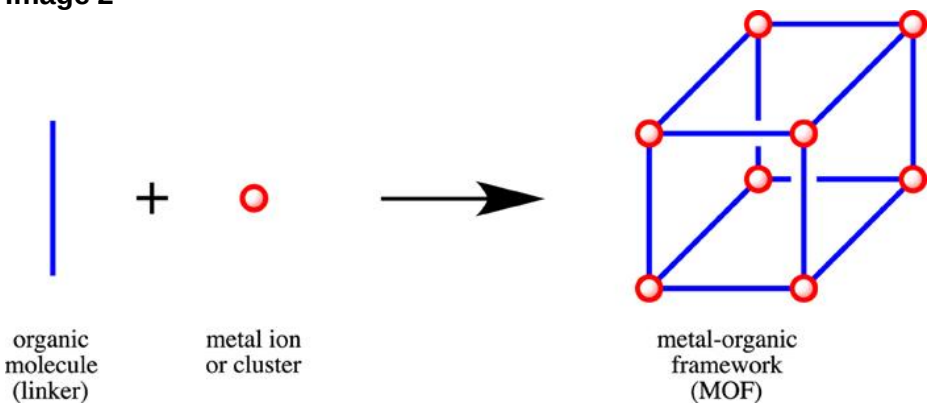
Pre-Requisite Knowledge
Students should have background knowledge about global warming. Students should also have prior experience in a lab with the understanding of lab safety.

Learning Objectives
After this lesson, students should be able to: Synthesize a simple metal organic framework that can potentially store CO2.

Introduction / Motivation (5E – Engage)
To start off the lesson students will read the cartoon about global warming and they are to explain why this image relates to global warming, what is global warming and what are ways that we can prevent or aid in global warming.

Lesson Background & Concepts for Teachers (5E – Explain)

Image 2



Vocabulary / Definitions

Word	Definition
Synthesis	the production of chemical compounds by reaction from simpler materials
Indicator	a compound that changes color at a specific pH value or in the presence of a particular substance and can be used to monitor acidity, alkalinity, or the progress of a reaction

Associated Activities (5E – Explore)

Lesson Closure

Assessment (5E – Evaluate)

Thumbs up/Thumbs down and white boards when asking questions.

Pre-Lesson Assessment
Descriptive Title: **Pre-test about MOFs and global warming.**

Post-Introduction Assessment
Descriptive Title: **Post-test about MOFs and global warming (same test as pre)**

Lesson Summary Assessment
Descriptive Title: **In notebook students will write an extension reflection about what they learned in class with this question in mind. *How can a metal organic framework aid global warming?***

Homework
Descriptive Title: ___?

Lesson Extension Activities (5E – Extension)

Carbon Dioxide Gizmo explorelearning.com

Amoeba Sisters: Carbon Cycle Video

https://www.youtube.com/watch?v=NHqEthRCqQ4

Additional Multimedia Support

Carbon Dioxide Gizmo explorelearning.com

Amoeba Sisters: Carbon Cycle Video

https://www.youtube.com/watch?v=NHqEthRCqQ4

References

Other

Redirect URL

Contributors

Briana Aguila

Supporting Program

Function Materials RET at USF

Acknowledgements

Attachments

(1) Synthesis of SIFSIX-3-Zn

(2) CO_2 Capture Demo

Synthesis of SIFSIX-3-Zn

Part I. Solutions

*****All solutions will be clear. LABEL each solution.

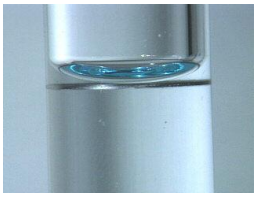
Part I will be done as a group.

A. Preparation of pyrazine solution

1. Add 0.52 g of pyrazine to a 20 mL scintillation vial (Fig. 1).
2. Add 6 mL of methanol to the vial. Close the vial.
3. Sonicate the solution until dissolved. (Your mentor will show you how to do this.)
4. Transfer the contents of the vial to a 10 mL volumetric flask (Fig. 2)
5. Add enough methanol to fill the volumetric flask to the line marked on the neck (calibration mark. The bottom of the meniscus should touch the mark (Fig. 3).

Figure 1. Scintillation vial

Figure 2. Volumetric flask



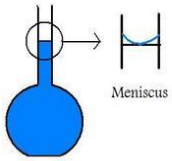


Figure 3. Meniscus

B. *Preparation of $ZnSIF_6 \cdot xH_2O$*

1. Add 0.62 g of $ZnSIF_6 \cdot xH_2O$ to a 20 mL scintillation vial.
2. Add 6 mL of methanol to the vial. Close the vial.
3. Sonicate the solution until dissolved. (Your mentor will show you how to do this.)
4. Transfer the contents of the vial to a 10 mL volumetric flask (Fig. 2)
5. Add enough methanol to fill the volumetric flask to the line marked on the neck (calibration mark. The bottom of the meniscus should touch the mark (Fig. 3).

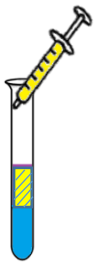
Part II. Layering

Part II will be done individually.

1. Add 1 mL of the $ZnSIF_6 \cdot xH_2O$ solution into a test tube using a syringe (Fig. 4).
2. Using a new, clean syringe, add 1 mL of the pyrazine solution to the test tube using the following method:
   a. Place the syringe at an angle with the tip pressed against the wall of the test tube (Fig. 5).
   b. SLOWLY press the top of the syringe to add the solution into the test tube. The solution should flow down the side of the glass.
3. You should see a line between the 2 clear layers.
4. Cover your test tubes with Parafilm.

Figure 4. Addition of $ZnSIF_6 \cdot xH_2O$ solution

Figure 5. Layering of pyrazine solution



Day 2: CO_2 Capture Demo

I. Explaining the Setup

The principal reactions to explain today are as follows:

$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_{2(}aq) \quad (1)$$

$$CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l) \quad (2)$$

When the solution becomes saturated, the following reaction occurs:

$$CO_2(g) + CaCO_3(s) + H_2O(l) \rightarrow Ca(HCO_3)_2(aq) \quad (3)$$

The CaO has already been prepared. SIFSIX-3-Zn is activated on the Schlenk line.

a. Explain the CO_2 problem.
b. Pack a glass pipette with the tip broken off with a piece of Kim wipe and then the SIF-SIX-3-Zn.
c. In another glass pipette with the tip broken off, place a piece of Kim wipe in the bottom.
d. Add 5-6 mL of $Ca(OH)_2$ to each of the 2 glass bubblers through a syringe filter.
e. Attach a tube from the flow control system to top of the second pipette, and attach a tube from the bottom to a bubbler. Secure each connection with Parafilm.

II. Formation of a Precipitate

a. Flow CO_2 through the pipette without the MOF at a rate 0.05-0.1 L/min. The clear solution should turn cloudy.
b. Repeat the process using the pipette that contains SIFSIX-3-Zn. No gas should bubble through. (Note: You may want to remove the tube from the bottom of the pipette to confirm the flow.)

III. Indicators

a. Have the students take about 3 leaves of red cabbage.
b. Cut the cabbage and soak about 15 minutes in a 70% ethanol solution.
c. Repeat the experiment using a few drops of indicator in each bubbler along with the $Ca(OH)_2$.

IV. pH color range for indicator

0-1	2	4	5-8	9	10	11-14
red	magenta	light purple	dark purple	dark green	light green	gold