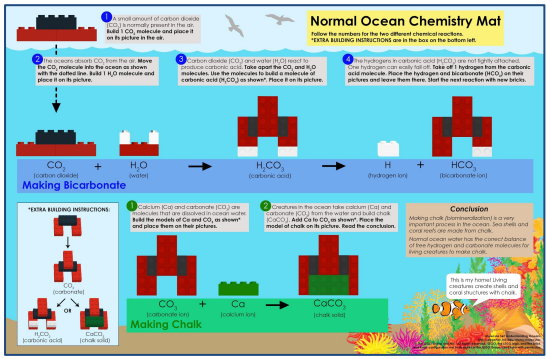
# MIT Edgerton Center Molecule Set

***--Online Pilot for Remote Instruction Spring 2021--***

**MIT Edgerton Center**

https://edgerton.mit.edu/molecule-set

## Part 4) Understanding Oceans








MIT CEHS Center for Environmental Health Sciences

EDGERTON CENTER



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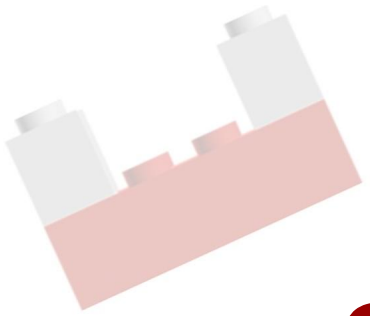
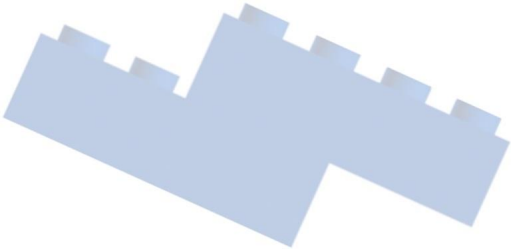
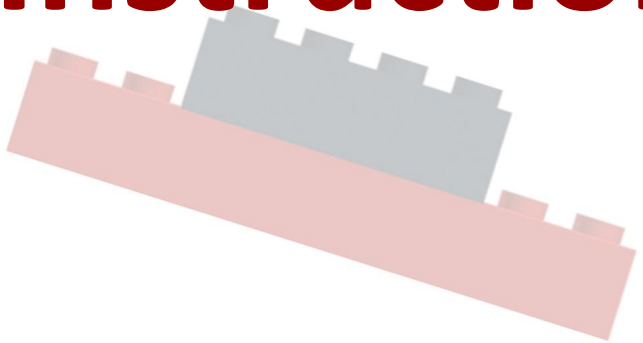




# Set up Instructions





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# A Package Contents Check
# and
# Assembly of Camera Stand

**The slides in this section were created for the Spring 2021 MIT OEOP SEED Program**
**Instructor and Teaching Assistants**

**Please use these slides as a models to write a description and Set of Instructions to suit your students and instructors**


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# First day Inventory for the Molecules Kit and Assembly of the Web Camera Stand

**Package from MIT OEOP**

**External Camera with a stand**
**(for viewing models on the table top)**

- Please see to the assembly instructions on the next slide.

**Components:**

1. Web camera in box.
   (Save box for return)
2. Pipe with holes drilled in both ends
3. Screw with black handle
4. White base with holder for pipe.

**Package from MIT Edgerton Center**

**Molecule Kit and Lesson Mats**
Save the box for shipping back!

**Molecule Kit with bricks**

- Check the number of each color brick using "Atoms and Molecules Layout Mat. #1"

**12 Small Mats**

- Numbers #1 - #12

**4 Large Mats + 1 Folded Large Mat**

- Numbers #13-16 + 1 Folded Large Mat #17

**Instructors' packages:** additional 4 LEGO clips for the cellulose model and Cellulose Instructions.


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# Inventory Details for materials on Loan

## Save the shipping box for returning all these items

| | MAT sticker # | Title of the Mat [Description] – please organize in this order 1-12<br>If in this package, mark "Y" (Yes) in this box -> | |
|---|---|---|---|
| | 1 | Atoms and Molecules Layout Mat + 1back KEY FOR THE ATOMS | |
| | 2 | What is Air Made of? Guess! | |
| | 3 | Burning Fuel (Complete Combustion) | |
| | 4 | Burning Fuel (Incomplete Combustion) | |
| | 5 | Air Chemistry and Pollution | |
| | 6 | Air Chemistry and Pollution Reactions | |
| | 7 | Layout Mat for Glucose Parts | |
| | 8 | Card A: Making Glucose Molecules | |
| | 9 | Card B: Making Starch Molecules | |
| | 10 | Plants from Thin Air? | |
| | 11 | Plant Cells and Molecules | |
| | 12 | Baking Soda + Calcium Chloride Reaction Reactants | |
| | 13 | Photosynthesis and Cellular Respiration [LARGE MAT] | |
| | 14 | Normal Ocean Chemistry Mat [LARGE MAT] | |
| | 15 | Ocean Acidification Mat [LARGE MAT] | |
| | 16 | Oceans and the pH Scale [LARGE MAT] | |
| | 17 | Toxic Mercury in our Environment [**Large mat, but folded up**] | |
| **Number in kit** | **LEGO Brick color** | **Use MAT #1 Layout Mat.** Place bricks on pictures to check number. **If None missing, write "NONE" or write in the number of MISSING BLOCKS.** | |
| 4 | **Brown** | | |
| 24 | **White** | | |
| 8 | **Pink** | | |
| 8 | **Yellow** | | |
| 8 | **Light Green** | | |
| 8 | **Green** | | |
| 12 | **Black** | | |
| 36 | **Red** | | |
| 32 | **Blue** | | |

Always return your bricks according to the INSIDE LABEL. (See the picture of the LEGO bricks on the inside of the lid.)

# Webcam Parts and Assembly


**Parts:** (Adapter USB-A to C not shown)
Either end of the pipe can be put into the base.


**Assembled stand:** Note that the screw with the handle screws into the camera.


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# Teacher to Teacher (Explanations)


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# Inclusive teachers are aware of these useful tools

**Essentials**

**1) Getting Attention**

**2) Focusing Learners on their task**

**3) Involving all students**

**Suggesting Three Inclusive Teaching Methods:**

**The Hook - This technique is used in the Protein Set Lessons**

- Start with something that no one has seen before. ( gets attention!)
- No prior knowledge necessary to participate. Only good observation and reasoning skills is needed to participate. This levels the playing field.

**The Discrepant Event - This technique is used for the PHOTOSYNTHESIS LESSON**

- All Learners are jolted into recognizing that they have a misunderstanding.
- Learners typically become motivated and will want to fix their beliefs.

**The Use Models - for visualization purposes**

- Concepts will be freed from vocabulary overload. Physical models are particularly helpful for English language learners.


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# Conceptual Rationale for Using Bricks as Atoms

When introducing middle school students to chemistry, employing bricks to represent atoms as shown in the **Molecules Set** with bricks is a great idea for many reasons, pedagogical and practical. Overall, chemistry concepts are well conveyed by the LEGO bricks:

- **Bricks visualize a favorite teaching analogy.** Texts often refer to elements/atoms as the building blocks of nature.

- **Bricks clearly demonstrate different elements.** Each color brick represents a different atom. Unlike working with random candy gumdrops, students become familiar with the standard chemical colors, black for carbon, red for oxygen, etc. Most of the atom bricks are of the standard 2X4 size, however hydrogen is modeled by the smaller, white 1X2 brick.

- **Bricks avoid confusing representations of chemical bonds.** Atoms cling together to make compounds. Students naturally create compounds by attaching bricks together. With the bricks, chemical bonds do not need to be physically represented by small sticks. At the middle school introductory level, for learning the first chemistry concepts (such the definitions of elements, compounds, mixtures, and chemical change) the details about single bonds and double bonds are unnecessary.

- **Bricks emphasize the importance of molecular shape.** LEGO atoms emphasize that molecules take specific, functional shapes. Although the exact chemical bond angles cannot be duplicated with the bricks, LEGO molecules are built to exacting shapes.


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# Practical Rationale for Using Bricks as Atoms

- **LEGO bricks simplify materials management** in the classroom.
- Molecule Sets of **LEGO bricks are long-lived products.**
- Molecule Sets **don't have lots of smaller components** to break or get lost.
- **LEGO bricks can be replaced from local stores**, unlike components of other molecular models. They can also be purchased New or second-hand from BrickLink, a reputable international dealer: https://www.bricklink.com/v2/main.page
- **LEGO kits are very motivational.** Students are eager to work with the LEGO bricks! **-- So much so that teachers will need to plan ahead.**


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# Guidelines for Teaching with Bricks as Atoms

Follow these guidelines below to successfully and happily keep your class working on-task.

- Then you won't need to reprimand students for playing or distracting others with off-task building!)
- Most middle schoolers love to build with bricks-- so this works well as a motivational aid for teaching.

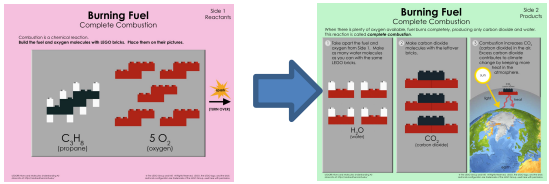
**1. When using the Building Mats, instruct your students with these words :**

"Build and place the molecules on their pictures."

"To show me when you are ready for the next action, put all extra bricks back into the kit and close the lid."

"We will need to wait until everyone shows me you are ready!"(Wait…. Stay firm )

Side 1 ( turn over) Side 2




C4H8 + 5 O2 -> 4 H2O+ 3CO2

This rule (to put away any extra bricks after Side 1) is necessary to prove the definition of a chemical reaction: In a chemical reaction the atoms get rearranged into different groups to produce different molecules.
The atoms change partners; no atoms are lost or gained.
***No new bricks are needed! -putting the extra bricks away will help to make the concept of a chemical reaction clear and exciting for the students***

**2. When you need the students' undivided attention, all bricks should be returned to the kit** An example: you plan to talk for a while to explain a concept. (You don't want to try to compete with LEGO bricks for their attention!)

**3. Overall, be sure to practice all the activities in advance with the hands-on models.** You will need to be a skillful and confident leader. Definitely practice building a glucose molecule!! *You may need to help others and fix mistakes.*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# Preparations for Teaching


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# Teacher Preparation needed in Advance for Teaching Part 4. Understanding Oceans

1. Be sure to try out the Understanding Oceans mats yourself.

2. You may want to find some good videos.

3. Plan to have students learn about positive actions they can take.

4. Learn and focus on alternative energy sources avoiding combustion of hydrocarbons.

Notes:

- Hydrocarbons are also called “fossil fuels” because substances like oil and coal were created a long time ago.
- Remember that natural gas is a hydrocarbon! Unfortunately, natural gas has been falsely advertised as being a “clean energy source,” and as a “helpful transition fuel.” It is not.


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# Materials Posted Online --Guides + Student Handouts

## MIT Edgerton Center

https://edgerton.mit.edu/molecule-set

**"MIT Blossoms"**
**Co-Teach with the Kathy Vandiver.**
**These are teacher-guided videos to use with your class:**

**(*Sorry, there isn't one for Understanding Air or Understanding Oceans*)**

**1) Photosynthesis**
http://blossoms.mit.edu/videos/lessons/roots_shoots_and_wood

2)**Recognizing Chemical Reactions**
https://blossoms.mit.edu/videos/lessons/recognizing_chemical_reactions


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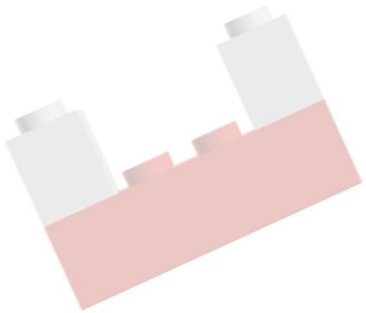
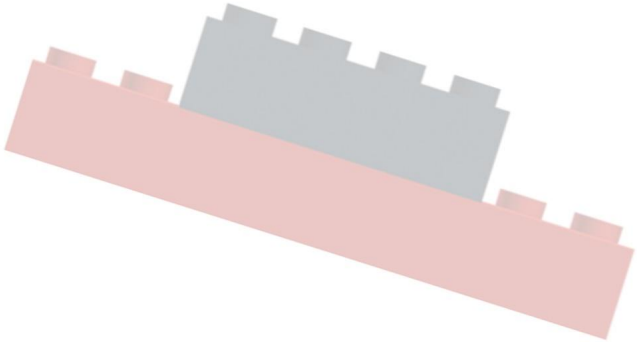


# Lesson Presentation





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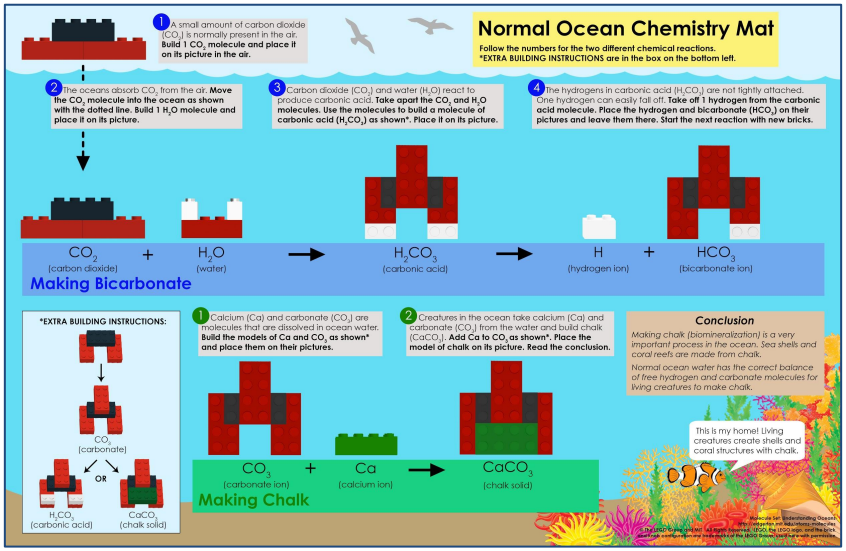
# *Teaching with the MIT Edgerton Center Molecule Sets and Curriculum*




# PART 4: Understanding Oceans

***Slides with Teacher Guide Notes and Zoom Notes on the slides for Feb 2021***

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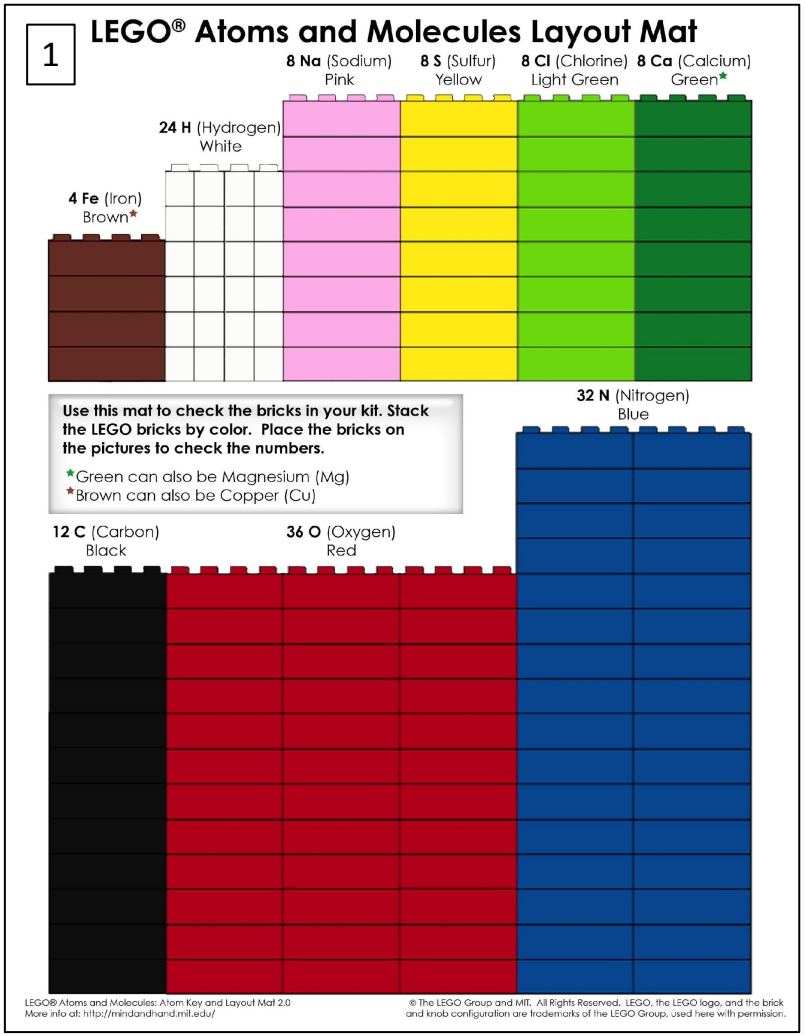
# Hi! Please get ready:

**1) Clear your table, have your Webcam plugged in.**
**2) Find a paper and something to write with.**
**3) Take out your Molecule Kit and have Mats #1-11 nearby.**

- **Begin by placing your bricks on the Layout Mat to check your kit.**
- **Wait for the teacher's ok.**




- ***Guide students to get ready with bricks on mat.***
- ***After checking, have students return all bricks.***
- ***Place bricks back into kit as shown on the lid's inside label.***
- ***Close the lid.***

***(Students will have a building task soon.)***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# A LEGO® brick represents an atom.

**(This key uses the CPK International chemistry colors for the elements.)**


***CONNECT WITH PRIOR KNOWLEDGE***

- ***Show a Periodic Table of Elements <u>or</u> ask … what are the elements in H2O?***

***T - WEBCAM Teacher Demo: build CO2 and H2O and N2 and show how to place each on top of picture on this mat. This is the shape of the molecule for this formula. It will be same shape always time, as that is way these atoms bind.***

***S – webcam Have students toggle to their webcam and do this simple exercise. <u>After, Put back in kit! Close the lid.</u>***


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# Normal Ocean Chemistry Mat

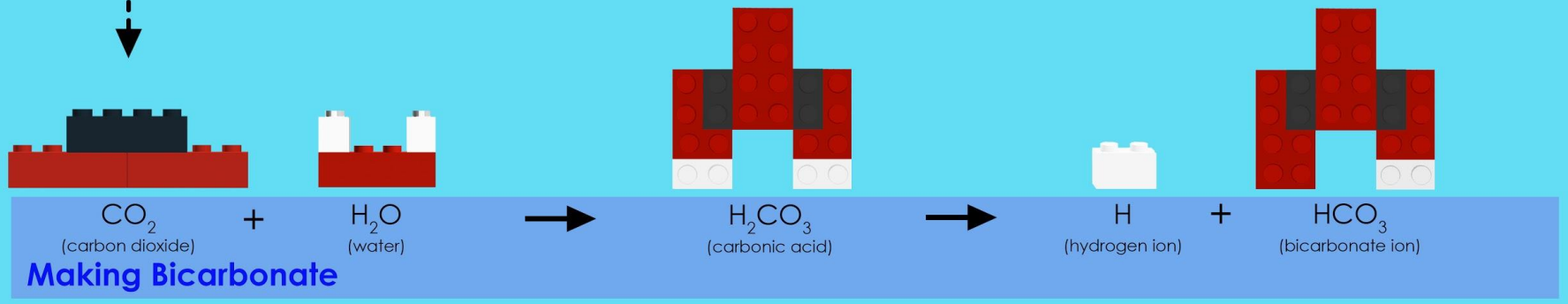
**Follow the numbers for the two different chemical reactions.**
***EXTRA BUILDING INSTRUCTIONS are in the box on the bottom left.**

1. A small amount of carbon dioxide ($CO_2$) is normally present in the air. **Build 1 $CO_2$ molecule and place it on its picture in the air.**

2. The oceans absorb $CO_2$ from the air. **Move the $CO_2$ molecule into the ocean as shown with the dotted line. Build 1 $H_2O$ molecule and place it on its picture.**

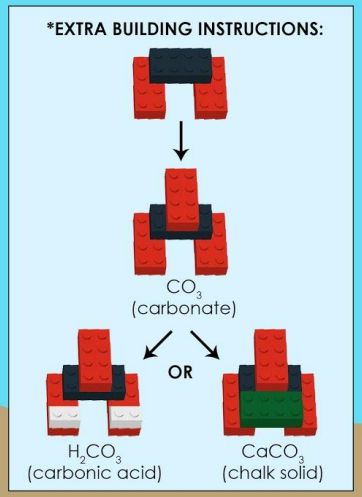
3. Carbon dioxide ($CO_2$) and water ($H_2O$) react to produce carbonic acid. **Take apart the $CO_2$ and $H_2O$ molecules. Use the molecules to build a molecule of carbonic acid ($H_2CO_3$) as shown*. Place it on its picture.**

4. The hydrogens in carbonic acid ($H_2CO_3$) are not tightly attached. One hydrogen can easily fall off. **Take off 1 hydrogen from the carbonic acid molecule. Place the hydrogen and bicarbonate ($HCO_3$) on their pictures and leave them there. Start the next reaction with new bricks.**



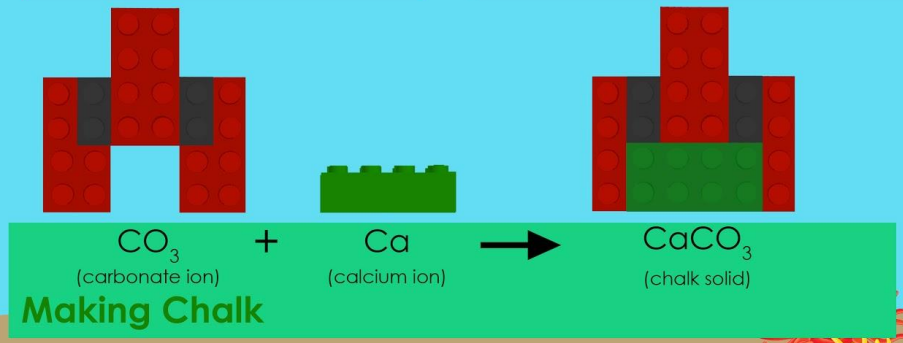

## Making Bicarbonate

***EXTRA BUILDING INSTRUCTIONS:**




1. Calcium (Ca) and carbonate ($CO_3$) are molecules that are dissolved in ocean water. **Build the models of Ca and $CO_3$ as shown* and place them on their pictures.**

2. Creatures in the ocean take calcium (Ca) and carbonate ($CO_3$) from the water and build chalk ($CaCO_3$). **Add Ca to $CO_3$ as shown*. Place the model of chalk on its picture. Read the conclusion.**

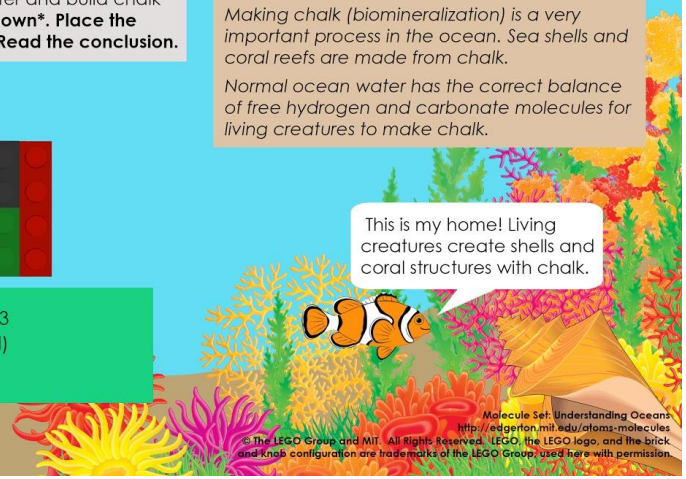



## Making Chalk

### *Conclusion*

*Making chalk (biomineralization) is a very important process in the ocean. Sea shells and coral reefs are made from chalk.*

*Normal ocean water has the correct balance of free hydrogen and carbonate molecules for living creatures to make chalk.*




***FIRST > Read the yellow box out loud. (Don't build yet)***

- ***Point to and name 2 reactions: (in blue and green.)***
- ***Students build CO2 + H2O first. Return all bricks.***
- ***Do steps (1,2,3,4.) Read out loud what is happening.***
- ***Now complete the reaction for making chalk. ( 1, 2, )***
- ***Read the Conclusion and what the clownfish says.***



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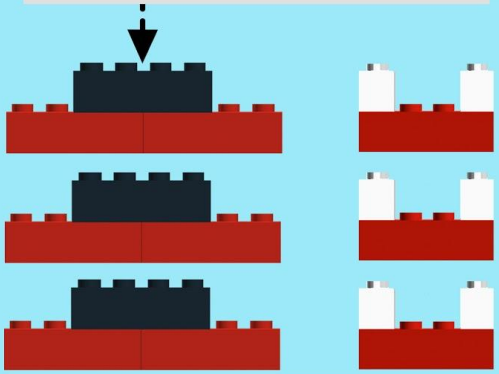
# Ocean Acidification Mat

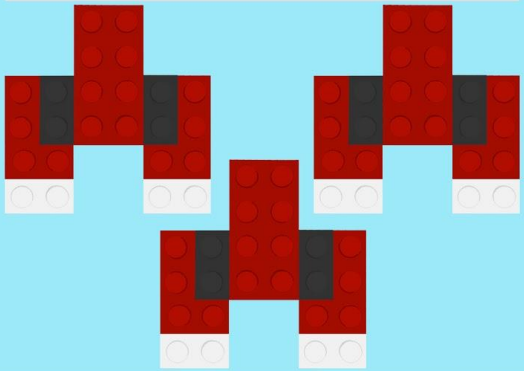
Follow the numbers for the two different chemical reactions.

1. Every day more carbon dioxide ($CO_2$) is released into the air from the burning of fossil fuels. **Build 3 $CO_2$ molecules and place them on their pictures in the air.**

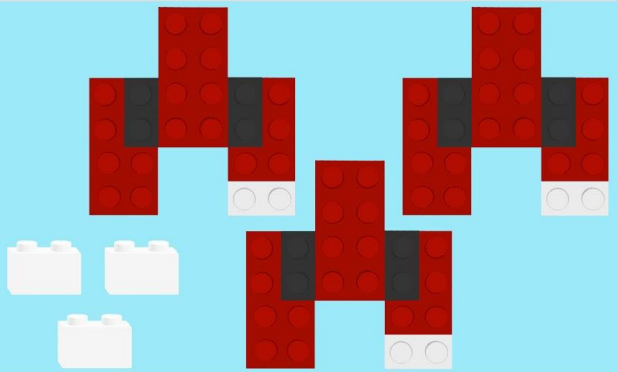
2. The oceans absorb more $CO_2$ from the air. **Move the 3 $CO_2$ molecules into the ocean as shown with the dotted lines. Build 3 $H_2O$ molecules and place them on their pictures.**



3. Carbon dioxide ($CO_2$) and water ($H_2O$) react to produce carbonic acid. **Take apart the 3 $CO_2$ and 3 $H_2O$ molecules. Use the bricks to build 3 molecules of carbonic acid ($H_2CO_3$). Place them on their pictures.**



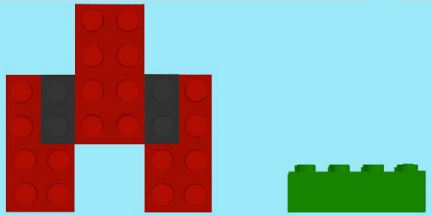
4. The hydrogens in carbonic acid ($H_2CO_3$) are not tightly attached. One hydrogen can easily fall off. **Take off 1 hydrogen from each carbonic acid molecule. Place the hydrogens and bicarbonates ($HCO_3$) on their pictures and leave them there. Start the next reaction with new bricks.**



$3\ CO_2$ (carbon dioxide) + $3\ H_2O$ (water) → $3\ H_2CO_3$ (carbonic acid) → $3H$ (hydrogen ions) + $3\ HCO_3$ (bicarbonate ions)

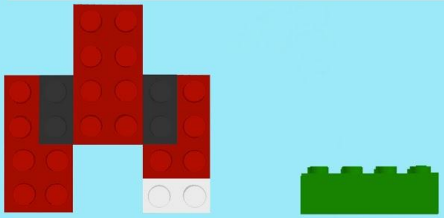
## Making Bicarbonate

1. Calcium (Ca) and carbonate ($CO_3$) are molecules that are dissolved in ocean water. **Build the models of Ca and $CO_3$ and place them on their pictures.**



2. More $CO_2$ in the air creates many free hydrogens in the ocean. **Move 1 hydrogen as shown with the dotted line. Place it on its picture.**

3. Too many free hydrogens interfere with normal ocean chemistry. **Add the H to $CO_3$ and place the bicarbonate ($HCO_3$) on its picture. Place the unused Ca on its picture below. Read the conclusion.**



$CO_3$ (carbonate ion) + Ca (calcium ion) + H (hydrogen ion) → $HCO_3$ (bicarbonate ion) + Ca (calcium ion)

## Making Less Chalk

### *Conclusion*

*Burning fossil fuels releases $CO_2$ into the air. Additional $CO_2$ in the air is absorbed by the ocean and more free hydrogens are created. The process of creating more free hydrogens in the ocean is called acidification.*

*When ocean acidification occurs, the free hydrogens bond to carbonates, making it harder for sea creatures to make chalk. Weaker shells are produced and there are fewer healthy coral reefs in the ocean.*




***FIRST > Read the yellow box out loud. (Don't build yet.)***

- ***Point and name the 2 reactions: (in blue and green.)***
- ***Students build CO2 + H2O first. Return extra bricks.***
- ***Do steps (1,2,3,4). Read out loud what is happens.***
- ***Complete the reaction for making less chalk. (1,2,3)***
- ***Read the Conclusion out loud carefully.***

***Ask for why rising CO2 in air matters?***



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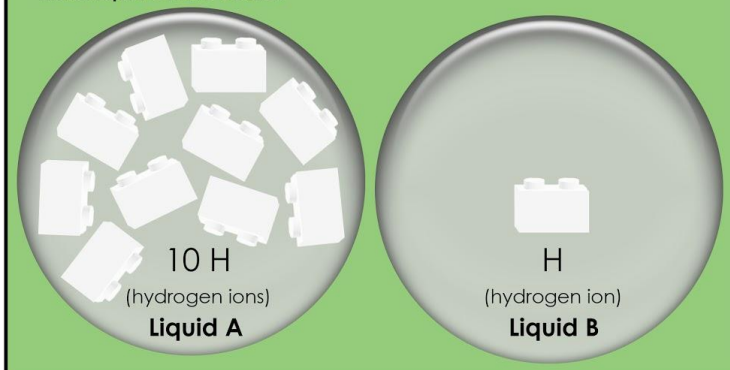
# Oceans and the pH Scale

Follow the numbers (1-4). Questions and actions to do are in **bold.** Answers upside down below.

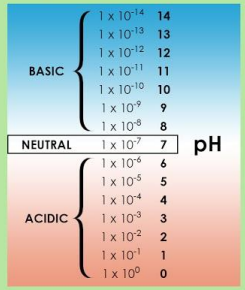
## 1 WHAT IS pH?

**Build a model of two liquids. Place the hydrogen bricks on their pictures.**
The H in pH means hydrogen. We use pH numbers to describe acids and bases. Acids have many free hydrogens. Bases have few free hydrogens.
**Which liquid is more acidic?**




***Optional Advanced Chemistry Fact!***

Liquid A and Liquid B are one pH unit apart. The pH scale is logarithmic. A change of one pH unit is a x 10 change in free hydrogens!

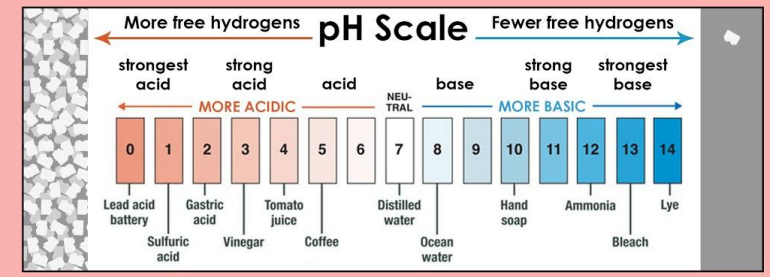



## 2 HOW DOES THE pH SCALE WORK?

The numbers on the pH scale may surprise you. Liquids with low pH numbers have lots of free hydrogens.

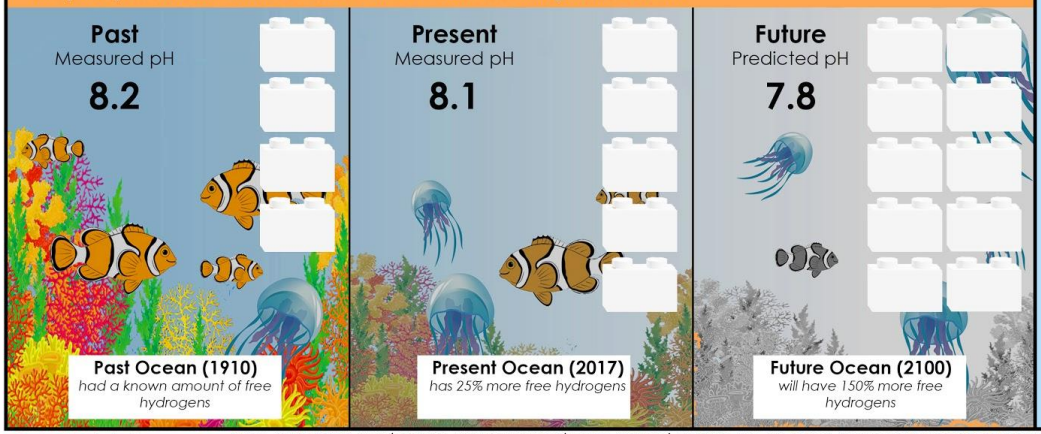
***Look at the pH scale below:***

- **Point to the number of the strongest acid.**
- **Point to the number of the strongest base.**
- **Is coffee an acid or a base?**
- **Is ocean water an acid or a base?**



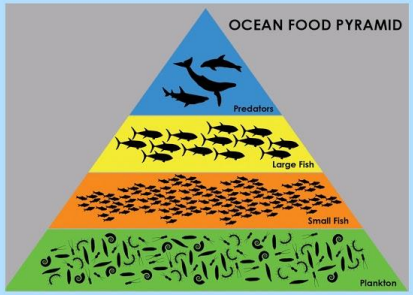

## 3 HOW IS OCEAN pH CHANGING?

**Place the hydrogen bricks on their pictures. Reuse the hydrogen bricks above. Compare the pH numbers for the past, present, and future ocean. Is the ocean becoming more acidic?**




## 4 WHY DO WE CARE ABOUT OCEAN pH?

A small change in ocean pH can affect many sea creatures. For example, if the tiny plankton with shells in the ocean fail to grow, many creatures that eat plankton, like fishes and whales, may die out.




**What can we do?** We can reduce the amount of $CO_2$ released into the air by not burning fossil fuels. We can produce energy from solar and wind power instead. We can conserve electricity, recycle, and bike or walk instead of driving. These actions will help keep the oceans healthy and help people who depend on fish for food. Let's work together for the planet! **Name the actions below that can help.**



ANSWERS: **1.** Liquid A **2.** 0, 14, coffee is an acid, ocean water is a base **3.** Yes **4.** Solar power, wind power, conserve, recycle, bike, and walk



***1. See the H? This is all about free Hydrogen. More free H? This means a more acidic liquid. 2. The numbers. Explain the numbering; Lower numbers are more acidic.***

***3. Place H bricks on their pictures. Is the ocean becoming more acidic? The number change looks small but count the Hydrogens! 4. Read and name some actions to help.***



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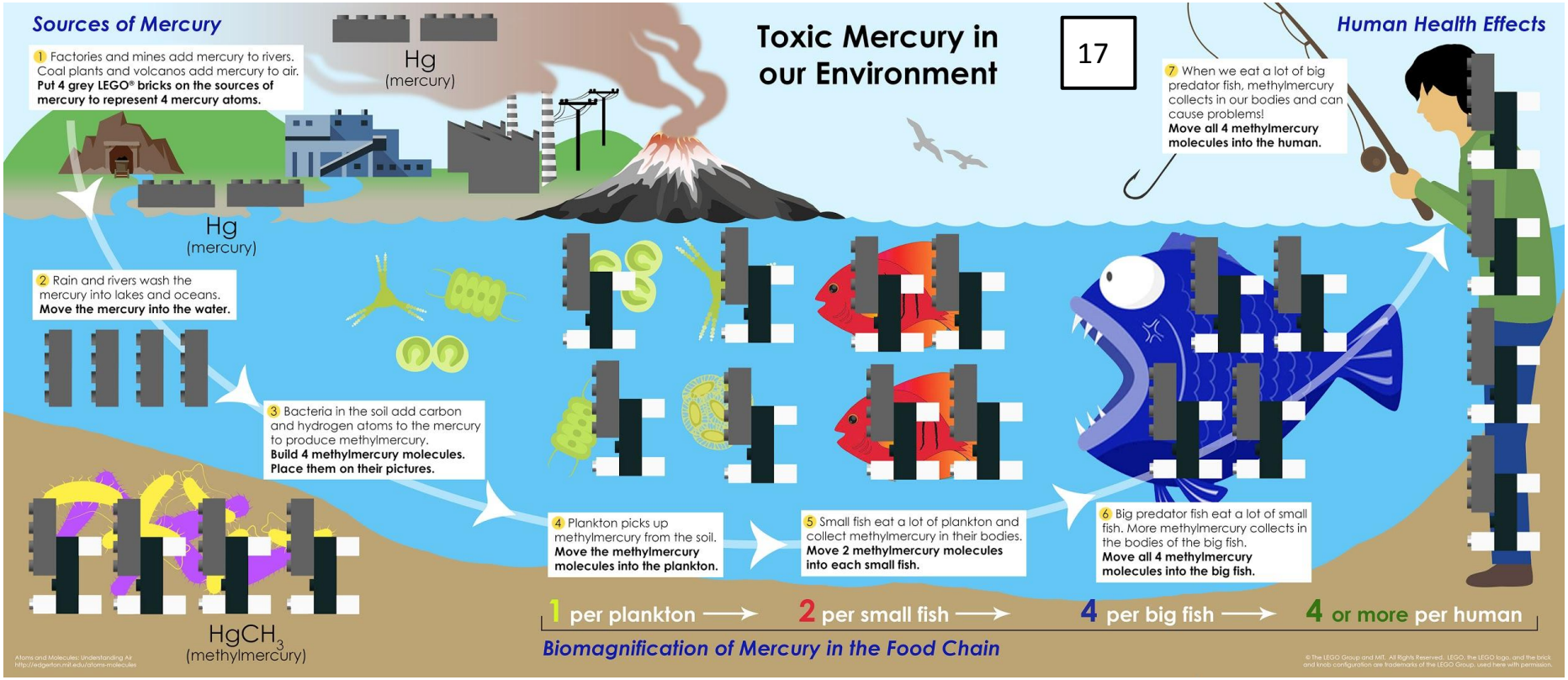


One of the major sources of mercury in the air comes from burning **COAL!** (Isn't that surprising?)

- Notice the Mercury in the air above the coal-fired smoke stack? It would be good to stop burning coal.

Burning coal puts a lot of mercury into the atmosphere where it can travel great distances around the planet. This mercury comes down in rain and it pollutes water sources, such as rivers and lakes.

- Next, follow the Mercury atoms as they settle into the mud. Bacteria add Carbon and Hydrogen atoms. Now tiny plants take in the molecules and begin the food chain as shown above. And the Mercury builds up.

**Question: What kinds of fish will be the most loaded with mercury?**

Mercury is toxic to the human nervous system.


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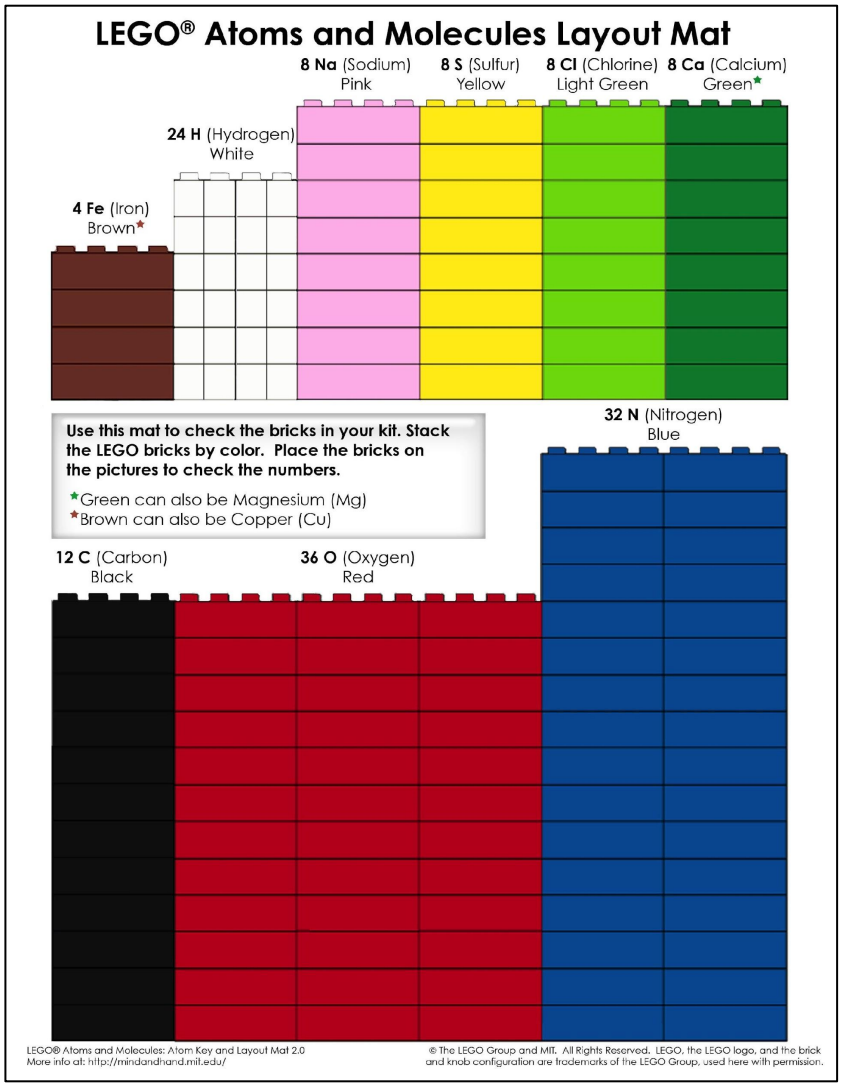
This concludes our photosynthesis time. Please Clean Up!

1) Make the bricks into stacks.
2) Check the stacks of bricks with the layout mat.
3) Place the stacks in the correct spaces in the kit.

# Place your bricks on the layout mat to check your kit.





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