ALGEBRA 1
“PATTERNS USING SIOP”

NATACHA VILNAY
SUMMER 2013
TSL 518
Introduction
1. Title: Representing Patterns in Algebra I

2. Grade Level: 9th Grade

3. Target Group: Mainstream class with integrated ELL students

4. Source of Written Reading Materials:


   New Haven Public Schools Algebra I Curriculum

   Book: 99 Ideas and Activities for Teaching English Learners with The SIOP Model. MaryEllen Vogt and Jana Echevarria.

5. Source of Lessons:

   New Haven Public Schools Algebra I Curriculum


   Unit 1 – Investigation 1 & 2 Overview

   Learn about hydrocarbons and Titan:


6. Overarching Learning Goals:

   I want my students to know how to use models (in science) to identify patterns

   I want my students to know the four representations of patterns

   I want my students to know how to represent patterns using tables, graphs, equations and written descriptions

   I want my students to know which representation is most useful for them or most difficult to understand
Lesson 1
### Content Objectives, Language Objectives and Performance Indicators: Lesson 1

<table>
<thead>
<tr>
<th>CONTENT OBJECTIVES</th>
<th>LANGUAGE OBJECTIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identify patterns from real world contexts</td>
<td>1a. In small groups, students will build hydrocarbon molecules and talk together about the relationship between carbon atoms and hydrogen atoms in those hydrocarbon molecules.</td>
</tr>
<tr>
<td>2. Represent patterns using tables and written descriptions</td>
<td>1b. After several group activities, students will individually complete a table of values by writing numbers into a table cell.</td>
</tr>
<tr>
<td>2. Individually, students will state the first two representations of patterns and represent patterns as tables and with verbal or written descriptions.</td>
<td>1c. Students will write in pairs or individually a description of the pattern in the hydrocarbon molecules from the table or from the models built.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOMAIN-TOpic</th>
<th>LEVEL 5</th>
<th>LEVEL 4</th>
<th>LEVEL 3</th>
<th>LEVEL 2</th>
<th>LEVEL 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Speaking and Listening:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Build hydrocarbon molecules</td>
<td>Lead a small group discussion of the different strategies used to build each hydrocarbon molecule.</td>
<td>Contribute to a small group discussion of the different strategies used to build each hydrocarbon molecule.</td>
<td>Given language prompts by the teacher, participate in small group discussion of the different strategies used to build each hydrocarbon molecule.</td>
<td>With the help of language prompts, answer a teacher question on how many of each atom is needed to build each hydrocarbon molecule.</td>
<td>Point to the atoms needed to build each hydrocarbon molecule in response to a teacher demonstration. Repeat the steps used to build the physical model.</td>
</tr>
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<td><strong>Speaking and Listening:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship between the 4 simple hydrocarbon molecules</td>
<td>Discuss the changes in hydrocarbon molecules as carbons are added to each structure to create the next hydrocarbon molecule in complete sentences and the use of appropriate vocabulary words.</td>
<td>Discuss the changes in hydrocarbon molecules as carbons are added to each structure to create the next hydrocarbon molecule in complete sentences.</td>
<td>Discuss the changes in hydrocarbon molecules as carbons are added to each structure to create the next hydrocarbon molecule by using sentence starters from the teacher.</td>
<td>Answer a question from a partner about the changes in hydrocarbon molecules as carbons are added to each structure to create the next hydrocarbon molecule by using phrases.</td>
<td>Point to the changes in each hydrocarbon molecule by giving a 1 to 2 word answer in response to a question or statement from the teacher.</td>
</tr>
<tr>
<td><strong>Writing:</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Represent patterns with a verbal description</td>
<td>Explain the pattern in the hydrocarbon molecules from the table as the number of carbons increases in a complete sentence individually or with a partner.</td>
<td>Explain the pattern in the hydrocarbon molecules from the table or the physical model as the number of carbons increases by using simple phrases or expressions individually or with a partner.</td>
<td>Explain the pattern in the hydrocarbon molecules from the table or the physical model as the number of carbons increases by using sentence starters from the teacher with a partner.</td>
<td>Explain the pattern in the hydrocarbon molecules from the table or the physical model as the number of carbons increases by using fill in the blank sentences and a word bank with a partner.</td>
<td>Show the pattern in the hydrocarbon molecules by sketching the four simple hydrocarbons built by labeling hydrogen atoms as “Hydrogen” and carbon atoms as “Carbon” individually.</td>
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### Functional Language Chart: Lesson 1

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>SITUATION</th>
<th>EXPRESSIONS</th>
<th>WORDS</th>
<th>GRAMMAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct/Analyze</td>
<td>Build hydrogen molecules</td>
<td>How many hydrogen atoms does ____ 1 ____ have?</td>
<td>1. Methane, Ethane, Propane, Butane, Octane</td>
<td>How – question</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How many hydrogen atoms are needed to build ____ 1 ____?</td>
<td>2. One, two, three, four, etc...</td>
<td>Nouns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>____ 1 ____ is a hydrogen molecule with ____ 2 ____ carbon atom(s) and ____ 2 ____ hydrogen atoms.</td>
<td></td>
<td>Counting numbers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sentence</td>
</tr>
<tr>
<td>Explain/Describe</td>
<td>Pattern in a Table of Values and or physical models</td>
<td>As the number of ____ 3 ____ increases by ____ 2 ____ , the ____ 4 ____ increases by ____ 2 ____.</td>
<td>3. Carbon atoms, Hydrogen atoms</td>
<td>Sentence</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Number of hydrogen atoms, Amount of energy released from combustion,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number of hydrogen atoms attached to carbon</td>
<td></td>
</tr>
</tbody>
</table>
Lesson Plan

**Duration:** 80 minutes (block period)

**Lesson Overview:** Molecular structures of hydrocarbons are explored to find patterns. The pattern is represented using tables and verbal descriptions.

**Essential Questions:** Where do you see patterns in the real world? How are patterns represented?

**Common Core Standards – CCSS:**

- **8.F.A.2** Define, evaluate, and compare functions.
  - Compare properties of two functions each represented in a different way
    - (Algebraically, Graphically, Numerically in tables, or by Verbal descriptions)

**Introduction: 10 minutes**

The day’s objectives will be posted on the white board:
Each one will be read allowed by the teacher.

1. Identify patterns from real world contexts
2. Represent patterns using tables and written descriptions

The students will have index card on their desk and are grouped in groups of 4.

To review the objectives with the students and to build background knowledge, the teacher will ask the students to think about the following the questions:

“What do you think of when you hear the word ‘pattern’?
“Where do you see patterns in your everyday life?”
“Where did you see patterns this morning?”

The teacher will pause to give the students the time to think. The teacher will tell the students that an answer is not yet required. But individual students can write answers on one of index cards on their desk to share later. The teacher will repeat the question, point to an index card, and illustrate to the students that an answer can be written or drawn on the index card.

To provide a visual of what patterns are for ELLs, the teacher will show a 51 sec video entitled “Patterns in real world” on Vimeo using the following link: [http://vimeo.com/22423987](http://vimeo.com/22423987) (during the video Level 1 students will have a copy of Poster #1 as a listening guide)
The Script of the video will be posted on the classroom wall as the students watch the video. (See Poster #1 on page 21)

At the end of the video, the teacher will ask once again:

“Where do you see patterns in your everyday life?”

The teacher will ask the students to record a response in words or in picture form on an index card. The students will have 1-2 minutes to do so. They will have the opportunity to share their answer out loud and also post their index card onto Poster #1 if they come up with an answer that is not already on the poster.

Anticipation: 10 minutes

The teacher will say that today the students will explore structures called hydrocarbons molecules to identify patterns and learn two ways of representing that pattern.

The teacher will refer to Poster #2, on page 22, to point to the pictures of a hydrogen atom and a carbon atom. The teacher will explain the characteristics of each while pointing to the pictures. The teacher will also show physical representations of a hydrogen atom and a carbon atom. The students will have a minute to touch the physical models of each atom that the teacher will place on their desk for their group to explore.

Then the teacher will refer to part b of the same poster to discuss methane. She will demonstrate to the class how to build a three dimensional representation of methane. She will give the students the opportunity to discuss within their groups how the structure was built.

As the teacher circulates around the room, the teacher will say the following:

“We just built methane. It is a hydrocarbon because it is made of carbon and hydrogen. Now it is your turn (by pointing at them) to build methane.”

“Methane is a hydrocarbon molecule because it has 1 carbon atom and 4 hydrogen atoms.”

Think about how methane is built. What if I ask you to build a hydrocarbon molecule? What if I ask you to build more than one hydrocarbon molecules? One with two carbons? Another with three carbons? And so on... Do you think the way in which they are built will follow a pattern? If the structures follow a pattern, in what ways will you be able to represent that pattern?

The teacher will tell the students that now it is their turn to continue to build the four simple hydrocarbon molecules in their respective groups. They have to discuss the strategies used to build the hydrocarbons by using full sentences or by pointing to the atom. The teacher will model both expectations. The teacher will distribute worksheet 1.1.1 Structure of Hydrocarbons, on pages 8-19, where the students will record their findings in a table cell and later write a written description of the pattern.
**Exploration: 30 minutes**

The teacher will distribute the worksheet to the students in order for them to build the hydrocarbons. The students will work in groups to explore the relationship between carbon and hydrogen atoms in hydrocarbon molecules. The students will use molecular structure kits to build three-dimensional physical models of each of the four simple hydrocarbons.

Worksheets for each level:

- Level 5 students will have: **1.1.1 Structure of Hydrocarbons**
- Level 4 students will have: **1.1.1 Structure of Hydrocarbons** with important parts of the text highlighted
- Level 3 students will have: **1.1.1 Structure of Hydrocarbons** with part of the text deleted and
  the graphic organizer called **Hydrocarbon Molecule Mapping** on page 23
- Level 2 and 1 will have: **1.1.1 Structure of Hydrocarbons** only with the problem numbers,
  the graphic organizer called **Hydrocarbon Molecule Mapping** on page 23, and
  **1.1.2 Hydrogen and Carbon Atoms** on page 20

To facilitate discourse within the groups, the students will use the following questions that will be written (or projected) on the board.

“How many hydrogen atoms does **methane** have?”

“How many hydrogen atoms are needed to build **methane**?”

To model an appropriate response, I will repeat the following sentence as I circulate around the room and assist individual students:

**Methane** is a hydrogen molecule with **1** carbon atom(s) and **4** hydrogen atoms.

Level 4 & 5 students will respond in full sentences: **Methane** is a hydrogen molecule with **1** carbon atom(s) and **4** hydrogen atoms.

Level 3 students will need sentence starters: **Methane** is ____________ with ____________ and ________________.

__________ carbon atoms are _________ to build ____________.

Level 2 students will use phrases or expressions: 4 hydrogen atoms

Level 1 students will use their **1.1.2 Hydrogen and Carbon Atoms** worksheet to point to the appropriate of atom.

**After Exploration: 20 minutes**

The students will represent the patterns in tables and using verbal and written representations.
The teacher will point to the worksheet to let the students know that they need to complete the written part of the assignment. Levels 1 through 3 will have a graphic organizer to complete. The students will receive a worksheet where they have to record their data in a table cell. They will also write a verbal description of the relationship between carbon atoms and hydrogen atoms in hydrocarbon molecules. Students will be allowed to work individually, with a partner, with the teacher depending on their level.

<table>
<thead>
<tr>
<th>Writing- Represent patterns with a verbal description</th>
<th>Explain the pattern in the hydrocarbon molecules from the table as the number of carbons increases in a complete sentence individually or with a partner.</th>
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<th>Explain the pattern in the hydrocarbon molecules from the table or the physical model as the number of carbons increases by using sentence starters from the teacher with a partner.</th>
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<th>Show the pattern in the hydrocarbon molecules by sketching the four simple hydrocarbons built by labeling hydrogen atoms as “Hydrogen” and carbon atoms as “Carbon” individually.</th>
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**Note:** Refer to the students’ worksheet for different levels to see the modifications. Level 5 will have to write complete sentences. Levels 2 and 3 have sentence frames with a word bank on the graphic organizer.

**Closure: 10 minutes**

The students will have an opportunity to share and discuss their answers with their group members.

To conclude the teacher will once again review the day’s objective which was to identify patterns from real world contexts and to represent patterns in two different ways. The teacher will ask the following questions that will also be written on the board. (Teacher will point to the questions)

“What are the two representations of patterns that you learned today?” Possible answers: “tables and written descriptions” “How will you continue to explore patterns in your world after this lesson?”

The teacher will point to the section of the worksheet where the students have to record their responses. Some of the students will work independently others in pairs. The teacher will use the response board method from the SIOP model from the 99 Book on page 185. One white board will be given to each group for one group member to record and answer and display the response board after conferencing with the other group members.

The teacher will conclude the lessons by telling the students that the next lesson will explore two more ways of representing patterns.
On June 30, 2004, NASA’s Cassini spacecraft entered orbit around Saturn to begin the first in-depth, up-close study of the ringed planet and its domain. As expected, the Saturn System has provided an incredible wealth of opportunities for exploration and discovery. Cassini has revealed that one of Saturn’s moons, Titan, has a surface shaped by rivers and lakes of liquid hydrocarbons ethane and methane (used as fuels), which form clouds and occasionally rain from the sky as water does on Earth.


You are chosen to travel to Titan in the year 2022 to get the fuel and return it to the Earth.

In order to identify the hydrocarbons, you will build some models and look for a common pattern. An example of the simplest hydrocarbon, methane, is shown below. In every simple hydrocarbon molecule, each carbon atom has four bonds (links to other atoms) and each hydrogen atom has one bond.
1. Build methane, ethane, propane, and butane with the number of carbon atom(s) indicated in the table. Complete the table below.

<table>
<thead>
<tr>
<th>Hydrocarbon</th>
<th>Carbon Atoms</th>
<th>Hydrogen Atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Ethane</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Propane</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Butane</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

2. Sketch the four simple hydrocarbon molecules you built. Label each atom as **Hydrogen** or **Carbon**.

<table>
<thead>
<tr>
<th>Methane</th>
<th>Ethane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Propane</th>
<th>Butane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Does the number of hydrogen atoms follow a pattern? ________ (yes/no)

Write a description of the pattern.

__________________________________________________________________________________________

__________________________________________________________________________________________
4. When hydrocarbons are burned, they create energy. The table below shows approximately how much energy (kJ/mole) is released from completely burning a fixed amount of each hydrocarbon.

<table>
<thead>
<tr>
<th>Simple Hydrocarbon</th>
<th>Number of Carbon Atoms</th>
<th>Energy Released from combustion (kJ/mole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>1</td>
<td>920</td>
</tr>
<tr>
<td>Ethane</td>
<td>2</td>
<td>1560</td>
</tr>
<tr>
<td>Propane</td>
<td>3</td>
<td>2200</td>
</tr>
<tr>
<td>Butane</td>
<td>4</td>
<td>2840</td>
</tr>
<tr>
<td>Pentane</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Hexane</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Heptane</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Octane</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

   a. Look for the pattern and complete the table.

   b. Describe the pattern in your table in words.

5. Based on the data from the table and graph, which hydrocarbons do you think might be the best to bring back from Titan?

   Explain your answer.

6. You learned two representations of patterns. State the first two representations of patterns.

   a. 

   b. 


1.1.1 Structure of Hydrocarbons – LEVEL 4

Algebra 1

Name: ___________________________ Date: _______________ Group: _______________

On June 30, 2004, NASA’s Cassini spacecraft entered orbit around Saturn to begin the first in-depth, up-close study of the ringed planet and its domain. As expected, the Saturn System has provided an incredible wealth of opportunities for exploration and discovery. Cassini has revealed that one of Saturn’s moons, Titan, has a surface shaped by rivers and lakes of liquid hydrocarbons ethane and methane (used as fuels), which form clouds and occasionally rain from the sky as water does on Earth.


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3. **Build methane, ethane, propane, and butane** with the number of carbon atom(s) indicated in the table. **Complete the table** below.

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<td></td>
</tr>
<tr>
<td>Butane</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

4. **Draw a picture** of the four simple hydrocarbon molecules you built. Label each atom as **Hydrogen** or **Carbon**.

<table>
<thead>
<tr>
<th>Methane  (with one carbon)</th>
<th>Ethane (with two carbons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Propane (with three carbons)</th>
<th>Butane (with four carbons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Does the number of hydrogen atoms follow a pattern? ________ (yes/no)

Write a description of the pattern.

As the number of __________________________ increases by ____________,
the number of __________________________ increases by ____________.
4. When hydrocarbons are burned, they create energy. The table below shows approximately how much energy (kJ/mole) is released from completely burning a fixed amount of each hydrocarbon.

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a. Look for the pattern and **complete the table.**

b. Describe the pattern in your table in words.

As the number of ____________________________

increases by ____________, the____________________

____________________________ increases by __________.

5. You learned two representations of patterns. State the first two representations of patterns.

a. ________________________________

b. ________________________________
One of Saturn’s moons, Titan, has a surface shaped by rivers and lakes of liquid hydrocarbons ethane and methane (used as fuels), which form clouds and occasionally rain from the sky as water does on Earth.

In order to identify the hydrocarbons, you will build some models and look for a common pattern.

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**USE THE GRAPHIC ORGANIZER CALLED HYDROCARBON MOLECULE MAPPING TO HELP YOU WITH # 2-5**

2. **Draw a picture** of the four simple hydrocarbon molecules you built. Label each atom as **Hydrogen** or **Carbon**.

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a. Look for the pattern and complete the table.

b. Describe the pattern in your table in words.

As the number of __________________________ increases by ______________, the __________________________ increases by __________.

5. You learned two representations of patterns. State the first two representations of patterns.

a. __________________________

b. __________________________
1.1.1 Structure of Hydrocarbons – LEVEL 2 & 1

Algebra 1

Unit 1: Patterns (Modified from New Haven Publics Schools Curriculum)

Name: _________________________________ Date: ________________ Group: ____________

You will build some models and look for a common pattern.

An example of the simplest hydrocarbon, methane, is shown below.

1. Build methane with 1 carbon, write the number of hydrogen in the table.
   Build ethane with 2 carbons, the number of hydrogen in the table.
   Then built propane with 3 carbons, and butane with 4 carbons, one after the other.

   Complete the table below.
   Hydrocarbon Molecules

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<tr>
<td>Propane</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Butane</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

USE THE GRAPHIC ORGANIZER CALLED HYDROCARBON MOLECULE MAPPING TO HELP YOU WITH # 1-5
2. Use **Worksheet 1.1.2** to cut out atoms, then tape or draw a picture of the four simple hydrocarbon molecules you built.

Label each atom as **Hydrogen** or **Carbon**.

<table>
<thead>
<tr>
<th>Methane (with one carbon)</th>
<th>Ethane (with two carbons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Propane (with three carbons)</th>
<th>Butane (with four carbons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Does the number of hydrogen atoms follow a pattern? _______ (yes/no)

Write a description of the pattern.

As the number of ____________________________ increases by ____________,
the number of ____________________________ increases by ____________.
4. Hydrocarbons create energy.

<table>
<thead>
<tr>
<th>Simple Hydrocarbon</th>
<th>Number of Carbon Atoms</th>
<th>Energy Released from combustion (kJ/mole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>1</td>
<td>920</td>
</tr>
<tr>
<td>Ethane</td>
<td>2</td>
<td>1560</td>
</tr>
<tr>
<td>Propane</td>
<td>3</td>
<td>2200</td>
</tr>
<tr>
<td>Butane</td>
<td>4</td>
<td>2840</td>
</tr>
<tr>
<td>Pentane</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Hexane</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Heptane</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Octane</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

a. Look for the pattern and complete the table.

b. Describe the pattern in your table in words.

As the number of ________________________________

increases by ____________, the____________________

______________________________ increases by ________.

5. You learned two representations of patterns. State the name of the first two representations of patterns.

Use the word bank below if necessary.

a. ________________________________

b. ________________________________

**WORD BANK:**
Butane, Propane, Methane, Ethane
One, two, three, four, etc...
Carbon atom, hydrogen atoms
Tables, written descriptions
1.1.2 Hydrogen and Carbon Atoms

Algebra 1  Unit 1: Patterns  (Modified from New Haven Public Schools Curriculum)

Name: ________________________________  Date: _______________  Period: ____________

During the group discussion, point to the atom(s) needed to build each structure:

During the group discussion, point to the atom(s) needed to build each structure:

Use the atoms below to answer #2 on Worksheet 1.1.1 Structure of hydrocarbon. Label each molecule.
Oh my patterns everywhere!

Where do we see patterns?

Workplace
DNA
Nature
Art
Animals
Environment
History
Wall and floor tiles

Now let’s create our own patterns.

VIDEO Listening Guide

Put a check ✓ next to these words when you hear them:

_____ Patterns
_____ Workplace
_____ DNA
_____ Nature
_____ Art
_____ Animals
_____ Environment
_____ History
_____ Wall
_____ Floor tiles
**WORD WALL – POSTER #2**

*Pictures to show characteristics for anticipation of lesson*

a) Hydrogen atom has one hole and carbon atom has 4 holes

b) Methane (carbon is black and hydrogen is white)

c) Ethane (carbon is big and hydrogen is small)
HYDROCARBON MOLECULE MAPPING

Name of Hydrocarbon Molecule

NUMBER OF CARBONS
Has ______ carbon atom

NUMBER OF CARBONS
Has ______ carbon atom

NUMBER OF CARBONS
Has ______ carbon atom

NUMBER OF CARBONS
Has ______ carbon atom

NUMBER OF HYDROGEN
Has ______ hydrogen atom

NUMBER OF HYDROGEN
Has ______ hydrogen atom

NUMBER OF HYDROGEN
Has ______ hydrogen atom

NUMBER OF HYDROGEN
Has ______ hydrogen atom

Relationship between carbon and hydrogen in hydrocarbon molecules

As the number of ______________________________ increases by __________,
the number of ______________________________ increases by __________.
NARRATIVE

I taught this lesson last year for the first time because the new common core standards were being implemented in Algebra I in my district. At the meeting where the new curriculum was handed out to teachers on the day prior to the beginning of the school year, we were told to use the documents without making any changes to the original documents. This lesson is the first activity in the first unit of instruction on patterns. This lesson was challenging for mainstream students because of the amount of reading involved. Lots of directions from me along with scaffolding and modeling helped the student reach some level of success.

The first thing that I changed in this lesson was to address fewer objectives instead of 5 or more, but to cover them more in depth. The first activity required so much of the students: explore the pattern by investigating, complete a table of values, create a graph, make predictions from the graph, sketch hydrocarbons, write the chemical symbols to represent them and to write a verbal description of the pattern observed. So I decided to focus only on discovering the pattern in the molecules and to represent the pattern using two of the representations.

The other objectives will be part of the lessons 2 and 3. The worksheets that were used to teach lessons 1-3, where modified and parts of each worksheet were used for this lesson. I also created a graphic organizer in order to make the topic more comprehensible. I also decided to show a video that is different from the one that was suggested in the original lesson plan. The one that I chose will help build background knowledge and create shared history. A script of the video is also included.
Lesson 2
Content Objectives, Language Objectives and Performance Indicators: Lesson 2

<table>
<thead>
<tr>
<th>CONTENT OBJECTIVES</th>
<th>LANGUAGE OBJECTIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Represent patterns using graphs</td>
<td>1a. In small groups, students will make a graph that shows the relationship between the number of carbon atoms and the number of hydrogen atoms listed in a table.</td>
</tr>
<tr>
<td>2. State the first three representations of patterns and use them to represent patterns</td>
<td>1b. After the group activity, students will individually create graphs that show the relationship between two quantities.</td>
</tr>
<tr>
<td>3. Use patterns to solve problems and make predictions</td>
<td>2. Individually, students will state the first three representations of patterns and repeat them with a partner. The will represent the pattern found in organic alcohols to create a table, a graph and write a written description.</td>
</tr>
<tr>
<td></td>
<td>3. In pairs or individually, students will use graphs to make predictions and solve problems.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DOMAIN-TOPIC</th>
<th>LEVEL 5</th>
<th>LEVEL 4</th>
<th>LEVEL 3</th>
<th>LEVEL 2</th>
<th>LEVEL 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Listening, Reading and Speaking- Creating Graphs</strong></td>
<td>Follow detailed oral directions on how to create graphs, read the information from a table and discuss as a leader with group members on how to create graphs from data tables</td>
<td>Follow short oral directions to create graphs, read simple directions and the information from a table and share in a discussion with group members on how to create a graph from data tables</td>
<td>Select the next step from a list of directions on how to create graphs; read simple directions and the information from a table and ask “what comes next?” questions in a discussion with group members on how to create a graph from data tables</td>
<td>Repeat the selected next step from a list of directions on how to create graphs; repeat simple directions and the information from a table and ask “what comes next?” questions in a discussion with group members on how to create a graph from data tables</td>
<td>Point to the next step from a list of directions on how to create graphs; Identify next step by arranging the simple directions in numerical order, and say “this comes next” in a discussion with group members on how to create a graph from data tables</td>
</tr>
<tr>
<td><strong>Reading and Writing- Analyze Data Making Predictions</strong></td>
<td>Summarize patterns with written descriptions in sentence form, and analyze the data from a graph and table to make predictions</td>
<td>Summarize patterns with written descriptions in short phrases, and analyze the data from a graph and table with a partner to make predictions</td>
<td>Organize and describe patterns with written descriptions by filling in the blank, and display the data in a graph and in a table to make predictions</td>
<td>Label parts of a graph with a partner, and extend the graph to the right or to the left to make predictions</td>
<td>Label parts of a graph with a partner, and extend the graph to the right or to the left to make predictions with a partner or teacher</td>
</tr>
</tbody>
</table>
### Functional Language Chart: Lesson 2

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>SITUATION</th>
<th>EXPRESSIONS</th>
<th>WORDS</th>
<th>GRAMMAR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sequence</strong></td>
<td>Steps to Create a Graph</td>
<td>What is the _<strong><strong>0</strong></strong> step when creating a graph?</td>
<td>0. First, second, third, fourth, etc</td>
<td>Ordinal Numbers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First <em><strong><strong>1</strong></strong></em>_ the <em><strong><strong>2</strong></strong></em>_, Second <em><strong><strong>2</strong></strong></em>_, Third give the graph a <em><strong><strong>2</strong></strong>, and <em><strong><strong>1</strong></strong></em></em> the appropriate <em><strong><strong>2</strong></strong>, Fourth <em><strong><strong>1</strong></strong></em></em> the <em><strong><strong>2</strong></strong></em>.</td>
<td>1. draw, label, set plot, read</td>
<td>Verb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First, _________ the data from the table, then find the value on the _<strong><strong>2</strong></strong>, and then find the corresponding value on the <em><strong><strong>2</strong></strong></em>.</td>
<td>2. x-axis, horizontal axis, y-axis, vertical axis, title, scale, points</td>
<td>Transitional phrases to show sequence</td>
</tr>
<tr>
<td></td>
<td>Steps to Plot a Point</td>
<td></td>
<td>Math vocabulary words</td>
<td></td>
</tr>
<tr>
<td><strong>Explain/Describe</strong></td>
<td>Prediction with Graph</td>
<td>To use the graph for prediction, I extend the graph to the <em><strong><strong>3</strong></strong></em>.</td>
<td>3. right, left</td>
<td>Noun</td>
</tr>
</tbody>
</table>
Lesson Plan 2

Duration: 80 minutes (block period)

Lesson Overview: Data tables of hydrocarbon molecules are used to represent patterns in a new way. The pattern is represented using graphs and graphs are used to make predictions.

Essential Questions: Are there more ways of representing patterns?
Once patterns are discovered through explorations, what are their uses?

Common Core Standards – CCSS:

8.F.A.2 Define, evaluate, and compare functions.
Compare properties of two functions each represented in a different way
(Algebraically, Graphically, Numerically in tables, or by Verbal descriptions)

Introduction: 5 minutes

The day’s objectives will be posted on the white board:
Each one will be read allowed by the teacher.
1. Represent patterns using graphs
2. State the first three representations of patterns
3. Use patterns to solve problems and make predictions

The teacher will ask the students to recall the first two representations of patterns from the previous lesson. The students will be in the same groups.

The teacher will say: ‘Name the two representations of patterns you learned. You will have 2 minutes to talk to your group members and to write a response on the white board that I am giving you. When the time is up, please raise your board to share your answer.”

(The teacher will point to the question on poster paper that has the prompt; give each group a small white board and a marker and signal that they have 2 minute to answer and share their responses with the class)

One or two groups will be chosen to read their answers. Possible answers will be: “Patterns can be represented with tables and written descriptions”
**Anticipation: 15 minutes**

The teacher will say that today they will learn a third representation of patterns which is a graph. The teacher will show them different types of graphs (See Poster #3, on page 39).

Graphs provide a visual representation. Something that is ‘visual’ is something that you can see. You will create graphs of the tables you created in the lesson about hydrocarbon molecules. You will also extend the graph to the left or the right to make predictions.

While pointing at the graphs on Poster#3, the teacher will ask:

“Which graph you think will best represent the relationship between the carbon and the hydrogen atoms?”

“Why can’t we use a bar graph?”

“Why can’t we use a pie graph?”

“Why is the line graph or the scatter plot the best graph to represent this relationship?”

The students will have 3 minutes to discuss similarities and differences among the graphs.

The teacher will tell them that today; they will represent patterns with line graphs. The teacher will point to the line graphs #4.

The students will be asked to talk about the different components/parts of a graph and the steps to follow in creating a graph.

(This will be considered a review because the students learned how to create graphs in previous lessons)

Then the teacher will sing a song with the students to help them remember the steps needed to construct a graph to the tune of the Hokey Pokey song as follows:

You draw the x-axis
You draw the y-axis

You label the x-axis
You label the y-axis

You give the graph a title and choose right scales
And then you plot the points

As they sing the song, the teacher will demonstrate with gestures while creating an actual graph on the board. Every time, they sing the song the teacher will create a quick graph. (See poster #4, on page 40)
**Group Guided Practice: 20 minutes**

The teacher will distribute the whole group assignment worksheet **2.1.1 Graphs of Hydrocarbons** on pages 31 and 35. The teacher will model how to read the data from the table of values, point to the first set of values in the table and find the corresponding values on the graph; first on the x-axis and then on the y-axis. The first three points will be plotted together as a class. The students will work in groups to graph the last point and discuss the pattern in the graph. They will write a description of that pattern in words on their worksheet.

To facilitate discourse within the groups, the students will use the following questions that will be written (or projected) on the board.

“What are the steps when creating a graph?” “What is the next step?”
“How can I plot a point correctly?”
“What pattern do you see in the graph?”
“How can I use the graph to make predictions?”

To model appropriate responses, as the teacher moves around the room to monitor the students’ progress. The teacher:

1. Will give each group a copy of poster#4 on page 40, and encourage them to sing the song as needed.

   Level 1 and 2 students will be given an extra copy to cut out the steps and arrange them in numerical order.

   This will facilitate their involvement in group discussions. They will also have a copy of the functional language chart on page 26.

2. Use the white board to model to individual students how to plot points.

3. Will ask – “What would happen if you extended the graph? Would the result be meaningful?”

   Show students how to find patterns in the graph and use the patterns to make predictions, the teacher will say

   “I can extend the graph to the right/left to make predictions.” The students will repeat this sentence.

The teacher will project worksheet **2.1.1 Graphs of Hydrocarbons** on the board and have a whole class share out where students will have the chance to show how they plotted the last point. They will also explain either in full sentences or short phrases any pattern they see in the graph while pointing at the points. The teacher will show how to extend the graph to make predictions.
Independent or Partner Practice:  30 minutes

The completed Guided assignment will remained projected on the board. The teacher will distribute worksheet 2.1.2 Graph of Energy Released by Burning Hydrocarbons on pages 32 and 36 for the students to complete with a partner.

The teacher will read the directions with the students and will point to the similarities between the assignment that was done as a class and the new one. The data is new but the worksheets are set up the same way and the questions are similar.

The students will be allowed to refer to the guided assignment if necessary. They will work at their own pace and transition to worksheet 2.1.3 Organic Alcohols on pages 33 and 34 for Levels 4 and 5, and pages 37 and 38 for Levels 1-3. The teacher will inform the students that manipulatives are available and will show the students the same ones from the previous lesson that they can use.

Note: Refer to the students’ worksheet for different levels to see the modifications. Levels 1-4 will be given hands on materials to build the organic alcohols and use the physical models to complete the table of values.

Closure: 10 minutes

To close the lesson and review the day’s objective, the teacher will read and point to each objective. After each one is read the teacher will ask one or two questions related to each objective to find out from the students if the objectives were met. The ‘Simultaneous Round Table’ activity from the 99 Activities Textbook on page 178 will be used. The students will be given three pieces of paper. Each paper will have different questions related to each objective. The teacher will hand them out as the questions are read. The students will have 2 minutes to take turn writing a response on the paper and will pass the paper around for other group members to read and/or write more answers. Then they will move on to the next objective. The questions for each worksheet will be the following.

1. Represent patterns using graphs
   “How did you represent patterns using graphs today?”    “How did you create the graph?”
2. State the first three representations of patterns
   “You learn three ways to represent patterns (show three fingers). Can you list them?
   If you need help, you can look for words in bold (darker prints) and underlined on your assignments. “
   (Point to a few bold and underlined words)
3. Use patterns to solve problems and make predictions
   “How did you use the pattern from the graph to make predictions?”

At the end, each group will have the opportunity to report some of their answers on a big piece of paper for all of the groups to review. The teacher will announce that the next lesson will teach another way to represent patterns.
1. Use the hydrocarbon molecules table to make a graph that shows the relationship between the number of carbon atoms and the number of hydrogen atoms in the hydrocarbons.

<table>
<thead>
<tr>
<th>Hydrocarbon Molecules</th>
<th>Number of Hydrogen Atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Carbon Atoms</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

Describe the pattern in your graph in words.

___________________________________
___________________________________
___________________________________

Use the graph to predict the number of hydrogen atoms in a hydrocarbon with 5 carbon atoms. ______

Use the graph to predict the number of hydrogen atoms in a hydrocarbon with 8 carbon atoms. ______
2. Use the table below to make a **graph** to show how much energy is released (kJ/mole) from the combustion of hydrocarbons.

<table>
<thead>
<tr>
<th>Simple Hydrocarbon</th>
<th>Number of Carbon Atoms</th>
<th>Energy Released from combustion (kJ/mole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>1</td>
<td>920</td>
</tr>
<tr>
<td>Ethane</td>
<td>2</td>
<td>1560</td>
</tr>
<tr>
<td>Propane</td>
<td>3</td>
<td>2200</td>
</tr>
<tr>
<td>Butane</td>
<td>4</td>
<td>2840</td>
</tr>
<tr>
<td>Pentane</td>
<td>5</td>
<td>3480</td>
</tr>
<tr>
<td>Hexane</td>
<td>6</td>
<td>4120</td>
</tr>
<tr>
<td>Heptane</td>
<td>7</td>
<td>4760</td>
</tr>
<tr>
<td>Octane</td>
<td>8</td>
<td>5400</td>
</tr>
</tbody>
</table>

Describe the pattern in your graph in words.

__________________________________________
__________________________________________
__________________________________________

Use the pattern in your graph to predict the amount of energy released from the combustion of a hydrocarbon with 10 carbon atoms. ____________
You are researching the possibility of life forms on a planet orbiting a neighboring twin star. In the chemical analysis, you discover **organic alcohols** that would suggest oxygen and perhaps living organisms may be present.

In the following models of organic alcohols, the dark gray atoms are carbon, the ones marked O are oxygen, and the black atoms are hydrogen.

1. As before, start with **a table** to see the pattern for these hydrocarbons. Show the number of **carbon atoms** and **hydrogen atoms attached to the carbon atoms** in each molecule pictured above.

   *(Do not count the hydrogen atom attached to the oxygen.)*

2. Does the number of hydrogen atoms follow a pattern? __________

3. Write **a verbal description** of the pattern.

   __________________________________________________________

   __________________________________________________________

4. The next larger alcohol is called butanol, which has four carbon atoms. From your answer in question [2 and 3], how many hydrogen atoms attached to carbon atoms do you predict for butanol? __________

5. Add butanol to the table.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Carbon atoms</th>
<th>Hydrogen atoms attached to carbon atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethanol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propanol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isopropanol</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. Based on your answer and your prediction in question [4], make a rough stick drawing of butanol. Propanol had 2 possible arrangements - so might butanol. Draw two arrangements.

7. Draw a graph that shows the relationship between the number of carbon atoms and the number of hydrogen atoms attached to carbon atoms.

What do you do if two points are the same?

_________________

_________________

_________________

8. Write a description of the pattern from your graph or from your table.

_________________

_________________

_________________

9. How many hydrogen atoms would be attached to carbon atoms in an alcohol with 5 carbon atoms?
   __________

10. How many hydrogen atoms would be attached to carbon atoms in an alcohol with 7 carbon atoms?
    __________
2.1.1 Graph of Hydrocarbons – LEVEL 1-3

Algebra 1

1. Use the hydrocarbon molecules table to **make a graph**.

<table>
<thead>
<tr>
<th>Number of Carbon Atoms</th>
<th>Number of Hydrogen Atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

**Hydrocarbon Molecules**

**Hydrocarbon Structure**

**Describe the pattern in your graph in words.**

As the number of ____________________________ increases by ____________, the ____________________________ _______________ increases by ____________.

Extend the **graph** to the right ( → ) to complete the sentence.

A hydrocarbon with **5 carbon atoms** has ______________ hydrogen atoms.

Continue to extend the **graph** to the right ( → ) to complete the sentence.

A hydrocarbon with **8 carbon atoms** has ______________ hydrogen atoms.
2. Use the table below to make a graph.

<table>
<thead>
<tr>
<th>Number of CarbonAtoms</th>
<th>Energy Released from combustion (kJ/mole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>920</td>
</tr>
<tr>
<td>2</td>
<td>1560</td>
</tr>
<tr>
<td>3</td>
<td>2200</td>
</tr>
<tr>
<td>4</td>
<td>2840</td>
</tr>
<tr>
<td>5</td>
<td>3480</td>
</tr>
<tr>
<td>6</td>
<td>4120</td>
</tr>
<tr>
<td>7</td>
<td>4760</td>
</tr>
<tr>
<td>8</td>
<td>5400</td>
</tr>
</tbody>
</table>

Describe the pattern in your graph in words.
As the number of __________________________ increases by __________, the __________________________ __________________________ increases by __________.

Extend the graph to the right (→) to complete the sentence.
The amount of energy released from the combustion of a hydrocarbon with 10 carbon atoms is ________.
In the following models of **organic alcohols**, the dark gray atoms are carbon, the ones marked O are oxygen, and the black atoms are hydrogen.

Build your own organic alcohol with the physical models of each atom.

1. Use your physical models to complete the table.  
   *(Do not count the hydrogen atom attached to the oxygen.)*

2. The number of hydrogen atoms follow a pattern.  
   Write a verbal description of the pattern.
   
   As the number of __________________________ increases by __________, the __________________________ increases by __________.

3. **Butanol** has four carbon atoms. It is the next organic alcohol.  
   I predict that **butanol** will have______ hydrogen atoms attached to carbon atoms.

4. Include **butanol** to the table.
5. Make a rough stick drawing of butanol.

6. Draw a graph of the data in the table.

7. Extend the graph to the right (➡️) to complete the sentence.
   I predict that an alcohol with 5 carbon atoms will have __________ hydrogen atoms attached to carbon atoms.

8. Extend the graph to the right (➡️) to complete the sentence.
   I predict that an alcohol with 7 carbon atoms will have __________ hydrogen atoms attached to carbon atoms.
Poster #3 - Different Types of Graphs

1. Pie Graph


2. Bar Graph

http://t1.gstatic.com/images?q=tbn:ANd9GcQA0Gjz6FYkV7KxMQw6YKkDHboX8F4kuWu8FpskzxEZN8O1

3. Scatter Plot

http://t2.gstatic.com/images?q=tbn:ANd9GcT7GMI3kVY9kXMoGFXvZ85GHGOn7Z9enBrqG0wKZ

4. Line Graphs

http://t3.gstatic.com/images?q=tbn:ANd9GcTrC_mZXQnWZrh8aM5mWOBE2rA_xVPskS7yIfEnftDTB_7pMhg

http://t1.gstatic.com/images?q=tbn:ANd9GcTthkFwYOLu4wz6VJy02u8F0FyE7n6tX44uW

http://t1.gstatic.com/images?q=tbn:ANd9GcT7GMI3kVY9kXMoGFXvZ85GHGOn7Z9enBrqG0wKZ

http://t3.gstatic.com/images?q=tbn:ANd9GcTrC_mZXQnWZrh8aM5mWOBE2rA_xVPskS7yIfEnftDTB_7pMhg
Poster #4- How To Make A Graph Song With Pictures
The Hokey Pokey Tune

1. You draw the x-axis
   You draw the y-axis

2. You label the x-axis
   You label the y-axis

3. You give the graph a title and choose right scales
   And then you plot the points

Hydrocarbon

Number of Hydrogen Atoms

Number of Carbon
Lesson 2 turned out to be more of a challenge than lesson 1 because the focus was on graphs only. The original lesson assumed that the students already knew so much, and set out to teach all four representations of functions in one assignment. I had to think about how to make the lesson interesting and keep the students engaged. So this lesson went into using graphs to make predictions. I used the tables from the lesson 1 and now use them to teach the 3rd representation of functions which was graphing. So I decided to include the completed data tables on their assignment to build shared history (the students completed those tables through explorations in Lesson 1). I also asked them to recall the first two representations of patterns that they had already learned (table and written description).

The lesson had three phases:
1st phase - Guided practice - was done as a class with the opportunity to discuss and clarify unclear concepts in their first language if possible.

2nd phase - Partner or individual - gave the option to work with a partner or individually depending on the student’s comfort level. I choose to leave the guided practice assignment on the board as a reference especially for students who may not be able to ask questions but can recall steps that were modeled during the lesson.

3rd phase - Partner or individual or teacher assistance - offered the opportunity to work alone or with assistance. Students were forced to tap into previous learned concepts, use manipulatives to represent patterns with tables, written descriptions and graphs.

I have never used a song to teach a concept. It will be interesting to see how students at the high school level appreciate learning the song and use it when creating graphs.
Lesson 3
### Content Objectives, Language Objectives and Performance Indicators: Lesson 3

<table>
<thead>
<tr>
<th><strong>CONTENT OBJECTIVES</strong></th>
<th><strong>LANGUAGE OBJECTIVES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Represent patterns using equations</td>
<td>1a. In small groups, students will practice checking which equation represents the hydrocarbon molecule pattern.</td>
</tr>
<tr>
<td>2. Decide which representation is most useful or most difficult to understand</td>
<td>1b. In a new group, students will share orally whether or not their equation was the correct one.</td>
</tr>
<tr>
<td>3. Identify which representation of patterns is the best for pattern recognition</td>
<td>2. In small groups, students will decide and negotiate which of the four representations of patterns (tables, graphs, equations and written descriptions) is most useful for them. (which is most difficult to understand)</td>
</tr>
<tr>
<td>3. Students will write in pairs or individually a response to a journal entry about which of the four representations is best for specific patterns and explain the value of representing patterns using multiple representations.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>DOMAIN-TOPIC</strong></th>
<th><strong>LEVEL 5</strong></th>
<th><strong>LEVEL 4</strong></th>
<th><strong>LEVEL 3</strong></th>
<th><strong>LEVEL 2</strong></th>
<th><strong>LEVEL 1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Speaking and Listening</strong></td>
<td>Identify which of the equations represents the hydrocarbon molecule patterns by orally contributing to a small group discussion using complete sentences</td>
<td>Identify which of the equations represents the hydrocarbon molecule patterns by orally contributing to a small group discussion using phrases and short sentences</td>
<td>Identify which of the equations represents the hydrocarbon molecule patterns by orally contributing to a small group discussion by using short phrases only</td>
<td>Identify which of the equations represents the hydrocarbon molecule patterns by giving one-two word responses to teacher questions about the equations</td>
<td>Identify which of the equations represents the hydrocarbon molecule patterns by pointing to the similarities or differences in Box A and Box B</td>
</tr>
<tr>
<td><strong>Use Equations to represent patterns</strong></td>
<td>Write a paragraph explaining their understanding of the four representations of patterns and choosing which representation is easier or more difficult for them, which is most useful</td>
<td>Write a series of short sentences explaining their understanding of the four representations of patterns and choosing which representation is easier or more difficult for them, which is most useful</td>
<td>Write a series of short phrases explaining their understanding of the four representations of patterns and choosing which representation is easier or more difficult for them, which is most useful</td>
<td>Write a series of short phrases explaining their understanding of the four representations of patterns with the help of the teacher and the use of the functional language chart</td>
<td>Write a series of short phrases explaining their understanding of the four representations of patterns with the help of the teacher and the use of the functional language chart</td>
</tr>
<tr>
<td><strong>Writing and Reading</strong></td>
<td><strong>Journal entry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Functional Language Chart: Lesson 3

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>SITUATION</th>
<th>EXPRESSIONS</th>
<th>WORDS</th>
<th>GRAMMAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ask Question</td>
<td>Peer Evaluation of Patterns</td>
<td>Which representation of pattern is <strong><strong>2</strong></strong>_____ for you to understand?</td>
<td>2. easier, harder, more helpful, least helpful, most difficult</td>
<td>Adjective to express feelings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compare and contrast</td>
<td>Understanding of the Four Representation of Patterns</td>
<td>I think that <em><strong><strong>1</strong></strong></em>__ is <strong><strong>2</strong></strong>___ because <em><strong><strong>3</strong></strong></em>.</td>
<td>1. the table, the graph, the equation, writing in words, the written description</td>
<td>Nouns, adjectives, phrases</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. easier, harder, more helpful, least helpful, most difficult</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. I can see it, I can add the numbers, subtract the numbers, use the equation to make predictions, there are too many words</td>
<td></td>
</tr>
</tbody>
</table>
Lesson Plan 3

**Duration:** 80 minutes (block period)

**Lesson Overview:** Patterns are represented using equations.
The four representations of patterns are used to represent a real life situation.

**Essential Questions:** Which representation of patterns is most/least useful?
Which representation of patterns is the best for pattern recognition?

**Common Core Standards – CCSS:**
HSF-BF.A.1 Building Functions
Build a function that models a relationship between two quantities.
  a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
  b. Combine standard function types using arithmetic operations.
  c. Compose functions.

**Introduction and Anticipation: 15 minutes**

The day’s objectives will be posted on the white board:
Each one will be read aloud by the teacher.
  1. Represent patterns using equations
  2. Decide which representation is most useful or most difficult to understand
  3. Identify which representation of patterns is the best for pattern recognition

Once the objectives are read, the teacher will tell the students that the classroom is divided into four corners. The teacher will point to each corner numbered 1 through 4 and explain that each corner has an equation. The equation will be posted on the classroom wall. The students will be asked to silently think about this question:

“Which of the following equations can be used to find the number of hydrogen atoms if we know the number of carbon atoms?”

(In previous lessons, the students learned about equations and variables.)
The question will be projected or written on the board and will be read several times.

The teacher will rephrase the question while holding up and pointing to the table of values of hydrocarbon molecules:
“Which **equation** represents this table of values?”

The teacher will discuss the different parts of the equations, what each variable or letter represents. The teacher will hold a basket with cards numbered 1-4, each student will pick a card, that card will determine where the student is to report. Each corner will have 4 copies of worksheet **3.1.1 Equations to Represent Hydrocarbons** on pages 49-50 that the students will use to write on.

**Exploration – Jig Saw Activity: 35 minutes**

The students will have 5 minutes to get to their corners and to familiarize themselves with the worksheet and to read the directions as a group. Once the students are settled, the teacher will read and review the data table and complete Box A as a class. The physical models can be shown as the class completes the table ‘when c = 1, h must be 4’ meaning that a hydrocarbon with 1 carbon must have 4 hydrogen, and so on. The visuals will be used the whole time and worksheet **3.1.1 Equations to Represent Hydrocarbons** on page 49 will be projected on the board or printed on a big poster paper for the teacher to write on.

The students will have 10 minutes to check their equation and to complete the verification box.

The students will regroup as 1,2,3,4 or depending on their level at the teacher’s discretion.

The students will share with their group members, their equations A, B, C or D.

Equations A, B and D are not the right equations, C is the right one. Each group member can either point to the work that was done or to their answers in the verification box.

They can also use the language prompt from the verification box to say:

- “My equation **is correct** because Box A and Box B **are the same.**”
- “My equation **is not correct** because Box A and Box B **are not the same.**”

The teacher will circulate the room during the group activity. Level 1 and 2 students can be paired with a level 5 who explored the same equation during the jigsaw activity. They can talk to each other in their first language to clarify concepts.

**Exit Slip: 20 minutes**

In the Jig Saw groups, the students will transition into the next activity which will be an exit slip.
The teacher will show the students the four different ways that they represented the patterns in the hydrocarbon molecules (See Poster #5 on page 53). Now, it is the students’ turn to represent patterns given a new situation. The Exit Slip 3.1.9 Tables Together, on page 51, will be distributed to students.

The teacher will set up tables and chairs similar to the diagrams on the exit slip to demonstrate and explain what happens as you put tables together. The teacher will ask for volunteers to come sit around one table, and give the students time to record the value in the table cell. Then ask for more people to sit around two tables and so one. Although the assignment will be projected on the board, the teacher will not write on the board but will point to where the students need to record their data.

For the graph, the teacher will remind the students to sing the song in order to remember the different parts of the graph (x-axis, y-axis, labels, title, and so on).

For the verbal description, students will be allowed to use their graphic organizers from lesson 1 for the sentence frame and the word bank.

To make predictions, students will be reminded to extend the graph to the right, extend the table of values or sketch a picture.

Students will have 5 minutes to work individually. Then they have 2 minutes to share their answers with a partner.

The teacher will urge the students to ponder on the following questions as they discuss their answers with their partner.

“Which representation of patterns is most **useful** in the Tables Together assignment?”
“Which representation of patterns is most **difficult to understand** in the Tables Together assignment?”
“Which representation of patterns is the best for pattern recognition?”

Level 1 and 2 students will be given a copy of the functional language chart to practice language with each other and to complete this sentence with missing words from the chart.

“I think that the table is **easier** because it has numbers.”

**Closure: 10 minutes**

The teacher will end with a value line activity adapted from the 99 Activities Textbook on page 94. The teacher will give each group 4 sheet of paper, labeled with table, graph, written description and equation, respectively.

The teacher will ask each of the questions from the journal prompt on page 53; give the students less than a minute to negotiate meaning and to form a line according to how they feel. The students will be encouraged to indicate their preference and express their opinions on the advantages and disadvantages of each representation.
**3.1.1 Equations to Represent Hydrocarbons All Levels**
(Modified from New Haven Public Schools Curriculum)

Equations are also used to represent patterns. Which of the following equations can be used to find the number of hydrogen atoms \( h \) if we know the number of carbon atoms \( c \)?

A. \( h = 4c + 0 \)  
B. \( h = 2c + 4 \)  
C. \( h = 2c + 2 \)  
D. \( h = 3c + 1 \)

The variable \( h \) represents _________________.  
The variable \( c \) represents _________________.

Let’s use the original table of values to verify.

<table>
<thead>
<tr>
<th>Hydrocarbon Molecules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Carbon Atoms</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

**Box A**

When \( c \) is 1, \( h \) must be 4.
When \( c \) is 2, \( h \) must be _____.
When \( c \) is __, \( h \) must be _____.
When \( c \) is __, \( h \) must be _____.

**VERIFICATION BOX**

Are the answers in Box B the same as Box A? Yes/no

If your answer is yes, you choose the right equation.
If your answer is no, you choose the wrong equation.
Can you use your equation to represent this pattern? Yes/no

**Box B**

When \( c \) is 1, \( h \) is _____.
When \( c \) is 2, \( h \) is _____.
When \( c \) is 3, \( h \) is _____.
When \( c \) is 4, \( h \) is _____.

**Equation A:** \( h = 4c + 0 \)
Equations are also used to represent patterns. Which of the following equations can be used to find the number of hydrogen atoms $h$ if we know the number of carbon atoms $c$?

A. $h = 4c + 0$
B. $h = 2c + 4$
C. $h = 2c + 2$
D. $h = 3c + 1$

The variable $h$ represents _____________________________.
The variable $c$ represents _____________________________.

Let’s use the original table of values to verify.

**Box A**
- When $c$ is 1, $h$ must be 4.
- When $c$ is 2, $h$ must be ______.
- When $c$ is ___, $h$ must be _____.
- When $c$ is ___, $h$ must be _____.

**VERIFICATION BOX**
Are the answers in Box B the same as Box A? Yes/no

If your answer is yes, you choose the right equation.
If your answer is no, you choose the wrong equation.
Can you use your equation to represent this pattern? Yes/no
3.1.1 Equations to Represent Hydrocarbons  All Levels
(Modified from New Haven Publics Schools Curriculum)

Equations are also used to represent patterns. Which of the following equations can be used to find the number of hydrogen atoms (h) if we know the number of carbon atoms (c)?

A.  \( h = 4c + 0 \)   \quad B.  \( h = 2c + 4 \)   \quad C.  \( h = 2c + 2 \)   \quad D.  \( h = 3c + 1 \)

The variable \( h \) represents ____________________________.

Let's use the original table of values to verify.

<table>
<thead>
<tr>
<th>Hydrocarbon Molecules</th>
<th>Number of Carbon Atoms</th>
<th>Number of Hydrogen Atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

Box A

When c is 1, h must be 4.
When c is 2, h must be _____.
When c is ___, h must be _____.
When c is ___, h must be _____.

Verification Box

Are the answers in Box B the same as Box A? Yes/no

If your answer is yes, you choose the right equation.
If your answer is no, you choose the wrong equation.
Can you use your equation to represent this pattern? Yes/no

To check your answer, let's check your equation.

Equation C:  \( h = 2c + 2 \)

<table>
<thead>
<tr>
<th>Number of Carbon Atoms ( c )</th>
<th>Equation ( h = 2c + 2 )</th>
<th>Number of Hydrogen Atoms ( h )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C = 1 )</td>
<td>( h = 2( ) + 2 )</td>
<td>( h = )</td>
</tr>
<tr>
<td>( C = 2 )</td>
<td>( h = 2( ) + 2 )</td>
<td>( h = )</td>
</tr>
<tr>
<td>( C = 3 )</td>
<td>( h = 2( ) + 2 )</td>
<td>( h = )</td>
</tr>
<tr>
<td>( C = 4 )</td>
<td>( h = 2( ) + 2 )</td>
<td>( h = )</td>
</tr>
</tbody>
</table>

Box B

When c is 1, h is _____.
When c is 2, h is _____.
When c is 3, h is _____.
When c is 4, h is _____.
Equations are also used to represent patterns. Which of the following equations can be used to find the number of hydrogen atoms \( h \) if we know the number of carbon atoms \( c \)?

A. \( h = 4c + 0 \)  
B. \( h = 2c + 4 \)  
C. \( h = 2c + 2 \)  
D. \( h = 3c + 1 \)

The variable \( h \) represents _____________________________.  
The variable \( c \) represents _____________________________.

Let’s use the original table of values to verify.

To check your answer, let’s check your equation.

Equation D:  
\[ h = 3c + 1 \]
A square table seats four people. Square tables are **pushed together** as shown to seat more people.

1. Represent the pattern with a **table**.

<table>
<thead>
<tr>
<th># of tables pushed together</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>total # of people seated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Represent the pattern with a **graph**.

3. Represent the pattern with a **written or verbal description**. (sentence or phrase)  
   
   

4. How many people could sit at 9 tables pushed together this way? __________

   **Table**

<table>
<thead>
<tr>
<th># of tables pushed together</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>total # of people seated</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Journal Entry Prompt

In this problem, you have examined many different representations of patterns. You made a **table of values**, you wrote a **verbal description**, and you examined a **graph**.

a. Which representation do you find **most useful**? Why?
____________________________________________________________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________

b. Which is the **most difficult** for you to understand? Why?
____________________________________________________________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________

c. Which representation made it easier for you to understand the pattern?
____________________________________________________________________________________________________
____________________________________________________________________________________________________
____________________________________________________________________________________________________
1. **Table**

<table>
<thead>
<tr>
<th>Number of Carbon Atoms</th>
<th>Number of Hydrogen Atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

2. **Graph**

3. **Written Description**

As the number of carbon atoms increases by 1, the number of hydrogen atoms increases by 2.

4. **Equation**

\[ h = 2c + 2 \]
NARRATIVE

I initially wanted to use the “Go to your Corner” Activity from the 99 Textbook to begin this lesson, not to build background knowledge but to have the students explore which equation represents the hydrocarbon molecule pattern. Having different groups use different equations would generate more thought when we come back as a whole group. Then I changed it into a jigsaw because the discussion would be less intimidating and students at all levels would be able to contribute to the small group discussion. They would be able to really see why one equation worked and not the other.

I choose to do the exit slip as a class to demonstrate how patterns from a science concept can transition into things we do in everyday life. Patterns in everyday life can be represented with tables, graphs, written descriptions and equations to make predictions. As I modified the exit slip from for this lesson, I realized that any modification made to this worksheet will be useful for English Language Learners at all levels. Since lesson 3 is a culmination of the previous two lessons, I wanted the level 1-3, to get use to the language that I have modeled and repeated constantly throughout the lessons. I wanted the directions to be familiar to them and for them to start using the vocabulary words from the word wall and on the different posters that were used to teach all three lessons.

To end the lesson, a value line activity was used for students to see their comfort level with the new concepts learned in relation to their classmates,
Checklists
Write the page numbers and any other identifying features to identify those parts of your lessons that employ the following strategies.

<table>
<thead>
<tr>
<th>SHELTERED STRATEGIES</th>
<th>Lesson 1</th>
<th>Lesson 2</th>
<th>Lesson 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Contextualize Lesson</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. A. Build and Activate Background Knowledge</td>
<td>4</td>
<td>27</td>
<td>44</td>
</tr>
<tr>
<td>I. B. Develop Vocabulary</td>
<td>5</td>
<td>27</td>
<td>44,45</td>
</tr>
<tr>
<td>I. C. Use extensive Visuals, Realia, Manipulatives, &amp; Gestures</td>
<td>4,5,6,22</td>
<td>27,28,30</td>
<td>44,45</td>
</tr>
<tr>
<td>I. D. Model (Instructions, Processes)</td>
<td>5</td>
<td>23,29,30</td>
<td>44</td>
</tr>
<tr>
<td>I. E. Create Opportunities To Negotiate Meaning</td>
<td>5</td>
<td>28</td>
<td>45</td>
</tr>
<tr>
<td>II. Make Text Comprehensible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II.A. Intentional Use of Graphic Organizers</td>
<td>6,7</td>
<td>30</td>
<td>47-49</td>
</tr>
<tr>
<td>II.B. Modify Written Text</td>
<td>17-19</td>
<td>35,36,37</td>
<td>49</td>
</tr>
<tr>
<td>II.C. Amplify Number of Activities per Text</td>
<td>19</td>
<td>31-38</td>
<td>47-49</td>
</tr>
<tr>
<td>III. Make Talk Comprehensible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III.A. Pace Teacher’s Speech</td>
<td>4</td>
<td>29</td>
<td>46</td>
</tr>
<tr>
<td>III.B. Use of Listening Guides</td>
<td>4,21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III.C. Use of Word Walls</td>
<td>5</td>
<td>39,40</td>
<td>50</td>
</tr>
<tr>
<td>III.D. Frame Main Ideas</td>
<td>4</td>
<td>28</td>
<td>43</td>
</tr>
<tr>
<td>III.E. Check for Understanding</td>
<td>6</td>
<td>30</td>
<td>43</td>
</tr>
<tr>
<td>IV. Change Traditional Classroom Talk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV.A. Use Teacher Question and Response Strategies</td>
<td>5</td>
<td>30</td>
<td>45,46</td>
</tr>
<tr>
<td>IV.B. Practice Instructional Conversations</td>
<td>5</td>
<td>30</td>
<td>46</td>
</tr>
<tr>
<td>V. Engage at Appropriate Language Proficiency Levels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V.A. Vary Question Techniques based on Student’s Language Proficiency level— in conversations, activities, and assessments</td>
<td>5,6</td>
<td>28,29</td>
<td>50</td>
</tr>
<tr>
<td>VI. Give Students Voice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VI. A. Challenge students to produce extended academic talk</td>
<td>5</td>
<td>28,29</td>
<td>46</td>
</tr>
<tr>
<td>VI. B. Model Language for Oral and Written Production</td>
<td>6</td>
<td>28,29</td>
<td>43,46</td>
</tr>
<tr>
<td>VI. C. Use Group/Pr. Work to Elicit Student Talk; Students as Researchers</td>
<td>5</td>
<td>28</td>
<td>45,46</td>
</tr>
<tr>
<td>VI. D. Respond to Student’s Voice – Writing and Error Correction</td>
<td>6</td>
<td>30</td>
<td>45</td>
</tr>
</tbody>
</table>
## Grammar and Functions Checklist

<table>
<thead>
<tr>
<th>Grammar</th>
<th>Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>How – question</td>
<td>1</td>
</tr>
<tr>
<td>Nouns</td>
<td>1, 3</td>
</tr>
<tr>
<td>Counting Numbers</td>
<td>1</td>
</tr>
<tr>
<td>Sentence</td>
<td>1</td>
</tr>
<tr>
<td>Ordinal Numbers</td>
<td>2</td>
</tr>
<tr>
<td>Verb</td>
<td>2</td>
</tr>
<tr>
<td>Transitional Phrases to show sequence</td>
<td>2</td>
</tr>
<tr>
<td>Math vocabulary words</td>
<td>2</td>
</tr>
<tr>
<td>Adjectives to express feelings</td>
<td>3</td>
</tr>
<tr>
<td>Phrases</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Functions</th>
<th>Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct/Analyze</td>
<td>1</td>
</tr>
<tr>
<td>Explain/Describe</td>
<td>1, 2</td>
</tr>
<tr>
<td>Sequence</td>
<td>2</td>
</tr>
<tr>
<td>Ask question</td>
<td>3</td>
</tr>
<tr>
<td>Compare and Contrast</td>
<td>3</td>
</tr>
</tbody>
</table>
Original Lessons
Natacha Vilnay  
Dr. Lorraine Stoops Verplaatse  
FLA 518 & FLA 418  
Summer 2013  
Lesson Plan #1 due on 7/12/13  

1. Title: Representing Patterns in Algebra I  
2. Grade Level: 9th Grade  
3. Target Group: Mainstream class with integrated ELL students  

4. Source of Written Reading Materials:  
   New Haven Public Schools Algebra I Curriculum  

5. Source of Lessons:  
   New Haven Public Schools Algebra I Curriculum  
   Unit 1 – Investigation 1 & 2 Overview  
   Learn about hydrocarbons and Titan:  

6. Overarching Learning Goals:  
   I want my students to know how to use models (in science) to identify patterns  
   I want my students to know the four representations of patterns  
   I want my students to know how to represent patterns using tables, graphs, equations and written descriptions  
   I want my students to know which representation is most useful for them or most difficult to understand
Unit 1: Investigation 1 (2 Days)

REPRESENTING PATTERNS

CCSS: 8-F 2, F-BF 1, F-IF 3

Overview
Students explore patterns in the molecular structure of hydrocarbons and represent patterns using tables, graphs, equations, and verbal descriptions. Students are introduced to the value of representing patterns using multiple representations.

Assessment Activities

Evidence of Success: What Will Students Be Able to Do?
Identify patterns from real world contexts. Represent patterns using tables, graphs, and equations, and use patterns to solve problems.

Assessment Strategies: How Will They Show What They Know?
Exit Slip 1.1 asks students to identify a pattern, represent the pattern using a table and graph, and use the pattern to solve a problem.

Journal Entry prompts students to identify which representation of patterns is the best for pattern recognition.

Launch Notes
Begin this investigation with a quick review of our known solar system – one sun, eight planets, and at least 146 moons. A good starting point is NASA’s Solar System Exploration website at http://solarsystem.nasa.gov/planets/profile.cfm?Object=SolarSys. Since this investigation begins with an activity concerned with Saturn’s moon Titan, showing a short video about Titan would be engaging. See http://saturn.jpl.nasa.gov/multimedia/flash/Titan/index.html.

Closure Notes
Conduct a whole classroom discussion in which students describe the four different representations of patterns. Students should be encouraged to indicate their preferences and their opinions on to the advantages and disadvantages of each representation. Exit Slip 1.1 may be used in advance of or at the conclusion of the class discussion.

Teaching Strategies

Lesson 1. Following the video or solar system review, show students a list of hydrocarbons (methane, propane, butane, and ethanol) and ask students if they have heard of these hydrocarbons and know how they are used? Ask students why the discovery of hydrocarbons on other planets is relevant? In Activity 1.1.1 Exploring Patterns with Hydrocarbons, students work in groups to explore the relationship between carbon atoms and hydrogen atoms in hydrocarbon molecules. Students represent

Intro: watch video 5 min
Anticipation: list of hydrocarbons 10 min
Activity: Exploration 20 min
patterns using multiple representations. After the group activity, provide students an opportunity to share their answers and opinions.

**Group Activity**

Arrange students in pairs or small groups and have them work together to complete Activity 1.1.1 Exploring Patterns with Hydrocarbons. To assist students visualize hydrocarbon molecules, allow students to build physical models using molecular structure kits or colored Styrofoam balls and toothpicks.

**Differentiated Instruction (For Learners Needing More Help)**

Activity 1.1.1a Using eChem to Model Molecules provides students with an opportunity to create three-dimensional models of hydrocarbons.

In Activity 1.1.2 Burning Hydrocarbons, students explore the amount energy that is released through burning hydrocarbons. A table presents the amount of energy that is released from completely burning a fixed amount of each hydrocarbon (the data values are approximate so they will clearly be linear).

Students will wonder what the unit kJ/mole represents. A kJ/mole is the amount of energy, measured in units called kilojoules, released when one mole (a unit measuring a defined amount of any chemical molecule) of a hydrocarbon is burned. You may have the class participate in an Internet search to find a more complete description of this unit of energy. Students look for a pattern in the data, complete the table and draw a graph using the data values. Once students have completed the activity worksheet, have them share answers. Students should be able to verbally describe the pattern.

Activity 1.1.3 Organic Alcohols extends the exploration of hydrocarbons through a study of organic alcohols. Similar to Activity 1.1.1, students represent patterns using a table, graph, verbal description and equation. Students are introduced to chemical formulas for organic alcohol molecules.

**Differentiated Instruction (Enrichment)**

Some students will discover as they create the models that there are actually two different structures of butane. The structure with the branch in the middle is called isobutane (the other is just butane), which is sometimes used in camp stoves. Ask students if they think the two chemical substances are identical or if they might have slightly different properties even though they have the same number of carbon and hydrogen atoms. Have them search for references that compare the two. Do they have the same chemical formula?
Journal Entry

What four ways did you represent patterns in hydrocarbons? Which representation made it easier for you to understand the pattern?

Resources and Materials

- **Activity 1.1.1** – Exploring Patterns with Hydrocarbons
- **Activity 1.1.1a** – Using eChem to Model Molecules
- **Activity 1.1.2** – Burning Hydrocarbons
- **Activity 1.1.3** – Organic Alcohols
- **Exit Slip 1.1** – Tables Together
- Molecular modeling kit
- Styrofoam spheres in black (carbon), yellow (hydrogen), and red (oxygen)
- Alternative: Gum drops
- Toothpicks
- Student journals
- LCD Projector
- Teacher computer with Internet access and speakers
- Computer Lab or student computers for Excel exploration
- Calculators

Photo Credits

- Artist’s Rendition of Hyugens Probe on the Surface of Titan (Activity 1.1.1) was copied from [www.nasaimages.org](http://www.nasaimages.org)
- Image of eChem applet (Activity 1.1.1a) was copied from [http://www.sciencegeek.net/eChem/eChem.html](http://www.sciencegeek.net/eChem/eChem.html)
- Images of organic alcohols (Activity 1.1.3) were generated and copied from eChem at [http://www.sciencegeek.net/eChem/eChem.html](http://www.sciencegeek.net/eChem/eChem.html)
1.1.1 Structure of Hydrocarbons

On June 30, 2004, NASA’s Cassini spacecraft entered orbit around Saturn to begin the first in-depth, up-close study of the ringed planet and its domain. As expected, the Saturn System has provided an incredible wealth of opportunities for exploration and discovery. Cassini has revealed that one of Saturn’s moons, Titan, has a surface shaped by rivers and lakes of liquid hydrocarbons ethane and methane (used as fuels), which form clouds and occasionally rain from the sky as water does on Earth.


You are chosen to travel to Titan in the year 2022 to get the fuel and return it to the Earth.

In order to identify the hydrocarbons, you will build some models and look for a common pattern. An example of the simplest hydrocarbon, methane, is shown here. In every simple hydrocarbon molecule, each carbon atom has four bonds (links to other atoms) and each hydrogen atom has one bond.

1. Build models of ethane, propane, and butane and complete the table below.

<table>
<thead>
<tr>
<th>Hydrocarbon</th>
<th>Carbon Atoms</th>
<th>Hydrogen Atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Ethane</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Propane</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Butane</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

2. Make a graph that shows the relationship between the number of carbon atoms and the number of hydrogen atoms in the hydrocarbons listed in the table.

3. Does the number of hydrogen atoms follow a pattern? Write a description of the pattern.

4a. Use the graph to predict the number of hydrogen atoms in a hydrocarbon with 5 carbon atoms. ________

b. Use the graph to predict the number of hydrogen atoms in a hydrocarbon with 8 carbon atoms. ________
5. Sketch the four simple hydrocarbon molecules you built. You can use H’s and C’s or circles for the atoms.

<table>
<thead>
<tr>
<th>methane</th>
<th>ethane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>propane</th>
<th>butane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Chemical Symbols** can be used to represent hydrocarbon molecules. For example, ethane can be represented as \( C_2H_6 \), because ethane has 2 carbon atoms and 6 hydrogen atoms.

6. Octane has eight carbon atoms; how many hydrogen atoms does it have? ________ What is its chemical symbol?

7. Suppose a simple hydrocarbon has 22 hydrogen atoms. Work backwards to determine how many carbon atoms it has _________ and then write its chemical symbol. ____________________________

8. Can a simple hydrocarbon have 25 hydrogen atoms? _________ Explain your answer.

9. In this problem, you have examined many different representations of patterns. You made a table of values, you wrote a verbal description, and you examined a graph.

   a. Which representation do you find most useful? Why?

   b. Which is the most difficult for you to understand? Why?
Use the atoms below to create hydrocarbon models. Copy and paste them if you need more. Label each molecule.
When hydrocarbons are burned, they create energy. The table below shows approximately how much energy (kJ/mole) is released from completely burning a fixed amount of each hydrocarbon.

<table>
<thead>
<tr>
<th>Simple Hydrocarbon</th>
<th>Number of Carbon Atoms</th>
<th>Energy Released from combustion (kJ/mole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>1</td>
<td>920</td>
</tr>
<tr>
<td>Ethane</td>
<td>2</td>
<td>1560</td>
</tr>
<tr>
<td>Propane</td>
<td>3</td>
<td>2200</td>
</tr>
<tr>
<td>Butane</td>
<td>4</td>
<td>2840</td>
</tr>
<tr>
<td>Pentane</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Hexane</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Heptane</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Octane</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

1. Look for the pattern and complete the table above.

2. Describe the pattern in your table.

3. Make a graph to show how much energy is released (kJ/mole) from the combustion of hydrocarbons.

4. Describe the pattern in your graph.

5. Based on the data from the table and graph, which hydrocarbons do you think might be the best to bring back from Titan? Explain your answer.
You are researching the possibility of life forms on a planet orbiting a neighboring twin star. In the chemical analysis, you discover organic alcohols that would suggest oxygen and perhaps living organisms may be present.

In the following models of organic alcohols, the dark gray atoms are carbon, the ones marked O are oxygen, and the black atoms are hydrogen.

![Models of organic alcohols](saturn.jpl.nasa.gov)

**Alcohols**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Carbon atoms</th>
<th>Hydrogen atoms attached to carbon atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol (Methyl alcohol)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethanol (Ethyl alcohol)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propanol (Propyl alcohol)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isopropyl alcohol (Rubbing alcohol)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. As before, start with a table to see the pattern for these hydrocarbons. Show the number of carbon atoms and hydrogen atoms attached to the carbon atoms in each molecule pictured above.

*(Do not count the hydrogen atom attached to the oxygen.)*

2. Does the number of hydrogen atoms follow a pattern? Write a verbal description of the pattern.

3. The next larger alcohol is called butanol, which has four carbon atoms. From your answer in question [2], how many hydrogen atoms attached to carbon atoms do you predict for butanol? ____________ Add butanol to the table.
4. Based on your answer and your prediction in question [3], make a rough stick drawing of a molecule of butanol. Propanol had 2 possible arrangements - so might butanol. Draw two arrangements.

5. Draw a graph that shows the relationship between the number of carbon atoms and the number of hydrogen atoms attached to carbon atoms.

What do you do if two points are the same?

6. How many hydrogen atoms would be attached to carbon atoms in an alcohol with five carbon atoms? ________________

7. How many hydrogen atoms would be attached to carbon atoms in an alcohol with seven carbon atoms? ________________

8. Describe the pattern in your graph.

Chemical symbols are also used to represent the formulas for alcohol molecules. For example, ethanol can be represented as $C_2H_5OH$.

9. Octanol has eight carbon atoms, how many hydrogen atoms are attached to carbon atoms in octanol? ________________ What is its chemical symbol? _______________________

10. Determine the missing value in the formula for an alcohol with the symbol $C_7H_{2x}OH$. What do you think it's called?
A square table seats four people. Square tables are pushed together as shown to seat more people.

1. Complete the following table of values.

<table>
<thead>
<tr>
<th># of tables pushed together</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>total # of people seated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Explain the pattern.

4. How many people could sit at 9 tables pushed together this way? _________
Hydrocarbons on Titan

Artist’s Rendition of Hyugens Probe on the Surface of Titan

Hydrocarbons are molecules made up only of hydrogen and carbon. They are found on Earth in crude oil and natural gas, and are the primary source of energy used throughout the world. Due to an increasing demand for energy, the Earth’s supply of hydrocarbon fuel is diminishing.

In 2004, the Cassini spacecraft orbited Titan, Saturn’s largest moon, sending images of Titan’s atmosphere and surface to Earth. The images confirmed that Titan has lakes which contain hydrocarbons. These hydrocarbons are gases on Earth, but due to Titan’s surface temperature, they are liquids, or even solids, on Titan. The image above is an artist’s rendition of the surface of Titan with the Hyugens probe parachuting toward Titan’s surface.

You have been selected for a mission to Titan departing Earth in 2020. The goal of the mission is to explore and catalog the mixture of simple hydrocarbons in the lakes of Titan and report your findings. Simple hydrocarbons are made up of specific patterns of hydrogen and carbon atoms. Each simple hydrocarbon has a name and its own properties.

As a first step, your task is to build models of hydrocarbons and find their mathematical pattern. You must use the following guidelines:

- Carbon atoms are represented by black Styrofoam spheres.
- Hydrogen atoms are represented by yellow Styrofoam spheres.
- Each carbon atom must have four links. Each link can connect another carbon atom or a hydrogen atom. The carbon atoms must lie along a straight line. This is called a straight-chain hydrocarbon.
- Each hydrogen atom can only have one link. Hydrogen atoms must be connected to a carbon atom.
The first hydrocarbon is called methane and it looks like this:

1. Build a model of methane using one black Styrofoam (carbon atom) and four yellow Styrofoam (hydrogen atoms). Check with your mission instructor (teacher) before continuing.

2. Build a model with 2 carbon atoms (black). Continue to follow the guidelines provided on the previous page. Check with your mission instructor (teacher) before continuing. Then count the number of hydrogen atoms.

3. Continue building models using three and four carbon atoms (black). Follow the guidelines for hydrocarbons listed on the previous page.

4. Complete the following table:

<table>
<thead>
<tr>
<th>Hydrocarbon Molecules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of Molecule</td>
</tr>
<tr>
<td>Methane</td>
</tr>
<tr>
<td>Ethane</td>
</tr>
<tr>
<td>Propane</td>
</tr>
<tr>
<td>Butane</td>
</tr>
<tr>
<td>Pentane</td>
</tr>
</tbody>
</table>

5. Draw a rough stick model of a hydrocarbon with five carbon atoms using C for carbon atoms and H for hydrogen atoms.

6. Complete the following sentence:

As the number of carbon atoms increases by 1, the number of hydrogen atoms
7. Use the coordinate plane below to graph the relationship between the number of carbon atoms and the number of hydrogen atoms in the hydrocarbons. Label and scale the axes appropriately.

![Graph](image)

8. Are you able to extend the graph to determine how many hydrogen atoms would be in a hydrocarbon with six carbon atoms? If so, what would you find?

9. What would happen if you extended the graph to the left? Is the result meaningful?

10. If we know there are 20 hydrogen atoms in ahydrocarbon with 9 carbon atoms, how many hydrogen atoms are there in a hydrocarbon with 10 carbon atoms?
11. Which of the following equations can be used to find the number of hydrogen atoms if we know the number of carbon atoms? Use the table to verify your answer.

(A) \( h = 4c + 0 \)  
(B) \( h = 2c + 4 \)  
(C) \( h = 2c + 2 \)

12. What do the variables \( h \) and \( c \) represent in the previous equations?

13. Use your equation from Question 11 to find the number of hydrogen atoms in a hydrocarbon with 20 carbon atoms.

14. Suppose there are 22 hydrogen atoms in a hydrocarbon. Use your equation from Question 11 to determine how many carbon atoms would be present.

15. Is it possible to have a hydrocarbon molecule with 25 hydrogen atoms? Explain.

In this activity, we examined many different representations of the relationship between the number of carbon atoms and hydrogen atoms. We used a table (Question 4), verbal description (Question 6), graph (Question 7), and an equation (Question 11).

16. Which representation did you find most useful? Why?

17. Which representation is the most difficult to understand? Why?

18. What similarities and differences do you see in the four representations?
Using eChem to Model Molecules

eChem is a free online software that allows students to create virtual, three-dimensional models of molecules. eChem was created by the Center for Highly Interactive Classrooms, Curricula & Computing in Education (Hi-Ce) at the University of Michigan. It is available at:

- hi-ce.org: http://hi-ce.org/echem/index.html

![eChem Screenshot](image_url)

eChem Instructions:

1. Run eChem from one of the websites listed above (or from the computer if installed).
2. To construct the model of methane (CH₄), start on the left side of the screen. When you see “Construct,” “Visualize,” and “Analyze.”
3. Click “Construct.”
4. In the popup window, enter the name of molecule: methane.
5. Click “Atoms,” and select “C” (carbon) from element table on the right side of the screen.
6. Select bond arrangement. In this case, select “tetrahedral” as the hybridization of carbon and click on the canvas (the large area in the middle of the window).
7. Select “H” (hydrogen) from the atom table.
8. Add hydrogen atoms to the carbon’s bond by clicking on the bonds of carbon.
Notes:

1. You can see a rotating structure; just hold down the mouse button and move the cursor.
2. Did you attach a wrong atom on carbon (like adding an oxygen atom for methane)? Select “Delete” on the left side of screen, and click the atom ball you want to erase.
3. If you are going construct a new model, pull down the bottom menu on the canvas, and select “build a new molecule.”
4. The “Visualize” button allows you to view the molecule in three different ways.
5. If you entered multiple molecules, the “Analyze” button allows you to check the pattern by choosing “Carbon Count” and “Atom Count” as column headers.

Enjoy!
Burning Hydrocarbons

When hydrocarbons are burned, they create energy. For example, when methane reacts with oxygen carbon dioxide, water, and energy are formed. This process is called combustion.

The table below shows approximately how much energy (kJ/mole) is released from completely burning a fixed amount of each hydrocarbon.

<table>
<thead>
<tr>
<th>Simple Hydrocarbon</th>
<th># of Carbon Atoms</th>
<th>Energy Released from Combustion (kJ/mole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>1</td>
<td>920</td>
</tr>
<tr>
<td>Ethane</td>
<td>2</td>
<td>1560</td>
</tr>
<tr>
<td>Propane</td>
<td>3</td>
<td>2200</td>
</tr>
<tr>
<td>Butane</td>
<td>4</td>
<td>2840</td>
</tr>
<tr>
<td>Pentane</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Hexane</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Heptane</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Octane</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

1. What pattern do you see in the table above?

2. Use the pattern to complete the table.

3. Draw a graph in the coordinate plane above showing the relationship between the number of carbon atoms and how much energy is released (kJ/mole) from the combustion of the simple hydrocarbon.

4. On your graph, what pattern do the plotted points make?

5. Based on the data from the table and graph, which hydrocarbon releases the most amount of energy? Explain your answer.
Organic Alcohols

You are researching the possibility of life forms on a planet orbiting a neighboring twin star. In the chemical spectra from the system, you discover organic alcohols that would point to the presence of oxygen and perhaps living organisms. Molecules of specific organic alcohols are pictured below. The gray atoms are carbon, the red atoms are oxygen, and the white atoms are hydrogen.

![Methanol (Methyl alcohol)](image)

![Ethanol (Ethyl alcohol)](image)

![Isopropanol (Rubbing alcohol)](image)

![Propanol (Propyl alcohol)](image)

1. Use the images above to complete the following table. For each molecule, identify the number of carbon atoms and the number of hydrogen atoms attached to the carbon atoms. Do not count the hydrogen atom attached to the oxygen.

<table>
<thead>
<tr>
<th>Organic Alcohol</th>
<th>Carbon Atoms</th>
<th>Hydrogen Atoms Attached to Carbon Atoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethanol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propanol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isopropanol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butanol</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Does the number of hydrogen atoms in a molecule follow a rule that is based on the number of carbon atoms? Write a verbal description of the pattern or rule.
3. The organic alcohol with four carbon atoms is butanol. Using your answer in Question 2, how many hydrogen atoms are attached to carbon atoms in a butanol molecule? Add the information for butanol into the table on the previous page.

4. Create a rough stick drawing of a molecule of butanol. If available, create a physical model of a butanol molecule. Similar to propanol, butanol has two possible arrangements. Draw two different arrangements below.

5. Graph the relationship between the number of carbon atoms and the number of hydrogen atoms attached to carbon atoms in the organic alcohols listed in the table. Label and scale the axes appropriately.

![Basic Organic Alcohol Molecules](image)

6. If you extend the graph, how many hydrogen atoms would be attached to carbon atoms in an alcohol with five carbon atoms?

7. How many hydrogen atoms would be attached to carbon atoms in an organic alcohol with eight carbon atoms?
8. What would happen if you extended the graph to the left? Is this meaningful?

9. We see a pattern emerging. If we know the number of hydrogen atoms attached to carbon in an alcohol with nine carbon atoms, how many will there be in an organic alcohol with ten carbon atoms?

10. See if you can figure out a formula that will work for any organic alcohol. Going from a pattern to a formula is a guess and check process. You have some practice guessing, so give it a try!

Chemical formulas are used to represent the formulas for alcohol molecules. For example, ethanol can be represented as \( \underline{C}_2 \underline{H}_5 \underline{O} \underline{H} \). In this formula, \( \underline{H} \) represents the five hydrogen atoms that are connected to the two carbon atoms.

If \( C \) represents the number of carbon atoms in an organic alcohol molecule, then the expression for the number of hydrogen atoms attached to carbon atoms is given by the equation \( H = 2C + 1 \).

11. Let's look at octanol. It has eight carbon atoms, so \( C = 8 \). How many hydrogen atoms are attached to carbon atoms in octanol?

12. Can you determine the missing value in the formula for decanol \( \underline{C}_\text{?} \underline{H}_\text{?} \underline{O} \underline{H} \)?
Exit Slip – Tables Together

A square table seats four people. When square tables are pushed together in a row, more people can be seated. The diagrams below show the number of total seats for one, two, and three square tables.

```
  o  o  o  o
  o  o
  o  o  o  o
```

1. Complete the following table of values.

<table>
<thead>
<tr>
<th>Number of Tables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Seats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Make a graph showing the relationship between the number of tables pushed together and the total number of people seated. Label and scale the axes appropriately.

![Graph](image)

3. Explain the pattern in the table above.

4. How many people could sit at 9 tables pushed together this way?
Stack of Cups

Your team works for a paper products company that creates different-size paper cups. You are responsible for designing the packaging for a new paper cup design. Your design team must design a cardboard carton that could be used to package the cups for sale. Since this is a new product for your team, you must study the cups to determine which features of the cup affect the height of a stack of cups.

You will be given a set of cups. First measure the height of one cup. Then add additional cups and measure the height of resulting stack. Continue until you have at least five measurements.

<table>
<thead>
<tr>
<th># of Cups</th>
<th>Height of Stack (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

1. Graph your data on the coordinate plane below. Include a title, and label and scale the axes appropriately.

2. Describe a rule that fits the pattern.
3. What would happen if you moved to the left on the graph? (What height corresponds to a stack of zero cups?)

4. Write a formula for the height $h$ of your stack of $n$ cups.

5. Another team at the company performed a similar experiment with a different cup. They came up with the formula, $h = 8.2 + 0.5n$, where $h$ is the height of a stack of $n$ cups. What information can you get from this formula?

6. A third team at the company did a similar experiment with a different cup. They came up with the rule: start with a height of 5.25 for the first cup and add 0.75 for each additional cup.
   a. What information can you get from this rule?

   b. Write a formula based on the information you got from the rule.
8. Your boss just gave your team the following data on a new cup design. Your job is to determine the heights of cartons that would hold stacks of 25, 50, and 100 cups.

<table>
<thead>
<tr>
<th># of Cups</th>
<th>Height of Stack (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14.2</td>
</tr>
<tr>
<td>2</td>
<td>14.8</td>
</tr>
<tr>
<td>3</td>
<td>15.4</td>
</tr>
<tr>
<td>4</td>
<td>16.0</td>
</tr>
<tr>
<td>5</td>
<td>16.6</td>
</tr>
</tbody>
</table>

a. Write a rule and a formula that model the boss's data, using $n$ for the number of cups and $H$ for the height of the stack.

Rule:

Formula:

b. Find the stack height for 25 cups.

c. Find the stack height for 50 cups.

d. Find the stack height for 100 cups.