GOVERNOR'S OFFICE OF ENERGY DEVELOPMENT

Advancing Utah's Energy Future

Natural Gas: How this Energy Source was Formed

Grade/Subject: 6th Science

Strand/Standard 6.2.2 Develop a model to predict the effect of heat energy on states of matter and density. Emphasize the arrangement of particles in states of matter (solid, liquid, or gas) and during phase changes (melting, freezing, condensing, and evaporating). (PS1.A, PS3.A)

Lesson Performance Expectations: Students will identify different states of matter, the conservation of mass with phase change and make observations of energy/heat loss during a physical change in matter

Materials: Divide the students into groups of 3-4 students.

- Ways to watch the videos
- **Materials for demonstration:**
  - vegetable oil ⅓ - ½ cup
  - water ⅓ -½ cup
  - antacids- example Alka-seltzer tablets,
  - clear cup 8 oz.
  - Density Tank
  - hot water
  - cold water
  - red, blue, and green food coloring
  - Infrared gun
- **Materials for lab for each group of 4:**
  - .5 Liter water bottle
  - balloon that will fit over the top
  - 2 ice cream buckets
  - hot water source (electric kettle)
  - ice water

Time: 1 class period 60 mins

Teacher Background Information:

Resource: This video explains the demonstration that you will be conducting. Utah's Energy Education: Natural Gas and Density (4:02 min)

- Solids, liquids, gases, and plasmas are different states, also known as phases of matter with different physical properties. Elements and compounds can move from one phase to another when specific physical conditions change. For example, when the temperature of a system of matter goes up, its atoms become more excited and active. If enough heat and/or pressure is placed on a substance, a phase change may occur as the matter moves to a more active state. When molecules change in state or phase, they still remain the same substance.

- Natural gas is a type of hydrocarbon (fossil fuel) that is formed over millions of years from the remains of ancient sea plants and animals. It underwent multiple phase changes: from solid to liquid and ultimately to gas. Hydrocarbons were formed from prehistoric organic materials like plants and animals that slowly transformed under immense heat and pressure over time. Different types of hydrocarbons were formed depending on what

combination of animal and plant debris was present, how long the material was buried, and what conditions of temperature and pressure existed when they were decomposing. Oil and natural gas were created from organisms that lived in the water and were buried under ocean or river sediments. As the gas forms, it eventually rises above the oil because it is less dense. Natural gas can also be found in tiny pores or fractures in rock. Sometimes the gas is dissolved in oil, and it has to be extracted.

- Natural gas is actually a combination of gases (methane, propane, butane, and ethane), but over 80% of its makeup is methane gas. Methane is tasteless, odorless, and colorless, so a chemical called Mercaptan that smells like rotten eggs is added to detect leaks easily. Burning any fossil fuel releases emissions into the air, including carbon dioxide; however, natural gases (methane and propane) release less Sulphur, carbon, and ash than others. Methane is the cleanest and most efficient because there are fewer carbon atoms (only one carbon atom for every four hydrogen atoms) that are released during combustion. Utah's conventional natural gas production is mostly concentrated within Uintah and Grand Counties to the east and Summit County to the north. Utah has 3 of the 100 largest natural gas fields in the country. In 2015, Utah ranked as the 12th largest producer of natural gas in the United States (not including production in the Gulf of Mexico). (Source: Utah Geological Survey) This provides economic benefits for both the region and the state.

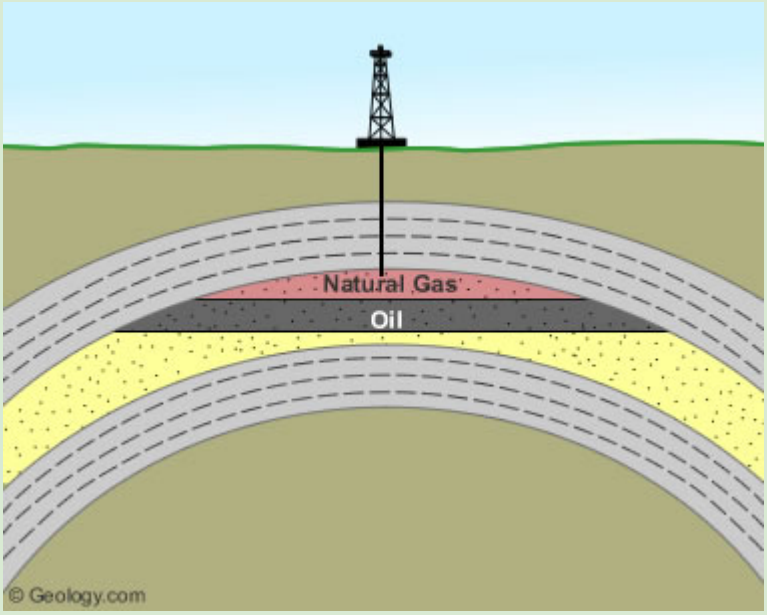
Student Background Knowledge:

- Students should know the differences between the physical changes of matter (solid liquid and gas). The teacher or students can learn more from these states in matter simulation. Focus on the energy or heat loss during the transition of a liquid to a solid and what happens to the particles. https://phet.colorado.edu/en/simulation/states-of-matter-basics

Teacher Step by Step: A 3-d lesson should insist students do the thinking. Provide time and space for the students to experience phenomenon and ask questions. The student sheet provided below provides guidance but is only an example of how students might respond.

1. Introduce the Phenomenon - show the demonstration (or video) of the oil, water, and antacid pills in a bottle. Alternative phenomenon - use the density tank with hot and cold water.
2. Students will write down 3 questions they have about the demo.
3. Discuss with the students the diagram (it is on their student sheet).

Diagram #1



Natural gas is one of the United States most useful gases. Because natural gas extracted from geologic reservoirs took millions of years to form, it is considered to be a non-renewable fuel. We use natural gas in for both residential and industrial purposes. According to the U.S. Energy Information Administration, natural gas accounts for 31% of energy consumed in the United States in 2017. So what makes this gas so unique? Check out this excerpt from

www.naturalgas.org

Natural gas is colorless, shapeless, and odorless in its pure form. Natural gas is combustible, abundant in the United States, and when burned it gives off a great deal of energy with fewer emissions than many other sources. Compared to other fossil fuels, natural gas is cleaner burning and emits lower levels of potentially harmful byproducts into the air. An ever-increasing supply of energy is needed to heat our homes, cook our food, and generate our electricity. This need for energy has elevated the integration of natural gas in our society, and in our lives.

4. Ask students to write down similarities that they see between the demo and the picture.
5. Ask students these questions and write their responses. On the picture above there are dots showing the particles that make up the oil and natural gas. Do you think they are a good model of these states of matter? Why or why not?
6. Have the students watch the oil and gas formation video. Write down two connections between the video and the demonstration. Oil and Gas Formation (2:47 min) **(Go to minute 1:26)**
7. Have a class discussion on what was seen in the video and make connections to the demonstration.
8. Students answer questions on the worksheet.
9. Discuss the question of what will happen when we add heat energy to matter?
10. Hand out the materials for the experiment. .5 Liter water bottle, balloon that will fit over the top, 2 ice cream buckets. Have available hot water and ice water.
11. Stretch the balloon over the top of the empty water bottle.
12. Fill half way one bucket with ice water and the other one half way with hot water.
13. Students will predict what will happen when heat energy is added by sketching the dots to represent particles of matter.
14. Students will put the bottle in the hot water bucket.
15. Students will put the bottle in the cold water bucket.
16. After the experiment the students will answer the questions. Have the students draw a new model making changes and adding more detail to their new model.
17. Question Answers:

    What is the the states of matter of the following?

    a. Oil? *Liquid*
    b. Natural gas? *Gas*

    Why do you think the natural gas reservoir was above the oil reservoir? *Natural gas and oil are formed from decaying animal and plant material that has been under a lot of heat and pressure. This heat and pressure come from the layers of sediment that have been piling up on top of it for millions of years. Heat will cause the material to separate into two forms- a gas and a liquid. The molecules in the gas are moving at a more rapid rate than the liquid so it will move to the top while the liquid will have more density and move to the bottom.*

    What happened to the particles of water when you added heat energy? *When heat energy is added the particles will move faster and farther apart.*

Assessment of Student Learning.

Summarize your experiments:

Claim: *When heat energy is added the particles will move farther apart making the matter less dense.*

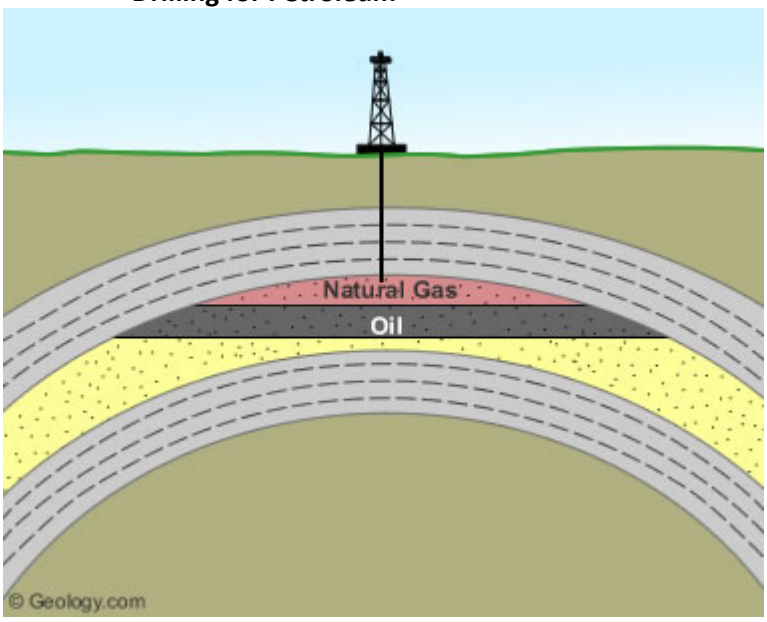
Evidence: *This was shown by the liquid water being heated up and turning into a gas that moved to the top of the flask into the balloon.*

Reasoning: *When matter is heated the particles move farther apart and make the substance less dense.*

Standardized Test Preparation:

Natural Gas: How this Clean Source of Energy was Formed

Drilling for Petroleum



1. The layers of rock, oil and natural gas are arranged in a typical pattern. Why is the natural gas always on top of the oil?
    a. It does not mix with oil.
    b. It is less dense than oil.*
    c. There is less of it than oil.
    d. It sticks to the rocks above it.

Bottle with Balloon over the Top

2. What will happen to the balloon if hot water is added to the dish holding the bottle?
    a. The balloon will shrink.

b. The balloon with fill up.*
c. The balloon will collapse.
d. The balloon will change color.

3. What happens to the air molecules in the bottle as it warms up in the hot water? Choose all that apply.
   a. They move faster.*
   b. They become larger.
   c. They get farther apart.*
   d. They turn into a liquid.

4. What are characteristics of natural gas?
   a. It is found everywhere.
   b. It is less dense than oil.*
   c. It burns and releases energy.*
   d. It is a clean burning fuel.*

Extension of lesson and Career Connections:
Have students look up different careers in the Oil and Natural Gas Industry. CareerGuide 2013 -- This long document does have a detailed section on each job in the oil industry. Look for the section Oil and Natural Gas Occupational Profiles on page 13.

Natural Gas: How this Clean Energy Source was Formed

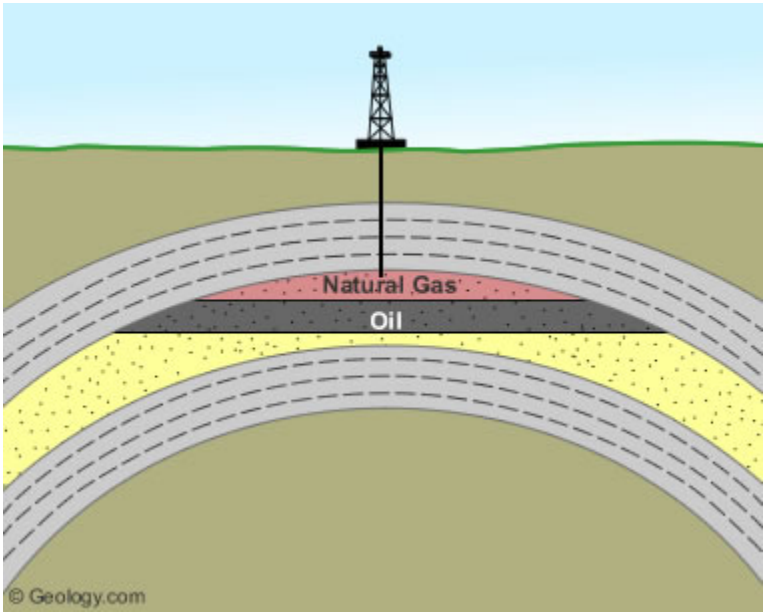
Name_____

Phenomenon: Demonstration:
List 3 questions you have about what happened?
1.
2.
3.

Natural gas is one of the United States most useful gases. Natural gas that is extracted from geologic formations is considered a non-renewable fossil fuel. We use natural gas in both residential and Industrial sectors. Energy from natural gas accounts for 31% of energy consumed in the United States. So what makes this gas so unique?

Natural gas is colorless, shapeless, and odorless in its pure form. Natural gas is combustible, abundant in the United States, and when burned it gives off a great deal of energy with fewer emissions than many other sources. Compared to other fossil fuels, natural gas is cleaner burning and emits lower levels of potentially harmful byproducts into the air. An ever-increasing supply of energy is needed to heat our homes, cook our food, and generate our electricity. This need for energy has elevated the integration on natural gas in our society, and in our lives.

What are two similarities between the demo and diagram # 1?



On the picture above there are dots showing the particles that make up the oil and natural gas. Do you think they are a good model of these states of matter? Why or why not?

Watch the following video about Natural gas and oil. **(Go to minute 1:26)**
Oil and Gas Formation (2:47 minutes) Write down two connections between the video and the demonstration.
1.

2.

Answer the following questions.

1. What is the state of matter of the following?
    a. Oil
    b. Natural Gas
2. Why do you think the natural gas reservoir was above the oil reservoir?

Heat Energy is required to form Natural Gas. We also know that heat energy affects the particles of matter.

Experiment:

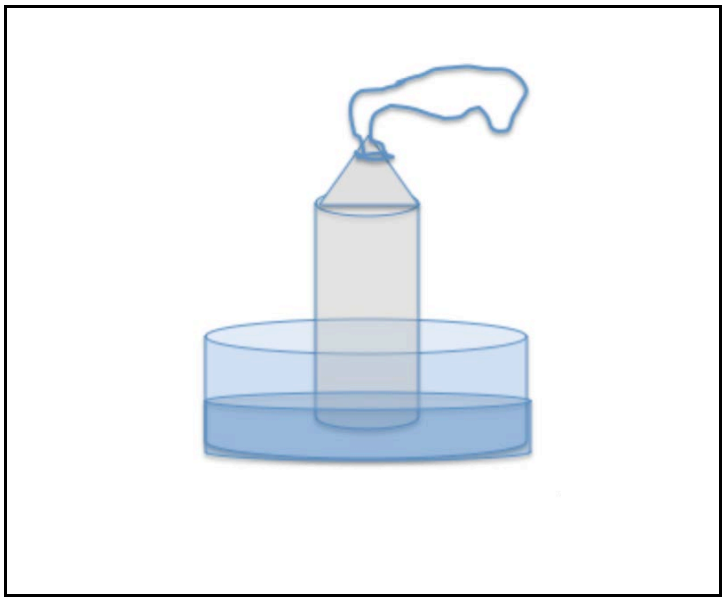
Equipment: Empty .5 Liter water bottle, balloon that will fit over the top, 2 ice cream buckets (or other containers about that size), hot water source (electric kettle), ice water

Set up: Put a balloon over the top of a plastic bottle. Add hot water to the bucket and set the bottle inside.

Use dots to show the particles of water in both the liquid and gas states in the sketch above.

Predict what you think is going to happen to the balloon when we set the bottle and balloon into hot water by writing it here:

Show the particles of the gas using dots.



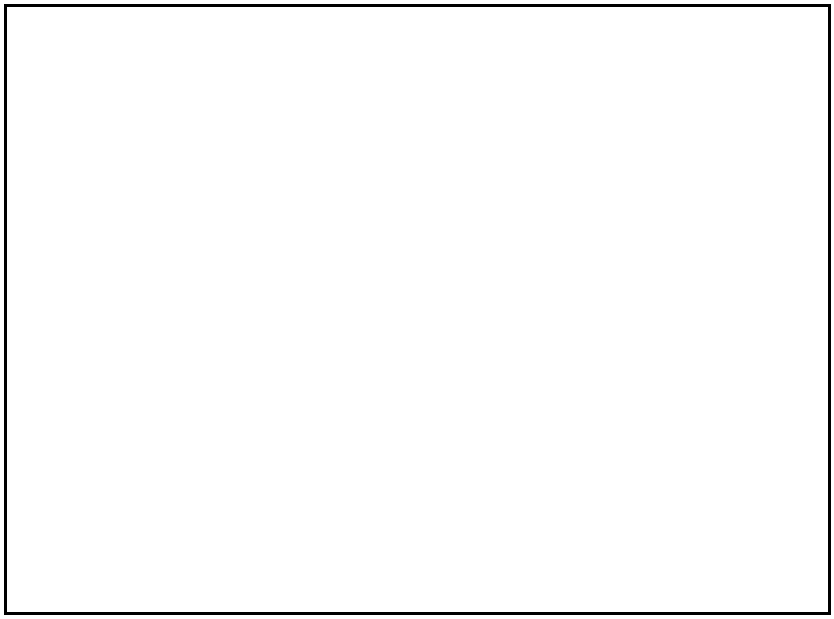
What happened to the particles of air when you added heat energy?

Now do the experiment again with cold water in the bucket. What do you think will happen?

Observe the dots that represent the layers in Diagram #1 at the beginning of this lesson. Do you think the dots are shown at the correct distance from each other for the Natural gas and the oil? Has your thinking changed?

What do you know now that might change the model?

Redraw the picture of the natural gas diagram adding more of your knowledge about the particles of natural gas and oil deposits. Use dots to show the particles of gas and oil.



Summarize what happens to particles when heat energy is added:

Write your **claim** of the changes.

State your **evidence** of these changes.

Support your **reasoning** with this explanation.