SICK! science®
insanely cool experiences

GHOST MARBLES
EXPERIMENT GUIDE

GHOST MARBLES

It looks like an ordinary glass of water, but hiding just below the surface of the water is an amazing collection of large, jelly-like marbles that become invisible when submerged in water. The Jelly Marbles™ become invisible due to an identical index of refraction with the water. In other words, they vanish like magic! As you'll see, there's more to this experiment than meets the eye.

WHAT YOU NEED

- **JELLY MARBLES**
- **ATOMIC GLOW™**
- **VARIOUS CLEAR CONTAINERS, INCLUDING A BOWL AND A SHALLOW DISH**
- **WATER**
- **ADULT SUPERVISION**

1

Pour one teaspoon of dry Jelly Marbles into a small clear bowl.

2

Fill the bowl with water. Good quality water, such as distilled water, that does not contain high levels of iron or minerals is best.

3

Set the bowl aside in a warm location for about 5 hours. Tip: It's okay to check on the marbles' growth, but be sure to wash your hands before touching them so you keep the water and the marbles as clean as possible.

4

Add some Atomic Glow or food coloring to the water. Watch the Jelly Marbles appear. If you use Atomic Glow, use a black light and watch as the water glows and the Jelly Marbles float!

HOW DOES IT WORK

Jelly Marbles start out as tiny, hard spheres. But, add water and the superabsorbent polymer they are made from absorbs 300 times its weight in water. These hydrophilic (water loving) spheres are approximately 99% water when fully hydrated. If you look closely at a sphere in a bowl of water, you can barely see its outline. That's because light passing through the sphere is refracted (or bent) only a tiny bit along the edge of the sphere. Without this refraction along their edges, Jelly Marbles would totally vanish altogether.

The water-filled spheres become invisible due to having an identical index of refraction with the water in the bowl. The secret to keeping them this way is to keep the Marbles clean and free of dirt and oil from your skin. The more the spheres are handled, the more visible they become because dirt and oils on your skin are transferred to the surface of the spheres. This increases the amount of light reflected from the spheres and reveals them.

It is also important to note that hydrating the Jelly Marbles in water is an example of a physical reaction. This water absorbing polymer undergoes a physical change. If you let the Jelly Marble polymer sit out, over time the water would eventually evaporate, and leave only the the Jelly Marble spheres behind.

TAKE IT FURTHER - SECRET MESSAGE

Can you use Jelly Marbles to send a secret message? In this activity you can!

1. Completely cover the bottom of a shallow, clear dish with already hydrated Jelly Marbles.
2. Write a message or place a picture under the clear dish. Challenge someone to read the message or describe the picture.
3. Then, fill the dish with water and watch them gasp as the message becomes crystal clear.

HOW DOES IT WORK - SECRET MESSAGE

In the hidden message demonstration, the message looks scrambled under the hydrated spheres because the light reflected off of the message is scattered in every direction by the water-filled Jelly Marbles. It's like trying to read through broken glass. When water is added to the dish, the light rays pass straight through the water and the spheres into your eyes without being scattered. This is due to the Jelly Marbles having an identical index of refraction with the water. So, it seems like you're looking through a dish of plain water and can easily read the message.

REAL WORLD CONNECTION

Get seeds for a fast-sprouting plant, such as grass, radish, or beans. Use three clear cups and fill one cup with just potting soil, another with a half-and-half mixture of potting soil and hydrated Jelly Marbles, and fill the last cup with all hydrated Jelly Marbles.

Plant the same kind of seed in each cup and find out which potting material helps the plants sprout fastest and grow the most. Check the progress of your plants every day or two. The results may surprise you.

SCIENCE FAIR CONNECTION

While making Jelly Marbles disappear is awesome, it is not a science fair project. You can create a science fair project by identifying a variable, or something that you can change, in this experiment. Let's take a look at some of the variable options that might work:

- Test liquids other than water. What's different about a Jelly Marble's reaction in orange juice, milk, soda, vinegar, bleach, coffee, tea, ketchup, etc? In which of these liquids do they grow the fastest? Slowest? Not at all? What's the same about each test? What's different? How long does the reaction take in each one?
- Try testing different kinds of water such as tap, bottled, sparkling, distilled, spring, rain, different concentrations of salt water and/or sugar water, etc.
- What happens to the reaction time if you raise or lower the temperature of the test liquids?

These are just a couple of ideas, but you aren't limited to them! Come up with different ideas of variables to test and give them a try. Remember, you can only change one variable at a time for each test. For example, if you are testing water temperature, make sure that all other factors in the test remain the same!

TEACHER NOTES:

SCIENCE CONCEPTS OVERVIEW ▸ Physical Reaction, Light Refraction

The learning experiences contained in the following Experiment Guide are designed to engage students and deepen understanding, not only of the underlying scientific concepts upon which these experiments/demonstrations are built, but also of critical thinking and problem solving skills. Teachers should allow students to actively participate in each activity as an investigation, where questions are being asked, hypotheses are developed and redeveloped, and where students own the discoveries. Vocabulary was included, assessments were created and critical thinking questions were designed with this underlying goal in mind.

The following are some suggested teaching points that could accompany this experiment/demonstration.

SICK Science Video: The SICK Science video can be utilized in a variety of ways. It can be used to introduce a scientific concept or in place of doing the demonstration/experiment if materials are unavailable. The video can also be used as a review or to help students complete the various learning experiences included in this guide. The video can also be used as a review or to help students complete the various learning experiences included in this guide.

Visit the landing page below to locate the appropriate video for this activity
stevespangler.com/sick-science-resources

Vocabulary: Students will enhance their science-content related vocabulary. You may choose to introduce the vocabulary words and explicitly teach the meaning of each. You may also use the vocabulary words as an investigation, where students may research the meanings of the words. Finally, students may develop their own meaning for each word through their experience with the experiments and critical thinking work.

The Scientific Method: Students can complete a full lab report for the experiment, including asking questions, identifying variables, forming a hypothesis, designing the experiment, collecting data, and drawing conclusions. Differentiation using the lab report is easy. For lower levels, complete the lab report as a class. As students are more independent, encourage students to work in partnerships or groups to complete the lab report. Eventually, students should be able to complete the lab report independently or design a new experiment using the lab report form based on the demonstration completed in class.

Vocabulary Comprehension: Students will be able to understand and define content related vocabulary words.

Summarize: Students will create a summary that includes the important ideas and details of refraction in the Jelly Marble experiment.

Relation and Application: Students will predict and describe the impact that changing the liquid that Jelly Marbles absorb would have on the experiment/demonstration.

Literature Connection: The Invisible Boy, Patrice Barton

Narrative Writing: Students can write a narrative story about a child who discovers a secret message that leads him/her to an amazing discovery. The story should include appropriate details and elaboration.

Expert Vocabulary

NAME _____

WORDS AND DEFINITIONS —
Match the word on the left with the correct definition on the right by filling in the blank with the correct letter.

VOCABULARY WORDS	DEFINITIONS
1 ____ **Physical Reaction**	A The bending of a wave of light when passing from one substance to another due to differences in density.
2 ____ **Index of Refraction**	B A chemical compound formed from a long chain of the same molecule group.
3 ____ **Polymer**	C To take in or soak up.
4 ____ **Refraction**	D Tool used to measure the amount of bend that occurs in a light wave when it crosses from one substance to another.
5 ____ **Absorb**	E A process that leads to a change in the form of matter.

Critical Thinking

NAME

Students will be able to understand and define content related vocabulary words.

Read the following definitions.

Transparent: describes when a substance can be seen through clearly and light passes through without distortion.

Translucent: describes a substance that does not allow light to pass through, but items on the opposite side my appear cloudy or fuzzy.

Opaque: describes a substance that does not allow light to pass through and items on the other side cannot be seen.

Which of the above best describes a single Jelly Marble out of water after it is fully hydrated? Explain your thinking with evidence.

Critical Thinking

NAME

Students will create a summary that includes the important ideas and details of refraction in the Jelly Marble experiment.

Explain how light refraction makes the Jelly Marbles seem to vanish in the water.

Critical Thinking

NAME

Students will predict and describe the impact of changing the liquid the Jelly Marbles will absorb would have on the experiment/demonstration.

Given what you observed about the Jelly Marbles that absorbed water and what you know about light refraction, what do you think a Jelly Marble would look like that absorbed red water instead of clear water? Would you be able to see these Jelly Marbles in a bowl filled with red water? Would you seem them in a different colored water, like blue, or in clear water? Explain your thinking.

Assessment

NAME _____

ASSESSMENT QUESTIONS —
Read each question carefully and circle the letter next to the correct answer or write your response in the box.

1. Jelly Marbles absorb liquid. Something that can absorb and hold liquid is called a(n):
   a. Gel
   b. Superabsorbent Polymer
   c. Absorbent Atom
   d. Refraction Holder

2. Which of the following is evidence that the Jelly Marble and water have a physical reaction?
   a. The Jelly Marble can absorb water, but the water can also evaporate from the Jelly Marble leaving it back in its original state.
   b. The Jelly Marble grows and becomes transparent as it absorbs the water.
   c. The Jelly Marble can be broken apart and still does not leak water.
   d. The Jelly Marble and water do not have a physical reaction, it is a chemical reaction.

3. Which example creates the least refraction and makes the Jelly Marbles most difficult to see?
   a. A thick layer of clear Jelly Marbles in a dish of clear water.
   b. A thick layer of clear Jelly Marbles in a dish of red water.
   c. A thin layer of clear Jelly Marbles in a dish of clear water.
   d. A thin layer of red Jelly Marbles in a dish of clear water.

4. Using the concept of refraction, explain why you would be able to see clear Jelly Marbles in colored water.

   _____

   _____

5. In the SICK Science explaination video, Mr. Spangler mentions that farmers use Jelly Marbles to hold water close to the roots of their plants. What other possible uses can you think of for Jelly Marbles in the real world?

   _____

   _____

Expert Vocabulary - Answer Key

WORDS AND DEFINITIONS —
Match the word on the left with the correct definition on the right by filling in the blank with the correct letter.

VOCABULARY WORDS		DEFINITIONS	
1	E Physical Reaction	A	The bending of a wave of light when passing from one substance to another due to differences in density.
2	D Index of Refraction	B	A chemical compound formed from a long chain of the same molecule group.
3	B Polymer	C	To take in or soak up.
4	A Refraction	D	Tool used to measure the amount of bend that occurs in a light wave when it crosses from one substance to another.
5	C Absorb	E	A process that leads to a change in the form of matter.

Critical Thinking- Answer Key

Students will be able to understand and define content related vocabulary words.

Read the following definitions.

Transparent: describes when a substance can be seen through clearly and light passes through without distortion.

Translucent: describes a substance that does not allow light to pass through, but items on the opposite side my appear cloudy or fuzzy.

Opaque: describes a substance that does not allow light to pass through and items on the other side cannot be seen.

Which of the above best describes a single Jelly Marble out of water after it is fully hydrated? Explain your thinking with evidence.

Possible Answer:
The Jelly Marble is translucent. It is mostly made of absorbed water which is transparent because it lets light through, but objects on the other side of the Jelly Marble are not perfectly clear because of the "jelly skin", so it is not completely transparent. Since things look a bit fuzzy, the Jelly Marble is translucent.

Critical Thinking- Answer Key

Students will create a summary that includes the important ideas and details of refraction in the Jelly Marble experiment.

Explain how light refraction makes the Jelly Marbles seem to vanish in the water.

Possible Answer:
Light refraction is when a light wave bends because of hitting a new surface with a different density. This refraction creates a contrast that allows the eye to see where on surface starts and another stops. However, the light refraction is minimal when the wave of light crosses from Jelly Marbles to water. This is because the Jelly Marbles are mostly made up of absorbed water and are transparent. So, when other water acts as their background, the qualities of the water match the qualities of the Jelly Marble in both color and density. The similarity in qualities between the two reduces the amount of light refraction that occurs and the Jelly Marbles "appear" to vanish.

Critical Thinking- Answer Key

Students will predict and describe the impact of changing the liquid the Jelly Marbles will absorb would have on the experiment/demonstration.

Given what you observed about the Jelly Marbles that absorbed water and what you know about light refraction, what do you think a Jelly Marble would look like that absorbed red water instead of clear water? Would you be able to see these Jelly Marbles in a bowl filled with red water? Would you seem them in a different colored water, like blue, or in clear water? Explain your thinking.

Possible Answer:
I think that a Jelly Marble will match the color of whatever liquid it absorbs. When the Jelly Marble absorbed clear water, it looked just like the water. So, if it absorbed red water then it would have the same red water in it. When the red Jelly Marbles are in red water, they would probably vanish the same way as clear water hydrated Jelly Marbles do in clear, uncolored water. I think this because they would be made mostly of red water so they would be very close to the same density as the red water around it, which means that the light would travel through them at the same speed as the red water and you would not be able to see them. You would be able to see the red water Jelly Marbles in other colors of water because the liquids are different colors and also different densities.

Assessment - Answer Key

ASSESSMENT QUESTIONS —
Read each question, then circle the letter next to the correct answer or write your response in the boxes.

1. Jelly Marbles absorb liquid. Something that can absorb and hold liquid is called a(n):
   a. Gel
   b. Superabsorbent Polymer
   c. Absorbent Atom
   d. Refraction Holder

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   b. A thick layer of clear Jelly Marbles in a dish of red water.
   c. A thin layer of clear Jelly Marbles in a dish of clear water.
   d. A thin layer of red Jelly Marbles in a dish of clear water.

4. Using the concept of refraction, explain why you would be able to see clear Jelly Marbles in colored water.

   Possible Answer: *You would be able to see clear Jelly Marbles in colored water because the color of the Jelly Marbles does not match the background color that the water creates. That means that refraction occurs and then you can see the change from the surface of the Jelly Marble to the water.*

5. In the SICK Science explaination video, Mr. Spangler mentions that farmers use Jelly Marbles to hold water close to the roots of their plants. What other possible uses can you think of for Jelly Marbles in the real world?

   Possible Answer: *I think Jelly Marbles could be used to soak up water from spills, floods, or other situations where there is too much water. They could also be used to soak up waste or other unhealthy/toxic materials.*

Common Core State Standards

Student Outcomes	Standards
Students will be able to ask and answer questions about key details about their observations and discussion to demonstrate their understanding of the scientific concepts presented through the experiment.	RI.K.1, RI.1.1, RI.2.1, RI.3.1, RI.4.1
Students will be able to ask and answer questions to help determine the meaning of vocabulary presented as part of an experiment.	RI.K.4, RI.1.4, RI.2.4, RI.3.4, RI.4.4, RI.5.4
Students will be able to explain the connection between scientific ideas presented in the experiment.	RI.1.3, RI.2.3, RI.3.3, RI.4.3, RI.5.3
Students will be able to retell key details presented in the experiment in order to understand/determine the main idea.	RI.K.2, RI.1.2, RI.2.2, RI.3.2, RI.4.2, RI.5.2
Students will actively engage in shared informational learning activity with purpose and understanding.	RI.K.10
Students will be able to refer back to their observations and discussion to demonstrate their understanding of the scientific concepts presented through the experiment.	RI.3.1
Explain the procedure and ideas presented in a scientific experiment including what happened and why, including cause and effect, based on the information presented.	RI.3.3, RI.4.3
Students will be able to write a narrative that includes details.	W.K.3, W.1.3, W.2.3, W.3.3, W.4.3, W.5.3