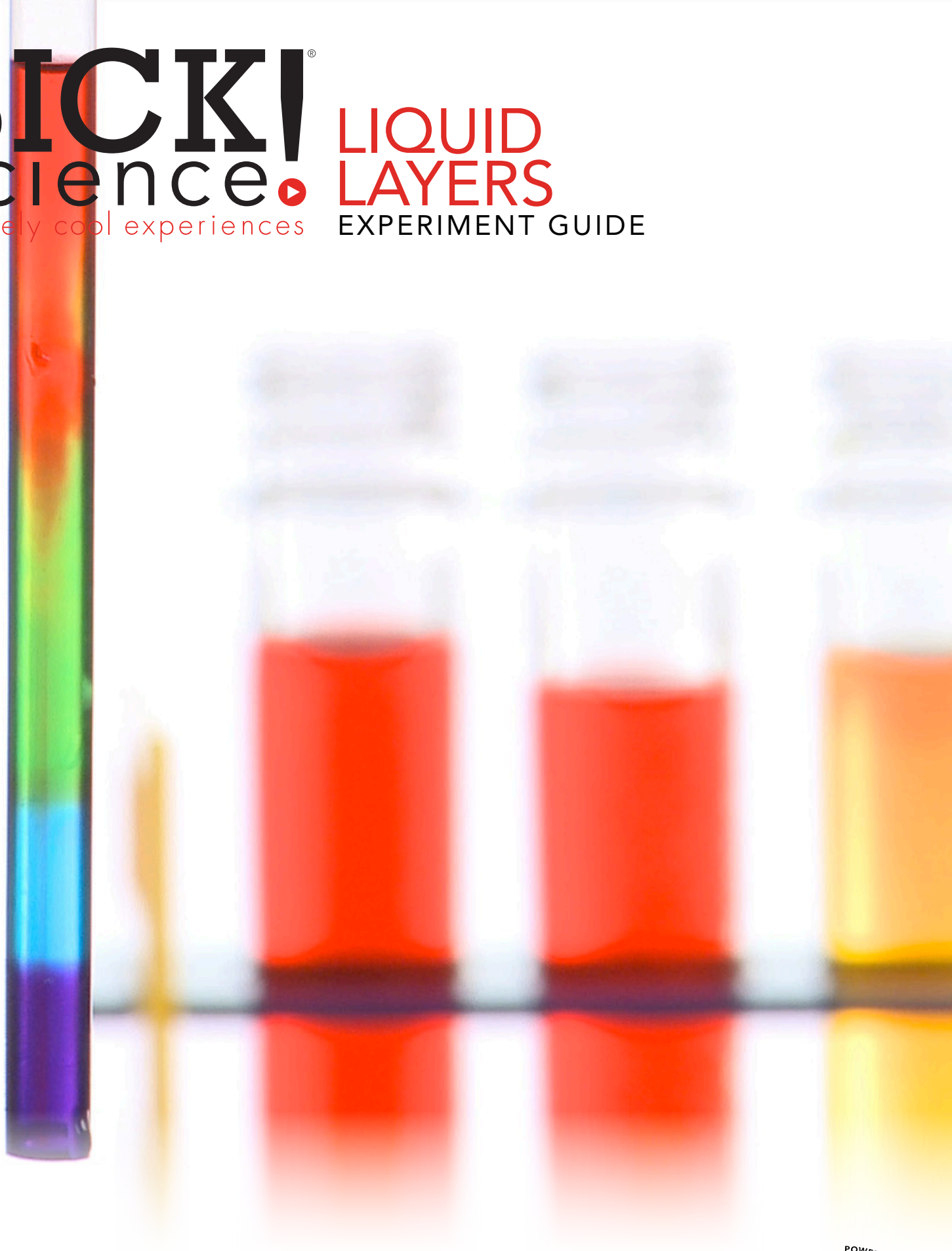
SICK! science®
insanely cool experiences

LIQUID LAYERS

EXPERIMENT GUIDE



as seen on YouTube™

POWERED BY Steve Spangler SCIENCE

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LIQUID LAYERS

Use your knowledge of density to create a colorful rainbow inside of a drinking straw in this science experiment.

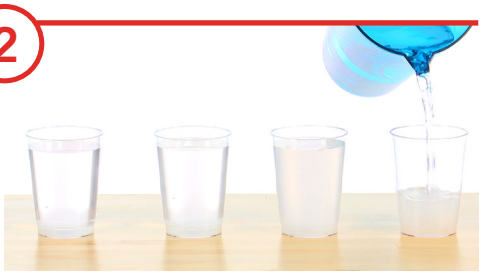
WHAT YOU NEED

- TABLE SALT
- SIX 9oz CUPS
- COLOR FIZZERS
- WATER
- TEASPOON MEASURER
- ADULT SUPERVISION
- CLEAR STRAWS
- BABY SODA BOTTLES AND RACK

1

Using the 9 oz cups, put 1 tsp of salt into Cup #1, 2 tsp of salt into Cup #2, 3 tsp in #3, etc. up to #6. Write the number on each cup.

2



Add about 9 oz of warm water to each cup. Stir the salt and water solution until all of the salt has completely dissolved.

3 Use the Color Fizzer tablets to dye the solutions in each cup a different color. If you want to make a rainbow of colors then add two red tablets to Cup #1, a red and a yellow tablet to Cup #2, two yellow tablets to Cup #3, a yellow and a blue tablet to Cup #4, two blue tablets to Cup #5, and a blue and a red tablet to Cup #6.

4

Carefully transfer the liquids to the six Baby Soda Bottles and place them in order from #1-6 in the Baby Soda Bottle Rack.

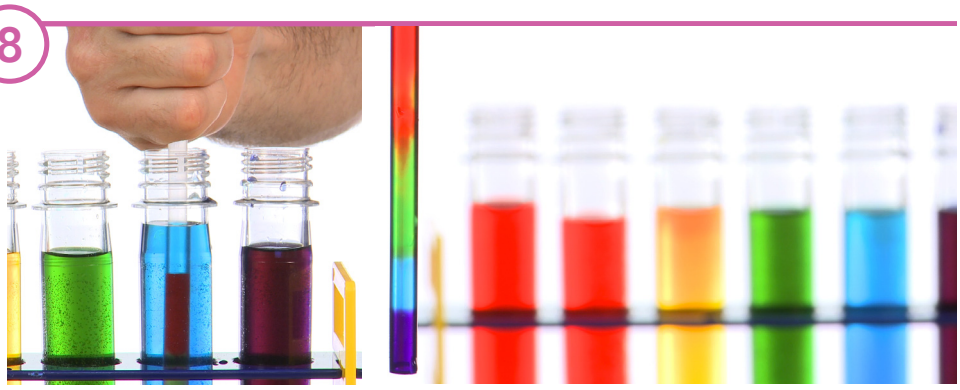
5

Grab a clear drinking straw. Keeping both ends open, dunk the bottom end of the straw into the liquid of the "1 tsp" solution. Cap the top of the straw firmly with your thumb and remove the straw from the solution.

6 Now that you have the first solution in the straw, dip the end of the straw into the "2 tsp" solution. This time, dip the straw deeper than you did into the first solution. After you've dipped the straw, lift your thumb and replace it.

7 Remove the straw and you should have the first and second colored solutions in a stack inside the straw.

8



Continue the dipping process until you have all six colored solutions inside the straw. It's a density column of salt water!

HOW DOES IT WORK

Density is the measurement of how much "stuff" is packed into a measured space. Nearly every substance and material imaginable has a different density. This is especially true for the six solutions you made using salt and water. By increasing the amount of salt in the solution but keeping the amount of water constant, you create solutions that have increasing densities. The more salt that is mixed into a measured amount of water, the higher the density of the solution. As the Density Straw shows, a solution with a low density stacks on top of a solution with a higher density.

So, density explains why the solutions stack on top of each other inside the straw, but what keeps the solutions in the straw? You might expect the solutions to just fall out of the straw as you lift the straw from a solution. However, because of cohesion (similar molecules attracting each other) and adhesion (different molecules attracting each other), there is surface tension sealing the water at the bottom of the straw. The surface tension is strong enough to help hold the solutions in the straw as long as air pressure inside the straw is lower than all the air pressure outside the straw. Gravity tugs the solutions downward which creates a slight vacuum in the empty part of the straw. That lowers the air pressure inside the straw which is why you need your thumb to cap the straw. This prevents air pressure from equalizing in the straw. If you remove your thumb, the air pressure equalizes, and gravity simply moves the colored solutions out.

TAKE IT FURTHER

Now that you have mastered Liquid Layers, it is time to try a different way of creating your colorful density column. What would happen if you added the layers to the straw in reverse order? How about if you went completely out of order and added colors from #1, then #3, then #5?

Another variation you could try would be using a different size of straw. Just remember that your thumb needs to fit over the end to create a complete seal in order for this to work.

ADDITIONAL INFORMATION

This dramatic salt water density change can be experienced in real life. While humans will (sort of) float in an ocean, we really float in bodies of water like Utah's Great Salt Lake and the Dead Sea in Israel and the West Bank. They are so salty that it's nearly impossible to sink in them!

SCIENCE FAIR CONNECTION

You may have mastered the Liquid Layers experiment, but now it is time to turn this experiment into a science fair project. You can make it one simply by identifying a variable (something that might change the outcome) in the experiment, then testing that variable, and correctly reporting the results.

- Try using something besides salt. Would sugar work the same?
- Instead of using salt water, try different liquids to see if you can layer them.

These are just a couple of ideas, but you are not limited to just 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 different liquids, make sure that all other factors in the test remain the same!

THIS EXPERIMENT

SCAN TO WATCH

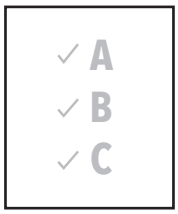
For step by step experiment instructions, the science behind it and ways to take it further, scan the code to the left.

Trouble scanning? Follow the URL below.
http://spanglersci.com/100wsks38tzofz3t1

WHAT ARE THESE SYMBOLS ALL ABOUT?

LAB REPORT

In this section, you will learn to define and prepare your experiments like scientists do. You will ask big questions, develop hypotheses, list materials, write procedures, record results and make big discoveries.

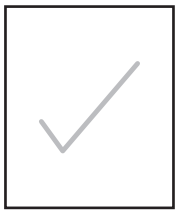


EXPERT VOCABULARY

In this section, you will learn to use the language scientists use to discuss and explain the concepts covered in this experiment.

CRITICAL THINKING

Follow the layers of critical thinking density with this icon. As the beakers fill from page to page, you will notice the level at which the beaker is filled indicates the depth of critical thinking needed to complete the question(s), from least complex being the least full to most complex being the most full.



ASSESSMENT

In this section, you will find questions at a variety of levels which assess student understanding of the scientific content covered in the experiment.

A WORD ABOUT SAFETY

Everything we suggest using in this guide is safe when used with proper adult supervision. We guarantee young scientists will get a lot more from the experience if you're there to guide them. Remember, this is science, and science tends to get a bit messy. Stuff falls on the floor... so you'll need to clean it up. Don't put chemicals in your eyes or ears and don't eat your experiment. Trust us, they don't taste good and it's a bad thing to do. The bottom line is that this science experiment guide requires adult supervision and common sense. These simple concepts help ensure a fun and safe experience.

TEACHER NOTES:

SCIENCE CONCEPTS OVERVIEW ▸ Density

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.

Suggested Teaching Points:

Sick Science Teaching Points: 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.

Vocabulary: Students 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 demonstration, 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 form based on the demonstration completed in class.

Paraphrase: Students will be able to restate the main ideas of density in their own language.

Cause and Effect: Students will identify cause and effect relationships and describe the connection between the density of the liquids and their order in the straw.

Generalize: Students will relate knowledge gained from the experiment/demonstration to other concepts such as the salt water concentration of the Dead Sea.

Informational Writing: Students can write a piece that teaches their classmates about density. They should include important vocabulary and explain their thinking about how density impacts whether an item sinks or floats. Younger students may include diagrams and pictures to share their thinking.

Lab Report

NAME

BIG QUESTION:
Scientists ask big questions to guide their experiment.

What big question are we answering in this experiment?

HYPOTHESIS:
Scientists make predictions about what they think will happen during the experiment.

What is your hypothesis for this experiment?

Lab Report

NAME

MATERIALS AND PROCEDURES:
Scientists make a list of materials they need and will use in their experiments. It is important other scientists are able to duplicate and test each other's experiments.

What materials do you need to conduct this experiment?

Write out a step-by-step procedure for this experiment.

Lab Report

NAME

RESULTS AND OBSERVATIONS:
Scientists make observations and take notes as they conduct their experiments. Scientists are good observers and record all results of their experiments. It is important to measure your results using precise units and careful review.

What were the results of your experiment?

What did you observe as you conducted your experiment?

Lab Report

NAME

CONCLUSIONS AND DISCOVERY:
Scientists look carefully at their results, think critically about their observations, and draw conclusions about their experiments, as they relate to their big question and original hypothesis.

What conclusions and discoveries did you make after completing the experiment?

NEXT STEPS:
Sometimes after scientists conduct their experiments, they think of new questions they want to test in new experiments.

What new questions do you have after you have completed your experiment?

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 ____ **Density**	A The act of like molecules sticking together.
2 ____ **Volume**	B A force that tries to pull two objects toward each other.
3 ____ **Cohesion**	C Like molecules stick together and resist an outside force such as gravity.
4 ____ **Surface Tension**	D The amount of a substance in a given space.
5 ____ **Gravity**	E The measurement of how much "stuff" is packed into a measured space.

Critical Thinking

NAME

PARAPHRASE —
Students will be able to restate the main ideas of density in their own language.

In your own words, explain how the definition of density relates to the Sick Science experiment.

Density: the measurement of how much "stuff" is packed into a measured space.

Critical Thinking

NAME

CAUSE AND EFFECT —
Students will identify the cause and effect relationships and describe the connection between the density of the liquids and their order in the straw.

What do you think causes the layers to stack on top of each other and not mix when you pick the colors up in order of red, orange, yellow, green, blue, purple?

What do you predict that the effect would be on the colors if you ? Why do you think this would happen?

Critical Thinking

NAME

GENERALIZE —
Students will relate knowledge gained from the experiment/demonstration to other concepts such as the salt water concentration of the Dead Sea.

The Dead Sea contains more salt than any other body of water in the world. Because it's so much denser than fresh water, people float! In fact, it's nearly impossible for people to sink. Explain why you think this happens in the space below. Use a diagram to show your thinking.

Assessment

NAME

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

1. What is the variable in the Sick Science experiment? Circle all that apply.
   a. Water
   b. Amount of salt
   c. Straw
   d. Cups

2. Find the constant(s) in the Sick Science experiment. Circle all that apply.
   a. Water
   b. Amount of salt
   c. Straw
   d. Cups

3. Imagine that your teacher set up an experiment to test your understanding of density. On your desk you found 6 clear cups filled with the same amount of clear liquid. All she told you was that all of the liquids were different densities. What supplies would you need and what procedure would you follow to figure out the density (from least dense to most dense) of all 6 cups? Explain below.

Assessment

NAME

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

4 Draw a diagram showing the density of each of the 6 cups that were mixed in the original Sick Science experiment. Remember to label your diagram with all materials used in the experiment, including the salt!

5 What is volume? Explain what volume is in your own words. Draw a picture to show your thinking.

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 C Density	A The act of like molecules sticking together.
2 E Volume	B A force that tries to pull two objects toward each other.
3 D Cohesion	C Like molecules stick together and resist an outside force such as gravity.
4 A Surface Tension	D The amount of a substance in a given space.
5 B Gravity	E The measurement of how much "stuff" is packed into a measured space.

Critical Thinking- Answer Key

PARAPHRASE —
Students will be able to restate the main ideas of density in their own language.

In your own words, explain how the definition of density relates to the Sick Science experiment.

Density: the measurement of how much "stuff" is packed into a measured space.

Possible Answer:
Density relates to this experiment because it measures how much stuff is packed into one space. In this case the "stuff" is salt and the space is the water. All of the cups have the same amount of water, but the amount of salt changed. The cups with more salt mixed in are more dense than the cups with less salt.

Critical Thinking- Answer Key

CAUSE AND EFFECT —
Students will identify the cause and effect relationships and describe the connection between the density of the liquids and their order in the straw.

What do you think causes the layers to stack on top of each other and not mix when you pick the colors up in order of red, orange, yellow, green, blue, purple?

Possible Answer:
I think the colors stack on each other and don't mix because each color has a different density. The color with the lowest density will stack on top of the other colors with higher densities (more salt). I think this happens because the colors with less salt are lighter or weigh less than the colors with more salt.

What do you predict that the effect would be on the colors if you ? Why do you think this would happen?

Possible Answer:
If you reverse the order of the colors so the low density (least amount of salt) colors are on the bottom and the high density (salt-heavy) colors are on the top, the colors would mix instead of stacking on each other. This happens because low density solutions travel to the top, and high densities travel to the bottom, causing the colors to mix.

Critical Thinking- Answer Key

GENERALIZE —
Students will relate knowledge gained from the experiment/demonstration to other concepts such as the salt water concentration of the Dead Sea.

The Dead Sea contains more salt than any other body of water in the world. Because it's so much denser than fresh water, people float! In fact, it's nearly impossible for people to sink. Explain why you think this happens in the space below. Use a diagram to show your thinking.

Possible Answer:
It's nearly impossible for people to sink in the Dead Sea because of the high amount of salt in the water. In order for someone to float, they must be less dense (or lighter) than the water. People can already float on fresh water (which isn't as high in salt as the Dead Sea), so when they float on the Dead Sea (which is very high in salt), they float even easier.

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. What is the variable in the Sick Science experiment? Circle all that apply.

   a. Water
   b. Amount of salt
   c. Straw
   d. Cups

2. Find the constant(s) in the Sick Science experiment. Circle all that apply.

   a. Water
   b. Amount of salt
   c. Straw
   d. Cups

3. Imagine that your teacher set up an experiment to test your understanding of density. On your desk you found 6 clear cups filled with the same amount of clear liquid. All she told you was that all of the liquids were different densities. What supplies would you need and what procedure would you follow to figure out the density (from least dense to most dense) of all 6 cups? Explain below.

   Possible Answer:
   The first thing that I would need is something to color my water so that I could tell the difference between the 6 cups of liquid. Then, I would need a straw to be able to "pick up" the liquid and begin to test the density of the layers. I would then try two colors. If the colors didn't mix, then I would know that the more dense color is on the bottom and the less dense is on the top. If they mixed than I need to empty the straw and try again, this time in the opposite order and see if the colors stay separated. As I discover which colors are more/less dense than each other, I would move the cups on my table to be in order from least to most dense.

   TEACHER NOTE: This question may be challenging for your students. You may consider having students work with a partner to develop a process for determining the density of each cup of water. We also suggest, as an extension to this question, to actually set up the scenario for your students and allow them to test their proposed procedure to see if they can in fact determine the correct densities of the cups of water.

Assessment

NAME

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

4 Draw a diagram showing the density of each of the 6 cups that were mixed in the original Sick Science experiment. Remember to label your diagram with all materials used in the experiment, including the salt!

Possible Answer:
Answers will vary

5 What is volume? Explain what volume is in your own words. Draw a picture to show your thinking.

Possible Answer:
Volume is the amount of space that a substance, like the liquid in our experiment, takes up in the cup.

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
Students will be able to retell key details presented in the experiment.	RI.K.2, RI.1.2, RI.2.2, RI.3.2, RI.4.2, RI.5.2
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 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 cause/effect of concepts presented in the learning activity.	RI.4.5
Students will be able to use information gained from observations of the experiment to demonstrate understanding of the concepts presented, including how a diagram can clarify understanding.	RI.2.7, RI.3.7
Students will participate in shared writing projects and record scientific observations.	W.2.7
Students will be able to recall information from experiences to answer a question.	W.K.8, W.1.8, W.2.8
Students will be able to write an informative/ explanatory text that includes facts.	W.K.2, W.1.2, W.2.2, W.3.2, W.4.2, W.5.2