2013

Matter, Density, and Buoyancy [6th-8th grade]

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UNDERSTANDING BY DESIGN

Unit Cover Page

Unit Title: Matter, Density, and Buoyancy

Grade Level: 6-8

Subject/Topic Area(s): Middle school general science

Designed By: Reid Agan

Time Frame: 15 lessons

School District: American School of Bangkok

School: Green Valley campus

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Brief Summary of Unit (Including curricular context and unit goals):

This unit provides students with basic understanding of what matter is and how different states of matter interact with one another. Students use concepts of mass, volume, and density to understand natural cycles of states of matter as well as buoyancy.

UNDERSTANDINGS:

1. Matter is neither created nor destroyed, but can change states.
2. State of matter is dependent on energy and density of particles.
3. Changes in states of matter causes natural continuous cycles on Earth. (water cycle, rock cycle, convection weather patterns)

Stage 1—Desired Results

Transfer

Established Goals
What content standards and program- or mission-related goal(s) will this unit address?

What habits of mind and cross-disciplinary goal(s) – for example, 21st century skills, core competences – will this unit address?

Student will understand:
Law of conservation of matter

states of matter

density

buoyancy

Students will be able to independently use their learning to . . . What kinds of long-term independent accomplishments are desired?
Identify states of matter, what causes changes in states of matter, and what changes in states of matter cause.

Meaning

UNDERSTANDINGS:

1. Matter is neither created nor destroyed, but can change states.
2. State of matter is dependent on energy and density of particles.
3. Changes in states of matter causes natural continuous cycles on Earth. (water cycle, rock cycle, convection weather patterns)

ESSENTIAL QUESTIONS *Students will keep considering . . .* (What thought-provoking questions will foster inquiry, meaning-making, and transfer?)

1. What is matter? What is not?
2. Can matter be created or destroyed?
3. How do changes in states of matter affect me?

Acquisition

Students will know . . . What facts and basic concepts should students know and be able to recall?
Heating a substance causes its particles to gain energy and move.
Heating a substance decreases the density of its particles.

The particles of a SOLID are closely packed together, and don't move around freely (so maintain shape) but do vibrate.
The particles of a FLUID (LIQUID or GAS) are increasingly less closely packed together, and can move around so the substance can flow and take the shape of its container.
Concepts of freezing, melting, evaporation, condensation, sublimation, deposition

Students will be skilled at . . . What discrete skills and processes should students be able to use?

Measuring temperature, mass, volume
Calculating density
Identifying examples of states of matter.

Stage 2—Evidence

Criteria
Are all desired results being appropriately assessed?
All questions answered
Followed instructions
Identified properties of states of matter

All questions answered
Followed instructions
Measured temperature

PERFORMANCE TASK(S): *Students will show that they really understand by evidence of . . .* How will students demonstrate their understanding (meaning-making and transfer) through complex performance?

Performance-Based Assessment 1
Key Organizing Question: Can a substance be a liquid and a solid?
Students will observe a mixture of cornstarch and water and answer a series of questions about the mixture's properties and how they determine the mixture's state of matter.

Performance-Based Assessment 2
Key Organizing Question: Can salt change the temperature at which something freezes?
Students will observe a mixture of cornstarch and water and answer a series of questions about the mixture's properties and how they determine the mixture's state of matter.

	OTHER EVIDENCE: *Students will show they have achieved Stage 1 goals by . . .* What other evidence will you collect to determine whether Stage 1 goals were achieved? Kitchen Confidential: look in your refrigerator for as many examples of each state of matter as you can find Labs with conclusion questions Quiz Frequent and immediate verbal feedback Unit test

Stage 3—Learning Plan

Code What's the goal for (or type of) each learning event? Is this transfer, meaning, or acquisition? Double check. Coding p.107. Bring meaning and stage one back down into activities in stage 3.	**Pre-Assessment/Advance Organizer** **Unit Test: Properties and States of Matter PRE**	
	Learning Events	*Progress Monitoring*
A A	Lesson 1: **EQ#1: What is matter? What is not?** Objective: Students will understand that all things are made of smaller particles of matter and that matter cannot be created or destroyed. Activity: • Teacher demo of "My Fingertips are Atoms" • Reading: What is Matter?	• How will you monitor students' progress toward acquisition, meaning, and transfer, during lesson events? • What are potential rough spots and student misunderstandings? • How will students get the feedback they need?
A M T	Lesson 2: **EQ#2: Can matter be created or destroyed?** Objective: Students will understand that all things are made of smaller particles of matter and that matter cannot be created or destroyed. Matter exists in 3 basic states: solid, liquid, gas. Activity: • Reading: Solids and Fluids • Vocab study • Introduce Performance Assessment 1 Homework: Kitchen Confidential	
M M	Lesson 3: Objective: Students will understand that all things are made of smaller particles of matter and that matter cannot be created or destroyed. Matter exists in 3 basic states: solid, liquid, gas. Activity: • Review Kitchen Confidential homework, list examples of 3 states on board • ***Performance Assessment 1*** • Introduce Performance Assessment 2	
T	Lesson 4: Objective: Students will understand that all things are made of smaller particles of matter and that matter cannot be created or destroyed. Matter exists in 3 basic states: solid, liquid, gas. Activity: • ***Performance Assessment 2***	
A	Lesson 5: Objective: Students will understand that matter exists in 3 basic states: solid, liquid, gas. Activity: • Performance Assessment 2 WRAP UP	

A A M	Lesson 6: Objective: Students will understand how an object's density affects its buoyancy. Warm Up: Suppose you drop a basketball and a baseball into a swimming pool. Which one will float and which one will sink? Why? Activity: • Reading and vocab: G6/MSELL pD94-D99, G7/G8 p108-113 • Students record words that are unfamiliar or that they cannot define. • Students talk to partners to define unknown words. • Entire class shares unknown words and define them. Students record definitions in their notes. • Students answer chapter questions and teacher gives feedback in journal Homework: Finish chapter questions	
M	Lesson 7: Objective: Students will understand how an object's density affects its buoyancy. Warm Up: Consider a glass of water and an entire freshwater lake. Are their densities the same or different? How could you change the density of a substance? Activity: • Reading Questions (from previous reading) • Partners- discuss • FLOATING EGG DEMO	
A	Lesson 8: Objective: Students will understand how an object's density affects its buoyancy. Warm Up: Explain: How do you think a hot air balloon works to lift people into the air? (Try to use science vocabulary!) Activity: • Reading and vocab: G7/G8 p116-121	
A M T	Lesson 9: Warm Up: What do you think has a greater density, molten lava or volcanic rock? Explain your answer. Activity: • csmurray Density and Buoyancy notes LAB: • Hands-on measurements- *mass, volume, density* • Use scales, balances, graduated cylinders and displacement method to determine dimensions of objects with same size but different densities	
A A M M	Lesson 10: Objective: Students will understand how an object's density affects its buoyancy. Warm Up: Describe all the forces you can think of that are acting on your body when you go swimming. Activity: • Reading and vocab: *What is Buoyancy?* • Students record words that are unfamiliar or that they cannot define. • Students talk to partners to define unknown words. • Entire class shares unknown words and define them. Students record definitions in their notes. • Students answer chapter questions and teacher gives feedback in journal	
	Lesson 11: Objective: Students will understand how an object's density affects its buoyancy. Warm Up: What is the best or worst idea you have ever had? Did this idea change anything about your life? Explain.	

A M	Activity: • Reading and vocab: *Archimedes and the Golden Crown* • Students record words that are unfamiliar or that they cannot define. • Students talk to partners to define unknown words. • Entire class shares unknown words and define them. Students record definitions in their notes. • Students answer chapter questions and teacher gives feedback in journal <u>Lesson 12:</u> **EQ#3: How do changes in states of matter affect me?** Objective: Students will understand how states of matter are the driving forces behind natural cycles like the water cycle, the rock cycle, and convection weather patterns. Warm Up: How could an iceberg melting effect the ocean around it? Activity: • Reading and vocab: *What is El Niño?* • Read in groups • ID main idea sentence in each paragraph • SUMMARIZE: o 1 sentence- main idea o 3 sentences- evidence from text o 1 sentence- conclusion	
M T	<u>Lesson 13:</u> Objective: Students will understand how states of matter are the driving forces behind natural cycles like the water cycle, the rock cycle, and convection weather patterns. Activity: • Reading and vocab: Water Cycle <u>Lesson 14/15:</u> Objective: Students will understand how an object's density affects its buoyancy. Warm Up: Study notes Activity: **Unit Test: Properties and States of Matter POST**	
A		
M T		

http://www.nsta.org/elementaryschool/connections/200804Flynn.pdf

Performance-Based Assessment 1
Key Organizing Question: Can a substance be a liquid and a solid?

Performance Task 1a:

Rachel Ray, the famous chef from the Food Network, needs your help. A recipe she wants to include in her new cookbook calls for cornstarch to be added into the mixture. This seemed easy enough to her but something strange happened. She accidentally spilled some water into the cornstarch—the new substance she created was interesting, but now she doesn't know how to explain what state of matter it is in her description. Help Rachel decide if cornstarch is a liquid or solid by conducting your own investigation. Is it possible for this new solution to both a liquid and a solid?—you decide!

Your teacher prepared a mixture of cornstarch and water in a resealable plastic baggie. 60mL of cornstarch and approximately 30mL of water was placed in each bag.

Make a prediction. Is the new substance a liquid or a solid?

Observe and feel the mixture in the bags. Answer the following questions.

What happens to the mixture when you squeeze the bag?

What happens to the mixture when you let go?

Do you think this mixture is a solid or a liquid? Why?

Describe two ways in which the mixture is like a liquid.

Describe two ways in which the mixture is like a solid. If you wish, empty the contents of the bags into plastic trays. Feel the mixture and

describe its properties. Share your observations.

What did you conclude? Is the new substance a liquid or a solid? Be sure to note the

reasons why you gave the answer you did regarding whether or not you think the mixture

is a liquid or a solid.

Performance Task 1b:

Now it's your turn! Gather the following materials: 1 cup of cornstarch, 1 cup of water, ½ cup of cooking oil, and a resealable baggie. Experiment with adding portions of the cornstarch, water, and cooking oil into the baggie.

How has the texture of the new substance changed?

What happens when you squeeze the bag?

What happens to the mixture when you let go?

Do you think this mixture is a solid or a liquid? Why?

Describe two ways in which the mixture is like a liquid.

Describe two ways in which the mixture is like a solid. Can you think of an original way for this new substance to be used?

Performance-Based Assessment 2
Key Organizing Question: Can salt change the temperature at which something freezes?

Performance Task: Have you ever wondered why people sprinkle a salt substance on their sidewalks, driveways, etc. when it's icy? What is it about salt that can change solid ice to a liquid? Can something change the temperature at which something else freezes? Explore with salt and water mixtures to see if you can determine if salt will change the temperature at which water freezes. Good luck!

Make a prediction. Does salt change the rate at which water can freeze?

Keep in mind that water freezes at 0°C. Take one cup. Pour water to the fill line and add

four spoonfuls of salt.

Take the other cup and pour water to the fill line. Do not add salt.

Place the cups in the freezer. Set a timer for 2 hours.

Reflect. Do you think the cups will freeze at the same time? Explain your reasoning.

After 2 hours, check the cups. Observe the substances in the cups. Consider the following

questions.

Did the water freeze?

Did the salt and water freeze?

What did you conclude? Does salt affect the rate at which water freezes? Why?

What other purposes could salt be used for?

Grading Rubric: Corn starch + water exploration Name:

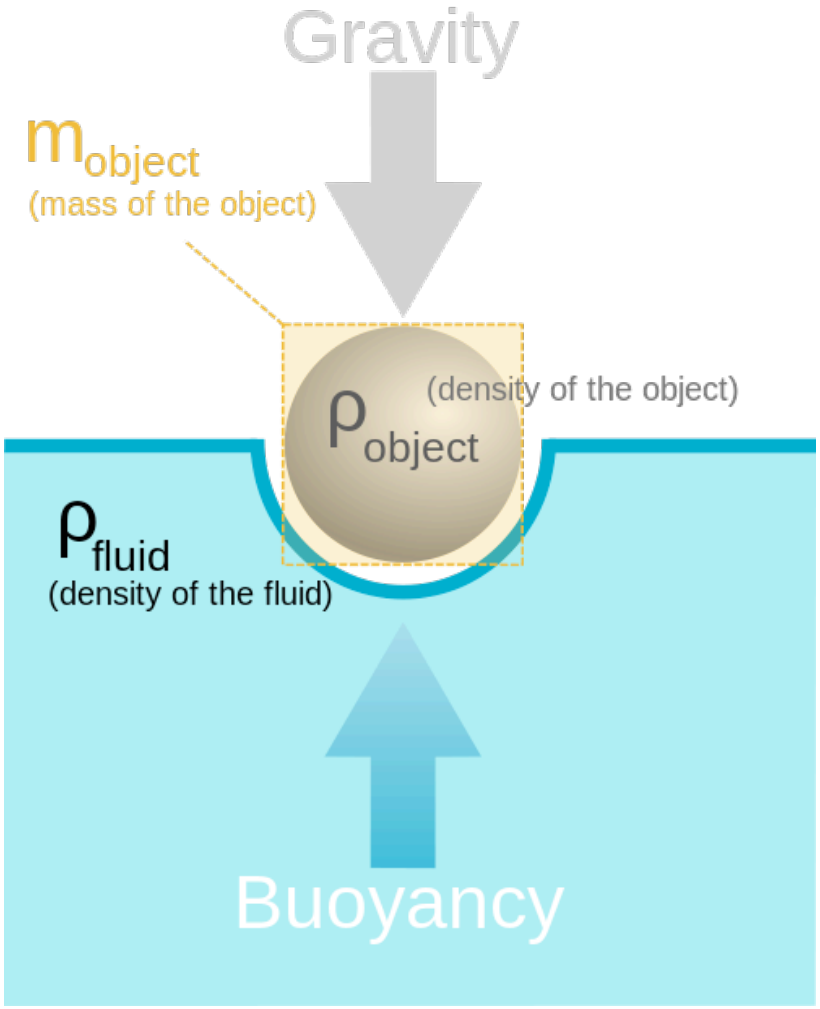
	Mastered (10/10)	Advanced (9/10)	Proficient (7/10)	Partially Proficient (6/10)	Unsatisfactory (5/10)
Neatness and Organization	All answers demonstrate careful attention to detail as described in "advanced." Student has gone above and beyond in terms of formatting and overall quality. Looks professional.	Answers are neat and organized with attention to detail. It is clear that the student has made an effort to make it easier to read (e.g. color coding, labeling.)	Answers are easy to read and follow. Ideas are organized.	Answers are partially organized, but there are sections that are difficult for a reader to understand or follow.	Answers are poorly organized and messy to the extent that is difficult to read.
Accuracy	All information in the answers are accurate. Additional information that was not required, but that is relevant is included.	All information in the answers are accurate.	All information in the answers are accurate, though some may be out of date.	Some information is out of date, not accurate or missing.	A substantial amount of the information is either missing or inaccurate.
Description of physical Features	Student clearly describes features and their relationship to one another.	Student clearly and accurately describes physical features.	Student describes some physical features.	Student lists physical features without descriptions or does not include all of the features.	Student does not describe or highlight physical features.

TOTAL: _____/30

Archimedes and the Golden Crown

Long long ago, a king named Hiero ruled the kingdom of Syracuse. After gaining power, the king wanted to pay tribute to the gods. He asked a goldsmith to craft a golden crown that he would place in a temple. He carefully weighed and gave a precise amount of gold to the goldsmith.
The goldsmith did an excellent job. He created a beautiful crown of golden leaves, and returned it to the king right in time. The king was very happy. He weighed the crown and saw that the weight was same as the gold he had provided.
Later on, however, the king began to suspect that the goldsmith had not used all the gold that he gave him, but had mixed in some less valuable silver while making the crown. The king, however, could not prove it.
King Hiero called upon his friend Archimedes to solve the problem. Archimedes was a genius. He began to think of a solution. He knew that gold and silver have different densities. This means that if you take similar-sized lumps of gold and silver, the lump of gold would be almost double in weight. Silver is much lighter than gold.
While he was still pondering on the matter, Archimedes went to a public bath to relax. When he stepped in the tub of water, he saw that some water spilled out of the tub. When more of his body sank in the tub, more water ran out. He realized then that the amount of water spilled must have exactly the same volume as his own body.
Suddenly Archimedes had a bright idea. As if a light bulb had flashed in his mind, he had a solution to the king's problem. He was so excited and happy, it is said that he started running home through the city streets before even putting his clothes back on, shouting "Eureka!" (a Greek word meaning "I found it")
Archimedes knew that the crown made by the goldsmith should displace the same amount of water as the amount of gold given to the goldsmith by the king, and not just weigh the same. The crown did have the same mass as the original gold, but if the volume was different, then the goldsmith would be proven a cheater.
For the king's second test of his crown's quality, he did not just weigh it to find out if it had the same mass as the original gold, but dropped it in water to see if the same amount of water spilled out. He filled up a vessel with water and dropped in the original gold amount, measuring the water that spilled out just like when Archimedes stepped in the bathtub. Then he filled the vessel again, dropped the crown in it, and measured the quantity of water lost that time.
Archimedes found that more water was lost with the crown than with the mass of gold of same weight. Thus it was concluded that the crown was not made of pure gold, but that some less dense, less expensive silver had been mixed in it. The goldsmith was punished for cheating the king. And Archimedes tried to remember to always put his clothes on before leaving the bathhouse from that day on.

Buoyancy is an upward force exerted by a fluid on an object in the opposite direction of the weight of that object. In a column of fluid, pressure increases with depth. This is because any fluid, liquid or gas, has mass, so the deeper you go the more weight you have pushing down on you due to gravity. Therefore a column of fluid, or an object submerged in it, experiences greater pressure at the bottom of the column than at the top. This difference in pressure results in a net force that tends to accelerate an object upwards- the deeper you go, the more pressure you have resisting your continued downward motion. For this reason, an object whose density is greater than that of the fluid in which it is submerged tends to sink. If the object is either less dense than the liquid or is shaped appropriately (as in a boat), the **buoyant** force can keep the object afloat!

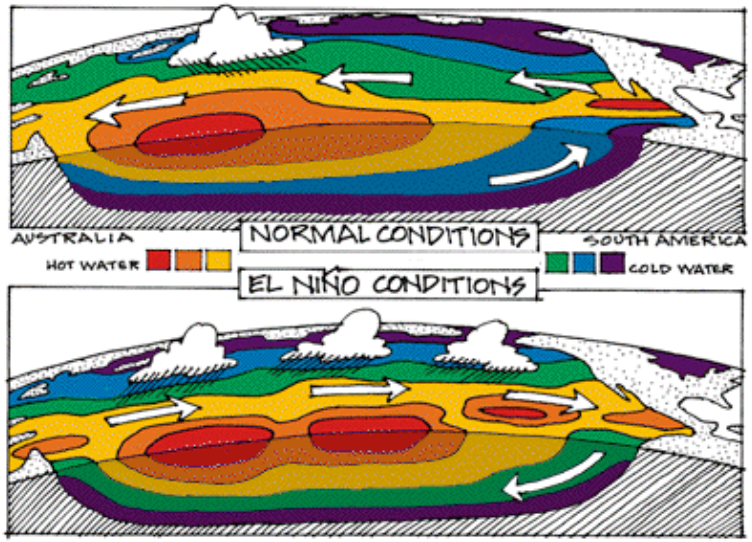


El Niño

El Niño is a climate pattern representing an unusual warming of the eastern tropical Pacific Ocean, which is linked to impacts on weather and climate patterns around the world.

Why do I care? El Niño affects areas all over the world through the warming of the Pacific Ocean. El Niño impacts include drought conditions, warmer or cooler than normal temperatures for different areas, precipitation pattern changes, and many other impacts which could all pose a threat for agriculture, animal and human health, and plant life.

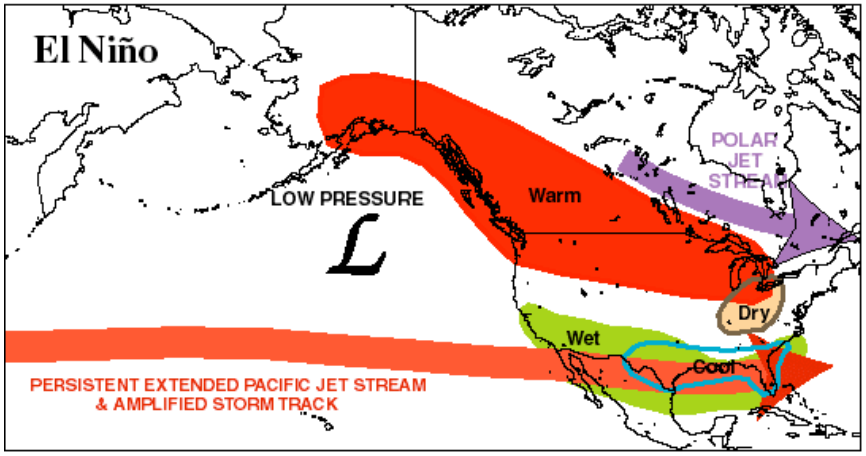
El Niño was first observed by Western scientists as an unusual ocean warming along the coasts of Peru and Ecuador in South America. The timing of this warming often coincided with the Christmas season, so it was called El Niño for the coming of the Christ Child. We now know that this pool of unusually warm water can shift atmospheric circulation patterns around the globe, leading to changes in temperature and precipitation in areas far away from the warm pool of water. Each El Niño event is a little different from the next, with variations in the timing of the warming and the position of the warmest water. ENSO, El Niño-Southern Oscillation, refers to the fluctuations in the temperature and pressure of the surface waters between the eastern and western tropical Pacific as part of the Walker circulation.



El Niño events typically occur every three to seven years and start when the trade winds blowing from the northeast, near the equator in the Northern Hemisphere, weaken. In a strong event, the winds can actually reverse and flow from the west. The trade winds weaken because the air pressure gradient between the eastern and western tropical Pacific decreases. As the winds die down, warm water from the western equatorial Pacific sloshes back towards South America, thickening the layer of warm surface water and cutting off the upwelling of nutrients from the deep ocean near Peru and Ecuador. This leads to the death of fish and the birds that feed on the nutrients, leading to economic impacts on commercial fishing and guano gathering for fertilizer from the nesting areas of the birds.

An area of thunderstorms and intense rainfall often accompanies the pool of warmest water, leading to changes in precipitation amounts along the South American coast. This causes flooding in western South America where it is usually dry and makes it excessively dry in the western Pacific where precipitation normally falls. All of these changes in the Pacific Ocean change the global atmospheric circulation, which in turn affects the weather and climate patterns all over the globe. Since the air flows unimpeded around the earth a shift in the atmospheric patterns at one location (similar to placing a large rock in a river) can lead to shifts in the flow of air and atmospheric patterns downstream. Figure B shows some of the known variability in climate associated with the occurrence of an El Niño episode.

In addition, the pool of warm water in the eastern Pacific ocean aids in the transfer of heat from this location. This also affects weather patterns all over the world. Areas usually receiving great amounts of rainfall could potentially dry out during an El Niño event and vice versa for other areas that are usually dry. Over the central Pacific Ocean, typhoons usually increase during strong El Niño events due to the ample supply of warm water at the surface. Since El Niño usually reaches its maximum strength in winter, El Niño has the strongest impacts on the weather in December, January, and February in the Southeast, although it can continue to impact weather regionally for several months.



The effects of El Niño also impact the location of the jet streams. The subtropical jet stream moves up into the southern United States during the winter months of an El Niño year. This jet brings warm, moist air into southern California. During the wintertime, southern California would then be mostly wet. South-central Texas and the southeast US will be mostly cool and wet because the cold, moist air from the Pacific Ocean entering the southern states enhances clouds and rainfall and cools temperatures due to lack of direct sunlight. In turn, much of the northern United States and Canada will be warm during an El Niño event because the polar jet stream swings farther east over the northeastern United States. For much of the southeastern United States during the summer of an El Niño event, the climate is usually warmer and drier. The strong subtropical jet stream also tends to disrupt the development of hurricanes in the Atlantic Ocean and Gulf of Mexico. Because of that, fewer hurricanes are likely during an El Niño year in the tropical Atlantic.