CaSTL

Investigating Surface Tension

Boys and Girls Club After School Science
NSF Center for Chemical Innovation
Chemistry at the Space Time Limit (CaSTL)
https://www.castl.uci.edu/

Standard(s) Addressed:

Students will explore properties of water and surface tension. After the lesson students will be able to describe properties of the surface tension of water and how the interaction of water molecules with itself and other molecules can create interesting observable effects.

Lesson Objective: The children will learn about surface tension, its definition and properties. Students will engage in a role play as water molecules attracted to each other modeling the effect of hydrogen bonding. Using substances like soap that disrupt the surface tension, students will explore ways to utilize materials that create interesting phenomena. Students will also understand when surface tension can be useful and when it is wanted and not wanted. They will extend their learning of surface tension by learning about creatures that take advantage of surface tension (water striders and water beetles.)

Materials Used:

- Water
- Aluminum pie plates/tins free of soap
- Soap
- Eye droppers/pipettes
- 3 to 5 gallon plastic bins for water tubs
- Index cards
- Scissors
- Plastic clear cups/tubs
- Wooden corks/wine corks
- Toothpicks
- Translucent wax/parchment paper
- Paper race tracks
- Pennies
- Metal aluminum pans/pie plates/aluminum chaffing pans (or plastic lunch trays) to catch water overflow

Student Talk Strategies Used:

Talk to your partner
Think/pair/share

Classroom Management:

Conversation: quiet indoor voices
Help: ask the teacher, ask helpers/volunteers
Activity: work with group of three or four children, brainstorm/answer questions
Movement: groups move from station to station
Participation: working well in groups, doing task, working cooperatively

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ENGAGE: ***Connect to Prior Knowledge and Experience and Preview New Vocabulary.*** **Estimated time: 10 minutes**		
Teacher's Role	**Teacher Questions**	**Children's Role**
Teacher tells children that they are going to investigate a property of water today but should first review the push & pull force.	See what the students recall from the previous lessons with forces (push & pull).	
Teacher will do a role-play with the students being water molecules. Their head is the oxygen and their two arms raised over their shoulders at the 105 degree angle are the hydrogen atoms. Have the students stand up and put their H arms near the O heads of their neighbor. Don't touch, just get near. Use an open space for them to be liquid water, moving, flowing, H is attracted to neighbor O. This is hydrogen bonding.	We are going to investigate the push & pull forces in water.	Students will participate in the role-play by being water molecules.
Teacher will want to introduce the concept of "Opposites attract and like repel." Reference to forces (push &	What happens between the H and O atoms as they get close to each other?	*"The H and O atoms attract/pull closer/stick together."*

pull) will help students grasp the idea.	What will happen if the H atoms get close to each other? What will happen if the O atoms get close to each other?	*"The H atoms repel/push away from each other."* *"The O atoms repel/push away from each other."*
EXPLORE: ***Hands-On Learning, Cooperative Learning, Check for Understanding*** **Estimated time: 20-25 minutes** **Description of Explore:** In small groups, students perform the investigations involving surface tension. They will determine if their predictions were correct and further investigate how surface tension can be utilized or removed to create desired effects. Staff members at each station ask questions to further children's understanding.		
Teacher's Role	**Teacher Questions**	**Children's Role**
Teachers demonstrate each station, help students perform the investigations, and ask relevant and probing questions. Teacher moves students along so that each group experiences each station. Station 1: Water droplets on a penny and cork in middle of water cup: Teachers will ask students to determine how many water droplets they can place on top of a penny using an eye dropper/pipette before they try the experiment.	Students, write your prediction for each station on the worksheet before doing the activity. Station 1: Your challenge today is to fit the most drops of water on a penny with out it spilling over. How many water droplets do you think will fit on top of the penny? Why doesn't the water slide off the penny? What keeps the water on top of the penny? What shape is the water that forms on top of the penny?	Students perform investigations and compare their findings to their predictions. Station 1: *"10, 50, 100, drops…"* *"The attraction of the water molecules for each other and the penny."* *"Gravity."* *"Push and pull forces."* *"A half ball or round shape."*

Station 2: Soap Boat Students will use corner sections of 3x5 index cards with small slots/notches cut in the middle of the corners. Have students predict what will happen to the paper boat when it is placed on top of the water. Have students predict what will happen to the boat when they place the soap drop behind the boat. When students are ready, have them place a single drop of soap at the notch of the index corner.	Station 2: Soap Boat Students, you will investigate what happens when you place a paper corner (boat) on top of water with and without soap. What will happen to the paper corner when we place it on top of the water? What will happen to the paper boat when we put the drop of soap behind it? Why does the paper boat behave the way it does when we add the soap to the water?	Station 2: Soap Boat *"The paper will float on top of the water."* *"The paper will sink."* ********after the soap****** *"It will sink."* *"It will shoot forward."* *"It will spin around in crazy circles."* *"The soap is disrupting the push and pull forces of the water molecules causing the boat to move all around."*
Ask students to predict what will happen if they continue to add soap after the first drop.	What do you think will happen if you added more soap to the boat? Will it cause the boat to move more/not much/not at all? Why?	*"The boat will move more if we add more soap after the first drop because there is more forces pushing on the water molecules to move the boat."* *"The boats will move very little because there is already soap in the water pushing on the water molecules. Adding more soap to the boats shouldn't make them move at all or even faster."*
Station 3: Racing water course Before students begin the race, have them predict what will	Station 3: Racing water course Write your prediction of what will happen to the water when	Station 3: Racing water course *"It will spread out."*

happen to the drop of water when placed on the wax paper. Place a drop of water on the wax paper and then have the students compare their answers.	placed on the wax paper. The water formed a droplet. Why do you think this happens?	*"It will form a smooth droplet."* *"The water likes to stick to itself."*
Now, have the students predict what will happen if I life the wax paper straight up and down (in a vertical direction).	What do you think will happen if you lift the wax paper up in a vertical direction?	*"The droplet will run off the paper."* *"The droplet will stick to the paper."*
Lift the wax paper.	Why does the water droplet stick to the wax/parchment paper?	*"The paper is sticky."* *"The paper is smooth so water likes to stick to it."*
A race course is drawn on a piece of white paper (two lines drawn in an S shape to provide a track with the Start and Finish clearly marked). Put translucent wax/parchment wax paper over the drawing. Each student at the station gets a race course. Have students create a 1 inch diameter bubble of water at the start of the race course. Make sure each student has the same number of drops. Each student is given a toothpick to drag the entire drop of water through the track. Whichever student gets to the finish first is the winner. BUT all the drop of water has to travel the course. Students should be monitored so no water is left behind and no shortcut through the track is allowed.	Now, you are ready for the race course. You can only use a toothpick to get your droplet of water across the finish line to win. All the drop of water has to travel and stay on the course.	

EXPLAIN: ***Listening, Speaking, Reading, and Writing to Communicate Conceptual Understanding*** **Estimated time: 10 minutes**

Description of Explain: Students regroup with the whole class to report their findings and explain what happened.

Teacher's Role	Teacher Questions	Children's Role
Teacher regroups the students and have them report what they did and what they observed at each station. Teacher has students explain what they think happened. Teacher records each group's response on 1 chart paper per station.	Station 1: Drops of water on penny Who had the most water droplets on their penny? Do you think the number of droplets each of you could place on the penny was similar or very different? What factors do you think caused all of you to have different answers/number of drops of water on your penny?	Station 1 *"We had similar number of drops."* *"We had very different number of drops."* *"The size of our drops was different."* *"Some of us counted the number of drops incorrectly."* *"Some of us tipped the pipette and some of us had our pipettes straight up and down."*
	Station 2: Soap Boat If you added more soap after the first time you added soap do you think the boats would keep moving/move faster? Why?	Station 2 *"Yes the boats would keep moving because adding more soap should make the boats go faster/adding a little soap made the boats go fast so adding lots more soap should make it go even faster."*
	Station 3: Racing water course What happened to the water when you placed it on the wax paper? Why were you able to drag the whole droplet of water along	Station 3 *"The water stuck to itself and formed a droplet."* *"It stuck to the wax paper."* *"Water likes to stick to itself."*

	the track? What can you say about water? Refer back to the students modeling a water molecules attraction to other water molecules.	*"As the water molecules is being pushed/pulled on the course, the H and O atoms move to stay attracted/pulled to each other."*
	Was it easy or hard to get the drops of water to move with you on the wax/parchment paper? Why do you think this is so?	*"Sometimes I pushed/pulled too fast and the droplet stretched out."* *"I had to slow down to get the whole droplet to the finish line because it stuck to the wax paper and would stretched out if I went too fast."*
Water molecules like to attract other water molecules close by and stick together. They can also attract to other objects that can disrupt the attraction of the water molecules for each other. When a water droplet is formed, the outer surface molecules have no other water molecules above it. This causes a stronger attractive force (push & pull forces) between the surface molecules called surface tension.	Can you rephrase your explanations using the new term: surface tension? Teacher provides a sentence frame for students to use at each station: "I think if I add ____ (write your maximum number) drops of water on a penny, the surface tension of the water will be the _____ (write strongest or weakest). But if I add more drops, then the surface tension will be _____ (write stronger or weaker)."	*"I think if I add 30 drops of water on a penny, the surface tension of the water will be the strongest. But, if I add more drops, then the surface tension will be weaker."*
	"I think the _____(name the object) disrupted the attraction between the water molecules making the surface tension _____ (write stronger or weaker)."	*"I think the soap/wax paper disrupted the attraction between the water molecules making the surface tension weaker."*

EVALUATE: ***Summarize Lesson and Review Vocabulary, Variety of Assessment Tools***
Estimated time: Throughout

Description of Evaluate: Evaluation will occur throughout the lesson and particularly during the explain component. Teachers should listen carefully to the conversations and presentations during the explain. Teachers should check for understanding throughout the investigations and explain.

Teacher's Role	Teacher Questions	Children's Role
Teacher will review what students had previously learned about surface tension. Teachers check for understanding.	What is surface tension?	*"Surface tension is the push/pull of water molecules against and towards each other."*
	How can we break the surface tension of water?	*"Using soap."*

EXTEND: ***Connections to Real World, Connections to Other Curricular Areas***
Estimated time: 5 – 10 minutes

Teacher's Role	Teacher Questions	Children's Role
Teacher shows students pictures of water striders or insects floating on top of water. Teacher asks students questions about what they notice about the insects and why they are able to float on top of the water.	Look at the pictures of the insects. What do you observe?	*"I see the water strider/insect floating on top of the water."*
	Why do you think the water strider/insect can "walk" on water?	*"Water striders use surface tension of water to float on the water."*
	Mosquitoes lay their eggs in water. When their eggs hatch, the larvae float on top of the surface.	
	After a recent rain, the county Vector Control came to put soap into some water in my backyard. Why do you think they did that?	*"To make the surface tension of the water weaker to make the larvae sink."*
	Note: An application of soap to create a fly trap is to use fruit juice or old fruit inside a cup with water and soap with a perforated plastic wrap on top to capture flies/fruit flies which will be attracted to the rotting fruit/juices and sink once they contact the soapy water.	

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Data Table to record observations in the investigations.

Station 1

1. How many water droplets do you think will fit on top of the penny? _____

2. How many droplets fit on the penny? _____

Station 2

Object	Prediction: Will it sink or float? Something else?	Observation: Did it sink or float? Something else?
Paper corner (boat)		
Paper corner (boat) with 1 drop of soap		
Paper corner (boat) with several drops of soap		

Station 3

1. What do you think will happen to the water when placed on the wax paper?

2. What happened to the water placed on the wax paper?

3. Will it be easy or hard to move the water through the race course? Why?

Summary

I think if I add _____ (your maximum number) drops of water on a penny, the surface tension of the water will be the _____ (strongest or weakest). But if I add more drops, then the surface tension will be _____ (stronger or weaker).

I think the _____(name the object) disrupted the attraction between the water molecules making the surface tension _____ (stronger or weaker).