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Measuring Surface Tension (Method 1)

Instructions: During this activity, you will be measuring the surface tension of water and water with a surfactant added to it. In the first part of the activity, you will be building a balance, consisting of a weigh basket, base, balance beam, and trough. In the second part of the activity, you will be conducting trials to measure the surface tension of both liquids.

Part 1: Building the Balance

Materials	
• 3 18 oz. plastic cups • 1 small weigh boat • 1 spool of thread • 1 sewing needle • 2 small wooden dowels (e.g., chopsticks)	• 1 pair of scissors • 1 utility knife • 1 permanent marker • 1 ruler with units in centimeters

Make the weigh basket:

1. Take the weigh boat and poke a hole through each corner using the sewing needle.
2. Measure 20 cm of thread and cut. Repeat one more time.
3. Insert one piece of the string from the top of one of the holes in the weigh boat and thread it through from the bottom of the adjacent hole. Repeat this with the remaining string and holes.
4. Take the four loose ends and tie them together at the top.
5. Make sure all strings are equally taut so the basket will not hang unevenly.
6. Cut off unnecessary thread.

Make the base:

1. Using two plastic cups, measure 2.5 cm up from the bottom and make a mark with a permanent marker.
2. Use a knife or other tool to make a cut on the mark of each cup. (Note: A wooden dowel needs to be able to fit securely in this opening, so make sure it is not too small or big.)
3. Take one of the dowels and, using the ruler, find the approximate middle of the dowel.
4. Use the knife to cut a v shape into the dowel, on the mark you just made. (Note: Make sure to not cut the v so deep that you cut entirely through the dowel.) This will be the fulcrum of the balance.
5. Flip the two cups upside down.
6. Insert the dowel from Step 3 into the openings cut into the cups.
7. Insert so that the cut out of the dowel is approximately in the middle between the two cups and is facing upward.

Make the trough:

1. Take the remaining plastic cup that has not been altered.
2. Measure 5 cm from the top using the ruler and make a mark with the permanent marker.
3. Make 2-3 additional marks around the cup at the same length.

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4. Connect these measurements and use this line as a guide to cut the cup. This will be your vessel for your liquid.

Make the balance beam:

1. Measure the length of the needle in mm and write that measurement in the Data Sheet below.
2. Measure out 15 cm of thread and cut.
3. Tie one end of the string to the middle of the sewing needle.
4. Tie the other end of the thread around one end of the remaining wooden dowel, 2 cm from the edge.
5. The remaining assembly for the balance will be done right before conducting the trials.

Part 2: Conducting Surface Tension Trials

Materials	
• Finished components of the balance • clay • tape • water, preferably distilled • 2 g SLSA powder • electronic balance	• weigh boat • spoon or stirring rod • graduated cylinder • 1 mL bulb pipette • permanent marker • paper towels

Setup:

1. Use the graduated cylinder to measure out 100 mL of water.
2. Pour this water into the trough.
3. Place the balance beam on the fulcrum of the base. The middle of the balance beam should be resting on the fulcrum.
4. Hold the balance beam so that it is lying flat and one end of the balance beam is not higher than the other.
5. Place the trough under the needle attached to the balance beam. The needle needs to be able to rest on the surface of the water.
 - a. If needed, wrap the string around the balance beam until the needle is able to rest on the surface and the string is not loose. If you have to adjust the length of the string, use a small piece of tape to secure this position.
 - b. If wrapping the string around the balance beam is still not giving the right length, remove some of the water from the trough with the pipette.
6. Attach the weigh basket to the opposite end of the balance beam. Gently adjust the position of the basket till you are able to let go of the balance beam and everything stays in place and the balance beam is even. You may need to add small pieces of clay to one end or the other to serve as a counterbalance. Double-check these conditions before moving on:
 - The needle is resting on the surface of the water.
 - The string attached to the needle is taut, not loose.
 - The balance beam is resting on the fulcrum of the base and is even.
 - The weigh basket is attached to the other end.

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- Everything can stand on its own without needing to hold onto it.
7. Once the balance is set up, use a permanent marker to mark where the balance beam sits on the fulcrum and where the basket is attached to the balance beam. These markers are important, as you should set up the balance by these measurements for each trial.

Conduct Trials With Water:

1. Make sure your balance is set up according to the instructions above.
2. Pour 10 mL of water into the graduated cylinder.
3. Put the end of the pipette above the middle of the weigh basket.
4. Slowly add water into the weigh boat one drop at a time, making sure to count how many drops of water are added. Do not touch any part of the balance or shake the surface it is sitting on.
5. Continue to add water into the weigh boat one drop at a time until the weight of the water pulls the needle from the surface of the water.
6. Record the number of drops on your Data Sheet.
7. Dump out the water in the weigh basket and wipe the basket dry with a paper towel.
8. Set the balance back up according to the instructions above and repeat the trials until you have completed the Data Sheet below.

Conduct Trials With the Surfactant:

1. Use the electronic balance, weigh boat, and spoon to weigh out 2 g of SLSA powder.
2. Pour this powder into the 100 mL of water in the trough and slowly mix with the spoon until the powder is dissolved. Mix slowly to avoid creating a lot of bubbles in the mixture.
3. Set up the balance as described above. You may need to adjust the amount and/or position of the clay counterbalance to ensure that the balance beam is even, and the needle is resting at the surface of the water.
4. Conduct the trials as explained above and fill in the Data Sheet below for the surfactant trials.

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Data SheetLength of needle: _____ mm $\times$ 0.001 = _____ m

Water Trials	Force Calculations
Trial 1	_____ drops of water $\times$ 0.05g = _____ g $\times$ 0.00981N/g = _____ N
Trial 2	_____ drops of water $\times$ 0.05g = _____ g $\times$ 0.00981N/g = _____ N
Trial 3	_____ drops of water $\times$ 0.05g = _____ g $\times$ 0.00981N/g = _____ N
Trial 4	_____ drops of water $\times$ 0.05g = _____ g $\times$ 0.00981N/g = _____ N
Trial 5	_____ drops of water $\times$ 0.05g = _____ g $\times$ 0.00981N/g = _____ N

Water Trials	Surface Tensions Calculations ($S=F/2d$)
Trial 1	_____ N / 2 $\times$ _____ m = _____ N/m
Trial 2	_____ N / 2 $\times$ _____ m = _____ N/m
Trial 3	_____ N / 2 $\times$ _____ m = _____ N/m
Trial 4	_____ N / 2 $\times$ _____ m = _____ N/m
Trial 5	_____ N / 2 $\times$ _____ m = _____ N/m

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Surfactant Trials	Force Calculations
Trial 1	_____ drops of water x 0.05g = _____ g x 0.00981N/g = _____ N
Trial 2	_____ drops of water x 0.05g = _____ g x 0.00981N/g = _____ N
Trial 3	_____ drops of water x 0.05g = _____ g x 0.00981N/g = _____ N
Trial 4	_____ drops of water x 0.05g = _____ g x 0.00981N/g = _____ N
Trial 5	_____ drops of water x 0.05g = _____ g x 0.00981N/g = _____ N

Surfactant Trials	Surface Tensions Calculations ($S=F/2d$)
Trial 1	_____ N / 2 x _____ m = _____ N/m
Trial 2	_____ N / 2 x _____ m = _____ N/m
Trial 3	_____ N / 2 x _____ m = _____ N/m
Trial 4	_____ N / 2 x _____ m = _____ N/m
Trial 5	_____ N / 2 x _____ m = _____ N/m

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Reflection Questions

1. Based on what you know, what is *expected* to happen to the surface tension of the water when the surfactant is added?
2. What *actually* happened when you ran your trials?
3. If your results do not match what you expected, what might have gone wrong (i.e., what are some potential sources of error in the experiment or procedure)?
4. If your results matched what you expected, what do you think helped you achieve these results (i.e., which specific steps in your experimental procedure or setup do you believe were most crucial to achieving accurate results)?

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