



S T E M

CHALLENGE

Featuring

Bubbles



Created by Teachers Are Terrific

Teacher Background



Kids love bubbles! This STEM Challenge has elements of fun, but it's also a great design and building challenge.

The Engineering Design Process has many steps and so many opportunities for students to engage in group problem solving and collaboration. The learning goes well beyond Science, Technology, Engineering, and Math. Group dynamics, determination, and critical thinking are all a part of STEM challenges.

This STEM Challenge will have your students exploring with a bubble solution. The Exploration or Imagining stage of the process includes trying to create bubbles in specific ways and learning how to manipulate the bubble solution. The design challenge is to create a working bubble wand from given materials and create the largest bubble possible.

The designs made by bubbles are fun to watch as they happen and your students will be so creative in how they create multiple bubble structures. Their bubble wands made of supplies you gather will be tested and rebuilt and tested again. Best of all, the kids will think it's all just fun!

Students will follow the steps of the Engineering Design Process for this challenge. Procedures for the teacher are marked with the steps of the process as well as the student lab sheets. It includes the chance to plan independently and then present the ideas to the team. Students will choose which design or combinations of designs might produce the best bubble wand. Designing, building, testing, and improving are all part of this task!

This package is intended to give you a list of materials, preparation ideas, and then step-by-step procedures to make this a successful event. It includes helpful hints and organizational tips to also give you some expectations and possible ways to use the challenge. Alter the procedures and events in any way you need to in order to suit your age level and student population. We loved this challenge! We enjoyed our bubbles and made some very creative bubble wands!

This challenge packet is presented in two files. **File 1** includes the teacher directions, science explanation, photos, lab sheets, hints, extension ideas, and a scoring rubric. **File 2** contains editable forms.

Materials and Prep

MATERIALS:

For Exploring you will need:

- Distilled water
- Dish soap (Dawn or Joy without any extra ingredients)
- Glycerin
- Lids to containers (round lids, like the tops to Play doh containers) (1 per student) or small bowls
- Straws (enough for each student)
- Towels
- Cups (1 for each group)
- Copies of lab sheets

For Designing you will need:

- Bubble Solution
- Lids to containers, small bowls, or small pans
- Supplies for bubble wands (pipe cleaners, tape, binder rings, paper or plastic cups, rubber bands, etc.)
- Straws (enough for each student and for building the wands)
- Towels
- Cups (1 for each group)
- Copies of lab sheets

Hints from my experience with using this challenge are embedded throughout the Teacher's Guide. Your event will differ, of course! Tips are meant to help you and let you know of things that did or did not work!

PREPARATION:

BEFORE CLASS:

- A day ahead of using this challenge mix up your bubble solution. (See the Recipe page)
- Group your students. (I used this challenge with groups of 3.)
- Copy a lab sheet or create your own method of recording. I have provided 2 versions of lab sheets in this packet. Each is two pages. I have used both sets. The first set (pages 17-18) has samples added to the teacher directions. The second set (pages 19-20) has a sample answer guide. The answers are a compilation from my students and are provided for your reference. Your answers will vary. You can also alter the wording on the lab sheets by using the editable files.
- Create a Challenge Constraints chart to display. I have provided one you can use with your document camera/projector. You can also try the editable file for this form.
- Assemble your supplies for the experimenting session and for the design challenge. (See the next page for Hints about Design Challenge Supplies.) Determine a way to display the supplies. I used a large round table and just spread everything out.
- Plan for this to take one long class session or two sessions.

Please take a look at the next page in this file. The page is devoted to the materials needed for this challenge and some things we tried that worked well.

There are also tips and more information included with the sections about the bubble experiments. These items are purposely placed within the teacher directions as a guide for you!

Supply Hints



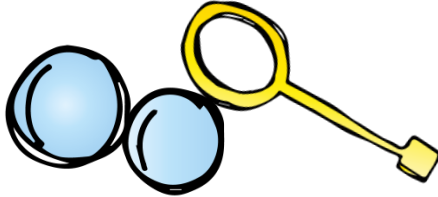
- **SUPPLIES-** Regular tap water can be used, but I used distilled water. I purchased a gallon jug at Wal-Mart for \$.88. Every source I found for a bubble mixture said to use Dawn or Joy dishwashing soap *without* any extra cleaners. Just look at the label and don't get anything that says Ultra or Extra. This was actually hard to find. I bought Dawn Simply Clean. Glycerin can also be purchased at Wal-Mart or a drugstore. At Wal-Mart I found it in the Band-aid aisle for about \$4.00. The small bottle is all you will need.
- **LIDS-** The lids I used for the kids to pour solution into were lids to plastic containers. I have also used petri dishes. Other lids to consider- play-doh cans, baby food jars, any container or jar, really. However, the solution can be poured right onto desks and tables and bubbles blown right off the table top!
- **PANS-** The pans we used for the design challenge are small aluminum pans (4.5 inch diameter). These could also be used instead of lids to containers in the exploring parts of this challenge. Small plastic or foam bowls will also work fine.
- **WHY USE A SHALLOW CONTAINER FOR THE SOLUTION?** Students were given a container of bubble solution and a lid or very shallow container to pour the solution into as they worked on blowing bubbles. There is a very simple 'kid' reason for this. When they spill that shallow container trying to get more solution onto their straws or bubble wands it will not waste as much as a large container! (And, they will spill it!)
- **DESIGN CHALLENGE SUPPLIES:** I went through my science lab cabinets and the craft aisle at a local store to find a good array of things students could use. This included: wide rubber bands, pony tail bands, washers, binder rings, metal key rings, straws, pipe cleaners, several sizes of paper cups, and plastic canvas. (see Photos) The plastic canvas was, by far, the most interesting supply. I found these in the sewing department of the local Wal-Mart. They come in many shapes. I got a pack of 10 for about a dollar. Almost all of these supplies are reusable! Paper cups and pipe cleaners are not! Kids asked if they could use masking tape. I allowed it but we quickly discovered that wet tape doesn't stick very well. This was a great learning experience for them! We also discovered that paper cups get soggy after a few uses and may even come apart. Again, this was a learning experience. You can use plastic cups, but I chose paper thinking that it would be easier to cut. If you use plastic cups, have kids use caution when trying to make a hole in the cups. Hole punchers might work for them!

Bubble Recipe

1. Pour 6 cups of water into a container.
2. Add 1 cup of dish soap and stir gently. You don't want to make bubbles yet!
3. Add 1-2 tablespoons of glycerin and stir gently again.

This solution can be used immediately, but making it the evening before using it will give the ingredients time to really activate.

There are many things you can use for the bubble wand your students will use for exploring. We used straws!



SCIENCE of BUBBLES

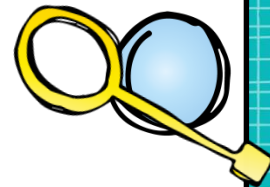
The outside of a bubble is actually made of three thin layers. The layers are soap, water, and more soap. This layering is called soap film. The width of these layers is about the thickness of a wavelength of light. Most of the light passes through the soap film, but some is reflected. That reflected light is what creates the rainbow colors of a bubble.

Bubbles pop for several reasons. One is that the water will end up at the bottom of the bubble due to gravity- thus creating a thinner film which pops easily. Another is due to evaporation of the water creating a thinner film. And, of course, anything touching the bubble can make it pop. However, if the object you touch to a bubble is wet the bubble might be less likely to pop.

Adding glycerin will increase the viscosity of the water (its ability to flow). You can also add corn syrup which doubles the sugar content and decreases evaporation.



Teacher Directions



INTRODUCTION

DISCUSS: If this is your first STEM challenge you may want to talk about ways engineers work and describe some things that have been invented by someone trying to solve a problem. Think about the nightlight some students may have in their bedrooms or hallways. Why do they have that light? It was to solve the problem of someone being frightened of the dark, but not wanting to leave a lamp or large light on all night. The nightlight provides just the right amount of light! An engineer thought of that solution and then invented it!

Introduce this task by talking about bubbles and what they are made of. (see Bubble Recipe page for more information) You can even create a class chart (KWL) of what kids know or think they know about bubbles.

PROBLEM/ASK

Talk with students and identify the problem to be solved in this challenge. You can provide them with a stated problem or have them brainstorm the wording. Example:

After experimenting with bubbles, design and use materials to make a bubble wand that creates the best bubbles.

Students will need the lab sheets you have chosen to use. The first version (pages 17-18) starts off with a question/problem to be solved already written for them. This is the beginning of the Engineering Design Process. We always start with a question or problem to set a purpose for the task. Samples from student sheets are also sprinkled throughout this package – in lieu of separate answer sheets. If you use the second set of lab sheets (pages 19-20) students will need to write the question that is being asked in this challenge.

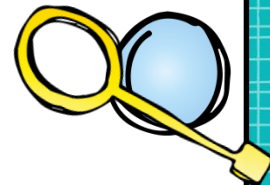
ANSWERS: In most of my STEM packages I provide a sample student answer sheet that is created by writing compilations of answers from my classes. That is included in this package, however, for the last several challenges we have undertaken I have used samples from actual lab sheets to share student answers with STEM challenge products. I have included photos of actual student sheets and have written out their words. In some cases you are seeing more than one student answer and their actual drawings. My goal is to give you a better visual and some expectations of how my students use the lab sheets.

EXPLAIN: Tell your class about the activity. Each group will need a cup of bubble solution, each student will need a straw and small round lid or container, and towels. Have students pour some bubble solution into the lids or containers and use the straw to blow and explore. Allow them to explore for a few minutes. Then begin the collection of data.

*Just a note: Allowing time to "play" will get everyone accustomed to using the straw as a blowing wand and it always helps to let this play happen. Once you get started on the actual experimenting, students should be encouraged to not blow bubbles in this playful manner.



Teacher Directions



EXPERIMENT 1: After students have had a chance to use the bubble solution and straw tell them they will have a few minutes to blow large bubbles and observe the bubbles. You can even let them know they will have to do some writing! After exploring for the few minutes you allow have them add some writing to the lab sheet describing what happens and anything they are learning during this exploration.

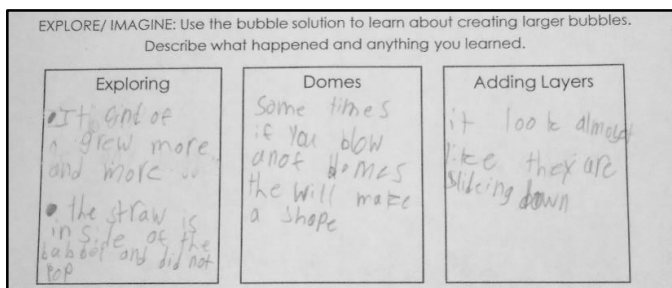
EXPERIMENT 1 Tips: While blowing the solution with straws students may find that a large bubble will suddenly begin to branch off into different "rooms". These begin to have a geometric shape other than round and may appear to have flat sides. Of course, you will also have students that just blow into the solution creating tiny bubbles.

EXPERIMENT 2: After recording observations on the lab sheet briefly talk about forming a large dome with the bubble solution right on the tabletop. Talk about what happens when you have to take a breath and then continue to blow. As students explore with this they should also record what is happening on their lab sheets. After enough time for all to experience the larger dome bubbles record observations and move on to the next experiment.

EXPERIMENT 2 Tips : The larger domes require some patience from the kids. Blowing slower and more gently will create the larger bubbles. Some things we observed: if you stop blowing to catch your breath, the bubble will sometimes deflate, when you resume blowing a new "room" may appear, bubbles will begin to attach to the sides, and will sink to the bottom of the dome quickly, and if you do this close to someone else the bubbles will grow together into a large bubble structure!

EXPERIMENT 3: Talk about adding layers to the domes. Can students remove the straw from a dome and blow another dome on top of the first? What happens? Can they blow a bubble inside a dome? What happens? They should try and then record what happens on lab sheets.

EXPERIMENT 3 Tips: You can remove the straw from a dome and reinsert it. We dipped our straws into bubble solution to do this and when you continue to blow, a bubble will form inside the larger bubble. If you remove the straw you can blow a new large bubble on top of the dome bubble so that it resembles a snowman. However, this bubble will quickly drop to the bottom of the dome.



Exploring: "It kind of grew more and more."

Domes: "Sometimes if you blow enough domes they will make a shape."

Adding Layers: "It looks almost like they are sliding down."



Teacher Directions



EXPLORE/ IMAGINE: Use the bubble solution to learn about creating larger bubbles.
Describe what happened and anything you learned.

Exploring	Domes	Adding Layers
<ul style="list-style-type: none"> bubbles are connected each blow is different 	<ul style="list-style-type: none"> They form bubbles inside domes stick on other domes 	<ul style="list-style-type: none"> they rolled over the side you need a straw to keep it from falling

Exploring: "Bubbles are connecting. Each blow is different."

Domes: "They form bubbles inside. Domes stick on other domes."

Adding Layers: "They rolled over the side. You need a straw to keep it from falling."

I did find that stopping to write was a good thing. This is a very exciting challenge and the lab sheet kept us focused and thinking. It is, of course, totally optional for you to have students use a different recording method.

EXPLAIN / IMAGINE

Finally, it's time for the design challenge! Discuss the task with students. They will be designing and building a bubble wand. Share the constraints of the task to use as they plan. Students will also need the list of supplies that will be used so they may sketch ideas with this in mind.

Although students are working within a group the next task is an independent one. **Each** student will now sketch his or her idea for the bubble wand. Sketches need to be labeled. After completing the sketch students need to write reasons their own idea is the best for the team.

INDEPENDENT DRAWINGS: For a long time I had groups discuss ideas and then choose a design. The one thing I heard repeatedly was from kids who did not feel they were being heard. The idea of having students **each** draw and write reasons their idea is best was born from that dilemma. This gives every student a voice! They all draw an idea and write why it will work. This makes them much more conscientious about their idea and then when the group talks everyone presents his/her idea. When the team chooses what to do it is almost always a joining of the ideas!

PLANNING: Sketch **your** idea for the building a bubble wand. Label materials.

Why is **your** idea the best for your team?
it has layers and a long handle I think it will work

"It has layers and a long handle. I think it will work."

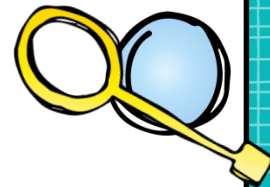
PLANNING: Sketch **your** idea for the building a bubble wand. Label materials.

Why is **your** idea the best for your team?
it might blow a lot of bubbles because it has small holes

"It might blow a lot of bubbles because it has small holes."

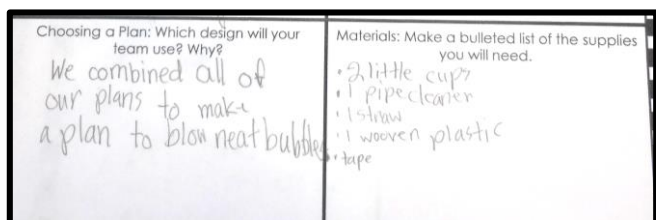


Teacher Directions

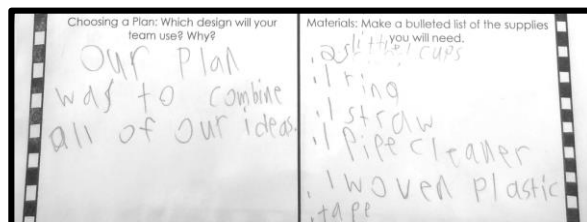


CREATE

When everyone completes the sketching and writing, the students need to talk! You may want to show them how to turn their papers to each other, look at the sketches, and then tell about their idea and why it is best. After all of the team members have had a turn the team makes a decision. They can choose one idea or combine ideas for their final bubble wand design. The lab sheet has a place to write about this decision and why it was made. The groups also need to make a list of the items they will specifically need to build the bubble wand.



"We combined all of our plans to make a plan to blow neat bubbles."



"Our plan was to combine all of our ideas."

BUILD AND TEST

As groups are ready they will visit the supply station to collect what they need. There is a purpose for having a "shopping list." It limits the amount kids can get and holds them to following their plan. (The shopping list is on the lab sheet- students make a list of the materials they will need.)

GATHERING SUPPLIES: One thing I have found in doing design challenges with students is that they will gather some of everything and often more than they will need. With this challenge I decided to hold them to their thinking and planning. So, when students arrived at the supply station and grabbed 15 pipe cleaners I asked questions about their planning. Did their plans include using that many? If I did not get answers that supported the amount of supplies they were gathering I sent them back to their planning! When they had a plan ready they could return and get *what they needed* and not just an endless supply.

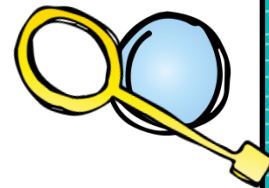
When the supplies are ready it's time to build a bubble wand. They will test as they build and revise their wand as they test it. You will have to decide if they can revisit the supplies after they discover there are problems. I did not allow this until later – during the Improving part of this challenge.

CLOSING THE SUPPLY STATION: On the same note- I closed my supply station after every team visited. I did this to make them use their plans! I discovered it made students rethink and redesign using what they had rather than giving up and getting more items! This is all optional for use of this design challenge.

TESTING: During the testing time students used small metal pans for dipping the wand into the bubble solution. This proved to be a problem as some of the wands would not fit in the pan. I learned to caution other groups to plan for a size requirement.

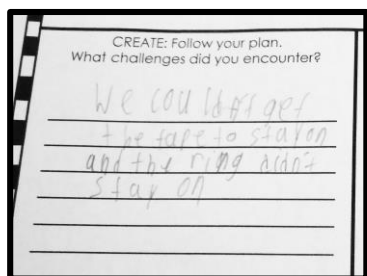


Teacher Directions

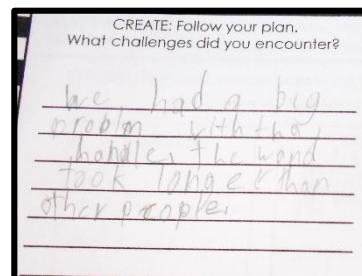


IMPROVING DURING BUILDING

One step of the Engineering Design Process is Improving the model. With this challenge (as with many challenges) I found that improvements take place as the students work. Their idea doesn't work as expected and they make quick modifications. It is interesting to stop your class and have each group report on one problem encountered and how it was solved. By having a class discussion of problems you will have the added bonus of helping groups that are struggling. The lab sheet has a place for students to write about the problems and solutions encountered.



"We couldn't get the tape to stay on and the ring didn't stay on."

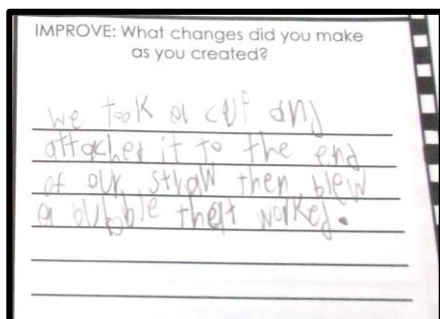


"We had a big problem with the handle. The wand took longer than other people."

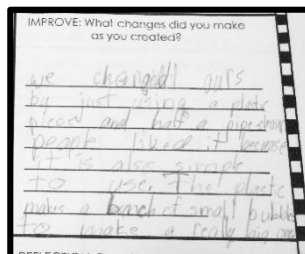
PRESENTATIONS

Each group needs to share the bubble wand, how they made it, how it works, and anything else they need to say. After each has shared (and it is possible that a group won't have a wand that works) offer them the opportunity to revisit the supplies and make improvements. Having seen other wands they may have new ideas!

After these final improvements have been made, share again! The lab sheet has places to record what improvements were made. In addition, students will draw their final bubble wand and write about their success or lack of.



"We took a cup, attached it to the end of our straw. Then blew a bubble and it worked."



"We changed ours by just using a plastic piece and half a pipe cleaner. People liked it because it is also simple to use. The plastic makes a bunch of small bubbles to make a really big one."

CLEAN UP- We poured unused solution back into containers to use with other groups or to save. Each group had a towel and wiped down the table tops. I later sprayed the tables with a cleaner and re-wiped them as the soap film can be gummy.



Teacher Directions



FINAL LAB SHEETS

CONCLUSION
Describe and draw your final bubble wand.

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Describe and draw your final bubble wand.

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Describe and draw your final bubble wand.

REFLECTION: Describe your success, or lack of success, with this challenge and why it occurred. Explain what you learned.

I learned that if you keep trying and try you get what you want, and my team worked together a lot.

"I learned that if you keep trying and try you get what you want. And my team worked together a lot."

REFLECTION: Describe your success, or lack of success, with this challenge and why it occurred. Explain what you learned.

We had success because we had teamwork.

"We had success because we had teamwork."

Extensions

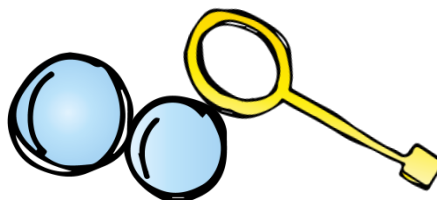


Just a few things to try that will add to this bubble experience!

- Try this activity with a budget. Set a price for each supply and have students design the bubble wand and stay within a budgeted amount. (I did this with a boat building activity and the kids loved it!)
- Try having students draw a bubble wand blue print and require they build the wand exactly like the blueprint. This is actually eye-opening. Some further reading about drawing blueprints might be inspired by this. Kids will get interested in this topic based on drawing their own. (Mine love the word "blueprint".)
- Another twist to a STEM challenge is to have a group sketch a blueprint and then have every group trade papers. You have to build the one you get! This makes everyone more conscious of drawing correctly and labeling every part of their sketches.
- Repeat this challenge, but add a requirement that every supply must be used in the final version. (This will eliminate those bubble wands made from only a bent pipe cleaner!)
- Offer some unusual items for blowing bubbles- like a tube sock stretched over the end of a water bottle. Cut the bottom off the water bottle first! This makes a long steady stream of bubbles that resembles a beard. (I would do this outside!) Some other things to try: PVC Pipe in different diameters, PVC Pipe with holes drilled through it, window screen, waxed paper with holes in it.
- After completing this challenge and using some unusual items to make bubbles, have students look around home and bring in items to try!
- Fill a small plastic pool with bubble solution and use a hula hoop as the bubble wand. When you do this the students actually stand in the middle of the hula hoop and when they pull up on the hoop it creates a bubble around them!
- Make a cube from pipe cleaners. Before twisting the corners completely together slide a straw onto each length of pipe cleaner for extra support. Dip the cube into bubble solution and when removed it will create a square bubble. Blow a bubble into the center of the cube to see what happens. Also, blow through the cube to see what happens.

Constraints of the Bubble Wand Task:

- You may use only the supplies provided.
- You may cut the cups and pipe cleaners. Ask before you cut any other supplies!
- You may use masking tape.
- Your goal is to build a bubble wand that will work successfully and be easy to operate.
- The bubble wand should have a way to hold it.

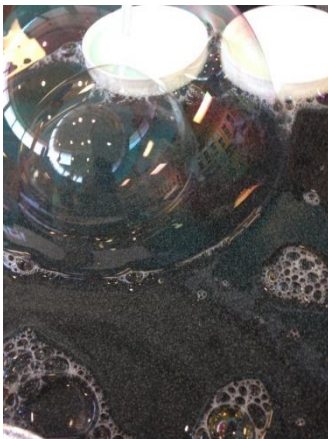
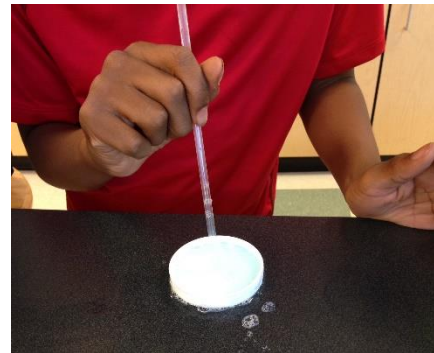


Photographs

SUPPLIES



EXPLORING



You can see the plastic lids we used in these photos. For the bubble solution I used a plastic beaker. A foam or plastic cup would work fine!

Photographs

EXPERIMENTS



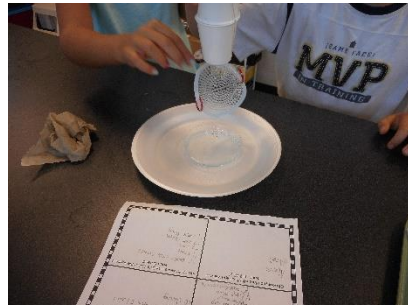
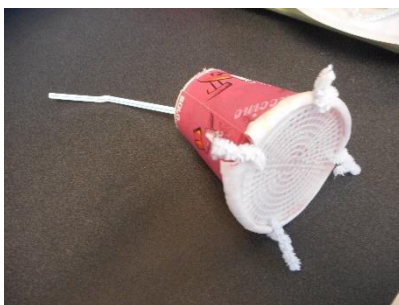
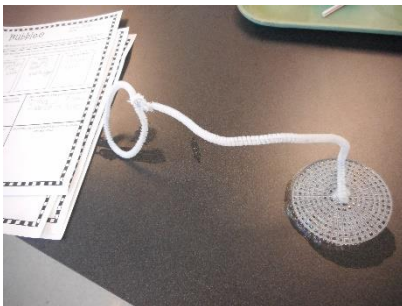
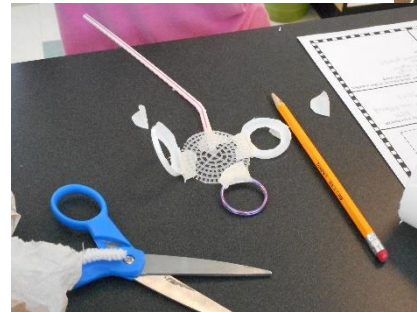
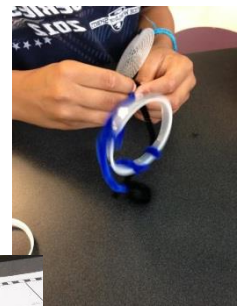
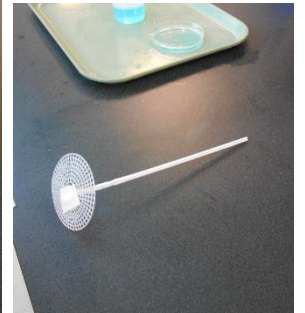
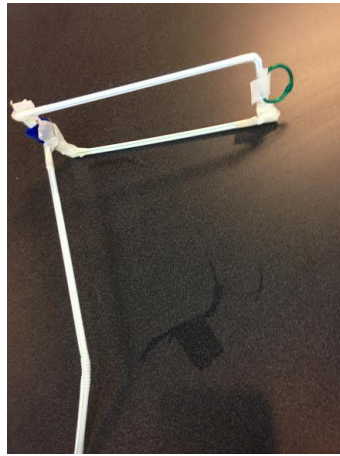
Expect some spilling and mess- we tried using real towels, plastic trays, and lots of paper towels.

BUILDING WANDS



Photographs

FINAL BUBBLE WANDS



Bubbles

Name _____

Date _____

ASK/ PROBLEM to be Solved: After experimenting with bubbles, design and use materials to make a bubble wand that creates the best bubbles.

EXPLORE/ IMAGINE: Use the bubble solution to learn about creating larger bubbles. Describe what happened and anything you learned.

Exploring

Domes

Adding Layers

PLANNING: Sketch **your** idea for building a bubble wand. Label materials.

Why is **your** idea the best for your team?

Choosing a Plan: Which design will your team use? Why?

Materials: Make a bulleted list of the supplies you will need.

Bubbles

Name _____

Date _____

CREATE: Follow your plan.
What challenges did you encounter?

IMPROVE: How did you improve your
bubble wand?

CONCLUSION
Describe and draw your final bubble
wand.

REFLECTION: Describe your success, or lack
of success, with this challenge and why it
occurred. Explain what you learned.

Date

STEM Challenge With Bubbles

Name

ASK: What is the question to be answered with this challenge?

EXPLORE: Use the bubble solution to learn about creating larger bubbles.

Describe what happened and anything you learned.

EXPLORE DOMES: Use the bubble solution to learn more.

Describe what happened and anything you learned.

IMAGINE: How can you add layers to your dome?

Describe what happened and anything you learned.

STEM Challenge- Page 2

PLAN: BUILDING A BUBBLE WAND

What supplies will you try and what design are you considering to build the ultimate bubble wand?

List of Supplies

Planning

Steps to Take

CREATE: Describe and draw your final bubble wand.

CONCLUSION: How did your bubble wand work? How did you test it? Did you make any improvements as you built it?

REFLECTION: Describe your success, or lack of success, with this challenge and why it occurred. Explain what you learned.

Date _____

STEM Challenge With Bubbles

**POSSIBLE
ANSWERS**

ASK: What is the question to be answered with this challenge?

How can we design and use materials to make a bubble wand that creates the best bubbles?

EXPLORE: Use the bubble solution to learn about creating larger bubbles.

Describe what happened and anything you learned.

We learned that we could blow bubbles with just a straw and right off the table. The bubbles would get a lot bigger than we thought and we could see a rainbow moving.

EXPLORE DOMES: Use the bubble solution to learn more.

Describe what happened and anything you learned.

When we stopped blowing inside a big bubble and then started again another bubble would form inside. The bubbles would move and join together and make shapes.

IMAGINE: How can you add layers to your dome?

Describe what happened and anything you learned.

We blew a big bubble and then tried to make another one on top of it. This works for just a minute and then the top bubble will slide down the side.

STEM Challenge- Page 2

POSSIBLE ANSWERS

PLAN: BUILDING A BUBBLE WAND

What supplies will you try and what design are you considering to build the ultimate bubble wand?

List of Supplies

2 pipe cleaners
2 paper cups

Planning

Wind the pipe cleaners around the paper cups. This will be the handle and the cup opening will be where the bubbles make.

Steps to Take

Cut a hole in the bottom of the cup. Wind the pipe cleaner around the cup. Add another pipe cleaner for the handle.

CREATE: Describe and draw your final bubble wand.

The bubbles were larger than we thought they would be. It worked well until the cup got soggy.

Drawings will vary

CONCLUSION: How did your bubble wand work? How did you test it? Did you make any improvements as you built it?

The bubble wand worked great at first. The bubbles were hard to make because we had to blow softly. Then the cup got soggy and wouldn't stay in shape. We would use a plastic cup if we did this over. The pipe cleaner was a good choice.

REFLECTION: Describe your success, or lack of success, with this challenge and why it occurred. Explain what you learned.

Our bubble wand was successful because it did work. We had really big bubbles, but not the biggest in the class. We learned that paper cups will get too soggy to use. We worked together the whole time.

Bubbles Scoring

1= Unsatisfactory 2= Needs to Improve 3= Good Effort 4= Outstanding Effort

Personal Score	1	2	3	4
I experimented with the bubble solution and tracked my thinking on the lab sheet.				
I had a job during the building of the bubble wand. My job was _____.				
I helped solve problems while we made the bubble wand.				
I took part in the improving step and the presentation of our bubble wand to the class.				

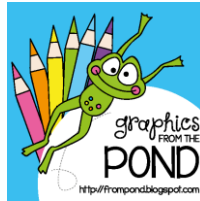
Team Score	1	2	3	4
The team worked well together. We experimented and then decided on a design for the wand.				
The team used problem-solving skills to improve the bubble wand.				
The rules of the task were followed. We used our materials wisely.				
The bubble wand was completed successfully. This includes the building and working together.				



If you have any questions or concerns, please email me at teachersareterrific@gmail.com.

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