



GIRLS PURSUING SCIENCE

EXPERIMENT GUIDE

A GIRL'S GUIDE TO SCIENCE, TECHNOLOGY, ENGINEERING, **ART** & MATH

Discovering STEAM & Loving it!

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A Girl's Guide to Science, Technology, Engineering, Art & Math... Discovering STEAM & Loving it!

www.girlspursuingscience.com

Printed in United States



GIRLS PURSUING SCIENCE

Dedications & Credits

It is only fitting that I dedicate the start of a new chapter of Girls Pursuing Science to the people who laid its foundation.

A special thanks to the sold out inaugural GPS Charlotte Summer Academy and staff. Ms. Shannon Woodson and Chinyere Williams, you rock!

To my friend and colleague, Dr. Rutha Carr and the Education Support Systems staff, (Leland High School), words are not adequate for the trust and loyalty you showed when GPS was just a figment of my imagination. Dr. Carr, you are the best!

Jacquelyn Thomas

GPS Founder

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INTRODUCTION

A Girl's Guide to Science, Technology, Engineering, Art & Math

A Girl's Guide to Science Technology, Engineering, Art & Math... Discovering STEAM & Loving It! is designed to make girls think, create, and lead! Follow this GPS standards-based curriculum and learn how to:

- ◆ Apply real world applications to Chemistry, Technology, Math, Art and Engineering
- ◆ Create your own Bath and Body Products
- ◆ Create an Advertisement
- ◆ Develop a Business Plan
- ◆ Prepare your Pitch

The Beauty of STEM (B.O.S.) Curriculum was designed especially for girls! Through fun and engaging activities, you will laugh and learn your way to the mastery of business, science and math, while experimenting with safe ingredients and real scientific tools. The scientific tools are attractive and designed to motivate girls to continue discovering, exploring, and finding careers in science, technology, engineering, and math.

The B.O.S. Curriculum includes ingredients and tools to make 11 professional grade cosmetic products:

- | | | |
|----------------|----------------|---------------|
| ◆ Bubble Bath | ◆ Soap Jellies | ◆ Shampoo |
| ◆ Bath Fizzies | ◆ Soap Crayons | ◆ Conditioner |
| ◆ Perfume | ◆ Lotion | ◆ Spritzer |
| ◆ Lip Balm | ◆ Eyeshadow | |

Other activities includes a fun lesson on reverse engineering - how to “knock off” a product, entrepreneurship, planning and budgeting, advertising, marketing, and storyboarding.

A Note to Students

Your Beauty of STEM (B.O.S.) kit is designed to make you a boss! You will have fun enriching your STEM skills, making cosmetics and learning how to sell them.

The B.O.S. kit includes everything that you need to extend your learning beyond the classroom! You will learn how to make cosmetic products which are safe, smell good and feel great on your skin. The curriculum is divided into three categories: STEM, STEAM, and Entrepreneurship.

The STEM section includes an activity, a pre-lab activity, hypothesis, and data collection.

In the STEAM section, you will do an activity for each category: Science, Technology, Engineering, Art, and Math.

The Entrepreneurship activities include business development activities which are designed to teach you how to save, grow, and manage your money into wealth.

Each section ends with an analysis and conclusion. This is a place where you can reflect back on what you have learned so when you get ready to make the product again, you will have detailed notes on what worked and what did not.

Salli, Chien, Valeri, and Antonia will be your guides in all of the B.O.S. activities. Each of these brilliant young scientists specialize in a different area of STEM. They will share their experience and insight on concepts that you may not yet have covered in school. The GPS scientists are very smart, pretty, and love making their own bath and body products!

For now, let's learn more about Salli, Chien, Valeri, and Antonia.

GIRLS PURSUING SCIENCE



Meet the GPS Scientists



Salli

Lab Scientist

Lab scientists play a crucial role in how to perform experiments that yield valuable scientific information. Salli will make sure you understand the procedures to be followed when completing the experiments.

Chien

Chemist

As a chemist, Chien performs experiments that deal with mixing chemicals and creating new products. Chien will help you understand more about the chemistry involved in your B.O.S. experiments.

Valeri

Physicist

Valeri enjoys doing experiments, making observations, developing theories, and using math to solve problems. Valeri will lead you throughout the pre-lab activities while exploring the beauty of mathematics.

Antonia

Research Scientist

As a research scientist, Antonia's primary job is to discover information about the materials, ingredients and procedures used during the experiments. Antonia will guide you through your own research when completing your B.O.S. experiments!



Safety Tips

- ◆ **Read** through ALL the steps before you start. We know that it is tempting to start with the procedure section where the products are made; however, if you understand the science behind the product, you can make a perfect product.
- ◆ **Read** the notes and follow the GPS Scientist's advice.
- ◆ **Before** you begin making your product, clean (sanitize) your work area. Wipe your work surface with a light cleaning solution or use a sanitized wipe.
- ◆ **Gather** all of your ingredients before you start making your product.
- ◆ The fragrance oil in your kit is **highly concentrated**. Always start with a small amount and add additional amounts until you are satisfied.
- ◆ The gel colorant is very concentrated. **Stir** until all of the colors are well blended. You will know that your product is well blended if you do not see any streaks.
- ◆ You may **measure your ingredients** by weight using a digital scale or by using measuring spoons and cups.
- ◆ Before reusing your pipettes, wash them in warm soapy water.
- ◆ If you do not understand some of the words or math process, research for the answer. Research is a key component of science.

The Beauty of Bubble Bath



Background Information

Research Activity

Great scientists like to know as much information as they can about their topic before they start their experiments. Use the questions below to guide your research on how bubbles form. This will help you to understand the science behind your product! You can use sources such as a dictionary or trusted science education websites on the Internet (with your teacher's permission, of course) and books from the library.

? *Question 1: Define the word "bubble."*

? *Question 2: How do bubbles form?*

? *Question 3: What is a preservative? Give two examples.*

Pre-Lab Activity: The Beauty of Mathematics

Before we began making bubble bath, we must complete the **formulation**.

A formulation is like a recipe the chemists follow in order to create their product. As a GPS chemist, you will need to edit the formulation below to make your bubble bath unique - like you!

Let's start with the **additives**, or the ingredients added to preserve or enhance the product. The fragrance oil, preservative and colorant are additives. You can add as little as 1% or as much as 4% of the additives to your product. The higher the percentage, the stronger the additive will be. For example, if you would like your bubble bath to have a strong fragrance, add 4% fragrance oil. If you are looking for a more mild scent, try 2%, and for a very light scent, try 1%. We suggest starting with 1% and increasing the amount by 1% until the desired fragrance is reached.

☑ **Predict:** What will happen to the color of the bubble bath if the percentage of the colorant is increased to the maximum 4%?

☑ **Calculate:** If you add 4% of colorant to 2 oz of soap base, how many teaspoons (tsp) of colorant will be added to your soap base?

- (a) .36 tsp (b) .48 tsp (c) .12 tsp (d) .24 tsp

☑ **Answer:**

1. **Convert oz to tsp:** 2 oz = 6 tsp
2. **4% of 6 tsp:** $.04 \times 6 = .24$ tsp
3. **Answer:** .24 tsp

☑ **Choose the amount of fragrance oil and colorant (additives) you will be adding to your soap base mixture using the reference chart below.**

% of Additive Desired	Milliliters (mL)	Tsp (tsp)	Pipette Drops (drops)
1%	0.6 mL	.12	12
2%	1.2 mL	.24	24
3%	1.8 mL	.36	35
4%	2.4 mL	.48	47

Example: I will use 2% of the fragrance oil, which is equivalent to .24 mL / tsp / drops.

I will use _____ % of the fragrance oil, which is equivalent to _____ mL / tsp / drops.

I will use _____ % of the colorant, which is equivalent to _____ mL / tsp / drops.

Hypothesis

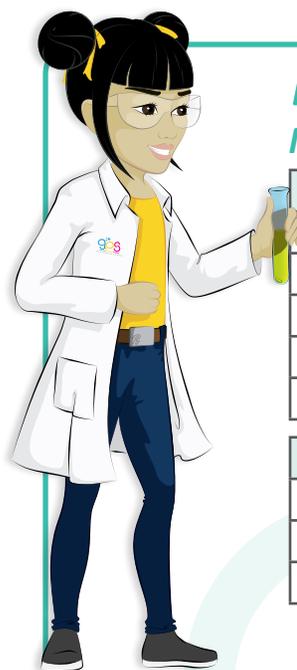
A **hypothesis** is a prediction that scientists make based on their research and prior knowledge. Based on the background information and research you have completed, write a hypothesis about changing the formulation for the fragrance oil and the colorant.

! To write like a GPS scientist, use the following format to guide you:

If I add more **fragrance oil** to my bubble bath, **then** my bubble bath will _____, **because** _____.

! **Hypothesize:** Write your own hypothesis for adding more or less colorant below.





Let's Make Bubble Bath!

Materials

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
Safety Glasses	1	GPS Lab Jacket	1
Pipette	1	Paper Towels	As needed
Product Bottle	1	Gloves	2
Stirrer	1	Beaker or Bowl	1
		Funnel (optional)	1

INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
Soap Base	15 mL (½ oz)	Distilled Water	30 mL (1 oz)
Fragrance Oil	1% - 4%	Salt (Preservative)	0.62 mL (¼ tsp)
Colorant	1% - 4%		

NOTE!

The materials list and formulation are for each person. If you are working in a group, multiply the quantity by the number of girls in your group!

Procedure

NOTE!

*Use caution when using the ingredients in your kit.
Be careful not to make any spills.*

DO NOT INGEST ANY OF THE INGREDIENTS!

Step 1: Read through all of the steps **before** you begin.

Step 2: Clean off your work surface and put on your safety glasses and your GPS Lab Jacket to protect your face and clothing.

Step 3: Gather all of your **ingredients** and **materials** (see list above) and arrange them in the order that they will be used.

NOTE!

Do not start making your product before you have all ingredients, supplies and equipment in front of you!

Step 4: Slowly pour 15 mL (½ oz) of the **Soap Base** into your **beaker**.

Step 5: Use a **pipette** to add _____ mL of **fragrance oil** to the Soap Base.

NOTE!

The amount of fragrance oil used is based on the percentage of oil you calculated in the pre-lab.

Step 6: Stir the mixture **slowly** until mixed well.

Step 7: Add 29.6 mL (1 oz) of **distilled water** and stir **slowly** until mixed well.

NOTE!

Make sure to stir SLOWLY or the mixture will result in too many bubbles!

Step 8: Add 0.6 mL ($\frac{1}{8}$ tsp) of salt as a **preservative** and stir slowly until mixed well.

Step 9: Measure out the amount of colorant you decided to use.

NOTE!

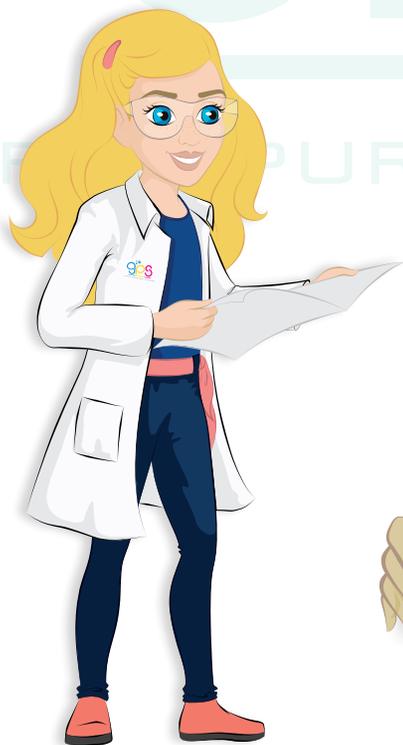
The amount of colorant used here is based on the percentage of oil you chose in the pre-lab.

Step 10: Using your pipette, add 1 tiny drop of **gel colorant** and stir until there are no visible color streaks. Add tiny drops until you have reached your desired color.

Step 11: Stir your mixture for about 2 - 3 minutes using gentle agitation with your stirrer.

Step 12: Fill your **bottle**. Screw on the cap.

DONE!



Analysis and Conclusion

After completing an experiment, scientists ask themselves questions in order to see what they have learned about their topic. Answer the following questions about your experiment in creating your own bubble bath.

? **Question 1: Did your bubble bath product turn out the way you wanted it to? Why or why not?**

? **Question 2: Describe how “bubbly” your bubble bath product is. Can you think of a way to make your product more “bubbly”?**

? **Question 3: Why is it important for scientists to follow procedures in the correct order? Explain the possible errors that could occur if they do not follow the procedure.**



The Beauty of Bath Fizzies



Background Information

Research Activity

Great scientists like to know as much information as they can about their topic before they start their experiments. Use the questions below to guide your research on how Bath Fizzies create fizz. This will help you to understand the science behind your product. You can use sources such as trusted websites on the Internet (with your teacher's permission, of course) or books from the library.

? **Question 1: Explain what a "Bath Fizzy" does to enhance the bath.**

? **Question 2: What is a chemical reaction? Give two examples.**

? **Question 3: What is the pH scale?**

Pre-Lab Activity: Reading a pH Scale

The pH scale is a scale from 1 - 14 that helps scientists to determine how acidic or basic something is. When acids and bases are combined, chemical reactions can occur and can sometimes be dangerous. Scientists test the pH before working with certain chemicals in order to determine the acidity level. A chemical with a pH of below 7, such as lemon juice or vinegar, is an **acid**. A chemical with a pH above 7, such as baking soda or bleach, is a **base**. A neutral pH is about 7, which is typically the pH of water.

☑ **Apply:** Sort the chemicals below into **ACID** or **BASE** groups according to their rating on the pH scale.

lime juice (pH 2)
coffee (pH 5)
bleach (pH 9)

vinegar (pH 3)
rain water (pH 5.5)
baking soda (pH 8)

dishwasher detergent (pH 12)
citric acid (pH 2.2)
cornstarch (pH 5)

ACIDS (pH < 7)	BASES (pH > 7)

Hypothesis

A **hypothesis** is a prediction that scientists make based on their research and prior knowledge. Based on the background information and research you have completed, write a hypothesis about what might happen when you combine an acid and a base.

! To write like a GPS scientist, use the following format to guide you:

If (I do something), then (what will happen) because (explain how you know).

! **Hypothesize:** Write your own hypothesis for combining an acid and a base together.

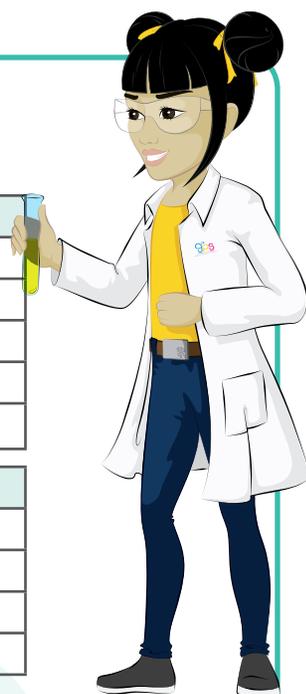


Let's Make Bath Fizzies!

Materials

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
Safety Glasses	1	GPS Lab Jacket	1
Pipette	1	Measuring Spoons or Scale	As needed
Stirrer	1	Paper Towels	As needed
1.5 oz Portion Cups	3	Small Bowls	2
		Large Container	1

INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
Sodium Bicarbonate	3 oz	Distilled Water	$\frac{1}{8}$ tsp
Citric Acid	1.5 oz		
Fragrance Oil	1% - 4%		
Colorant	1% - 4%		



NOTE!

The materials list and formulation is for each person. If you are working in a group, multiply the quantity by the number of girls in your group!

Procedure

In this experiment, you will make three Bath Fizzies. The Bath Fizzies will be used to demonstrate a chemical reaction taking place between the different ingredients within the Bath Fizzy. Two of the Bath Fizzies will be used to test the formulation. Take the third Bath Fizzy home and use it in your bath water!

NOTE!

Use caution when using the ingredients in your kit.

DO NOT INGEST ANY OF THE INGREDIENTS!

Step 1: Read the entire procedure **before** you begin.

Step 2: Clean off your work surface and put on your safety glasses and your GPS Lab Jacket to protect your face and clothing.

Step 3: Gather all of your **ingredients** and **materials** (see list above) and arrange them in the order that they will be used.

NOTE!

Do not start making your product before you have all ingredients, supplies, and equipment in front of you!

Step 4: In one small bowl, combine the dry ingredients (sodium bicarbonate and citric acid) and stir together with your stirrer.

Step 5: In the second bowl, combine the wet ingredients (fragrance oil, colorant and distilled water) and stir until well mixed.

NOTE!

Before reusing your pipettes, wash in warm soapy water to clean and remove the oils from them.

Step 6: Use your pipette to gradually add a few drops of the wet mixture to the dry mixture. (You will record your observations in the data chart on the next page).

Step 7: If your mixture began to fizz, quickly stir the mixture. This should stop the fizziness. Continue to stir the mixture with your stirrer or use your fingers (with gloves on) to press out the clumps. As you add the wet mixture, stir, stir, and stir. Continue to stir the mixture until all the clumps are out.

Step 8: To test the consistency of your mixture, take a small amount in between two fingers and squeeze it together. It should stick together in one chunk. If it is still too powdery to hold together, just add a drop of the wet mixture and mix until it does hold together in one chunk.

Step 9: Fill the portion cups with the bath fizzy mixture. Use the back of a spoon or your thumb (with gloves) to pack the mixture into the portion cups. Pack the mixture as you pour it in the portion cups. Pack the cups as tightly as you can.

NOTE!

The challenge to making Bath Fizzies occurs when the wet and dry ingredients are combined. If your fizzy mixture appears to be expanding after you fill your portion cup or appears puffy, you have added too much water to the wet mixture. If so, we have included enough of each ingredient to start another batch. Start with Step 4 and use less water in your formula.

Step 10: Set the compacted portion cup to the side in a dry area at normal room temperature. Let it sit for about an hour to dry and harden.

NOTE!

If your fizzy is very crumbly, your recipe may not have had enough water. To fix this, remake the fizzy and use a little more water.

Step 11: After letting the Bath Fizzy harden, remove the fizzy from the cup by turning the cup upside down on a flat surface and pressing the bottom of the cup with your thumb. The Bath Fizzy should pop out.

NOTE!

When you make additional fizzies, you may store them separately in plastic baggies or airtight containers. Another great idea is to place them in your bathroom, away from the water flow. It's convenient for when you are ready to take a bath. They also make great air fresheners. If you decide to make them as gifts or to sell, wrap them in cellophane or tissue paper.

DONE!

Analysis and Conclusion

After completing an experiment, scientists ask themselves questions in order to see what they have learned about their topic. Answer the following questions about your experiment when creating your own Bath Fizzy.

? **Question 1:** *When creating your Bath Fizzy, you created a chemical reaction. Describe the reaction and explain what caused it.*

? **Question 2:** *Test one of your Bath Fizzies by dropping it in an 8 to 10 oz container of cold water. Test the second Bath Fizzy by dropping it in an 8 to 10 oz. container of hot water. Write a hypothesis about the effect of water temperature on the fizziness of your Bath Fizzy.*

? **Question 3:** *Why is it important for scientists to follow procedures in the correct order? Explain the possible errors that could occur if they do not follow the procedures in the correct order.*

Data Collection

While performing experiments, scientists collect data along the way. They do this in order to go back and understand what the data is telling them about the lab. During your lab experiment, be sure to collect data when prompted.

PROCEDURE STEP/QUESTION	OBSERVATION
Analysis Question 1: What happened when you added drops of the wet mixture to the dry mixture?	
Analysis Question 2: What happened when you dropped the fizzy in cold water?	
Analysis Question 3: What happened when you dropped the fizzy in hot water?	

The Beauty of Perfume



Background Information

Research Activity

Great scientists like to know as much information as they can about their topic before they start their experiments. Use the questions below to guide your research on the art of making perfume. This will help you to understand the science behind your product. You can use sources such as trusted websites on the Internet (with your teacher's permission, of course) and books from the library.

? Define the word "volatility".

? Why would volatility be important when creating a perfume?

? Question 3: What is an essential oil?

Pre-Lab Activity: The Beauty of Fragrance

The secret to making perfume lies in the percentage of fragrance contained in the entire mixture. Different percentages of fragrance create different products. Analyze the chart below and answer the questions that follow.

PRODUCT	PERCENTAGE OF FRAGRANCE	AMOUNT
Eau de Toilette	15 - 18 %	5.3 - 6.6 mL (1 - 1.3 tsp)
Eau de Parfum	19 - 22 %	7.0 - 8.5 mL (1.4 - 1.7 tsp)
Perfume	23 - 28 %	9.0 - 11.7 mL (1.8 - 2.4 tsp)



Infer: Based on your definition of “volatility”, which fragrance is the most volatile and why?

Choose the amount of fragrance oil you will be adding to your perfume mixture using the reference chart above.

I will use _____ % of the fragrance oil, which is equivalent to _____ mL or _____ tsp.

Hypothesis

A **hypothesis** is a prediction that scientists make based on their research and prior knowledge. Based on the background information and research you have completed, write a hypothesis about changing the formulation for the fragrance oil.

! To write like a GPS scientist, use the following format to guide you:

*If I add more **fragrance oil** to my perfume, **then** my perfume will be _____, **because** _____.*

! **Hypothesize: Write your own hypothesis for changing the volatility of your perfume.**



Let's Make Perfume!

Materials

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
Safety Glasses	1	GPS Lab Jacket	1
Pipette	1	Paper Towels	As needed
30 mL (1 oz) Mist Spray Bottle	1	Gloves	2
		Beaker	1

INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
Perfumers Base	30 mL (1 oz)		
Fragrance Oil	15% - 28%		
Colorant	Tiny drop		

NOTE!

The materials list and formulation is for each person. If you are working in a group, multiply the quantity by the number of girls in your group!

Procedure

Step 1: Read the entire procedure, all 8 steps, before you begin.

NOTE!

Use caution when using the ingredients in your kit.

DO NOT INGEST ANY OF THE INGREDIENTS!

Step 2: Clean off your work surface and put on your safety glasses and your GPS Lab Jacket to protect your face and clothing.

Step 3: Gather all of your **ingredients** and **materials** (see list above) and arrange them in the order that they will be used.

NOTE!

Do not start making your product before you have all ingredients, supplies, and equipment in front of you!

Step 4: Waft all of the fragrance oils towards you in order to get an idea of which scent you would like for your perfume.

Step 5: Choose which fragrance oil you will use. Choices include:

- ◆ Strawberry
- ◆ Japanese Cherry Blossom
- ◆ Pink Sugar

Step 6: Pour 1 oz of the perfume base into a beaker. Add your chosen amount of fragrance oil (one pipette drop at a time). Refer to the table in the pre-lab activity for the quantity of fragrance oil for your product.

Step 7: Add a tiny drop of gel colorant if desired. Start with one drop. You will add more gradually until you get the color you want.

Step 8: **Slowly** pour the mixture into the mist sprayer, screw on your fine mist sprayer and shake well to mix.

ENJOY!

Analysis and Conclusion

After completing an experiment, scientists ask themselves questions in order to see what they have learned about their topic. Answer the following questions about your experiment in creating your perfume.

? **Question 1: Did your perfume product turn out the way you wanted it to? Why or why not?**

? **Question 2: Perfume is usually made with an essential oil, water, and alcohol. What do you think is the purpose of the alcohol in the mixture?**

? **Question 3: Based on what you know about chemical reactions, explain why perfumes smell differently on each person.**



The Beauty of Lip Balm



Background Information

Research Activity

Great scientists like to know as much information as they can about their topic before they start their experiments. Use the questions below to guide your research on the composition of lip balms. This activity will help you to understand the science of creating attractive and effective lip balms. You can use sources such as trusted websites on the Internet and books from the library.

? *What is the purpose of lip balm?*

? *List at least 3 ingredients of lip balm?*

? *Question 3: Who was Max Factor? What was his birth name?*



Pre-Lab Activity: What is lip balm made of?

Lip balms are one of the most frequently used cosmetic products on the market. Lip balms are also very complex products which require the perfect formulation of ingredients to create the desired consistency. The ratio of ingredients controls the form and solidity of the lip balm. Typically, creamier lip balms contain more oil and the harder lip balms contain more wax. Other added ingredients, like fragrance, are very important and must be used with caution. Girls naturally like to make products that smell good; however, the fragrance and flavor properties are combined. Therefore, the chemist must create a formulation that balances scent and taste.

The base ingredients of lip balm are: **oils**, **butters**, **fragrance**, **wax**, **colorant**, **emollients**, **emulsifiers** and **preservatives**.

However, the secret to creating the perfect lip balm is creating the perfect formulation of these ingredients.

☑ Complete the table below, filling in the blank columns.

◆ Ingredients

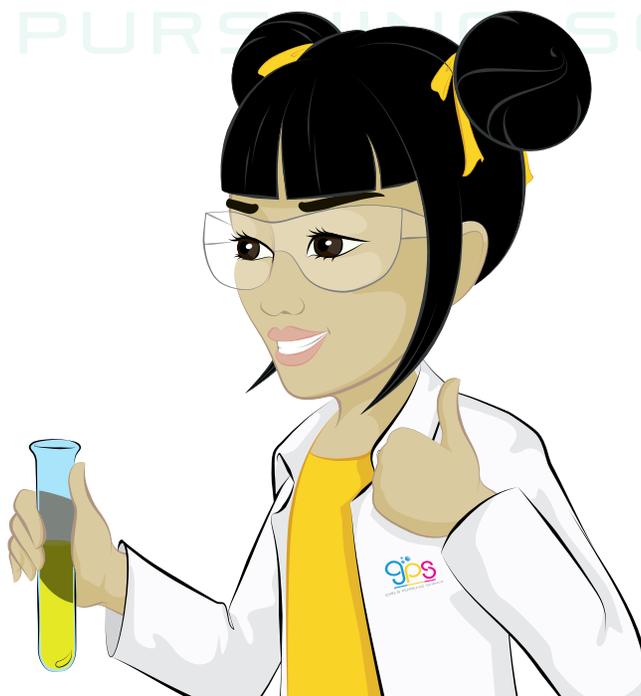
Relatively few ingredients are required to make the perfect lip balm. Each ingredient contributes to the way the balm tastes, feels, and how long it lasts. In the “**INGREDIENT**” column is a list of the typical ingredients of a lip balm. Review each ingredient and complete the “**PURPOSE**” and “**SOURCE**” columns in the table.

◆ Purpose

How does lip balm stay on your lips and prevent chapped lips? It is the chemistry behind the ingredients. Before you begin making lip balm, you must research and understand the ingredients that are used to make lip balm and why we use them. In the column labeled “**PURPOSE**,” write the purpose of the ingredient. Example: oils (thick sticky liquids such as olive or coconut oil) usually have a soothing effect and moisturize the lips. Use a dictionary or trusted cosmetic chemistry education websites to complete this column in the table.

◆ Source

Write the source next to the purpose. “Source” means where you got your information. Example: “encyclopedia” or if you researched the information online, list the name of the website.



☑ Complete the table below. Fill in the blank columns.

INGREDIENT	PURPOSE	SOURCE
Oils	<i>Thick sticky liquids such as olive or coconut oil have a soothing effect and are used to moisturize the lips.</i>	www.beautyofstem.com
Butters		
Fragrance		
Wax		
Colorant		
Emollients		
Emulsifiers		
Preservatives		

Hypothesis

A **hypothesis** is a prediction that scientists make based on their research and prior knowledge. Based on the background information and research you have completed, write a hypothesis about what you think will happen to the final product if you use too much of a certain ingredient. Write a hypothesis with your predictions.

! To write like a GPS scientist, use the following format to guide you:

*If I add more **fragrance oil** to my perfume, **then** my perfume will be _____, **because** _____.*

! **Hypothesize: Write your own hypothesis for mixing too much oil, fragrance, and wax in your lip balm.**

Let's Make Lip Balm!

NOTE!

Your container for the lip balm measurement is only 2mL or 0.07 oz. Therefore, it will only hold slightly less than ½ tsp of lip balm. For that reason, it is best to work as a group to complete this activity.

Materials

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
Safety Glasses	1	GPS Lab Jacket	1
Lip Balm Containers (2 mL)	2	Measuring Cup	1 oz
Pipette	1	Mixing Container	1
Stirrer	1	Paper Towels	As needed
		Refrigerator	1
		Heating Source (microwave, hot plate, etc.)	1
		Thermometer	1

INGREDIENTS IN YOUR KIT	FORMULATION
Lip Balm Base	1 oz per group of 15
Flavor oil	1-2 drops per oz

Procedure

NOTE!

Use caution when using the ingredients in your kit.

DO NOT INGEST ANY OF THE INGREDIENTS!

In this experiment, you will make your own lip balm using a lip balm base. The lip balm base formulation includes wax that was derived from soy beans, luxury oils and exotic butters. It is also rich in Vitamin E. The lip balm base is made from 100% natural vegetable ingredients and contains no animal products. It also has hydrogenated Soybean Oil, Shea Butter, Cocoa Butter, Sweet Almond Oil, Vitamin E and Apricot Kernel Oil. It has a very creamy consistency, is not sticky, and is long wearing.

To create the perfect lip balm, follow the procedures listed below.

- Step 1:** Read the entire procedure **before** you begin.
- Step 2:** Clean off your work surface and put on your safety glasses and your GPS Lab Jacket to protect your face and clothing.
- Step 3:** Gather all of your **ingredients** and **materials** (see list above) and arrange them in the order that they will be used.

NOTE!

Do not start making your product before you have all ingredients, supplies, and equipment in front of you!

- Step 4:** Place your lip balm containers on paper or a tray on a level surface.
- Step 5:** When working in groups, evenly space each lip balm container to prevent spillage.
- Step 6:** Heat required batch of lip balm base (for the entire group) to 150 degrees Fahrenheit.

NOTE!

Occasionally, use a thermometer to test the temperature before removing the lip balm base from the heat source.

- Step 7:** Once the lip balm base has reached 150 degrees Fahrenheit, remove it from the heating source and use a pipette to add flavor oil. Typically, 1 to 2 drops per ounce is adequate. Example: If you are making 2 oz of lip balm for your group, you will need to add 2 - 4 drops of flavor oil.

NOTE!

The GPS flavor oil is professional grade oil and is highly concentrated. Do not use more than the amounts outlined in this guide.

- Step 8:** Use your stirrer to blend flavor oil completely into the mixture.
- Step 9:** Fill your lip balm container with a pipette until just below the top surface.
- Step 10:** Place containers (with lids off) in the refrigerator and let them harden completely (about 60 to 90 seconds).

ENJOY!

Analysis and Conclusion

After completing an experiment, scientists ask themselves questions in order to see what they have learned about their topic. Answer the following questions about your experiment in creating your own lip balm.

? **Question 1: Did your lip balm turn out the way you wanted it to? Why or why not?**

? **Question 2: Describe how “smoothing and moisturizing” your lip balm product is. If it is not as smooth as you would like, can you think of a way to make your product smoother?**

? **Question 3: Why is it important for scientists to follow procedures in the correct order? Explain the possible errors that could occur if they do not follow the procedure.**



STEAM Experiment #1

The Beauty of Soap Jellies



Science

Clean up time, everybody! Using soap is a part of our daily regimen. We use soaps for washing, cleaning, and relaxing. As with all of our products and everything around us, soaps are made up of atoms and molecules. Therefore, it is matter. You may recall from your elementary science class, matter is all around us. Anything that occupies space and has weight is matter. Matter takes three forms or states: solid, liquid and gas. Matter can change from one of these forms to another.

Great scientists are critical thinkers! Think about what you have learned about soap and making soap based products like bubble bath and complete the chart below. Do not use the internet or other resources. Combine your understanding of matter and soap to express your thoughts and ideas in the chart below.

Write the three states of matter in the left column below. In the right column, write the form of which soap can be found.

Example: Ice cubes, water in a glass, and steam from a kettle are the three forms in which water can be found.

STATE OF MATTER:	WHAT DOES SOAP LOOK LIKE IN EACH FORM?



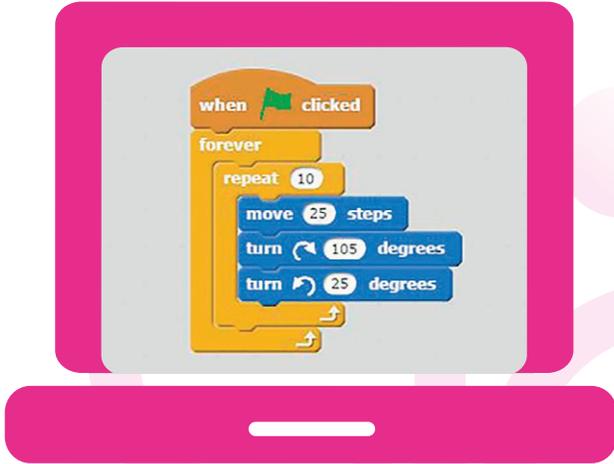


Technology

Coding - When you think of Soap Jellies, think of animation! Use Scratch to create a wiggly animation! You will need a computer and internet access to complete this section.

Open Scratch (<https://scratch.mit.edu>) and click "Create."

Start with this code:



? *What happens to your sprite (the cat)?*

? *How can you adjust this code to make your sprite wiggle or bounce?*



Engineering

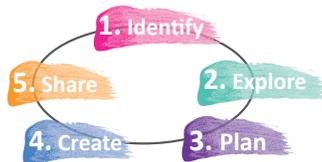
Now that you have made a "digital" wiggly, let's make a "physical" wiggly, also known as Soap Jellies! We will use the Engineering Design Process (EDP) to make Soap Jellies. Soap Jellies are wiggly soap shapes which jiggle while softening, cleansing and nourishing your skin. They extract essential and fragrance oils that leave your skin smelling good.

The EDP process are steps that engineers follow to discover creative solutions to problems. The steps of the EDP vary based on the problem that is being solved. We will use the B.O.S. EDP to create beauty products.

The five steps are: **1.** Identify Problem; **2.** Explore Solutions; **3.** Plan; **4.** Create; and **5.** Share it with a girl.

Part 1:

Let's start by matching the description of the steps in the engineering design process in the chart below:



? *Use the chart above to write the number that matches the steps of the EDP on the line in front of the descriptions below:*

- _____ Use other girls to evaluate your Soap Jellies to find out how it worked for them.
- _____ Write down what you have discovered. Review what you will need to make Soap Jellies.
- _____ Do background research to learn what others have done.
- _____ Ask: "Is there a need?" "Who has the need?" "Is it important enough to create a solution?"
- _____ Follow your plan and make Soap Jellies.

Part 2:

Now that you understand how the EDP helps engineers to create solutions, let's make Soap Jellies and make bath time fun time! Follow the procedure below and be sure to think about your final product along the way. Upon completion, share your Soap Jellies with your friends!

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
1.5 oz Soap Jellies Cups	3	Microwave	1
Pipette	1	Spoon or spatula	1
		Glass measuring cup	1
		Digital scale - optional	
		Bowl - optional	
INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
B.O.S. jelly soap base	3 oz	N/A	N/A
Fragrance oil	1 - 4 %		
Gel color - optional	1 - 4 %		

Procedure:

1. Measure out the jelly soap base into your measuring cup.

NOTE! You'll need to scoop it from the pail into your measuring cup, which should break it up enough to ensure even melting. Break up any large chunks with a spoon or spatula.

2. Heat the soap base in 30 second bursts until it's completely liquid.

NOTE! Jelly soap base hardens quickly, so work quickly. If it gets too thick to pour, microwave it until it's liquid again.

3. Use a pipette to add fragrance oil to melted soap base and stir until mixed well.

NOTE! Calculate the percentage of oil required to create the desired strength. Review the pre-lab Beauty of Bubble Bath video (www.beautyofstem.com) to refresh your memory of how to calculate percentages.

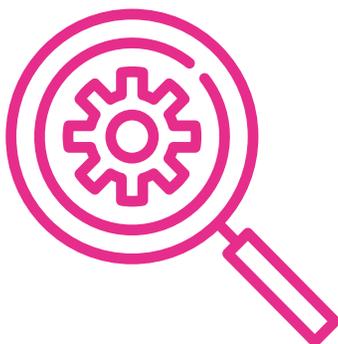
4. Use a pipette to add colorant to jelly soap mixture and stir until mixed well.

NOTE! Add about 5 drops of colorant to get a nice vibrant color, but keep adding gel color until you get the right shade.

5. Pour the mixture into your jelly soap cups.

6. Let harden and share or exchange your Soap Jellies with another student.

NOTE! Once the soap has set, it's ready to use. It will be a soft, jelly consistency when ready. You should be able to remove it from the cups 12-24 hours after pouring.

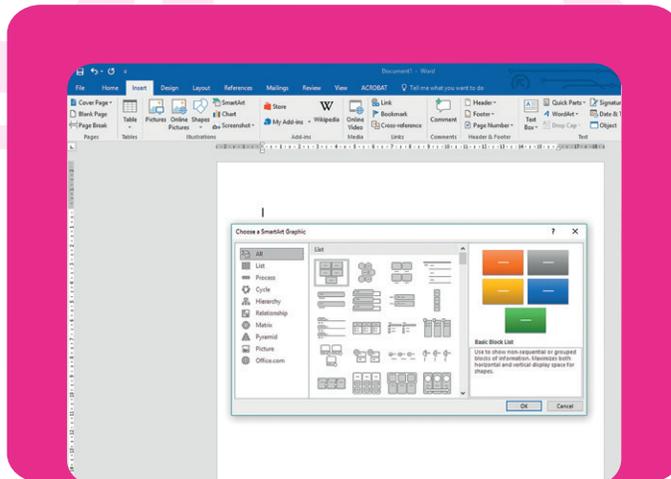
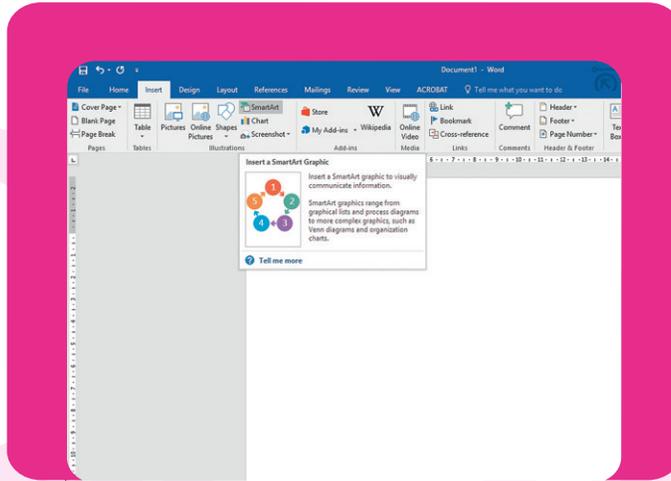




Art

Develop a diagram for the Engineering Design Process (EDP) using Microsoft Word SmartArt:

1. Open Microsoft Word on your computer.
2. Use the SmartArt feature to create a SmartArt graphic of the EDP. Label each shape as:
 1. Identify Problem
 2. Explore Solutions
 3. Plan
 4. Create
 5. Share It



3. Click through the different formats and designs and pick one which you prefer. Don't forget to add color, adjust shapes, and text.

Extra: Print your diagram out and save it. Study the EDP and use it to create solutions to problems. The EDP process helps to build **critical thinking** and problem solving skills.



Mathematics

Weight vs. Volume - As a scientist, the subject of **Weight vs. Volume** is a recurring question that you will be challenged with when making soap products. Most soap products are measured by weight and not by volume.

For example, in the engineering section, the amount of soap base is measured in oz, not cups. Soap ingredients have different densities. Some soap bases are heavier than others; therefore, to get a more accurate measurement, weight measurements are used.

When determining a soap's weight, it is determined by the heaviness, or **mass**, of the soap, and is measured with the use of a scale. On the other hand, **volume** is the amount of space that an item you are measuring takes up. Products like baby oil are labeled by their volume. An 8 oz bottle of baby oil will hold 8 oz of baby oil by volume but not by weight.

Part 1: Application

To build your **divergent thinking** skills, think about what you have learned about solids, liquids, gas, weight and volume. See how well you understand the concepts of volume by answering the question below:

When using your Soap Jellies, you noticed pretty rainbow colored bubbles that look like a glass sphere. The sphere is full of liquid.

In this concept, calculate the **volume** of a sphere.

☑ **Example:** If a sphere has a radius of 5 ft, find the volume.

First, substitute what you know into the volume formula.

$$V = \frac{4}{3} \pi r^3 \rightarrow V = \frac{4}{3} \pi (5)^3$$

Next, use algebra to calculate the volume.

$$V = \frac{4}{3} \pi (5)^3$$

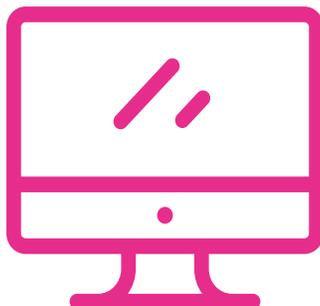
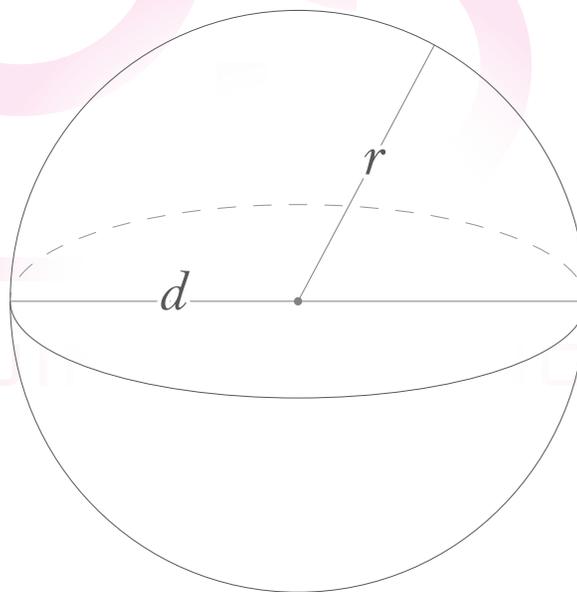
$$V = \frac{4}{3} \pi (125)^3$$

$$V = 166.67 \pi$$

$$V = 523.60$$

The answer is 523.60.

The volume of the sphere is 523.60 ft³.



Part 2: Geometry - Find the Volume

1. A sphere with a radius of 3 m	2. A sphere with a radius of 4.5 cm
3. A sphere with a radius of 2.5 m	4. A sphere with a radius of 5.5 m

Part 3: Extra - Find the Radius

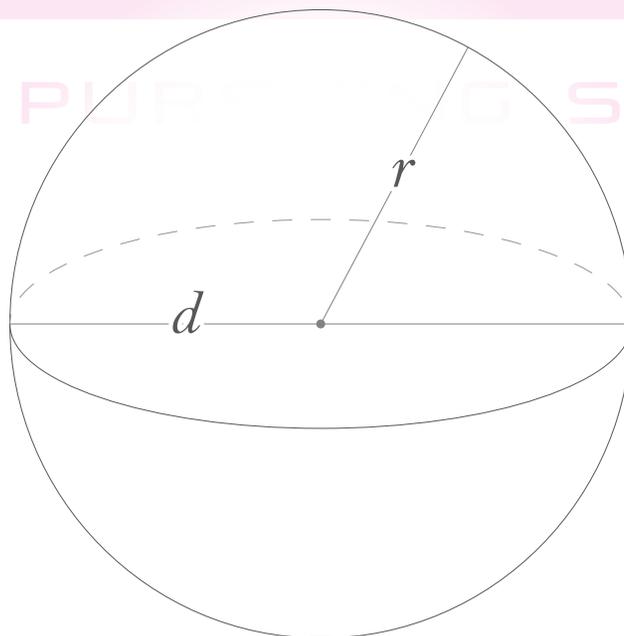
How do you find the radius of the sphere if you know the volume?

Substitute the variable into the volume formula.

If $V = 72 \text{ m}^3$

Use the formula to find the radius.

$$V = \frac{4}{3} \pi r^3$$



STEAM Experiment #2

The Beauty of Color Science

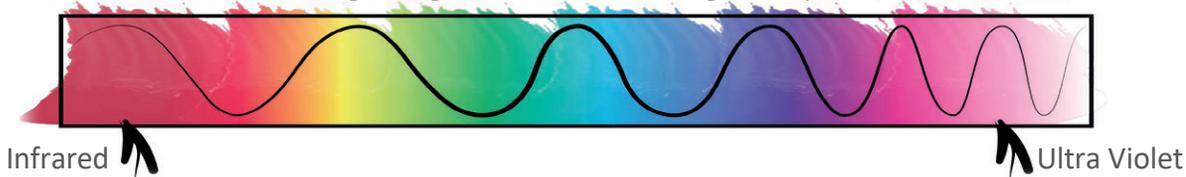


Science

Colors play an important role in our everyday lives. Colors are used to create an emotion or trigger a response. Emergency vehicles and images of them are typically red. The color red creates a sense of urgency. Yellow creates a sense of caution. Color is also a creative marketing tool as colorful advertisement can “control” a consumer’s buying habits.

Color is quite scientific, too. Light is a form of energy. When we see color, we are actually seeing light that has been reflected off of an object. Light moves from its source in waves of different lengths. When we see light, we are seeing energy from certain wavelengths. This is called the visible light spectrum which is all the colors that can be seen with the human eye. (See image below.) The spectrum presents the colors in a particular order, ranging in wavelength from 700-400 nm (nanometers): Red, Orange, Yellow, Green, Blue, Indigo, and Violet. Red forms from light with longer wavelengths. Violet forms from light with shorter wavelengths.

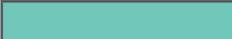
Visible Light Region of the Electromagnetic Spectrum



An object’s color is the light, or energy, that it did not absorb. When you see something as “red,” it is because the object has absorbed all the other visible colors except for red. The energy for red bounces off the object and is reflected back to your eyes. The colors white and black aren’t really on the spectrum. A black object is black because it does not scatter any light.

Now that you understand the power of colors and the science behind colors, complete the chart below:

? *Quickly look at the color in the left column, write down how it makes you feel. What is the first thing you think of when you see each color?*

? *Why are the colors white and black not on the spectrum? Explain what happens when you see something that is black or white.*



Technology

The color spectrum displays colors when light is dispersed by a prism. A spectrum can take on various shapes, circles, triangles or squares.

For this section, you will use your creativity skills to design a color spectrum, using Microsoft Paint.

NOTE! Review the videos and instruction sheets in the resource folder to learn more about Microsoft Paint.



Engineering

Now that you understand the color spectrum, you will engineer (design and create) your own soap crayons using some of the same colors. Follow the procedure below and be sure to think about your final product along the way. Good engineers are constantly thinking of new ways to make their product better and more advanced!

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
Pipette	1	Small bowl or measuring cup	1
Soap Mold	1	Spoon or spatula	1
INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
Crayon Soap Base	1 oz	Alcohol (optional)	N/A
Colorant	1-2 drops		
Fragrance Oil	1-3 drops		

Part 1: Imagine Your Product

In order to make your own soap crayons, you need to determine how much of each ingredient you will need. Answer the questions below to make decisions about your final product.

? *What color will you select for your soap crayons? Why did you choose this color?*

? *Do you want your crayons to have a strong scent? Why or why not?*

Part 2: Plan Your Product

Based on your responses above, determine how much of each ingredient you will need.

? You will need the following ingredient and the amount listed:

1. 1 oz of crayon soap base

? Determine how much of the Fragrance Oil you will need based on your product design. Circle which amount you think is appropriate.

1. 1 drop of Fragrance Oil (faint scent); or
2. 2 drops of Fragrance Oil (medium scent); or
3. 3 drops of Fragrance Oil (strong scent).

? Determine how much of the Colorant you will need based on your product design. Circle which amount you think is appropriate.

1. 1 drop of Colorant (light color); or
2. 2 drops of Colorant (medium color).

Part 3: Create Your Product

Follow the procedure below using the ingredients and the amounts you selected.

1. Add 1 oz of Crayon Soap Base into the measuring cup. Place the soap base into the microwave for 10 - 30 seconds.
2. Once the soap is melted, add your chosen amount of Fragrance Oil and stir until mixed completely.
3. Place the soap mold close by and have it ready to use.

NOTE! The soap base hardens very quickly.

4. Pour about 0.25 oz of soap in small bowl. Add one drop of one of your chosen colors. Mix with the spoon or spatula until completely mixed. Add a second drop, if desired.
5. Pour this mixture into one of the soap molds.
6. Repeat steps 4 and 5 for the remaining 3 colors.

NOTE! Perform these steps quickly as soap will harden fast!

7. Spray with alcohol to get rid of any bubbles.
8. Keep the tubes in the tray until completely hardened or about 30 minutes. Once they are hardened, remove them.

Part 4: Evaluate Your Product

Reflect on the final product you have created. Answer the questions below in order to consider changes you could make that would improve your product.

? Did your product turn out the way you imagined it would be in Part 1? Why or why not?

? What are some additions you could make to the formula of your product? Are there any ingredients you would like to add that would improve the quality? Give an explanation for each addition.



Art

Let's take a fresh look at light and build a spectroscope! Because we cannot "see" the separate wavelengths in any light source, we need a device to split them apart and examine different kinds of light sources in school, at home, and around the city. Make a spectroscope using simple materials like a cereal box, tape, CD, etc. Use the internet and a search engine to find ideas on how to make a spectroscope. Remember to be creative, use your engineering, research and problem solving skills. Spectrometers are also used by scientists to split light into an array of colors. This allows scientists to see the details in light from a distance.



Mathematics

Now that your soap crayons have been created you must calculate the correct dimensions of your box. All five tubes need to fit inside without using excess paper. The dimensions for each tube are given below. Use the space to measure out (or sketch) all five soap crayons according to their proper dimensions. Then calculate the length, width and height of the box you will need to package them. This formula is often abbreviated as $V = l \times w \times h$.

? Soap Crayon Dimensions

*If each tube have a length of 3 in, width of 0.6, and height of 2.7 in, what is the volume of the box?
Show your work here:*

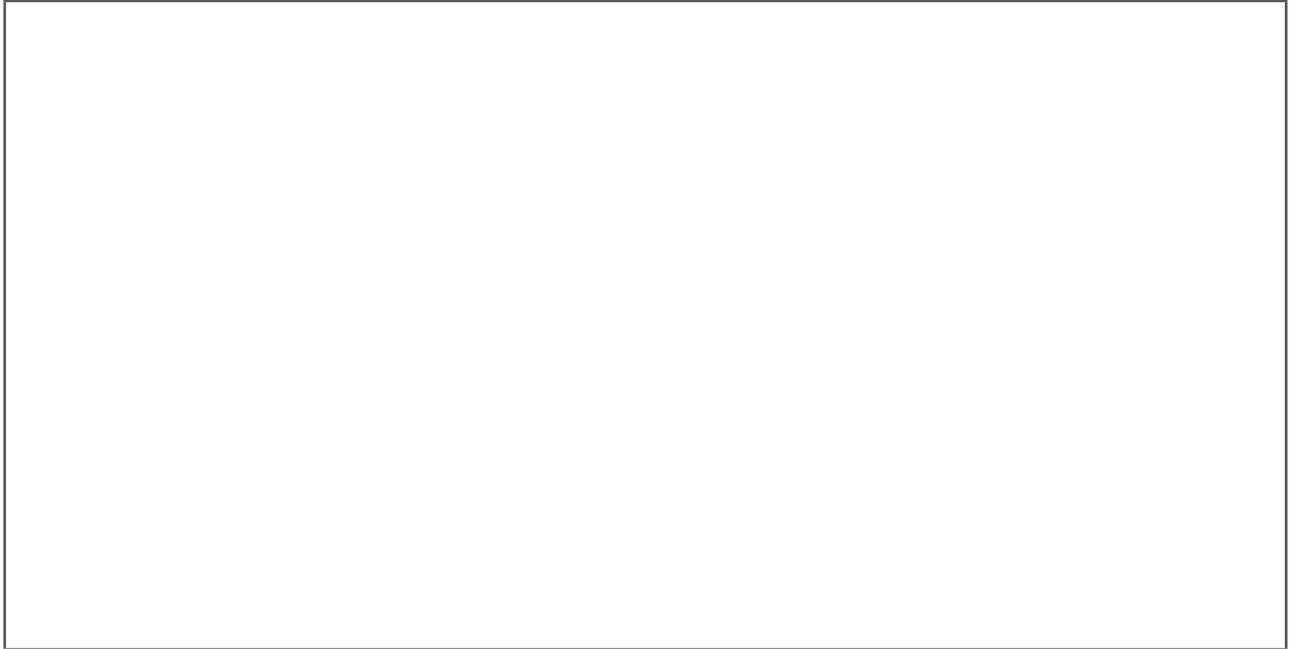
Now that your soap crayons have been created, you must calculate the correct dimensions of your box. All 5 tubes need to fit inside without using excess paper. The dimensions for each tube are given below. Use the space to measure out (or sketch) all 5 soap crayons according to their proper dimensions. Then calculate the length, width and height of the box you will need to package them (Recall: $V = l \times w \times h$).

? Box Dimensions

Determine the length, width and height of the box that will fit all 5 crayons side by side.

1 crayon = 2.7 in. high, 0.6 in. wide, and 3 in. long.

Sketch the crayons side by side according to the height and width calculated. Use the space below:



Use a ruler to outline the crayons in your image above.

Measure the width and height of the box and record them below.

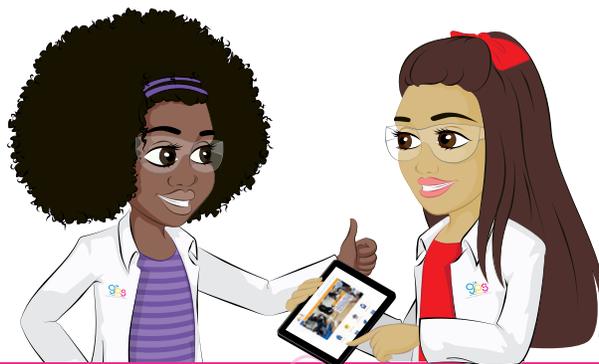
Width of the box: _____

Height of the box: _____

Determine the length of the box. It should be equal to the length of 1 crayon tube.

Length of the box: _____

List the final dimensions of the box: _____ x _____ x _____

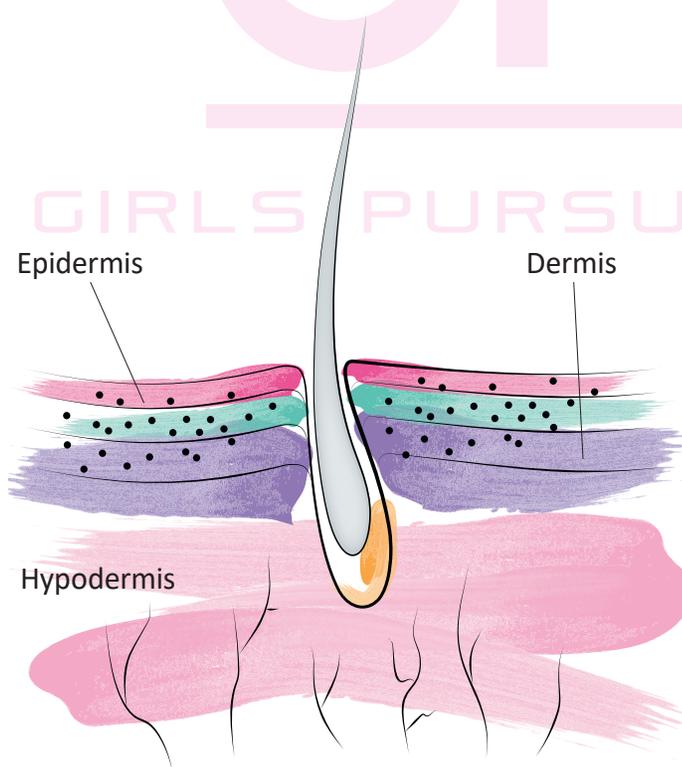


The Beauty of Lotion



Science

Have you ever wondered why people put lotion on their skin as part of their daily beauty ritual? Or how lotion works to keep your skin hydrated and moisturized? The answer can be understood by finding out about the layers of skin and why they need protection. Your skin is made up of three layers: epidermis (top), dermis (middle), and hypodermis (bottom). These layers are made of thousands of cells that need water in order to maintain elasticity (the ability to move and stretch easily). When you shower and use harsh soaps, the natural oils of your skin are taken away. The natural oils protect your skin by keeping the water in your skin cells. When the oil is taken off, the water can escape more easily (through evaporation and sweat), leaving your skin very dry and flaky. Before we began to make lotion and products for our skin, we must understand the basic science of skin. The skin is the body's largest organ. It protects our bodies from germs, maintains body temperature, and senses touch. Read the labels on the image below, then write the function of the epidermis, dermis and hypodermis. Use sources such as a dictionary or trusted science education websites to complete this activity.



Epidermis:

Dermis:

Hypodermis:



Technology

Understanding the science of your skin is the first step in understanding how lotion works to protect your skin. The second step is understanding the chemistry behind the ingredients. In this section, you will be researching the two main ingredients of lotion and discovering how they combine to create lotion.

Part 1: Internet Research

Use the Internet to find information about the two main ingredients in lotion. Write down 1-2 facts for each ingredient, such as the purpose or function and if it benefits your skin.

INGREDIENT 1: Water	FACTS:
INGREDIENT 2: Oil	FACTS:

Part 2: The Mixture

As you may know, water and oil don't mix! However, why doesn't the oil and water separate in a bottle of lotion? The answer is in the third main ingredient. Use the Internet to research the function of emulsifiers and explain your findings below.

TYPES OF EMULSIFIERS	HOW EMULSIFIERS WORK

Part 3: Software

Design a label for your lotion using the label feature in Microsoft Word.

NOTE! Review the resources in the B.O.S. resource folder to learn more about Microsoft Word.



Engineering

Now that you know how lotion works and what ingredients are needed to make it, you will engineer (design and create) your own lotion. Follow the procedure below and be sure to think about your final product along the way. Good engineers are constantly thinking of new ways to make their product better and more advanced!

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
1 oz Lotion Bottle	1	Bowl - optional	1
Lotion Pump	1	Spatula - optional	1
Beaker	1	Funnel - optional	1
Pipette	1		
INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
B.O.S. Lotion Base	1 oz	N/A	N/A
Fragrance Oil	1 - 4 %		
Gel Color - optional	1 - 4 %		

Part 1: Imagine Your Product

In order to make your own lotion, you need to determine how much of each ingredient you will need. The main ingredient in your lotion is the base. The fragrance and colorant are additives. You know the amount of the base is 1 oz, regardless how much of the fragrance and colorant you need to fill your 2 oz bottle. Use a proportion to find the amount of fragrance and colorant you will need to make lotion. The amount of the lotion base is 1 oz and the option for the amount of fragrance and colorant is 1 – 4 %. In the example below, Valeri loves the scent of strawberries so she used more fragrance than normal. To demonstrate how to use proportions to find the missing value or amount, Valeri used 5%.

What is 5% of 1 oz?

Step 1: Start with what you know. Valeri used 5%; therefore, you can fill in that half of the proportion.

$$\frac{5}{100}$$

Step 2: The base is given is 1 oz; however, the amount is not given. So that's the unknown; therefore, write that half of the proportion as:

$$\frac{a}{1}$$

Step 3: Combine Step 1 and Step 2 as a proportion to solve for cross products. The proportion is written as:

$$\frac{a}{1} = \frac{5}{100}$$

Step 4: Cross multiply:
Therefore

$$a \times 100 = 100a$$

$$100a = 1(5)$$

$$\text{multiply } 1 \times 5;$$

$$100a = 5$$

$$\text{Divide each side by } 100;$$

$$a = .05$$

Remember that the amount you are solving for is a unit of measurement of ounces. Therefore, the answer is .05 oz.

You are using a 5 mL or (1 tsp) pipette to measure your ingredients. Therefore, you can approach this in 1 of 2 ways.

1. Convert .05 oz to mL
2. Convert .05 oz to drops.

NOTE! You may find a converter online to convert oz to mL or convert oz to drops.

Part 2: Create Your Product

Follow the procedure below using the ingredients and the amounts you selected.

1. Measure and add 1 oz of B.O.S. lotion base to your beaker or a bowl.
2. Using your pipette, add your selected amount fragrance oil to your lotion base, one drop at a time and stir.

NOTE! The color of the oil may affect the color of the final product!

3. Using your pipette, add your selected amount of gel color, one drop at a time.

NOTE! To give your lotion a fun color, add one drop at a time. The GPS Gel Colorant is very concentrated; therefore, add only a tiny drop to create a pretty pastel color.

4. Stir the lotion mixture until all of the gel colorant is blended.

NOTE! GPS Gel Colors are formulated to use on your skin; therefore, the color won't get on your skin!

5. Pour your lotion into the bottle and screw on the lotion pump.

Part 3: Evaluate Your Product

Squirt a small amount of the lotion in your hands to evaluate the texture, scent, and color. Answer the questions below in order to consider changes you could make that would improve your product.

? Did your product turn out the way you imagined it would be in Part 1? Why or why not?

? What are some additions you could make to the formula of your product? Any ingredients you would like to add that would improve the quality? Give an explanation for each addition.





Art

Now that your product has been created, you will need to design your package label. Package designers need to keep a couple things in mind: Who is the customer you are trying to reach? How can you get your customer's attention?

! *Design your company logo using the space below.*

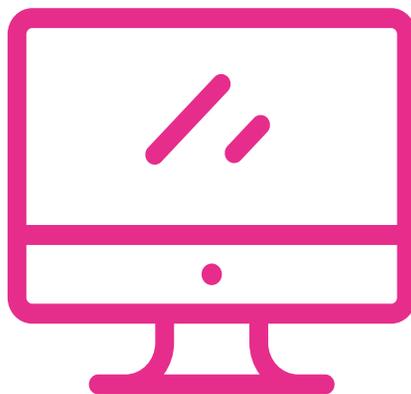
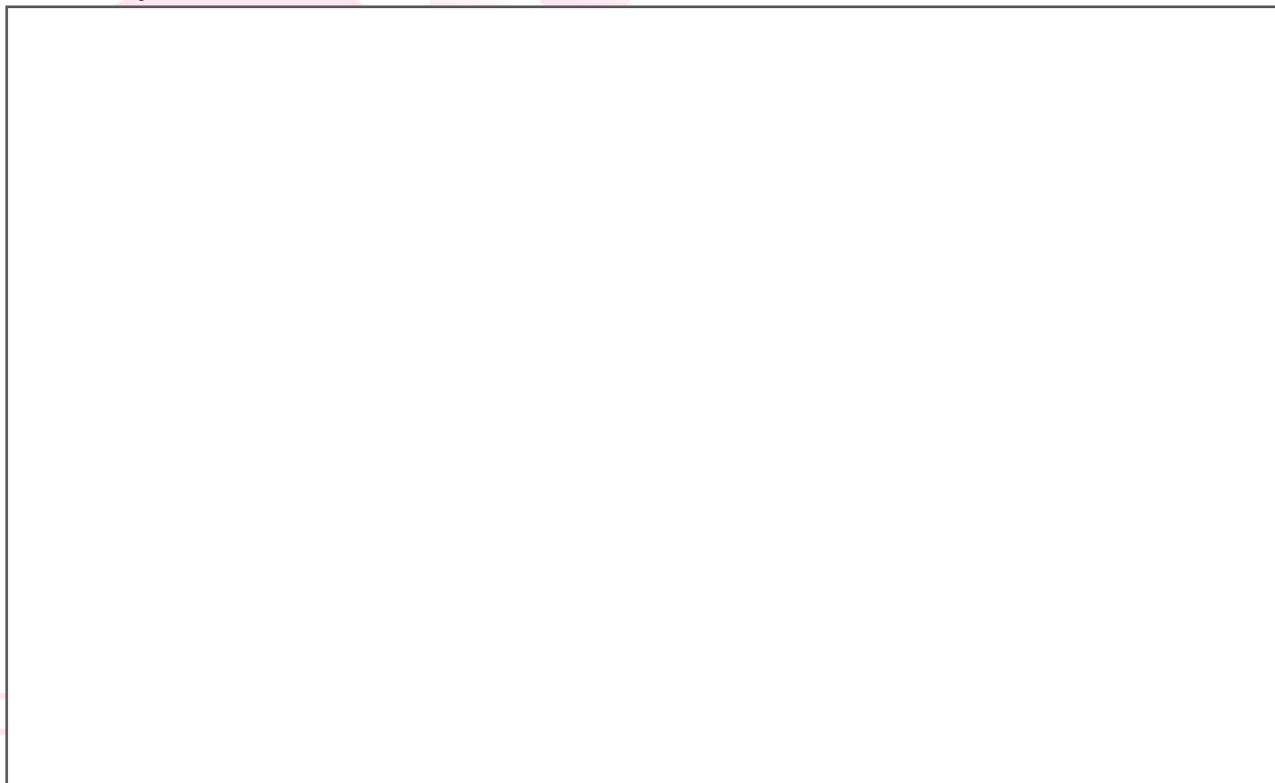
What is the name of your company?

What is the name of your lotion?

What is the scent of this lotion?

Focus your label on the effects it will have on the skin, e.g. "ultra moisturizing" or "especially for dry, flaky skin."

Sketch a label for your bottle below. Then create a final edition using the bottle label template and stick it on your bottle!





Mathematics

In the technology section, you learned about emulsifiers and how they combine with water and oil to make a mixture. In order to create the perfect mixture, chemists must determine the correct amount of each ingredient. They must determine a formulation. Given the amount of each ingredient below, determine the composition percentages of each ingredient. See the example below. Then complete the next two on your own!

INGREDIENT	AMOUNT	COMPOSITION PERCENTAGE
Lotion Base	1 oz	67 %
Fragrance Oil	0.25 oz	16 %
Gel Color	0.25 oz	17 %

To find the percentage of composition, we must first find the total amount of product. To do this, add all of the amounts together.

$$1 \text{ oz} + 0.25 \text{ oz} + 0.25 \text{ oz} = 1.50 \text{ oz}$$

Then, we have to find the percentage each ingredient contributes to the total of 100 %. To do this, we divide each individual amount by the total amount. Round your answer to the nearest hundredth.

$$1 \text{ oz} / 1.50 \text{ oz} = 0.67$$

$$0.25 \text{ oz} / 1.50 \text{ oz} = 0.16$$

$$0.25 \text{ oz} / 1.50 \text{ oz} = 0.17$$

Next, we have to multiply each decimal from above by 100 in order to get the percentage.

$$0.67 \times 100 = 67 \%$$

$$0.16 \times 100 = 16 \%$$

$$0.17 \times 100 = 17 \%$$

Try the method above to calculate the formulations for the following two examples.

Example:

INGREDIENT	AMOUNT	COMPOSITION PERCENTAGE
Lotion Base	2 oz	
Fragrance Oil	1 oz	
Gel Color	0.50 oz	

Show your work here:

Example:

INGREDIENT	AMOUNT	COMPOSITION PERCENTAGE
Lotion Base	2.50 oz	
Fragrance Oil	0.75 oz	
Gel Color	0.25 oz	

Show your work here:

The Beauty of Eyeshadow



Science

Have you ever wondered how eyeshadow stays on your eyes all day? What is the main ingredient and where does it come from? This experiment is all about eyeshadow and will help you to understand the physical nature of the main ingredient: mica!

The word “mica” means “crumb” in Latin. This describes the consistency of mica itself. It is a naturally occurring mineral that forms in thin sheets that can be crumbled into a fine powder.

For this section of the lab, complete the chart below about how we actually classify minerals. Use the Internet to research the following characteristics about minerals and how we can test them.



Mica Sheets

DEFINITION	HOW IS IT TESTED?
Streak:	
Hardness:	
Luster:	
Fracture:	
Cleavage:	



Technology

For this section, you will research a mystery mineral based on its properties that are listed below. Use the Internet to identify possible matches based on the given properties. Write the matches on the chart below and see which property is left at the end!

DEFINITION	HOW IS IT TESTED?
Streak: white	
Hardness: 4	
Luster: vitreous (having reflective properties similar to glass)	
Fracture: uneven	
Cleavage: octahedral	

? Based on the properties listed above, I believe the mystery mineral is:

? Some of the uses for this mineral are:



Engineering

Now you will engineer (design and create) your own eyeshadow! Follow the procedure below and be sure to think about your final product along the way. Good engineers are constantly thinking of new ways to make their product better and more advanced!

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
6 mL Eyeshadow Jar	1	Popsicle Stick	1
Portion Cups	1	Set of Metal Measuring Spoons	1
Pipette	1	Microwave	1
		Refrigerator (optional)	1
INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
Mica	4 g		
B.O.S. Shea Butter	1.5 tsp (7.4 mL)		

NEXT

Part 1: Imagine Your Product

In order to make your own eyeshadow, you need to determine how much of each ingredient you will need. Answer the questions below to make decisions about your final product.

? *What color will you select for your eyeshadow? Why did you choose this color?*

? *What colors of mica will you need to mix in order to get the perfect color? Test a small amount.*

Part 2: Plan Your Product

Based on your responses above, determine how much of each ingredient you will need.

? *You will need the following ingredient and the amount listed.*

1. 1.5 tsp (7.4 mL) shea butter

? *Determine how much mica of each color you will need in order to create the perfect color you desire.*

You will need a total of 1 tsp (4 g). Measure out the amount you will need of each color and write it down here:

1. Color 1 amount: _____
2. Color 2 amount: _____

Part 3: Create Your Product

Follow the procedure below using the ingredients and the amounts you selected.

1. Measure out your shea butter and microwave it until it's almost completely liquid.

NOTE! *Do this in 30-second bursts to avoid getting it too hot!*

2. Add your mica and stir it into the melted shea butter until the color is even throughout. A popsicle stick works best.

NOTE! *You can experiment with different colors and combinations of colors to get the perfect eyeshadow for you. However, note that the formulation is 4 g of mica. If you mix micas to create a different color, it should not exceed 4 g for this formulation. You may also develop your own formulation.*

3. Use a small metal measuring spoon (the flat end) to transfer your eyeshadow into your eye shadow jar. Let it cool.

NOTE! *As the shea butter cools, it will harden; however, you may put it in the refrigerator to speed up the process. If your eye shadow is too creamy, try adding small grains of mica powder. Let it set for 24 hours before using it.*



Part 4: Evaluate Your Product

Reflect on the final product you have created. Answer the questions below in order to consider changes you could make that would improve your product.

? *Did your product turn out the way you imagined it would be in Part 1? Why or why not?*

? *What are some additions you could make to the formula of your product? Are there any ingredients you would like to add that would improve the quality? Give an explanation for each addition.*



Art

Now that your product has been created, you will need to design your package label. Package designers need to keep a couple of things in mind: Who is the customer you are trying to reach? How can you get your customer's attention?

! *Design your eye shadow box using the space below.*

What is the name of your company?

What is the name of your product?

Keep in mind the age of your customers too.

Sketch a design for your eyeshadow box label below. Be creative. Design a label that is the same shape and size of the top of your eyeshadow jar. Use the top to trace the shape of the top. Add text, shapes, or colors to design the label. Then cut it out and use glue or tape to stick it to the top.

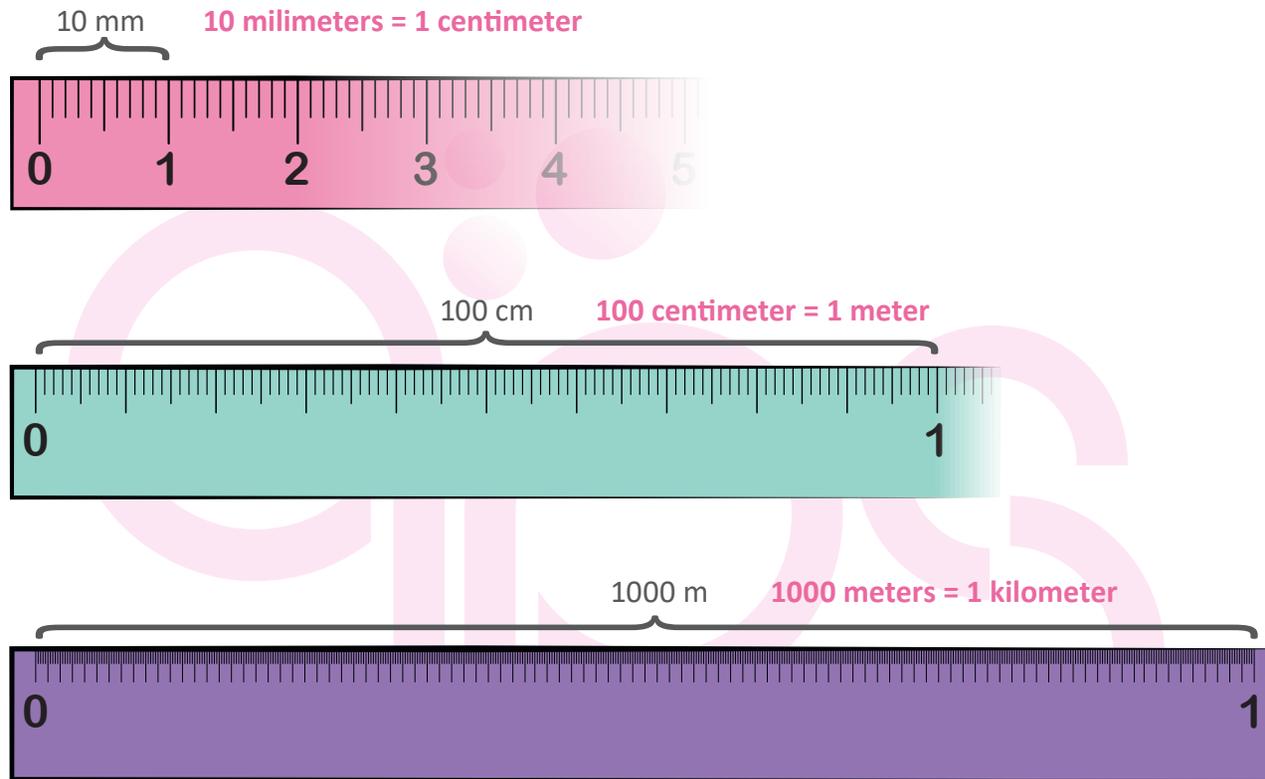


! *If you made several colors, set up a display of your shadows to show to potential customers.*



Mathematics

The Metric System - Outside of the United States, units of measurements are different. Almost all nations in the world use the metric system as the official system of weights and measures. However, in the U.S., we measure lengths by distance in inches, feet, and yards. Weight is measured in ounces and pounds.



However, the metric units of measurements from smallest to largest are **millimeter**, **centimeter**, **meter**, and **kilometer**.

Millimeters are used to measure small items like paper clips and the width of a USB port of a mobile device. The abbreviation for millimeters is mm (for example, 5 mm).

Next smallest is the centimeter. A centimeter is about the width of a staple. The abbreviation is cm (for example, 1 cm). 10 millimeters (mm) equals 1 centimeter (cm).

? **Observation:** Take a look at the rulers above, notice the size of the metric units of measurements. Take a look at a ruler with U.S. measurements and compare the size of a millimeter on the metric ruler to the size of an inch on your ruler.

? Think about the metric system measurements listed above and complete the exercise below. Read through the projects and answer the questions that follow.

Today you will be selecting new furniture for your bedroom.

You will need to measure the length of the bedroom so all the furniture fits into the space without overcrowding your room.

Use metric units to measure your room. Your options are millimeters, centimeters, meters or kilometers. Which unit of measurement should you use to measure your bedroom?

NOTES!

1. Think about your room and imagine the size.
2. Review the metric units above and decide which one is the most feasible to use to describe the measurements.
3. Keep in mind that millimeters are used to measure small item like paper clips; therefore, you know measuring using millimeters is not the best option.

Practice critical thinking and quickly decide the applicable unit of length using metric units for each item listed below.

Use millimeters, centimeters, meters or kilometers to answer the following:

HOW WOULD YOU MEASURE:	UNIT OF MEASUREMENT:
The depth of a lip balm tube	
The height of a lotion bottle	
The distance of a football field	

GIRLS PURSUING SCIENCE

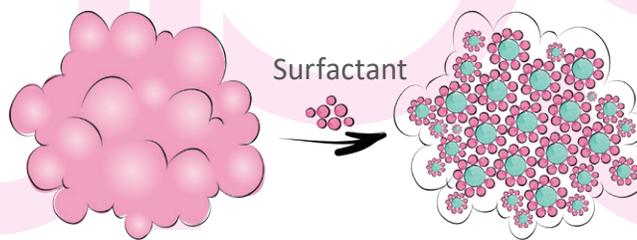


The Beauty of Shampoo



Science

Have you ever wondered how shampoo actually works to make your hair silky and clean? The answer is surfactants. Surfactants are short for “surface-acting agents” and are one of many different compounds in personal-care products. The surfactant in shampoo reduces the surface tension of water to help it spread and move around our hair to remove the oil and dirt. Surfactant molecules have two different ends. One end of the molecule attracts water (hydrophilic). The other end of the molecule repels water (hydrophobic). Therefore, hydrophilic end of the molecule cleans and rinses away oil and dirt that is attached to the hydrophobic the end. The image below shows the surfactants surrounding the oil and dirt. The outside of the molecule will attract the water, taking the oil and dirt down the drain.



Technology

Think about your favorite brand of shampoo. Write the name of it down below. Use the Internet to research the active ingredients in your favorite shampoo. Write down the top 3 ingredients below. Using your science knowledge from above, identify which ingredients might be the surfactants and explain their function.

- My favorite shampoo is _____.
- The top 3 active ingredients are _____, _____ and _____.
- Based on my research, the ingredient that is the surfactant is the _____.
- The function of the surfactant is to _____.

Create a spreadsheet in Microsoft Excel that has 3 columns and 3 rows. Label each column.

1. Brand of shampoo
2. The first 3 ingredients
3. List the ingredient that might be a surfactant

NOTE! Use the B.O.S. resource folder to learn more about Microsoft Excel.



Engineering

Now that you know how shampoo works and what ingredients are needed to make it, you will engineer (design and create) your own shampoo. Follow the procedure below and be sure to think about your final product along the way. Good engineers are constantly thinking of new ways to make their product better and more advanced!

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
2 oz Shampoo Bottle	1	None needed	N/A
8 oz Beaker	1		
Pipette	1		
INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
Natural Organic Soap Base	½ oz	Distilled Water	1 oz
Essential Oil	1-3 drops		
Colorant (optional)	1-3 drops		
Q-Pearl	1-3 drops		

Part 1: Imagine Your Product

In order to make your own shampoo, you need to determine how much of each ingredient you will need. Answer the questions below to make decisions about your final product.

? *What color will you select for your shampoo? Why did you choose this color?*

? *Do you want your shampoo to have a strong scent? Why or why not?*

Part 2: Plan Your Product

Based on your responses above, determine how much of each ingredient you will need.

? *You will need the following ingredients and the amounts listed.*

1. ½ oz of natural organic soap base
2. 1 oz of distilled water

? *Determine how much of the Essential Oil you will need based on your product design. Circle which amount you think is appropriate.*

1. 1 drop of Essential Oil (faint scent); or
2. 2 drops of Essential Oil (medium scent); or
3. 3 drops of Essential Oil (strong scent).

NEXT



? Determine how much of the following ingredient you will need based on your product design. Circle which amount you think is appropriate.

1. 1 drop of colorant (light color); or
2. 2 drops of colorant (medium color); or
3. 3 drops of colorant (dark color).

Part 3: Create Your Product

Follow the procedure below using the 4 ingredients and the amounts you selected.

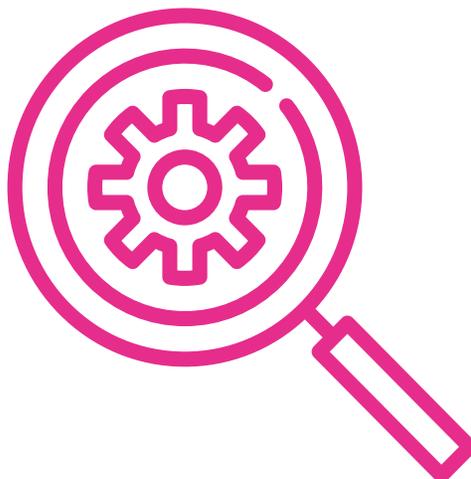
1. Pour ½ oz of the Natural Organic Soap Base into your beaker.
2. Add 1 oz distilled water.
3. Add the desired amount of Essential Oil to the soap and water mixture.
4. Add the desired amount of colorant of your choice.
5. Stir the mixture until mixed well.
6. Add 1-3 drops of Q-Pearl.
7. Pour the mixture into your shampoo bottle, screw the top on tightly and shake vigorously.

Part 4: Evaluate Your Product

Reflect on the final product you have created. Answer the questions below in order to consider changes you could make that would improve your product.

? Did your product turn out the way you imagined it would be in Part 1? Why or why not?

? What are some additions you could make to the formula of your product? Are there any ingredients you would like to add that would improve the quality? Give an explanation for each addition.





Art

Now that your product has been created, let's design a shampoo holder to hang in the shower!

Materials that you will need:

- An empty product bottle
- Scissors
- Markers

! Instructions:

Step 1: Bring an empty bottle from home like the one shown below:



Step 2: With adult supervision, cut the bottle in the pattern as shown below (front and back):



Step 3: Cut a hole in the back as shown:



Step 4: Use the color markers to decorate it!



Mathematics

Once your product has been created, your job now is to use your mathematics skills to determine the right selling price for your shampoo. Mathematicians consider two questions while computing the cost of products: How much did the product cost to make? How much can you sell it for to make a profit?

? **Calculate the cost of the product based on your price list and calculations below.**
(To calculate, take the amount of each ingredient you used and multiply it by the price.)

☑ **Example:** 1 drop of colorant = \$0.25 What is the cost of colorant if I use 3 drops?

$$\$0.25 \times 3 = \$0.75 \text{ for colorant}$$

Natural Organic Soap Base	\$1.00 per oz	Your Cost _____
Lavender Essential Oil	\$0.75 per drop	Your Cost _____
Distilled Water	\$0.50 per oz	Your Cost _____
Colorant	\$0.25 per drop	Your Cost _____
2 oz Shampoo Bottle	\$0.23 per bottle	Your Cost _____

? **Calculate the total cost of your product by adding all the individual ingredient costs.**

Total Cost of Your Product _____

? **Based on the total cost, determine a price that people will pay that will cover your total cost and pay you a profit. You may want to research the price of other similar products in order to be competitive.**

Price you will charge _____

Cost to manufacture your product _____

Profit for each bottle sold (calculate the difference between the cost and price above).

? **If you sold 100 bottles, what would be your profit? Show your work in the space below.**

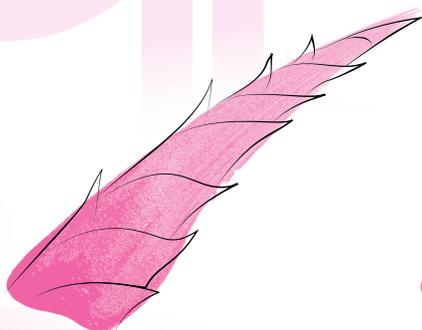
? **How many bottles would you have to sell to make a profit of over \$1,000? Show your work in the space below.**

The Beauty of Conditioner

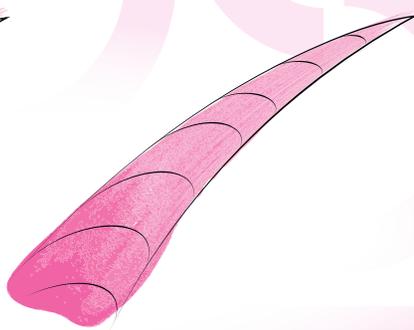


Science

After washing your hair with shampoo, the next step is to use hair conditioner. Your hair is left feeling clean and smooth! But how does it do this? Is there something magic in conditioner that leaves it untangled and shiny? The answer is in the science! Your hair, at the microscopic level, looks like a frayed rope. As the days go by, your hair becomes more and more frayed. Conditioner works to bind the frayed strand together to make one solid strand of hair. This leaves your hair feeling silky and smooth!



Hair before Conditioner



Hair after Conditioner



Technology

Conditioner works by binding your hair into one, smooth and silky strand, but what specific ingredients are actually doing this work? What causes it to bind? In this section, you will research ingredients in conditioners and find out what each one is doing to play a part in conditioner's effectiveness.

INGREDIENT	FUNCTION



Engineering

Now that you know how conditioner works and what ingredients are needed to make it, you will engineer (design and create) your own conditioner. Follow the procedure below and be sure to think about your final product along the way. Good engineers are constantly thinking of new ways to make their product better and more advanced!

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
2 oz Conditioner Bottle	1	None needed	N/A
8 oz Beaker	1		
Pipette	1		
INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
Conditioner Base	1 oz	Distilled Water	0.5 oz
Lavender Essential Oil	1 - 4 %		
Colorant (optional)	1 drop		

Part 1: Imagine Your Product

In order to make your own conditioner, you need to determine how much of each ingredient you will need. Answer the questions below to make decisions about your final product.

? *What color will you select for your conditioner? Why did you choose this color?*

? *Do you want your conditioner to have a strong scent? Why or why not?*

Part 2: Plan Your Product

Based on your responses above, determine how much of each ingredient you will need.

? *You will need the following ingredients and the amounts listed.*

1. 1 oz of conditioner base
2. 0.5 oz of distilled water

? *Determine how much of the Lavender Essential Oil you will need based on your product design. Circle which amount you think is appropriate.*

1. 1 drop of Lavender Essential Oil (faint scent); or
2. 2 drops of Lavender Essential Oil (medium scent); or
3. 3 drops of Lavender Essential Oil (strong scent).

? Determine how much of the Colorant you will need based on your product design. Circle which amount you think is appropriate.

1. 1 drop of Colorant (light color); or
2. 2 drops of Colorant (medium color); or
3. 3 drops of Colorant (dark color).

Part 3: Create Your Product

Follow the procedure below using the 4 ingredients and the amounts you selected.

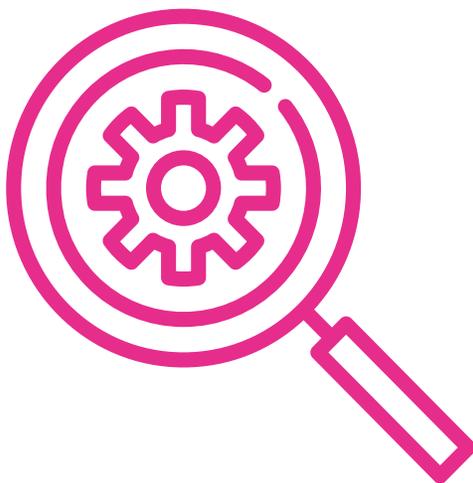
1. Pour 1 oz of the Conditioner Base into your beaker.
2. Add 0.5 oz distilled water.
3. Add your chosen amount of Lavender Essential Oil to the conditioner and water mixture.
4. Add your chosen amount of colorant, one drop at a time.
5. Stir the mixture until mixed well.
6. Pour the mixture into your conditioner bottle, screw the top on tightly and shake vigorously.

Part 4: Evaluate Your Product

Reflect on the final product you have created. Answer the questions below in order to consider changes you could make that would improve your product.

? Did your product turn out the way you imagined it would be in Part 1? Why or why not?

? What are some additions you could make to the formula of your product? Are there any ingredients you would like to add that would improve the quality? Give an explanation for each addition.





Art

Now that you have made shampoo and conditioner, let's design the matching conditioner holder to hang in the shower! Follow the same instructions that you used to make your shampoo holder.



Mathematics

Consider the following: Your main retail customer has decided they want to sell an economy-sized version and a travel-sized version of your conditioner. Currently, you are selling your product in 2 oz bottles for individual sales. Your customer would like the economy size to be double the current amount and the travel size to be $\frac{1}{2}$ of the current size. Calculate the new product sizes and the amount of each ingredient you will need to create each bottle.

Example: I have 10 g of sugar and need double the amount for a recipe. To figure out how much I need, I have to determine double the amount of 10.

$$10 \text{ g} \times 2 = 20 \text{ g of sugar needed!}$$

Example: Now, make half of the recipe. Instead of 10 g of sugar, I only need half the amount of sugar.

$$10 \text{ g} / 2 = 5 \text{ g of sugar needed!}$$

TRAVEL SIZE ($\frac{1}{2}$)	CURRENT SIZE	ECONOMY SIZE (2x)
Final Product ____ oz	Final Product 2 oz	Final Product ____ oz
Conditioner Base Amount ____ oz	Conditioner Base Amount 0.5 oz	Conditioner Base Amount ____ oz
Distilled Water Amount ____ oz	Distilled Water Amount 0.5 oz	Distilled Water Amount ____ oz
Lavender Oil and Colorant Amount ____ ounce	Lavender Oil and Colorant Amount $\frac{1}{2}$ ounce	Lavender Oil and Colorant Amount ____ ounce

The Beauty of Spritzer



Science

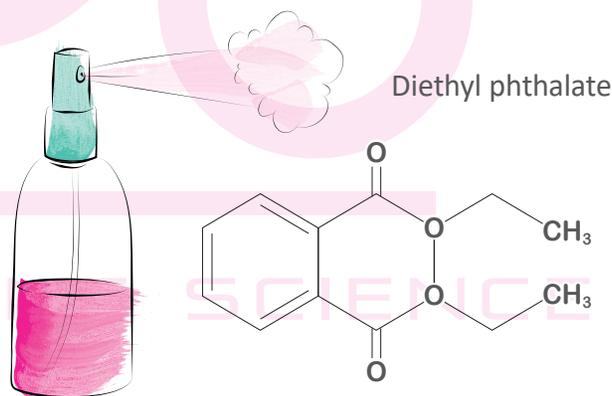
When you think of fresh smells, what scents come to mind: Lavender? Strawberry? Pink Sugar? What keeps your room and clothes smelling fresh? Spritzers are special sprays that are used to remove unwanted smells from our clothes and living spaces. Despite the popularity of air fresheners and linen sprays, do you really know what you're spraying all over your room and on your clothes? What chemistry concepts are used to make spritzers?

Spritzers and room fresheners contain aroma-compounds: chemical compounds consisting of two or more atoms, at least two from different elements. Unfortunately, most aerosol air fresheners contain harmful chemicals and impact the Earth's ozone layer too.

This is the chemical formula for diethyl phthalate (DEP). It is used to enhance the spray function in most store-bought air fresheners. Over time, DEP, as well as other ingredients in these products, can affect the nervous system, cause harm to the lungs, and have cancer-causing results.

How do they work?

Any type of "freshener" (air, linen spray, germ fighting, etc.) masks the unwanted odor, but does not eliminate it! This means you need to keep spraying periodically to continually cover that odor. It may smell like a spring meadow, but the chemicals are toxic.



Research

The best thing for the U.S. as scientists is to make our own environmentally safe spritzer! Spritzers can be made with safe ingredients like essential oils to make your room smell great without harmful chemicals. Find out more about air freshener ingredients and the Earth's ozone layer.

Research: Complete the chart below to identify some common ingredients in spritzers/air fresheners.

INGREDIENTS/CHEMICALS IN SPRITZER AND AIR FRESHENERS	TOXIC	NOT TOXIC	DOES IT HURT THE OZONE? (YES/NO)
diethyl phthalate	✓		Yes



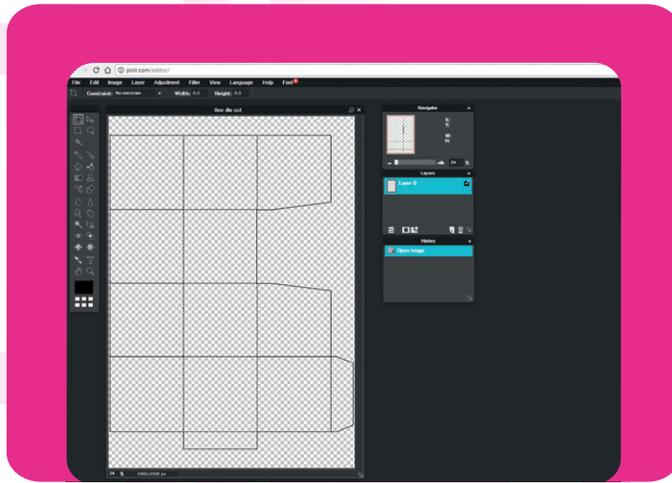
Technology

As much as artists need to have excellent drawing skills, creating things digitally is equally as important. Let's use Pixlr (<http://pixlr.com/editor>) to customize your packaging materials.

Before you begin: Find and download the image "blank_art_box.png" to your computer. This is located online in the B.O.S. resource folder.

1. Launch the Pixlr Editor.
2. Choose "Open an image from your computer".
3. Find and select the "blank_art_box.png" file.

Once the blank art box image appears on your workspace, experiment with different colors, shapes and functions of *pixlr.com* with the tools to the left of your *pixlr.com* workspace.

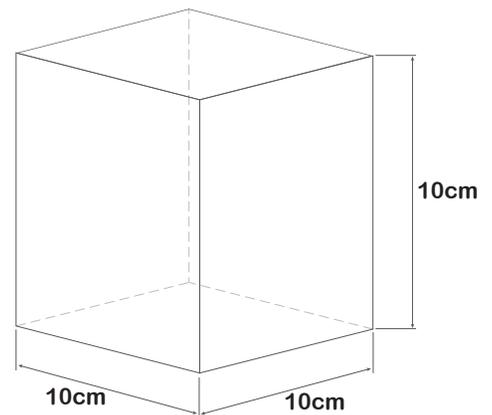


Engineering

Before we make a spritzer, we will design a gift box that is sturdy enough to hold our spritzer, has the correct dimensions, and looks appealing to our customers.

What is the formula for calculating the volume of an object?

1. Let's start by selecting one of the pre-designed gift boxes from the B.O.S. resource folder. Choose a box that you think will hold maximum weight of your product.
2. Follow the directions on the box to cut it out and fold it into a box.
3. Use tape to secure the box.
4. Measure the dimensions of the box.
5. Calculate the approximate volume of the box.
6. Predict how much weight the box might hold and write it down.
7. Test the strength of your box by holding the box by the handles and placing various weights in the box until it breaks.
8. If the box breaks with less than an ounce of water, reassemble your box and start over.



NOTES:

- Carefully follow the folding directions on the box.
- The materials used will determine the strength of your box.
- The measurements determine the weight the box will hold.

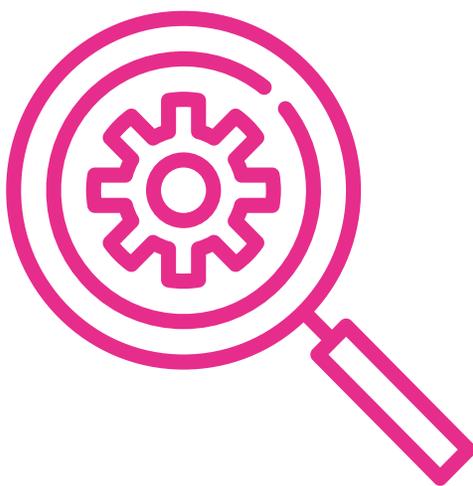
☑ **Activity:** Now that you understand the importance of package design to secure your products, let's make the product to fit into our perfect packaging!

Let's Make a Spritzer

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
1 oz Bottle	1	Beaker	1
Fine mist sprayer top	1	Funnel - optional	1
Pipette	1		
Stirrer	1		
INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
Spritzer Spray Base	21 mL	N/A	N/A
Fragrance Oil	3 mL		

☑ Procedure:

1. Use your pipette to measure the correct amount of Spritzer Spray Base into your beaker
NOTE! The pipettes in your kit holds 3 mL; therefore, you will need to calculate how many times you will fill the pipette to complete your measurements.
2. Use a clean pipette to add the fragrance oil.
NOTE! Depending on which fragrance oil you use, your spray may be slightly cloudy or have a reddish color. This won't affect how it works!
3. Stir until mixed well.
4. Pour the mixture into your bottle and top it with the sprayer.
NOTE! Your bottle should be about 80% full. You may want to use a funnel for this step to avoid spilling.
5. Shake the spritzer until mixed well.
6. Done!





Art

Free Hand Design - Great engineers make observations of their finished product. After mixing and pouring your spritzer into the bottle, you may have observed that the oil and spritzer spray base separates after sitting. Therefore, each time you use it, you will have to shake it. Create a colorful label like the sample below that instructs the user to “Shake Well Before Using.”



Design your label here:



Mathematics

A ratio compares the value of two things. In this case, we are determining the ratio of chemicals to essential oils in our spritzer. Let’s take a look at a ratio of two ingredients that are frequently used to make bath and body products. Take a look at the example.

Example: Bubble bath requires 3 cups of sodium laureth sulfate and 1 cup of water.

1 Bottle of bubble bath → The ratio of sodium laureth sulfate to water is **3 : 1**

What if you made 3 - 32 oz bottles of bubble bath?

3 Bottles of bubble bath → The ratio of sodium laureth sulfate to water is _____ ?

To determine the ratio, multiply the numbers by the same number. Multiply each part by 3 to identify the amount of ingredients needed for 3 cakes.

$$3 \times 3 : 1 \times 3 = \text{new ratio is } 9 : 3$$

So we need 9 cups of sodium laureth sulfate and 3 cups of water to make 3 bottles of bubble bath. As you can see, dividing the ratio 9 : 3 by 3 (similar to reducing a fraction to lowest terms) equals **3 : 1**.

Let’s do another together:

? Write the ratio of the essential oils in the following spritzer formulation listed below?

FORMULATION OF ESSENTIAL OILS IN THIS SPRITZER	RATIO
10 drops of Wild Orange essential oil 8 drops of Peppermint essential oil	:

? *Two of your friends birthdays are next month and you would like to make each friend a bottle of Sweet Lavender Air Freshener Spray.*

The ingredients for Sweet Lavender Air Freshener Spray are:

FORMULATION OF ESSENTIAL OILS IN THIS SPRITZER
10 drops of Lavender essential oil 5 drops of Chamomile essential oil 2 tbs of Real Vanilla extract

What is the ratio of Lavender to Chamomile? _____ :

What is the ratio of Lavender to Real Vanilla? _____ :

? *After giving your friends Sweet Lavender Air Freshener Spray for their birthday, one of them loved it so much that she asked you to make her a bottle of Summer Citrus Air Freshener Spray.*

The ingredients for Summer Citrus Air Freshener Spray are:

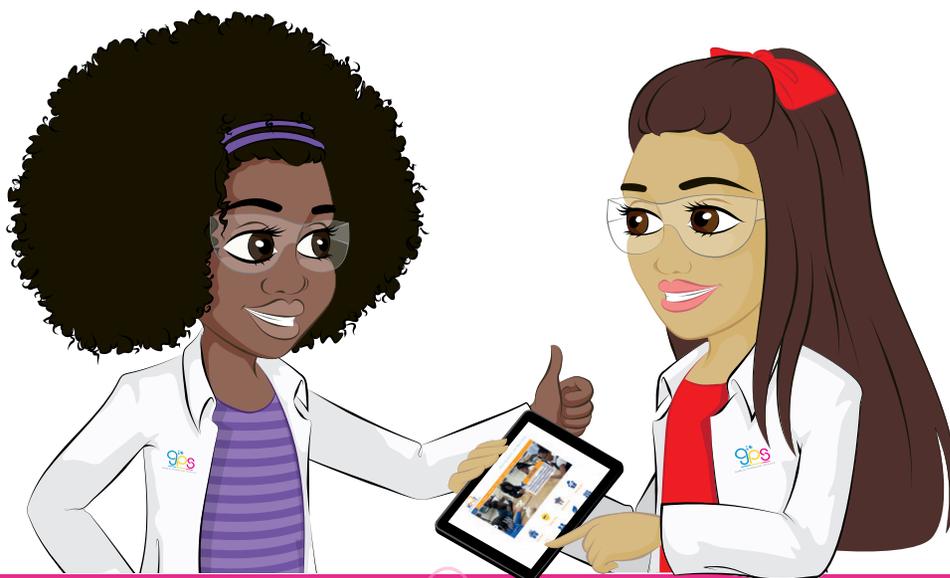
FORMULATION OF ESSENTIAL OILS IN THIS SPRITZER
5 drops of Wild Orange essential oil 5 drops of Lemon essential oil 5 drops of Lime essential oil 5 drops of Grapefruit essential oil

What is the ratio of Wild Orange to Lemon? _____ :

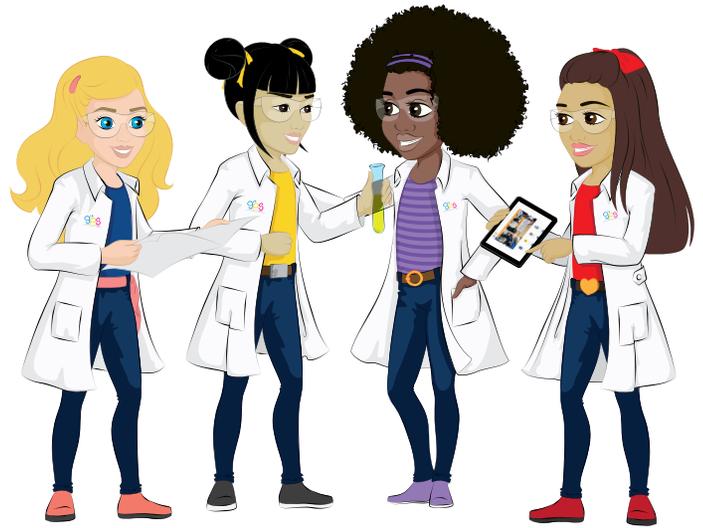
What is the ratio of Wild Orange to Lime? _____ :

What is the ratio of Wild Orange to Grapefruit? _____ :

GIRLS PURSUING SCIENCE



The Beauty of Product Labeling



Science

Do you read the label on the back of your favorite snack before eating it? Have you ever wondered why our snacks have labels? These labels list the ingredients and nutritional information of the food that we are eating. It is important to know what ingredients are in our foods in the case of allergies, a special diet, etc. Product labels provide information about the manufacturer, ingredients, quantity, price, usage, warnings, date of expiration, and how to handle the item. Products that we buy to put in (food) or on (cosmetics) our bodies are required by law to have labels. There are many types of labels such as: branding, grade, descriptive, and informative labels.

Research

Research the different types of labels listed in the table below. Write a brief description of each. You can use sources such as a dictionary or trusted science education websites to complete the table.

Example:

LABEL TYPE	DESCRIPTION
Brand	A brand label has only the name of the manufacturer applied to the product or to the package. Clothes and automobiles are examples of products that have brand labels.

? It's Your Turn:

LABEL TYPE	DESCRIPTION
Grade	
Descriptive	
Informative	



Technology

Labels have many functions and benefits to the customer as well as to the seller.

After making your products, you will be required to make labels for each of them. Before you design your label, create a data sheet that lists the different types of labels and each of their functions. Use the information in the table below to create a data sheet in Microsoft Excel.

NOTE! Refer to the B.O.S. Resource Folder to learn more about Microsoft Excel.

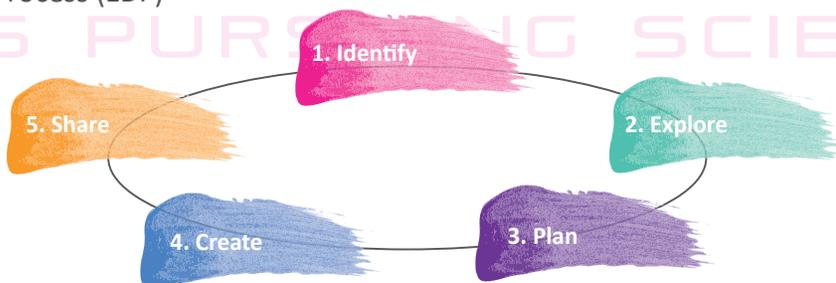
TITLE: LABELS DATA SHEET	
Product Identity	A label that list the name of product and provides a proper description which identifies the product or brand easily, e.g., lotion.
Product Description	A label that lists the quality, quantity, and method of use of the product, e.g., shampoo and conditioner.
Product Promotion	A label that displays colorful graphic designs which attract the customers to buy the product, e.g. fresh bright colors on a soapbox.
Consumer Protection	A label that lists information that protects the consumer from unsafe or unwholesome products, e.g., information about ingredients, date of manufacture and expiration dates on lip balm.
Ingredient	A label that helps to provide complete information regarding the product. It mainly includes ingredients of the product, its usage, and caution in use and cares to be taken while using it, etc.



Engineering

Labels with great designs help to sell products, therefore it is important to create a label that is attractive, provides clear information about the quantity, brand name, and ingredients. As an engineer we will design a label that fits the product packaging for the products that you have made in previous activities. Use the steps of the engineering design process to create a label that is large enough to display an eye catching design that includes your logo, valuable product information and the ingredients.

Engineering Design Process (EDP)



Use the steps of the EDP to sketch a draft label for your products.

- We have identified the problem. You need a label for your products.
- What are some options for shapes, size, and colors? Brainstorm ideas. Choose the best one.
- Use the space below to draw a diagram. Make a list of materials and resources that you will need to create your labels.

Sketch your label here:

Let's Make a Label

EQUIPMENT IN YOUR KIT	QUANTITY	CLASSROOM EQUIPMENT	QUANTITY
N/A	N/A	Sheet of plain paper	1
		Ruler	1
		Pencil	1
		Scissors	1
INGREDIENTS IN YOUR KIT	FORMULATION	CLASSROOM INGREDIENTS	FORMULATION
N/A	N/A	N/A	N/A

Procedure:

1. Measure the dimensions of your product packaging.
2. Use a plain sheet of paper to draw the dimensions.
3. Use your Excel data sheet that you created to design a label to include your product name, ingredients, quantity, and how to use the product.
4. Cut the labels out to fit your product packaging.
5. Show your labels to your friends and ask the following questions:

What do they think of when they see the label?

Are they attracted to your product?

If they saw it online or in the store, would they buy it?





Art

Now that you understand the importance of designing a label that provides important information to customers, use the space below to create a consumer protection label. Make it colorful to attract the customer's attention.

☑ **Example:**



FLAMMABLE
LIQUID

Create a Consumer Label



Mathematics

Mental Math and the Distributive Property - After making a line of beauty products, you have decided to open a store. Before opening, you have to make labels for your inventory. You would like to hire the most creative girls in your class to help design the labels. Each of the girls will be given a set of 15 color markers to create beautiful product labels. There are 25 girls in your class who can definitely handle this project.

As you sit in class, looking around the room and thinking about whom you will select, calculate the number of markers you will need in your head.

The Distributive Property - This mathematical property lets you multiply a sum by multiplying each addend separately, then adding the products.

☑ **Example:** **What do we know already?**
15 markers for each student
25 students participating

1. For this exercise, let's change one of the numbers to the sum of two smaller numbers.

$$15 = 10 + 5$$

2. Set up the problem: Use the distributive property to find the product of a number and then the sum.

$$25 (10+5) = 25 (10) + 25 (5)$$

3. Mental Math: Calculate the products in your head and add the sum.

$$25 (10) + 25 (5)$$

$$25 \times 10 = 250$$

$$25 \times 5 = 125$$

$$250 + 125 = 375$$

You will need a total of **375** color markers.

Extra: Practice solving the following problems in your head using mental math:

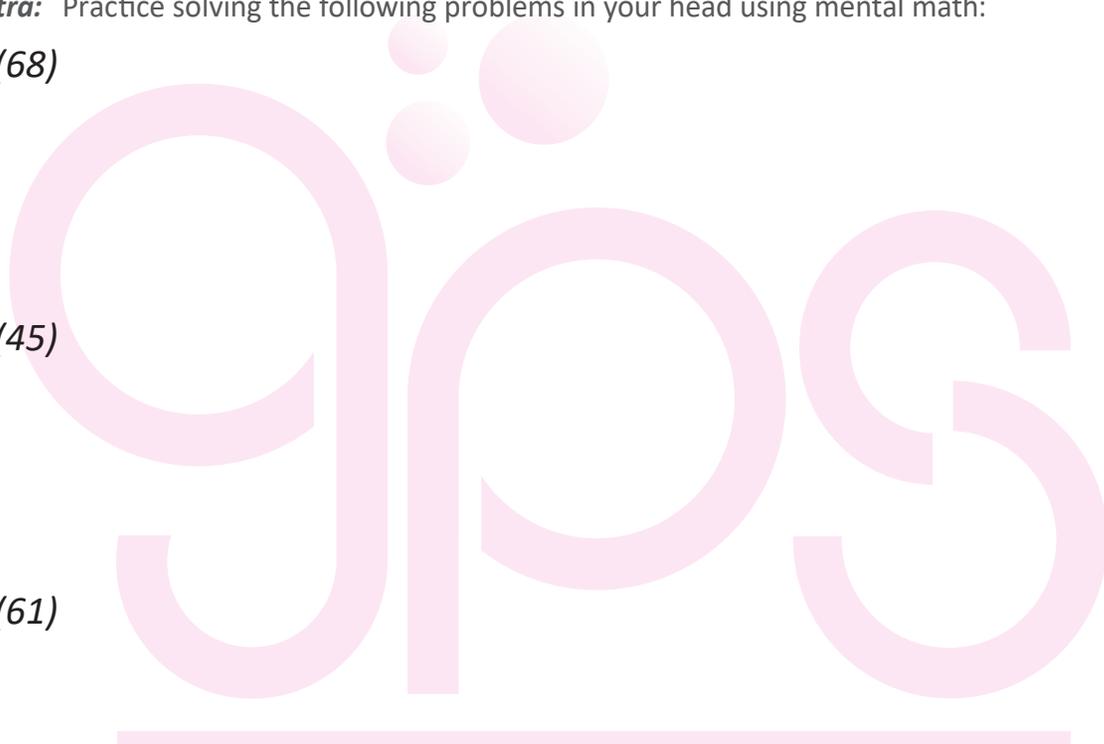
1. $4 (68)$

2. $8 (45)$

3. $3 (61)$

4. $2 (53)$

5. $9 (22)$



GIRLS PURSUING SCIENCE



STEAM Experiment #9

The Beauty of Reverse Engineering



Science

When you hear the term “reverse engineering,” it is typically referring to reversing code. However, in this section, we will be referring to reversing formulations. The dictionary definition of “reverse engineering” is “to disassemble and examine or analyze in detail (a product or device) to discover the concepts involved in manufacture usually in order to produce something similar.”

As a chemist, this means you analyze the ingredients in a product, copy the formulation, and “knock it off.” Lotions, eyeshadow, and perfumes are very popular “knock off” items which the chemists reversed engineered the formulations. Purses are also popular “knock off” items. As a scientist or engineer, it is important that you learn practical skills in reverse engineering to prepare you for a successful STEM career. Companies reverse engineer products because it is faster, easier to make, less risky, and less expensive. It is important to note that scientist and engineers analyze a product or device and find another ingredient that provide the same benefit as the ingredient that is in the competitors product. It is not the same as analyzing and using the exact same ingredients and design. There are laws in our society that protect products and designed from being copied and used without the owner’s permission.



Technology

In this section, we will “knock off” the packaging of three products and create a PowerPoint presentation to present those products as our new product line. You will need a computer with Internet and Microsoft PowerPoint access.

1. Create a new folder on your desktop. Rename it with your name.
2. Do an image search for a bottle of shower gel, shampoo, lotion, and perfume.
3. Save your images in your desktop folder. In most instances, you can right-click on the image and select “Save.”
4. Use Pixlr (www.pixlr.com) to edit the images and place your business name on each bottle.
5. Place the image back in your desktop folder.
6. Open PowerPoint and create a new presentation for your new product line.

NOTE! Have questions? Be sure to reference the B.O.S. Resource Folder for more information on PowerPoint and Pixlr.



Engineering

Now that you understand the importance of knowing how to “knock off” a product, we will compare the formulation that we used to make lip balm to the formulation of a popular lip balm that you buy from your favorite store.

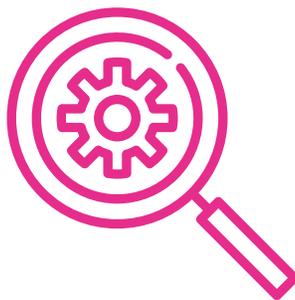
Your formulation:

MY INGREDIENTS	THE INGREDIENTS FROM THE COMPETITION
Soybean Oil	5% Coconut oil
Cocoa Butter	1% Lanolin
Shea Butter	3% Sunflower seed oil
Apricot Kernel Oil	89% Beeswax
Sweet Almond Oil	2% Peppermint oil

Follow the steps below to create a formula almost identical to the competition.

1. Analyze the ingredient list.
2. Put the ingredients in ascending order (lowest to highest).
3. Use the Internet to look up all the ingredients to learn what each ingredient does.
4. Create a formula for the competitor’s product using products that performs the same function.

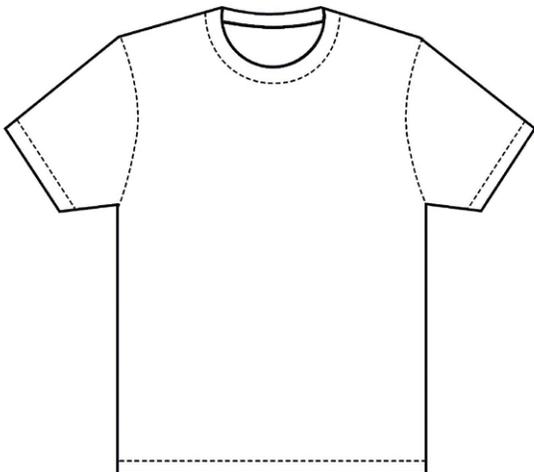
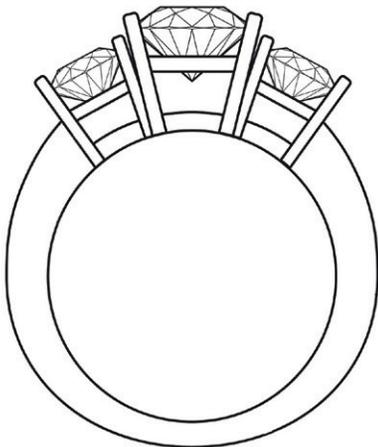
ORDER	INGREDIENT	WHAT IT DOES	FORMULA %





Art

Duplicate a Product Design - In the fashion industry, products like purses, jewelry, and clothes are popular “knock off” items. Look at the designer merchandise on the left and draw a design that looks very similar to the competitor’s more expensive version.





Part 1: Expressions

Great scientists have great mathematical skills that require understanding mathematics. In the engineering section, you were required to research and analyze the competitor’s ingredients to create a formula to duplicate the product. One way to create a formula is to use expressions to group numbers, symbols and operators (such as “+” and “x”) together to show the value of an ingredient. Example: 2×10 is a numerical expression or an arithmetic expression. However, when duplicating products, scientists combine numbers and variables to create a formula.

Let’s say, during your research of the competitor’s ingredients, you discovered that if you used four times the number of the main ingredient “a” in your list less twice the amount of ingredient “b” in the competitor’s list, you would duplicate a perfect match of competitor’s lip balm. How would you write the formula as an algebraic expression with both ingredients represented?

- ☑ **Example:**
 1. Let “a” represent your main ingredient and “b” represent the competitor’s ingredient.
 2. Write the variables: $4a$ and $2b$.
 3. Represent the mathematical operation (less) by its symbol “-.”

- ☑ **The algebraic expression is:** $4a - 2b$.
 Four times the amount of ingredient *a*
 Less twice the amount of ingredient *b*

Part 2: Mathematical Operations

Complete the table below. Write the letter that represents the mathematical operation on the line in front of the corresponding words in the table.

A. Addition

B. Subtraction

C. Multiplication

D. Division

_____ Increased by	_____ Minus	_____ Shared	_____ Plus
_____ Decreased by	_____ Times	_____ Product	_____ Quotient
_____ Sum	_____ Total	_____ Difference	_____ Twice
_____ Split between	_____ Reduced by	_____ Of	_____ Divided by
_____ More	_____ Less than		

Part 3: Variable Expressions

Let’s look at an example of translating words into a variable expression.

Remember that a variable expression has one or more variables (letters) that represent an unknown quantity.

- ☑ **Example:** Write the following as a mathematical expression with one variable:

A number increased by four.

1. First, name the variable. Let “n” represent the number.
2. Next, represent the mathematical operation by its symbol “+.”
3. Then, insert the constant (4) after the symbol.

The variable expression is $n + 4$.

Write a variable expression to represent each of the following:

1. The sum of a number and ten. _____
2. The difference between a number and five. _____
3. Four times a number. _____
4. A number squared plus three. _____
5. A number divided by seven plus seven. _____
6. Two times the quantity of an ingredient plus three. _____

The Beauty of Entrepreneurship



Research Activity

Business owners like to know as much information as they can about their product as well as their competitor's products. Use the questions below to guide your research on products that are currently being sold, what you like about them, how much do they cost and who is buying the product. This will help you to understand how to market and sell your products! You can use sources such as trusted websites on the Internet (with your teacher's permission, of course).

? **Question 1: What is your favorite type of bubble bath, bath fizzy, or perfume?**

? **Question 2: Of the product or products that you listed in Question 1, what do you like most about the product or products and why?**

? **Question 3: How much do the product or products cost?**

? **Question 4: Where do you buy your bath and body products? Why do you buy them from this store or place as opposed to other stores that sell the exact same products?**

? **Question 5: Find two bubble baths that are very popular and compare them. List things that are different about the two products.**

BUBBLE BATH A	BUBBLE BATH B
1.	1.
2.	2.
3.	3.

Steps to Building a Brand

Keep in mind the things that you liked and disliked about products that you researched in the previous section. Think about how you want your product to be different. In this activity, we will focus on one of the products that you made. In our example, we are using Bubble Bath. However, you may choose either of your products to design a label. Select one of your products and think about its features. As a business owner, your product feature is one of the distinguishing characteristics that help to boost its appeal to potential consumers. Think about a problem that your product is solving, such as dry skin. Therefore, your product feature may be that it has extra Vitamin E. This is just one thing that makes your product different.

Materials you will need:

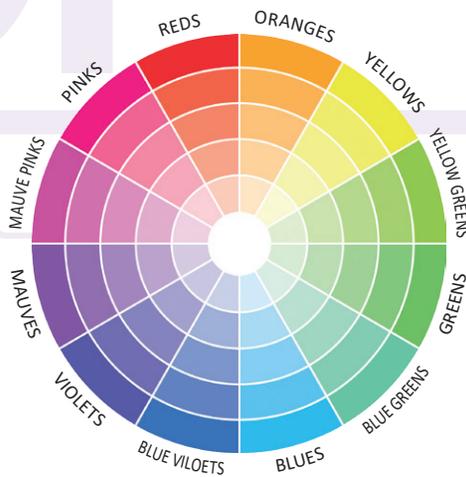
- Paper
- Color Pencils or Markers
- Computer with Internet access and word processing software application

Step 1: Give your product a name (For example: Cool and Moisturizing Bubble Bath). Keep in mind that you want something that is easy to remember so when a person has a problem, your product comes to their mind as the way to solve it.

Step 2: Test the name out on your friends. Ask them something such as: What do you think when you hear (the name you chose for your product)?

Step 3: Ask at least three (3) people. If the response is something other than what your product feature is, you should re-think the name and try three (3) additional people with whom to test the name. If at least two (2) of them tell you what you are looking for, keep the name.

Step 4: Choose Your Color(s). Use the color wheel to get ideas of which colors blend well together. Use the blocks below to color in your favorite colors.



Four empty rectangular boxes with dotted lines, intended for coloring or drawing.

Step 5: Choose your Font Type and Style. Draw different lettering in the box to test your art skills.

Font Samples:



Practice your font here:



Step 6: Use computer software to type out different fonts or research free fonts and select a font for your product name. If you use a font that is not included in your software, follow the directions that are listed on the site that you found during your research and download these fonts to your computer. (You may need your teacher to assist you with instructions on how to download new fonts).

NOTE!

*Before downloading anything from the Internet,
get your teacher's permission and assistance.*

Step 7: Create an image for your product. Use your computer to get ideas on images that you may like. Use the box below to practice drawing an image:



Step 8: If your drawing skills are not as great as you would like, you may use free clip art as an alternative. Use a search engine like Google Images to search for images to fuel your creative ideas. As your business grows, you can hire a person to design your logo.

Step 9: Take your ideas and use a graphic program like Microsoft Paint or Blender to create your logo. Then print it out, cut and tape it on your product.

The Beauty of Planning & Budgeting



The Beauty of Planning and Budgeting

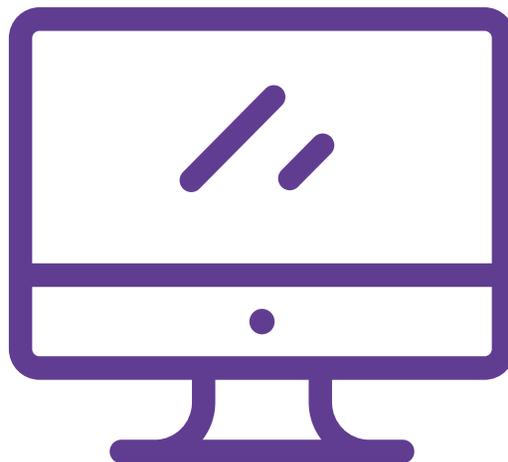
Plan and Budget

Before you start selling your products, it's important that you develop a plan and budget. Business owners develop business plans as a road map to starting and managing their business.

A **business plan** describes the business, lists the goals and details, and how they will be reached. In this section, you will answer a few questions that will help you to develop a short term business plan as an introduction to entrepreneurship.

Entrepreneurship is the process of designing, launching and running a new business. You will also develop a product budget. Budgets help entrepreneurs estimate the amount of money they have for business related spending. Then you can determine the cost of your product, how much you should sell it for, and how much money you should make as a result.

! Use the Business Plan Template in the Appendix to create a short term business plan.



The Beauty of The Budget



The Budget

This sample budget is based on the cost to make ten 2 oz bottles of bubble bath.

ITEM	PRICE	QUANTITY	PROJECT COST
			
Bubble Bath Base	\$ 2.00	20 oz	
Fragrance	\$ 1.00	1 bottle	
Color	\$ 1.50	1 bottle	
Bubble Bath Bottle	\$ 0.10	10	
Labels	\$ 0.15	1	
Lab Equipment	\$ 4.50	1	
Total Cost			

? **Question 1:** What is the total cost to make 10 (2 oz) bottles of Bubble Bath?

? **Question 2:** How much is the cost to make 1 (2 oz) bottle of Bubble Bath?

? **Question 3:** What price do you think you will charge for your 2 oz bottle of Bubble Bath?

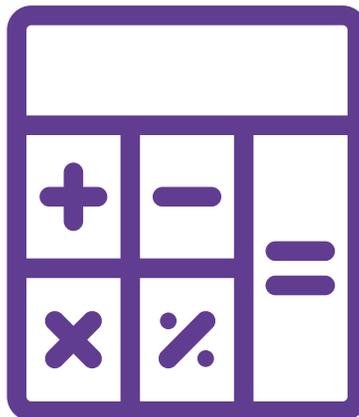
? **Question 4:** The difference between the price that your customer pay you, and the amount it cost to make it, is the profit that you will make when you sell a bottle of bubble bath. How much profit will you make if you sold 3 bottles of Bubble Bath?

? **Question 5:** Based on the cost to make 1 (2 oz) bottle of Bubble Bath, how much would it cost you if you decided to give three of your friends a free bottle of bubble bath?

? **Question 6:** Based on your sales price, listed in Question 3, how much money will you make in a month (4 weeks), if you sold three bottles of Bubble Bath each week?

NOTE!

It takes 1 bottle of fragrance base and 1 bottle of color to make ten 2 oz bottles of Bubble Bath.



The Beauty of Marketing & Advertising



Research Activity

Marketing and advertising are how businesses get their products or services sold. Business owners like to know as much information as they can about marketing and advertising before spending money to sell their products. Use the questions below to guide your research on the features of successful advertisements. This will help you to think of appropriate words and pictures to communicate your goals, understand the most effective way to market your product as well as see how other products are being advertised. With your teacher's guidance, you will need access to the Internet to include social media sites like YouTube.

Do an Internet search for "bubble bath ads online." Watch 2-3 of the current and popular video ads.

? Question 1: Did the ads have music? If so, how did the music affect you as a consumer?

? Question 2: Do the ads feature actors or graphics only?

? Question 3: What do you think the advertisers could have done differently to make the ads better?

What is your favorite video ad or TV commercial that you have watched lately?

? Question 1: What product or service is your favorite video or TV commercial trying to sell? Clothes, shoes, music, soap, food, etc.?

? Question 2: What happens in your favorite commercial that convinces you to spend your money on the product? The features? The music? The people in the ad?

? Question 3: Why is this your favorite commercial?

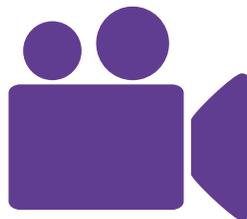
Pre-Production Activity

Before advertisements are published, they must be developed by a creative team that consists of writers and artists. Choose a partner or organize a group of three or four girls to form a creative team. The creative team works together to think of the right words and pictures to communicate the best features of their product or service. Before you begin developing your first advertisement, select a person who will write down the ideas and someone who will draw the images. To organize your creative ideas, we will use a storyboard.

Procedure

Follow the storyboard example in the Appendix as a guide to complete your storyboard for your advertisements. A storyboard is a written or graphical representation of the elements that will be included. A storyboard will save you a lot of time as well as help organize your thoughts and ideas in one easy to follow document. After reading the storyboard example, use the storyboard template to create a storyboard for your ad.

! *Review the sample storyboard in the Appendix before moving to the next section.*



The Beauty of Making a Storyboard



Create a storyboard for your ad

- Step 1:** Use the storyboard template in the Appendix to create a storyboard for your ad.
- Step 2:** The template is divided into a total of 11 frames with titles.
- Step 3:** The first three boxes are for the description, idea, and production notes. Use the description box to write a brief description of your product. Use the idea box to explain your thoughts behind your ad. Write a summary in the production note box.
- Step 4:** The final 8 boxes of the template will have pictures and text. You can draw pictures, type or handwrite a description of the action in the boxes. For each picture or action, write a script or summarize the action for your pictures.
- Step 5:** If you need more storyboard pages, make copies of the storyboard template.
- Step 6:** Use the script box to describe what is currently happening in the ad.
- Step 7:** If sound effects (music) are being used, draw or paste musical notes and text in the scene box. The sound may also be an audio recording of you or your team's voice.

NOTE!

Your advertisement may include music, voices, or words that appear on the screen. Sometimes, it includes all three. Choose the method that you think would work best for your product. In the advertising industry, this is called the "copy."

- ! **Remember to keep your ad brief; therefore, your storyboard should not be long or complex.**

Be creative! Be original! Have fun!

Create an Advertisement

Now it is time to make a fun and effective ad and to share your work with the class, community or the world! Effective advertising is what business owners do to tell people about their product or service.

Use your storyboard to create an ad that will get people to buy your product.

You have the option to create a print, video, radio, or Internet ad. Print ads use words and pictures. Video ads are great for storytelling and humor. Radio ads are effective for conveying emotions and feelings. The Internet ads reach more people faster than traditional ads.

Internet ads are also called online ads and are more likely to be viewed by your peers than traditional ads. If your learning environment permits the use of social media, post your ad to Snapchat, Facebook, or Instagram!

NOTE!

As a fun alternative to traditional ads, present your work to the class by acting it out!

Video Ad

- Computer Lab with Internet
- Cameras, computers or mobile devices with microphones
- Apps or software of your choice to edit and post your video, e.g., iMovie, iMotion HD (iOS), Magisto Video Editor & Maker (Android), Andromedia Video Editor (Android)
- Props and costumes (optional)
- Green screen (optional)
- Paper, pens or pencils
- Your Storyboard

Internet Ad

- Computer Lab with Internet
- Instructions for designing and posting your ad to a specific social media platform such as Facebook
- Cameras, computers or mobile devices with microphones
- Apps and software of your choice to edit and post your video, e.g., iMovie, iMotion HD (iOS), Magisto Video Editor & Maker (Android), Andromedia Video Editor (Android)
- Props and costumes (optional)
- Paper, pens or pencils
- Your Storyboard



Optional Resources and Materials



Print Ad

- Computer Lab with Internet
- Printer
- Software of your choice to create flyer, e.g., Microsoft Word, Publisher, Canva.com, Adobe Photoshop, or InDesign
- Paper, pens or pencils
- Your Storyboard



Radio Ad

- Computer Lab with Internet
- Recording device with microphone
- App, e.g., Smart Voice Recorder
- Paper, pens or pencils
- Your Storyboard



Class Presentation

- Props and costumes
- Students who want to sing a jingle or act it out
- Your Storyboard





Guidelines for Designing a Video Ad

- Step 1:** Capture the viewer's attention immediately! Within the first 2-5 seconds!
- Step 2:** Make it exciting and fun to watch. Keep it short and sweet!
- Step 3:** Use metaphors that your future customers can relate to.
- Step 4:** Keep your script to less than 65 words. Thirty-second video ads have only 28 seconds of audio.
- Step 5:** Include information on how and where your future customers can buy your product.
- Step 6:** Know your storyboard before going into production!



Guidelines for Designing a Web Ad

- Step 1:** Use words that urge your future customers to take an immediate action, such as "Send Text To" or on the Internet, "Click Here" or "Buy" button.
- Step 2:** Create a simple ad that's quick and can be posted to social media sites like Facebook. It's the best way to reach a lot of people fast!
- Step 3:** Search for specific instructions to post an ad to an online platform such as Facebook.
- Step 4:** Include information on how and where your future customers can buy your product.
- Step 5:** Use your storyboard to create the ad.



Guidelines for Designing a Print Ad

- Step 1:** Carefully choose words that specifically describe the benefits of your product.
- Step 2:** Select and combine colors to create a pretty color scheme.
- Step 3:** Consider the size of the text and pictures. Make sure that they fit neatly on the paper.
- Step 4:** Keep it short, grab the reader's attention, and communicate one clear idea.
- Step 5:** Determine whether you want to use graphics, photos, or both. It's important that images are clear, colorful and relate to your ad.
- Step 6:** Include information on how and where customers can buy your product.
- Step 7:** Use your storyboard to create the ad.



Guidelines for Designing a Radio Ad

- Step 1:** Select good music or sound effects.
- Step 2:** Create a rap or jingle. A short song about your product maybe good idea!
- Step 3:** Mention your product name at least three times in a 30-second ad.
- Step 4:** Keep your script short (less than 65 words for a 30-second ad are typical).
- Step 5:** You will not have the art of pictures or video to connect to customers so select your voices carefully. Chose the person in your group with the best sounding voice or who reads aloud very well.
- Step 6:** Speak with a sense of urgency in the first four seconds of the ad. It is critical in capturing the listener's attention.
- Step 7:** Use music that is not protected by copyright and can be used without paying (often costly) fees.
- Step 8:** Include information on how and where your future customers can buy your product.
- Step 9:** Know your storyboard before recording your ad!



Class Presentation

- Step 1:** Select the props and pictures to use.
- Step 2:** Chose a role for each member of the group: speaker, singer, actor, etc.
- Step 3:** Use creativity as if you were making a video.
- Step 4:** Use your storyboard.
- Step 5:** Have fun!

APPENDIX



STORYBOARD EXAMPLE

Your Name Valeri

Advertisement or Product Title Smart Bubbles!

Advertisement Description

We are a team of 3 girls. The name of our product is 'Smart Bubbles.'

Smart Bubbles is made with shea moisturizer and lavender so when you take a bath and add Smart Bubbles, it softens your skin and relaxes your body.

Smart Bubbles uses a secret ingredient that works like magic!

When you mix it in water, the bubbles float around the tub! We will use pictures and music to communicate our message to customers.

As the pictures are displayed, we will describe the unique qualities and benefits of Smart Bubbles!

Commercial Idea

Girls use a special bubble bath called "Smart Bubbles" before going to bed at night. The bubble bath has special ingredients that soften the skin and leave you feeling and looking good.

Smart Bubbles has magic bubbles that float around the tub. Oh what fun!

Production Notes

THEME Smart Bubbles are fun, and make you feel and look good!

TONE Happy and Fun

CASTING Graphics and voice, no actors.

MUSIC Hip Hop Beat, rhythm enhanced.

Scene 1



Script

We will introduce Smart Bubble as a "Smart" bubble bath that helps relax you before bed, and by morning your brain is energized! You look sharp! Smart! And ready to go!

Scene 2



Script

Show a picture of a girl in the tub who is enjoying her bath. While showing the picture, say "SMART BUBBLES are fun bubbles! And feel terrific!"

Scene 3



Script

Show another picture and say "Smart Bubbles are sparkling bubbles! Catch the bubbles as they float around the tub!"

Scene 4



Script

Show a picture of a girl that is looking good and ready for school! Say "Get Smart Bubbles... Get Pretty Smart!"

Scene 1

Script

Scene 2

Script

Scene 3

Script

Scene 4

Script

GIRLS PURSUING SCIENCE



My Business Plan

Draw or glue your logo here

GIRLS PURSUING SCIENCE

Name of Your Business

Date

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Owner(s)	96
Summary	97

GIRLS PURSUING SCIENCE

About Us

- In this section, write a paragraph about why you want to start a business and describe what you are selling.

- Write a paragraph explaining the current position of your idea such as just starting (Startup Phase) or Growth Phase (you are ready to expand your business), etc. Also state the type of business that you are in, e.g., skin care, hair, etc.

- Briefly state what makes your product better than other similar products and why should someone buy it.



Objectives

List at least three objectives for your business. The objectives are the results you hope to achieve and maintain as you run and grow your business. Make sure your objectives are very specific and not too vague. Include a date for achieving your goal. This will keep you focused and keep your objectives short and sweet. This will also prevent you from getting too overwhelmed with all you may have going on in school.

An example of a good business objective:

I will sell at least two products a week for the first six months of my business.

1. _____
2. _____
3. _____

GIRLS PURSUING SCIENCE

Open FOR BUSINESS

