# Designing Lotion: A Hand Cream Experiment

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# Florida Next Generation Science Standards:

## STANDARDS SCIENCE HIGH SCHOOL:

**SC.912.N.1.1 –** Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science. This includes posing questions about the natural world, conducting systematic observations, and using tools to gather, analyze, and interpret data.

**SC.912.P.8.6 –** Distinguish between bonding forces holding compounds together and other attractive forces, including hydrogen bonding and van der Waals forces.

**SC.912.P.8.9 –** Apply the mole concept and the law of conservation of mass to calculate quantities of chemicals participating in reactions.

**MA.912.DP.1.1 –** Given a set of data, select an appropriate method to represent the data, depending on whether it is numerical or categorical data and on whether it is univariate or bivariate. Instruction includes discussions regarding the strengths and weaknesses of each data display.

**MA.912.DP.1.2 –** Interpret data distributions represented in various ways. State whether the data is numerical or categorical, whether it is univariate or bivariate and interpret the different components and quantities in the display.

**ELA.11.C.2.1 –** Present information orally, with a logical organization, coherent focus, and credible evidence, while employing effective rhetorical devices where appropriate.

**ELA.10.C.4.1 –** Conduct research to answer a question, refining the scope of the question to align with findings and synthesizing information from multiple reliable and valid sources.

**SS.912.E.1.1 –** Identify the factors of production and why they are necessary for the production of goods and services.

**SS.912.E.1.3 –** Compare how the various economic systems (i.e., traditional, market, command, mixed) answer the questions: (1) What to produce? (2) How to produce? and (3) For whom to produce?

**VA.912.F.1.1 –** Use divergent thinking, abstract reasoning, and various processes to demonstrate imaginative or innovative solutions for art problems.

**VA.912.H.3.2 –** Apply the critical-thinking and problem-solving skills used in art to develop creative solutions for real-life issues.

# Florida Next Generation Science Standards:

## STANDARDS MIDDLE SCHOOL:

**SC.8.P.9.2 –** Differentiate between physical changes and chemical changes.

**SC.7.P.9.3 –** Investigate and describe how temperature influences chemical changes.

**MA.7.DP.1.5 –** Given a real-world numerical or categorical data set, choose and create an appropriate graphical representation.

**ELA.8.C.1.3 –** Write to argue a position, supporting at least one claim and rebutting at least one counterclaim with logical reasoning, credible evidence from sources, elaboration, and using a logical organizational structure.

**SS.8.Fl.2.2** – Analyze a source's incentives in providing information about a good or service, and how a consumer can better assess the quality and usefulness of the information.

**VA.68.H.3.2 -** Discuss the use of background knowledge and critical-thinking skills, learned in the visual arts, to understand varying concepts, viewpoints, and solutions.

# Florida Next Generation Science Standards:

## STANDARDS ELEMENTARY:

**SC.4.P.9.1 –** Identify some familiar changes in materials that result in other materials with different characteristics, such as decaying animal or plant matter, burning, rusting, and cooking.

**SC.5.P.8.4 –** Explore the scientific theory of atoms (also called atomic theory) by recognizing that all matter is composed of parts that are too small to be seen without magnification.

**MA.5.DP.1.1:** Collect and represent numerical data, including fractional and decimal values, using tables, line graphs or line plots.

**ELA.5.C.1.3:** Write to make a claim supporting a perspective with logical reasons, relevant evidence from sources, elaboration, and an organizational structure with varied transitions.

**SC.4.FL.1.7** – Entrepreneurs are people who start new businesses. Entrepreneurs do not know if their new businesses will be successful and earn a profit. Identify ways in which starting a business is risky for entrepreneurs.

**VA.4.F.1.2** – Examine and apply creative solutions to solve an artistic problem.

## Goals:

I wanted to have a project that would bridge the gap between abstract textbook chemistry and tangible everyday consumer products. By taking the role of cosmetic chemists, students connect classroom theory to product formulation, marketing and material science. This project works well for any grade level and incorporates the other subject matters in Science to be an excellent STEAM project. I have used it with my Honors Chemistry classes and AICE Environmental Management AS Level to explore and have discussions on the environmental impacts of material science, globalization and trade, and even plastic waste.

Students are challenged by implementing the omission strategy, where we deliberately leave out key ingredients such as the emulsifier, to provide immediate visual proof that polar (water) and nonpolar (oil) molecules separate on their own. Students are then guided on a strict 1:1 stoichiometric acid-base reaction (neutralizing steric acid with triethanolamine) to synthesize a functional surfactant and alter sub-microscopic molecular bonds. In addition, students can calculate the mass percentages, raw ingredient ratios, scaling factors and percent yield calculations. An integration of cost-benefit analysis could be applied in this lab to determine the economics of producing and selling a product like hand lotion. Students also get the opportunity to design their own labels, add their own signature scent with essentials oils and mark their product to "sell".

This activity can be expanded to include all the facets of a STEAM project or can be completed piecewise to meet the needs of the learners. By participating in this challenge, teachers are able to answer, "When will I ever use this?" by showing students how chemical composition, directly dictates product performance, stability, spreadability and texture. Students execute the engineering design loop by shifting from passive recipe-followers into active problem-solvers who run empirical testing stations, diagnose product failures and use data to redesign better recipes like quality control managers in manufacturing plants. Student engagement is boosted throughout this lesson as the students are able to keep their labeled, custom hand creams, shifting classroom sentiment from "boring" to "fun" and inspire future STEM or entrepreneurial interest.

In my classroom, my chemistry students followed the omission strategy where they first synthesized their product with a missing ingredient and comparing the outcomes on the first day of the lesson. We had already covered chemical bonds, stoichiometry, and chemical reactions as part of unit of studies. I pushed them further to formulate a "better" recipe to test and compare it to my standard recipe on the second day of the lesson. On the final day, students worked on their labels and completed their marketing presentation and lab report as Canva projects.

In my AICE Environmental Management, the students followed the straightforward prescribed recipe to make the lotion and add their own scents. They did not participate in the label making and marketing activity. But we did have discussions on waste management, plastic recycling and the role of globalization in trade and manufacturing. Students discussed how essential global trade and markets are necessary to maintain the commodity of goods and the role personal care products have in waste management.

This project is adaptable across grade levels, making it an excellent addition to any curriculum. The science behind making the lotions is straightforward and can be modified to any grade level where students are simply following a prescribed recipe to make the lotions to see how nonpolar and polar molecules interact, to a full exploration with a missing reactant to verify the effects on the lotion product. Presentations on marketing, business design, label making and the science learned can be used to assess student's learning. A pre and post test on the science of lotion making can be utilized to gauge learning outcomes.

## Objectives:

- Students will be able to explain how polar (water), and nonpolar (oil) molecules interact and prove the necessity of emulsifiers by executing the "omission strategy" to observe phase separation when the surfactant is absent.
- Students will be able to calculate and execute a 1:1 stoichiometric mole ratio between stearic acid and triethanolamine to synthesize a functional emulsifier that alters molecular bonding and binds water and oil into a uniform mixture.
- Students will be able to evaluate how varying ingredient ratios—such as waxes, oils, and water—directly dictate macroscopic properties like texture, spreadability, viscosity, and product stability.
- Students will be able to calculate raw ingredient mass ratios, exact percent compositions, and scaling factors required to scale up chemical formulas accurately.
- Students will be able to weigh finished products to compute their actual percent yield against theoretical starting masses, identifying sources of physical material loss during production.
- Students will be able to select, construct, and analyze appropriate graphical representations of physical testing data (such as texture ratings, phase separation times, and pH levels) to evaluate product performance.
- Students will be able to apply the engineering design process by using empirical data and diagnostic analysis to troubleshoot formulation failures and engineer a revised, optimized lotion recipe.
- Students will be able to analyze the environmental impact of plastic waste management.
- Students will be able to articulate how abstract high school chemistry principles apply directly to personal care manufacturing, product safety, marketing, and commercial cosmetics entrepreneurship.

# Project Overview:

I teach 9-12 at Miami Norland Senior High School. This project is an applied cosmetic chemistry activity that transforms abstract high school chemistry into a tangible, real-world engineering challenge. By stepping into the role of cosmetic chemists and product developers, students formulate, test, analyze and redesign consumer hand lotions. The students created their own lotion by either perfecting an emulsification after missing an ingredient and designing their own formulation or following a prescribed formulation. Students were able to then integrate their own signature scent by adding a mixture of different essential oils and bottling it up in their individual containers. They also had the ability to design their own label and mark their product to "sell".

This enables students to connect textbook concepts like molecular polarity, chemical neutralization and stoichiometry directly to everyday personal care products. High school students frequently struggle with abstract chemistry concepts, such as chemical bonding, intermolecular forces, and stoichiometry, because they feel disconnected from daily experience. This project directly addresses the perennial classroom question, "When will I ever use this?" by demonstrating how molecular composition directly controls macroscopic properties like product stability, texture, viscosity, and skin feel.

Survey results from 125 high school chemistry students validated the project's motivational and education impact where:

- Prior to the lab, 32% of students anticipated chemistry would be boring or confusing. Following the project, 37% reported that chemistry is "fun" and 52% expressed increased interest in exploring STEM electives.
- 89% of students reported that creating a functional, personalized product they could keep made the learning experience significantly more meaningful.

Some examples of how this project could be applied to other classes and grade levels:

In science, students observe molecular polarity, intermolecular forces, and phase changes firsthand by synthesizing emulsions and testing ingredient omission variables. They also perform an acid-base neutralization reaction by reacting stearic acid with triethanolamine to create a custom emulsifying surfactant. Abstract molecular concepts become instantly visible. Watching polar water and nonpolar oil separate without an emulsifier provides concrete proof of "like dissolves like," turning memorized definitions into intuitive understanding.

In mathematics, students calculate ingredient mass ratios, solve multi-step percent composition equations, apply scaling factors to adjust batch yields, convert grams to moles using molar mass, and compute percent yield. They also construct and analyze comparative graphs tracking physical metrics like texture, viscosity, or melting speed. Math is transformed from abstract whiteboard drills into an essential manufacturing tool. Students realize that precise calculations directly control whether a product succeeds or fails, building confidence in applied data analysis.

In Language arts, students complete structured lab summaries, draft diagnostic troubleshooting explanations for formula defects, write persuasive packaging copy, and present experimental findings orally or in technical reports to market their products. Students develop technical literacy by translating quantitative lab observations into clear, evidence-based prose, where they are able to communicate their findings to diverse audiences.

In Social Studies, students can explore the history of cosmetics, industrial resource allocation, consumer safety regulations, supply chain resourcing raw materials, and the economic principles of production costs, pricing and consumer demand. Students bridge science and society, learning how chemical innovation drives consumer markets and local economies. Creating a marketable, finished item sparks interest in cosmetics

entrepreneurship, helping students understand the trade-offs businesses make between raw material costs, product stability, and consumer appeal. Discussions on waste management and resource allocations can lead to a greater understanding of globalization of trade and goods.

In Visual Arts, students evaluate the cosmetic aesthetics —such as product color, smoothness, and visual consistency—and design custom packaging, logos, and product labels for their lotion jars. They apply graphic design principles, color theory, and visual communication strategies to clearly convey key product attributes, scent profiles, and safety information to target consumers. Students see how graphic design and aesthetic choices transform a raw chemical mixture into a market-ready consumer item. Designing unique labels fosters personal ownership and pride, while showing how visual storytelling drives brand identity, consumer appeal, and commercial success

## Lesson Plan High School Adaptation (Grades 9-12)

Overview & Objectives

Students act as cosmetic process engineers to explore chemical bonding, molecular polarity, and stoichiometry.

Students will be able to:

- Calculate reactant quantities using 1: 1 mole ratios and determine percent yield.
- Evaluate product texture, viscosity, and pH using data tables and graphs.
- Analyze consumer production costs, market pricing, and product packaging design.
- To investigate how molecular polarity, intermolecular forces, and stoichiometric calculations dictate the stability, texture, and physical performance of personal care emulsions.
- To explore how different ingredients—water, oil, wax, and an emulsifier—affect the texture, stability, and appearance of a lotion.

Materials Needed:

| Nonpolar Phase | Polar Phase | Equipment |
|---|---|---|
| Stearic acid (5.5 g),<br>Shea Butter (4 g),<br>Coconut or Mineral oil (5 mL)<br>Optional:<br>Vitamin D oil (0.5 mL, reduce other oil by 0.5 mL) | Deionized water (25 mL),<br>Triethanolamine (1 mL),<br>Propylene glycol (0.5 mL). | Hot plates<br>Digital Scale<br>125-mL, 250-mL, 400-mL beakers,<br>Graduated cylinder<br>Crucible or beaker tongs<br>Pipettes or Syringes<br>Stirring rods or Stir Sticks<br>pH paper.<br>Whiteboards to record Data |

Background Information:

- Lotions are mixtures of water (polar) and oils (nonpolar). Because these two types of molecules do not naturally mix, a special compound called an emulsifier is needed.
- Emulsifiers have both polar and nonpolar regions, allowing them to bind water and oil together to create a smooth, stable mixture.
- In this lab, you will investigate how different ingredients contribute to the texture, appearance, and stability of a lotion.
- Safety: Must wear gloves, goggles and apron

Day 0: Teacher Preparation

Set up all the materials in a centralized location and allow student groups to go collect their needed materials. Have the students weigh out the materials needed for the nonpolar phase and measure the volumes needed in the polar phases to bring back to their workstations. Print out the Procedures for each Mixture (A, B, C or D).Place these on the lab stations.

If you want students to make each mixture, have them divide the amounts into half or quarters with 4 smaller beakers so they can make the direct observations. This lab is designed that each group makes one of the 4 mixtures, compare data whole group and then reformulate with the designated prescribed recipe or add the missing ingredient to complete their lotion. The choice depends on time and availability of materials.

If students need more guided practice, provide them with the premeasured amounts at their stations akin to *mise en place* (everything in its place).

Day 1: Pre-Lab Calculations and Synthesis Lab

1. Introduction (30 minutes):

Direct instruction on molecular polarity, dipole moments, intermolecular forces and surfactant chemistry may be reviewed. Students can answer the pre-lab questions. Review of Stoichiometric Calculations. Students calculate the theoretical yield and require moles of triethanolamine needed to neutralize 5.0 g of stearic acid at a 1:1 mole ratio.

Alternatively, students can complete a pre-lab assessment to gauge their understating and measure their feelings about chemistry/science overall. The amount of background information and context provided to students is dependent on the goals of the lesson and ultimate work product that the student produces.

2. Omission Strategy (30 to 60 minutes):

Students teams synthesize one of four batches or all the batches depending on time and availability of materials. Students will first need to set up a hot plate with a 400-mL beaker filled halfway with tap water and heat up to make the water bath. Water need to be warm enough to melt wax and oils, but not too hot.

Students will record observations on appearance, texture mixture, temperature and pH.

Mixture A (control) will have all the ingredients, while the other mixtures are missing an ingredient.

Print Procedures on their own half sheets for the students to follow. Place at their Lab Station.

Procedures for Mixture A, **complete lotion**:

1. In the 250-mL beaker, add 5.5 g of stearic acid, 4.0 g of shea butter, and 5 mL of coconut oil.
2. In a 150-mL beaker, add 25 mL of water, 1 mL triethanolamine, and 0.5 mL propylene glycol.
3. Place the 250-mL beaker directly on the hot plate for 5 minutes or until completely melted on setting 3 or 4. Set on the lab table.
4. Using the crucible tongs, hold the edge of the 150-mL beaker in the water bath until the liquids completely mix. Set on the lab table
5. Pour the ingredients of the small beaker into the larger beaker, stir for 5 minutes until smooth.

Mixture B, **missing oil**:

1. In the 250-mL beaker, add 5.5 g of stearic acid, 4.0 g of shea butter, and **NO coconut oil.**
2. In a 150-mL beaker, add 25 mL of water, 1 mL triethanolamine, and 0.5 mL propylene glycol.
3. Place the 250-mL beaker directly on the hot plate for 5 minutes or until completely melted on setting 3 or 4. Set on the lab table.
4. Using the crucible tongs, hold the edge of the 150-mL beaker in the water bath until the liquids completely mix. Set on the lab table
5. Pour the ingredients of the small beaker into the larger beaker, stir for 5 minutes until smooth.

Mixture C, **missing emulsifier**:

1. In the 250-mL beaker, add 5.5 g of stearic acid, 4.0 g of shea butter, and 5 mL of coconut oil.
2. In a 150-mL beaker, add 25 mL of water, **NO triethanolamine**, and 0.5 mL propylene glycol.
3. Place the 250-mL beaker directly on the hot plate for 5 minutes or until completely melted on setting 3 or 4. Set on the lab table.
4. Using the crucible tongs, hold the edge of the 150-mL beaker in the water bath until the liquids completely mix. Set on the lab table
5. Pour the ingredients of the small beaker into the larger beaker, stir for 5 minutes until smooth.

Mixture D, **missing wax**:

1. In the 250-mL beaker, add 5.5 g of stearic acid, **NO shea butter**, and 5 mL of coconut oil.
2. In a 150-mL beaker, add 25 mL of water, 1 mL triethanolamine, and 0.5 mL propylene glycol.
3. Place the 250-mL beaker directly on the hot plate for 5 minutes or until completely melted on setting 3 or 4. Set on the lab table.
4. Using the crucible tongs, hold the edge of the 150-mL beaker in the water bath until the liquids completely mix. Set on the lab table
5. Pour the ingredients of the small beaker into the larger beaker, stir for 5 minutes until smooth.

After completing the mixtures, the students add the missing ingredients to create a stable lotion. Additionally, they could create their own formulation to manipulate the creaminess, texture, appearance, feel and viscosity of their lotion. This would be part of the Engineering Deign Process.

After completing the stable lotion, students need to test for a neural pH. Students should do a spot test to check for any sensitivity to the ingredients. This would have them dab a small amount of the created lotion on their forearm to check for any reactions.

Students with sensitivities should not add any essential oils to their lotions.

The students can add a few drops of the essential oils to the batch in the beaker. A standard batch can have 5 to 6 drops of oil added, more if they want extra smell. Students will fill their lotion containers with equal amounts of their created product to take home.

3. Empirical Analysis (15 to 30 minutes)

Groups measure time to phase separation, test pH, record appearance, texture of mixture, viscosity and stability. They can also plot comparative bar graphs. Testing the material occurs as they complete observations.

<u>Day 2: Product Branding and Lab Report</u>

Students design a commercial product label using software such as Canva to design label. Uploaded to google classroom LMS, all can be collected to be printed in bulk. Student can calculate unit production costs, establish retail pricing and create a business plan or marketing plan to “sell” their product.

A formal lab report containing stoichiometric calculations, percentage yield analysis, graphing of physical properties, diagnostic troubleshooting of formula failures and a custom label design can be completed.

# Hand Cream Chemistry High School Worksheet

Name: _____ Date: _____ Period: _____

**Lab: Investigating Polarity, Emulsions and Lotion Ingredients**

**Purpose**

To investigate how molecular polarity, intermolecular forces, and stoichiometric calculations dictate the stability, texture, and physical performance of personal care emulsions.

To explore how different ingredients—water, oil, wax, and an emulsifier—affect the texture, stability, and appearance of a lotion.

**Background**

Lotions are mixtures of water (polar) and oils (nonpolar). Because these two types of molecules do not naturally mix, a special compound called an emulsifier is needed. Emulsifiers have both polar and nonpolar regions, allowing them to bind water and oil together to create a smooth, stable mixture. In this lab, you will investigate how different ingredients contribute to the texture, appearance, and stability of a lotion.

**Part 1: Pre-Lab Chemical Concepts & Stoichiometry**

1. Define a **polar molecule** versus a **nonpolar molecule** in terms of electronegativity and dipole moments.

_____

_____

_____

2. Explain why water and mineral oil are immiscible on a sub-microscopic level.

_____

_____

_____

3. What is an emulsifier? What does it help do?

_____

_____

_____

4. Stoichiometric Calculation: Steric acid ($C_{18}H_{36}O_2$, molar mass = 284.48 g $mol^{-1}$) reacts with triethanolamine ($C_6H_{15}NO_3$, molar mass = 149.19 g $mol^{-1}$) in a strict 1:1 mole ratio to form the emulsifier triethanolammonium stearate.

   If your formulation requires 5.00 g of stearic acid, calculate the exact number of moles of stearic acid used:

$$moles\ of\ stearic\ acid = \frac{5.00\ g}{284.48\ g\ mol^{-1}} = _____ mol$$

Based on the 1:1 stoichiometric ratio, calculate the mass in grams of triethanolamine required to react completely

$$required\ mass\ of\ triethanolamine = _____ mol\ x\ 149.19\ g\ mol^{-1} = _____ g$$

**Part 2: Experimental Data Collection (Omission Strategy)**

Prepare the four mixtures as directed in the laboratory procedure. Record qualitative and quantitative observations in the data table below:

| Formulation Variable | Ingredients Included | Visual Appearance & Color | Texture & Viscosity (Rate 1-5) | Phase Stability (Does it separate?) | Measured pH |
|---|---|---|---|---|---|
| Mixture A (control) | Water, Wax, Emulsifier | | | | |
| Mixture B (Missing Oil) | Water, Oil, Wax, Emulsifier | | | | |
| Mixture C (Missing Emulsifier) | Water, Oil, Wax | | | | |
| Mixture D (Missing Wax) | Water, Oil, Emulsifier | | | | |

Additional Observations (Include written and visual observations in this space)

**Part 3: Yield & Diagnostic Analysis**

1. Percent Yield Calculation

$$Percent\ Yield = \left(\frac{Actual\ Mass\ of\ Recovered\ Lotion\ (g)}{Total\ Mass\ of\ Starting\ Ingreidents\ (g)}\right)\ x\ 100$$

Total Starting Mass: _____ g | Actual Recovered Mass: _____ g | Yield: _____%

2. Explain the physical cause of product loss during the heating and mixing process. Where was the missing mass lost?

_____

_____

_____

3. Compare Mixture A and Mixture C. Using evidence regarding intermolecular forces, explain why Mixture C failed to form a uniform cream and describe how you would modify the formula to increase shelf-life stability

_____

_____

_____

_____

_____

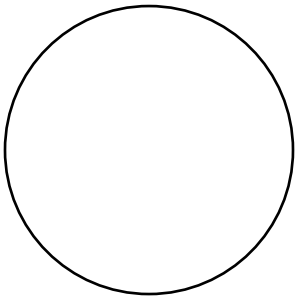
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**Part 4: Packaging & Economic Design**

1. Unit Cost Analysis: If raw ingredients cost $0.04 per gram and packaging containers cost $0.35 per unit, calculate the total cost to manufacture 1 unit (35 g net weight) of your custom lotion.

$$Manufacturing\ Cost = (35\ g\ x\ \$0.04) + \$0.35 = \$\ _____$$

2. Product Label Design: In the space below, design a compliment primary design panel for your lotion including Brand Name, Net Weight, Scent Profile, and key Chemical Features (e.g. pH-balanced Emulsion). Finish Design on Canva.



## Lesson Plan Middle School Adaptation (Grades 6-8)

Overview & Objectives:

Students investigate the physical properties of matter, differentiate between solutions and heterogenous mixtures, and explore how engineering design improves everyday products. As part of preparation for this lab, teachers must make decision whether students will measure and mix their own nonpolar and polar ingredients, or if teacher will premix and provide students with the pre-measure amount of nonpolar and polar ingredients. Teacher will add the emulsifying agent (triethanolamine) to each group's sample when they are ready for that step in the lab.

**Students will be able to:**

- Differentiate between polar and nonpolar substances based on physical observations.
- Measure liquid volumes and masses accurately to calculate percentage ratios.
- Graph texture ratings and spreadability metrics across variable formulas.
- Write explanatory technical summaries and design functional container labels

Materials Needed:

| Nonpolar Phase | Polar Phase | Equipment |
|---|---|---|
| Stearic acid (5.5 g),<br>Shea Butter (4 g),<br>Coconut or Mineral oil (5 mL)<br>Optional:<br>Vitamin D oil (0.5 mL, reduce other oil by 0.5 mL) | Deionized water (25 mL),<br>Triethanolamine (1 mL),<br>Propylene glycol (0.5 mL). | Hot plates<br>Digital Scale<br>125-mL, 250-mL, 400-mL beakers,<br>Graduated cylinder<br>Crucible or beaker tongs<br>Pipettes or Syringes<br>Stirring rods or Stir Sticks<br>pH paper.<br>Construction Paper |

Background Information:

- Lotions are mixtures of water (polar) and oils (nonpolar). Because these two types of molecules do not naturally mix, a special compound called an emulsifier is needed.
- Emulsifiers have both polar and nonpolar regions, allowing them to bind water and oil together to create a smooth, stable mixture.
- In this lab, you will investigate how different ingredients contribute to the texture, appearance, and stability of a lotion.
- Safety: Must wear gloves, goggles and apron

Day 0: Teacher Preparation

For each group, they will get 4 different mixtures that ideally are pre-prepared. Do the following.

1. Create two samples of the following nonpolar mixtures for each group: In the 250-mL beaker, add 5.5 g of stearic acid, 4.0 g of shea butter, and 5 mL of coconut oil. Cover with parafilm or a watch-glass. Set aside
2. In a 150-mL beaker, add 25 mL of water and 0.5 mL propylene glycol. **DO NOT** add the 1 mL triethanolamine until the day of the lab. Save in bottle or cover beaker in parafilm. Set aside
3. In a second 150-mL Beaker, add 40 mL of water and 0.5 mL propylene glycol. **DO NOT** add the 1 mL triethanolamine until the day of the lab. Save in bottle or cover beaker in parafilm. Set aside.

Day 1: Lab Procedures & Marketing

1. Introduction

Teacher demonstrates mixing water and oil in a clear flask to show layer separation. Teacher adds a drop of emulsifying agent (liquid soap or triethanolamine) and shakes to demonstrate an emulsion. Students will answer pre-lab questions.

2. Formulation Lab

Students follow a recipe to create the hand cream sample. If mixtures are premixed per group, as provided by the teacher, students will add the nonpolar and polar ingredients together when needed. The students should use the same nonpolar mixture for both formulas, but one formula will have the 25-mL water solution and the other will have the 40-mL water solution.

Procedures for Mixture, complete lotion:

1) Grab the prefilled nonpolar ingredients in the 250-mL beaker, place on hot plate for 5 minutes or until completely melted on setting 3 or 4, set on lab table.
2) Set a water bath and use the crucible tongs, hold the edge of the 150-mL beaker with the polar ingredients in the water bath until the liquids completely mix. Set on the lab table.
3) **AT this point, the teacher should add the 1 mL triethanolamine to each student's solution.**
4) Pour the ingredients of the small beaker into the larger beaker, stir for 5 minutes until smooth.
5) Students should have two solutions, one with the standard amount of water and one with excess water.

3. Data collection

Students can collect data on appearance, texture, viscosity, pH. Dependent on what teacher wants students to record. Students will test for water barrier using construction paper.

4. Marketing and Branding

Groups write a product description and create a brand name and label for their lotion.

Day 2: Finishing Activity

Students complete the lab observations, write a paragraph on observations and draw a conclusion on what they learned. Students can present their lotion ideas to the class.

## Hand Cream Chemistry Middle School Worksheet

Name: _____ Date: _____ Period: _____

**Lab: Formulations, mixtures and Product Testing**

**Part 1: Pre Lab Questions**

1. What is the difference between a homogeneous mixture and a heterogeneous mixture?

_____

_____

_____

2. Predict what happens when you mix oil and water together without soap or an emulsifier. Why?

_____

_____

_____

Part 2: Formulation Data Collection

Follow your teacher's directions to prepare Formula 1 and Formula 2

Formula 1:

Beaker A: 5.5 g of stearic acid, 4.0 g of shea butter, and 5 mL of coconut oil

Beaker B: 25 mL of water and 0.5 mL propylene glycol, 1 mL Triethanolamine*

Mass of Formula 1: _____ g

Formula 2:

Beaker A: 5.5 g of stearic acid, 4.0 g of shea butter, and 5 mL of coconut oil

Beaker B: 40 mL of water and 0.5 mL propylene glycol, 1 mL Triethanolamine*

Mass of Formula 2: _____ g

Mix your two solutions when directed:

| Physical Properties | Formula 1 (standard) | Formula 2 (High Water) |
|---|---|---|
| Color & Appearance | | |
| Thickenss/ Texture (1-5) | | |
| Spreadability (Easy/Hard) | | |
| Does it stay mixed? | | |
| pH | | |
| Additional Observations | | |

**Part 3: Performance Testing & Graphing**

1. Water Barrier Test: Place 1 drop of water on construction paper coated with Formula 1 and 1 drop on paper coated with Formula 2. Time how many seconds it takes for the water to soak in. Repeat this 3 times and determine a mean (average)

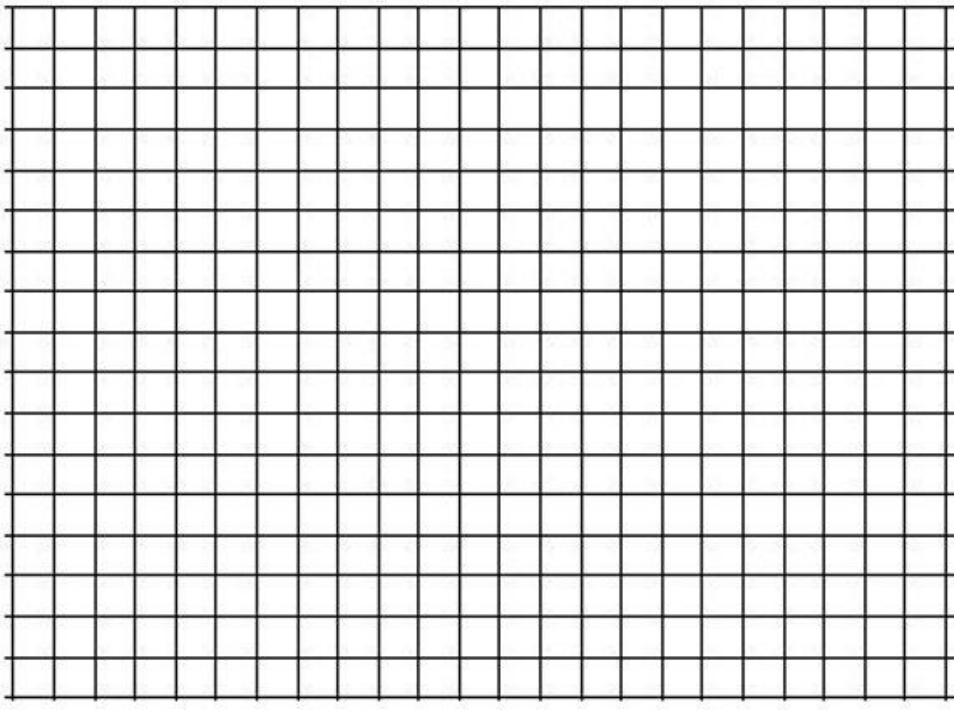
   Trial 1: Formula 1 Soak Time: _____ seconds | Formula 2 Soak Time: _____ seconds

   Trial 2: Formula 1 Soak Time: _____ seconds | Formula 2 Soak Time: _____ seconds

   Trial 3: Formula 1 Soak Time: _____ seconds | Formula 2 Soak Time: _____ seconds

   Mean Formula 1 Soak Time: _____ seconds | Formula 2 Soak Time: _____ seconds

2. **Graphing Activity:** Draw a bar graph below comparing the thickness rating (1–5) and soak time between Formula 1 and Formula 2.



**Part 4: Product Marketing & Reflection**

1. Which formula made the best hand cream? Use data from your experiment to support your answer.

_____

_____

_____

2. Create a catchy brand name and write a 2-sentence advertisement for your hand cream:

Brand Name: _____

Ad Copy: _____

## Lesson Plan Elementary School Adaptation (Grades K-5)

Overview & Simplified Objectives:

Students explore physical states of matter (solids and liquids), observe state changes through heating and cooling, and learn how ingredients combine to form everyday items.

**Students will be able to:**

- Classify raw materials by physical properties (color, texture, state of matter).
- Observe and record phase changes (solid wax melting into liquid; cooling back to solid).
- Solve simple multiplication/addition scaling problems to adjust recipe batch sizes.
- Express personal ideas through decorative container art and descriptive brand names.

Materials Needed:

Same materials can be used for the elementary students as the high school and middle school. However, a modification would be to use pre-melted shea butter and allow the students to mix the shea butter, coconut oil, water with the emulsifying agents and fragrance drops already mixed in.

Since the shea butter is melted, all students will need plastic cups, wooden craft sticks and the two mixtures to complete the lotion.

Emphasis would be on allowing the students to decorate their containers with stickers, markers, glitter, ribbon, small glue-on beads.

Background Information:

Students would need to be aware of the state of matter, solid, liquid and gas. They would need to know terms of phase transition like melting and freezing (or solidifying).

Day 0: Teacher preparation

Prepare the nonpolar and polar mixtures beforehand, place in individual plastic cups per group. Give students stir sticks to mix their solutions. Melt their solids with a water bath from a kettle. The water need to be warm, not hot as the melting point of shea butter is 31°C to 38°C (89°F to 100°F), 31°C to 38°C (89°F to 100°F), which allows it to stay solid at room temperature and melt smoothly upon contact with human skin (around 37°C / 98.6°F).

Day 1: Lab activity

3. Introduction

Students inspect raw ingredients (solid shea butter, liquid oil, liquid water mixture) and record physical properties on a chart (hard, soft, wet, shiny).

4. Guided mixing activity

Teacher acts as heat supervisor, melting the solid fats into liquids. Students pour their melted solids and liquid water mixture into a third mixing cup. Students stir continuously for 3 minutes, observing the mixture thicken as it cools from a liquid to a cream

5. Math exercises, writing and art decoration

Students solve simple math questions like “If I lotion jar takes 2 spoons of butter; how many spoons do we need for 4 lotion jars?”. Afterwards, students color a custom logo sticker, add stickers, and other decorations to their individual jars. Students write a short response on how their lotion feels.

**Hand Cream Chemistry Elementary School Worksheet**

Name: _____ Date: _____ Period: _____

**Lab: States of Mater & Mixing Magic Hand Cream**

**Part 1: Science Inspection (Solids and Liquids)**

Look at your ingredients before heating them. Put a checkmark (✓) in the correct box:

| Ingredient | Is it Solid? | Is it Liquid? | How does it feel? (Hard, Soft, Wet, Smooth) |
|---|---|---|---|
| Water | | | |
| Plant Oil | | | |
| Solid Wax/Butter | | | |

What happens to the solid wax when the teacher heats it up?

It changes from a _____ into a _____.

**Part 2: Fun Recipe Math!**

Help the class scale up the recipe to make enough jars for your group!

1. If 1 jar of hand cream takes 2 spoonfuls of plant oil, how many spoonfuls do you need for 4 students? Color the number of spoons needed

2 spoonfuls × 4 students = _____ spoonfuls of oil



2. If 1 jar takes 3 spoonfuls of warm water, how many spoonfuls do you need for 4 students? Color the number of spoons needed.

3. 3 spoonfuls × 4 students = _____ spoonfuls of water

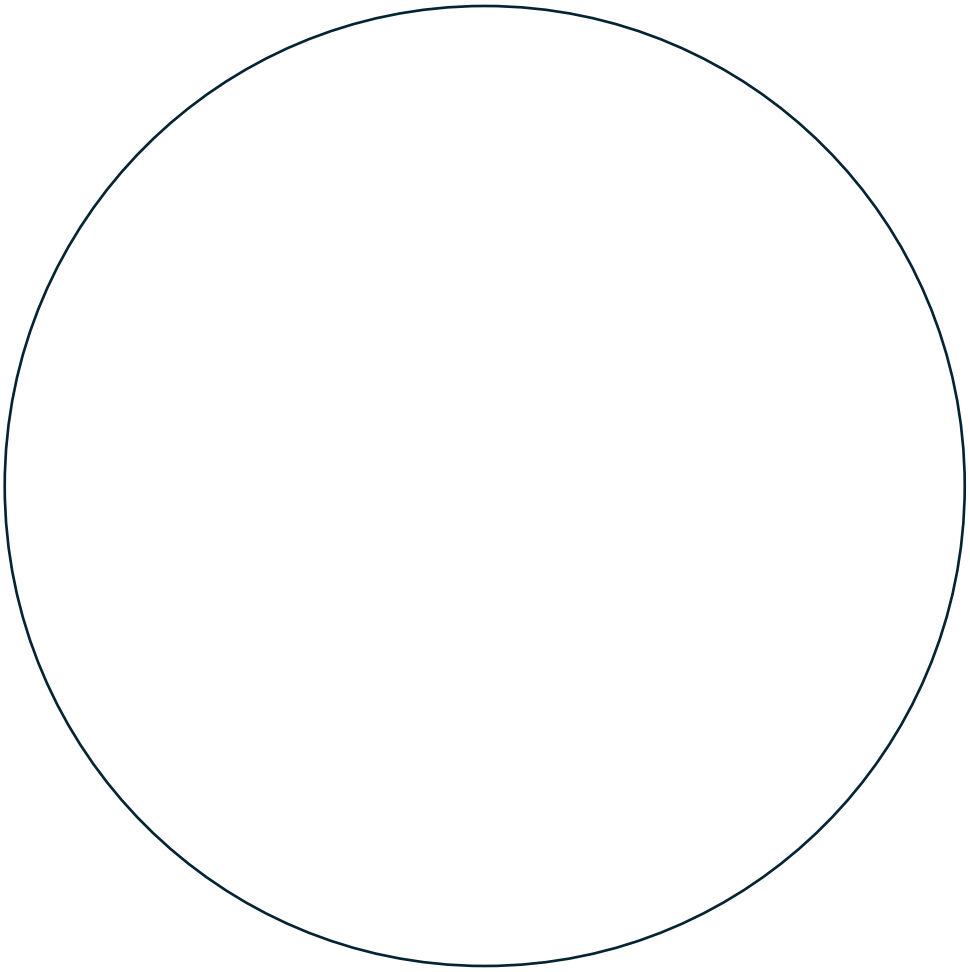


Part 3: Product Label Art & Reflection

1. How does your finished cream feel on your hands? Circle all that apply:

   *Soft* | *Smooth* | *Creamy* | *Bumpy* | *Wet*

2. Draw and color a logo for your lotion jar inside the circle below:



3. **My Lotion's Name:**

   _____

4. **Sentence About My Lotion:** My lotion is special because

   _____

   _____