STEM SCHOOL CHATTANOOGA
Mini-PBL
Unit Plan Template

Fragrance Synthesis

Chemistry

Standards (Learning Targets)

LT10: Solutions - Identify properties of a solution, determine concentrations, classify solutions, and use separation techniques.
LT11: Intermolecular forces - Compare and contrast intermolecular forces and predict intermolecular forces' effects on chemical and physical properties. .

Grade Level	10th	Unit Length	3.5 Weeks
Mini-PBL Overview	In this Mini-PBL students will take on the role of entrepreneurs in research and developmental chemistry with the goal of synthesizing and promoting their own perfumes and colognes. Students will learn about key chemistry concepts including solutions and intermolecular forces through the distillation of essential oils, and they will practice critical thinking via evaluation of the fragrance synthesis process and its pitfalls. Students will engage in digital fabrication through the development of an original product design logo that they will fabricate using a mini CNC carving device. Students will have an opportunity to showcase their products to the the 10th Grade Class.		
Mini-PBL Driving Question	How can we, as entrepreneurs in research and developmental chemistry, distill essential oils to be synthesized into perfumes and colognes that can be sold to companies or other entrepreneurs for production and/or further development?		
Hook Event	Students will view the first 5 minutes of Henrik Scheel's TED Talk: "How the Entrepreneurial Mindset Can Change You," (https://www.youtube.com/watch?v=SjLhFdxnPJc&t=320s). In the talk, Scheel, a Silicon Valley based entrepreneur, educator, author and innovator, explains how becoming an entrepreneur is about adopting a mindset of seeing problems as opportunities and requires no credentials. The talk was selected to show students that they actually are entrepreneurs as long as they are thinking critically to solve a problem. The classroom teacher will facilitate a brief discussion about the ideas presented.		
Scaffolding Activities	**Class Activities (CA)** ❑ Hook Event: Students will be introduced to the Mini-PBL. ❑ Rubric Review: The classroom teacher will guide students through the Mini-PBL rubric. ❑ Group Selection: Students will be placed into teams of three at the classroom teacher's discretion. ❑ Mini PBL Team: Contract Writing: Teams will develop a contract that includes contact information, expectations, roles and responsibilities, a pacing guide, behaviors, and interventions. The contract must be signed by all team members and the classroom teacher. ❑ Solutions Lesson: Students will be given an introduction to solution chemistry. This will include identifying solvents versus solutes and calculating concentrations by molarity, ppm, and percent by volume. ❑ Distillation Lesson and Trial #1: Students will be given a short lesson on the theory and technique of distillation. The classroom teacher will guide students through distilling their first essential oil. ❑ Ingredient Profile Overview: The classroom teacher will guide students through the "Ingredient Profile" tasks for their first essential oil. ❑ Branding Lesson: Students will be given a short lesson on what makes a logo appealing to the eye and mind. The classroom teacher will review the requirements for the students' digitally fabricated logo, and the students will begin their designs.		

- ❑ Intermolecular Forces Lesson: Students will be given a lesson on the three types of intermolecular forces. The lesson will include how to identify the forces in the essential oils based on the chemical formulas of the organic materials.
- ❑ Fragrance Synthesis Lesson: Students will be given a short lesson on the technical process of synthesizing a perfume or cologne from essential oils.
- ❑ Distillation #2: Students distill their second essential oil. Students will research this oil's required "ingredient profile" content during the distillation process, as well as the required "ingredient profile" content for the previously distilled essential oil (#1). Students with completed logo designs will rotate to the mini CNC to produce their digitally fabricated logo prototype.
- ❑ Distillation #3: Students distill their third essential oil. Students will research this oil's required "ingredient profile" content during the distillation process. Any remaining students with completed logo designs will rotate to the mini CNC to produce their digitally fabricated logo prototype.

Station Activities (SA)

- ❑ Sample Exploration and Requests: Students will rotate through stations to smell a variety of essential oils that have been distilled by the classroom teacher. Students will fill out a form requesting the organic materials they would like to distill. Every group will request three organic materials.
- ❑ Separation Techniques: Students will rotate through lab stations set up by the classroom teacher to learn about separation techniques beyond distillation. Students will look at filtration, chromatography, and crystallization.

Workshops (W)

- ❑ Mini CNC Workshop: Students can participate in an optional workshop on using the mini CNC machine. Students will submit a Google Form the previous day to state if they want to participate in the workshop. If no students sign up, there will be no workshop.

Focus Groups (FG)

- ❑ Concentration Focus Group: Selected students will participate in a focus group with the classroom teacher to work on calculating the concentration of their solution. Students will be selected for the focus group via the classroom teacher reviewing the students' "Ingredient Profile" progress for Distillation #1.
- ❑ Intermolecular Forces Focus Group: Selected students will participate in a focus group with the classroom teacher to reinforce the theory of intermolecular forces in solutions. Students will be selected for the focus group via the classroom teacher.

Mini-PBL Teams (MPT)

- ❑ Team Time (Week 2, Tuesday): Teams have structured work time to progress on logo design.
- ❑ Team Time (Week 2, Friday): Teams have structured work time to progress on logo design, "Ingredient Profile" and begin fragrance synthesis.
- ❑ Team Time (Week 3, Monday): Teams have structured work time to continue progress on logo design and "Ingredient Profile."
- ❑ Team Time (Week 3, Tuesday): Teams have structured work time to continue progress on logo design and "Ingredient Profile."
- ❑ Team Time (Week 3, Friday): Teams have structured work time to continue progress on logo design and "Ingredient Profile," and to begin fragrance synthesis.
- ❑ Team Time (Week 4, Mon.): Teams have structured work time to continue progress on logo design, fragrance synthesis, and "Ingredient Profile."
- ❑ Team Time (Week 4, Tues.): Teams have structured work time to finalize logo digital fabrication, fragrance synthesis, and "Ingredient Profile" in preparation for the culminating event.

Digital Resources

- ❑ Chromebooks
- ❑ Molarity: https://www.youtube.com/watch?v=KLjWa9cE2uk&t=164s
- ❑ PPM: https://www.youtube.com/watch?v=2m6nkkmaChc
- ❑ Distillation: https://www.youtube.com/watch?v=0IWy_hdgKJM
- ❑ Branding: https://www.youtube.com/watch?v=JKIAOZZritk

Calendar Overview

Monday (1 hr)	Tuesday (1 hr)	Wednesday (2 hrs)	Thursday (2 hrs)	Friday (1 hr)
CA: Hook event CA: Rubric Review CA: Group Selection CA: Mini-PBL Team: Contract Writing	CA: Mini-PBL Team: Contract Writing CA: Solutions Lesson SA: Sample Exploration and Requests	CA: Distillation Lesson and Trial #1	CA: Distillation Lesson and Trial #1	CA: Ingredient Profile Overview CA: Branding Lesson
CA: Intermolecular Forces Lesson SA: Separation Techniques FG: Concentration Focus Group	W: Mini CNC Workshop CA: Fragrance Synthesis Lesson MPT: Team Time (W2, Tues.)	CA: Distillation #2	CA: Distillation #2	MPT: Team Time (W2, Fri.)
MPT: Team Time (W3, Mon.)	MPT: Team Time (W3, Tues.)	CA: Distillation #3	CA: Distillation #3	MPT: Team Time (W3, Fri.)
MPT: Team Time (W4, Mon.)	MPT: Team Time (W4, Tues.)	Culminating Event		

Culminating Event

Product

- ❏ Students will synthesize an original fragrance through the distillation of essential oils. An "Ingredient Profile" will accompany the fragrance.
- ❏ Students will digitally fabricate a logo prototype to accompany their fragrance after being taught about branding.

Showcase.

- ❏ Students will showcase their fragrance product and logo to STEM faculty and students in a grade-wide gallery event. Participants will have the opportunity to vote on the best produce based on both fragrance and logo quality.

Common Assessment

Mini-PBL Rubric

	Advanced	**Proficient**
LT10 - Solutions	Ingredient Profile includes: ❏ Concentration of each ingredient in units of parts per million (ppm) with calculations shown ❏ Percent composition by volume with calculations shown for final product ❏ Name and description of an ingredient that was unavailable but would have improved the final product	Ingredient Profile includes: ❏ List of all ingredients in final fragrance product ❏ Explanation of why each ingredient was used to produce the fragrance ❏ Concentration of each ingredient in units of Molarity with calculations shown ❏ Separation techniques used to distill each ingredient ❏ A written introduction pitching the product to a consumer
LT11 - Intermolecular Forces	Ingredient Profile includes: ❏ An original image of the solution that shows visual representations of the different intermolecular forces present in the final fragrance product	Ingredient Profile includes: ❏ List of all types of intermolecular forces in the final fragrance product ❏ An explanation of how each intermolecular force is present in the final fragrance product
Critical Thinking: Evaluation	❏ Students complete a written reflection at the end of the project and provide ideas for potential project improvement including:	❏ Students complete a written reflection at the end of the project explaining in detail how they learned from any failures and adjusted their approach during the

		❑ One idea to improve the chemistry component ❑ One idea to improve the entrepreneurial component	fragrance synthesis and digital fabrication logo prototype production processes.
	Minimum Requirement Components: **Must be included to be graded**	❑ Successful synthesis of a fragrance prototype ❑ Completion of a product logo and production of a digital fabrication prototype of this logo ❑ Completion of "Ingredient Profile" ❑ Completion of reflection at the conclusion of the project	
	Grades	❑ If the work meets all the Advanced criteria for a Learning Target, the grade for that Learning Target is Advanced (100). ❑ If the work meets all the Proficient criteria for a Learning Target but not the Advanced criteria, the grade for that Learning Target is Proficient (85). ❑ If the work does not meet all of the Proficient criteria for a Learning Target, the grade of that Learning Target is Below Basic (50). ❑ If the work does not meet the minimum requirements, the grade is Missing (0).	

Vocabulary

Science - Chemistry	1. Solution - solute, solvent 2. Molarity/Concentration 3. Separation Techniques - distillation, chromatography, crystallization, filtration 4. Synthesis 5. Intermolecular Forces - London dispersion forces, dipole-dipole interactions, hydrogen bonding 6. Entrepreneurship 7. Branding