14-16s LESSON 1

HOW CAN WE EXTRACT A NATURAL FRAGRANCE?

In this lesson students distil essential oils from strongly-scented herbs such as crushed mint or basil.

They consider fragrance molecules by applying their understanding of the states of matter and the concept of volatility, before completing a simple distillation. Students can then explore how different essential oils and nature identical fragrances can be combined to create the fragrances that make toiletries and cosmetics pleasant and distinctive.

This lesson may be more suitable as a teacher demonstration owing to the equipment set-up required.

TOPIC AREAS

- States of matter
- Changes of state
- Particle model of matter
- Distillation and separation
- Practical skills

LEARNING OUTCOMES

Students will be able to:

- Explain distillation using the particle model of matter
- Describe fragrance in terms of the particle model and the concept of volatility
- Complete a simple distillation to extract an essential oil from a botanical

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RESOURCES

FROM THIS PROGRAMME

14-16s lesson 1: activity sheet 1 (one per student)

14-16s lesson 1: PPT presentation

FROM YOUR LAB

Per pair of students:

- Distillation apparatus based on a conical or round-bottomed flask (recommended) or large side-arm test tube:
- Bunsen, tripod, gauze and heatproof mat
- Clamp stands
- Flask or test tube
- Spatula
- Connectors as required
- Leibig condenser and tubing
- Delivery tubes (straight / bent)
- Thermometer in bung
- Small measuring cylinder or test tube for condensate
- Pipette
- Watch glass or spotting tile
- Mint, basil or other strongly-scented leaves – see preparation section below.

PPE as required by your school, eg eye protection.

PREPARATION

We recommend you complete a trial distillation of your chosen botanical(s) to ensure sufficient quantities as the essential oil content can vary.

You may want to assemble sets of distillation apparatus beforehand if you feel this will be challenging for students.

You will need sufficient fresh rosemary, mint, basil, sage or bay for students to be able to tightly fill their flasks or large test-tube. **Do not use dried herbs.**

If it is difficult to source sufficient fresh herbs for the whole class, deliver the lesson as a demonstration.

You will need time to clean out flasks and test tubes once they have cooled. Long spatulas or rods are good for this. Avoid using glass stirring rods in case of breakage.

SAFETY

We recommend students wear eye protection. Follow your school's risk assessment and safety procedures for this activity.

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STARTER

1. Explain that students are going to explore how cosmetic chemists who specialise in fragrance extract and blend fragrant plant extracts, known as essential oils, to perfume toiletries and cosmetics.
2. Pass round samples of botanicals and let students smell their fragrances.
3. Explain that you would like students to explain how they can smell the fragrance molecules from each sample using what they know about the particle model of matter and the three states of solid, liquid and gas. To help students, ask them to rub a small sample between their fingers to break open the botanical. Give students a minute or two to discuss ideas in their table groups.
4. Share ideas and show **slides 1 and 2**. Help students identify that fragrance molecules easily turn from liquid (in the botanical) to free molecules / gas (in the air). Rubbing the sample exposed more of these molecules by breaking open the plant cells, so more could escape easily into the air. The other molecules in the plant stay as solids or liquids. Ensure students note that this involved evaporation – changing state from a liquid to a gas. Explain that molecules that easily change state like this are known as 'volatile'.
5. Show **slide 3**. Now ask students to suggest how cosmetic scientists could harness this property (volatility) and speed up / increase the release of volatile fragrance molecules so they can capture them to add to products.
6. Share suggestions and help students identify that distillation is one possible approach. (Solvent extraction is another.)

MAIN ACTIVITY

1. Show **slide 4** and brief students that their challenge is to distil an essential oil sample from one of these botanical sources. Explain that cosmetic chemists who specialise in fragrance often need to do this in the lab, for example to assess the quality of a fragrance source or to work with new samples that can help them develop a new product fragrance blend.
2. Use **slide 5 (animated)** and **activity sheet 1** to review how to complete the practical distillation and then circulate to help students assemble their apparatus, if required.
3. Remind students that they are distilling oil from their botanical, but this will be carried over alongside water vapour. Discuss briefly what students can expect to see condense in their measuring cylinder or test tube. (They should see a very small amount of clear oil on the surface of the water that condenses).
4. Help students crush their botanicals to release the fragrance and then pack their flask or test tube with the crushed leaves. They should continue filling until completely full, pressing down with the spatula, (but not up into the neck if using a flask).
5. Students complete their distillation. They should heat the water until it reaches boiling point and the thermometer reaches 100°C, then maintain just enough heat for a gentle boil. Students should not vigorously boil their botanicals.
6. While this is happening you may wish to ask if students have heard of 'nature identical' fragrances. These are fragrances that contain identical molecules to those found in nature, but which have been manufactured rather than extracted.
   - Use **slide 6** to explain how nature identical fragrances are made.
   - Ask if they can suggest some reasons why these can offer a good alternative to natural fragrances. Many students may suggest cost and this is the most important reason – students should be beginning to identify that it can require a huge quantity of plant matter to extract a tiny amount of essential oil.
   - Ask students what might happen to their essential oils if they leave them for a period of time, both open or sealed in a container.

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- Explain that most essential oils will decay over time, losing their fragrance and in some cases turning unpleasant. This is because they contain hundreds or even thousands of compounds including many that are not stable. Nature identical fragrances contain only the most important and stable compounds. This makes them last for a long time (like in fragrance vaporisers for the home), but they have a slightly 'simpler' smell that can lack some of the depth and complexity of natural essences.

7. Once students have collected a few millilitres of condensate ask if they can see the oil on the surface. Continue distilling until students can extract the oil from the surface using their pipette and place it on a watch glass or spotting tile. It doesn't matter if a little water is still present.

PLENARY

1. Share extracts to see how strongly each one smells. Help students identify that the quantity of botanicals required can be very large indeed – kilos of materials for a small quantity of essential oil.
2. Show **slide 7** and invite students to share their extracts and think of some blends that might smell pleasant together. Students can think of a particular product (shower gel, antiperspirant etc) when considering their blend and come up with a name that will appeal to consumers.

DIFFERENTIATION IDEAS

EASIER

Set up as a demonstration and simplify your discussion of particles and volatility to suit.

MORE CHALLENGING

Invite students to use a greater theoretical understanding in their explanations, eg volatility, diffusion, reactivity, oxidation etc.

EXTENSION IDEAS

Leave open and sealed samples of students' extracted oils, in sunlight and in a dark, cool place, and test each day to see which ones decay the fastest.

Students can bring in their favourite toiletries and describe how different smells can be used to evoke different moods or aim at different customers, suggesting which smells these would be, eg uplifting, relaxing, young, sporty etc.

Create a display of students' fragrance blend and name ideas.