11-14s LESSON 2

HOW CAN WE MAKE THE TEXTURE JUST RIGHT?

In this lesson students explore the properties of waxes and oils to create a mixture with the right 'feel' that could become the base for a hair styling wax or lip balm.

Students review their understanding of mixtures and then prepare a range of sample formulae by mixing a wax and oil of different molecular weights in different ratios.

Students compare samples and identify the optimum formulae, and then suggest how the mixture of molecular lengths and different shapes is providing the texture they most prefer.

TOPIC AREAS

- Mixtures
- Properties of materials
- Practical skills
- Applications of science

LEARNING OUTCOMES

Students will be able to:

- Recall and explain how waxes and oils have different molecular lengths and this affects their physical properties.
- Suggest how varying the proportion of waxes and oils with different molecular sizes and shapes in a mixture will alter its viscosity or hardness.

RESOURCES

FROM THIS PROGRAMME

11-14s lesson 2: activity sheet 1 (one per student)

11-14s lesson 2: PPT presentation

Beeswax

Sunflower oil or other vegetable oil

FROM YOUR LAB

Per pair of students:

- Small beakers
- Scales (accurate to 0.1g)
- Hot plate or hot water bath
- Cold water bath
- Spatula
- Stirring rod
- Paper towels

PPE as required by your school, eg eye protection.

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PREPARATION

Students should have already explored mixtures and be aware that in general terms, longer and more branched molecules have higher melting / boiling points and are more viscous. If they haven't, this can be outlined first, and the lesson used as an introduction to the topic.

It's useful to have one or two sample hair styling products and lip balms available for students to feel, to help them understand the properties they are looking to achieve when they formulate their lip balm or styling wax.

Students will mix one formula as a pair, and then groups of four pairs will work together to put their formulae in order by testing each sample. Write formula letters on pieces of paper so you can assign one to each pair without the rest of their group knowing which formula they are making.

You may wish to pre-measure the two components into suitable amounts for each group to share and measure and mix their assigned formulae.

SAFETY

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

STARTER

1. Explain that students are going to apply their understanding of mixtures to create a popular toiletry product: a hair styling wax or a lip balm.
2. Show **slides 1 & 2**. Ask students to work in groups to review and note down some key facts about waxes and oils and long-chain molecules. Share ideas.
3. In particular, ask students if they can explain how the physical properties of substances with long molecules, or ones that have more branches, change with molecular length. How does their viscosity change? How does their melting point change?
4. Share ideas and help students identify that substances with longer chain molecules tend to be harder or more viscous than shorter chain molecules.
5. This explanation may help:
   - Ask students to imagine you need to cut down two bushes in your garden and take the branches to your local recycling centre in your car.
   - The first bush has short, smooth stems and you can cut these into small lengths. It's easy to put these into your boot because the short sections of stem slide easily around each other. This is like a short-chain molecule or one that's not branched.
   - But the other bush has long stems from which lots of other stems grow. You have to leave these as long sections. It's difficult to put these into your boot because the long sections get tangled and caught up with one another to form a large, quite rigid mass of stems. This is like a long-chain polymer or one with lots of branched molecules.
6. Show and discuss **slides 3 and 4**. Discuss what many products might be like without waxes and oils, for example foundation that won't stay on, hair gel that runs off, creams that are too dry or lip balm that is runny and won't go onto lips.
7. Allow students to feel some product samples and ask them how these products might change if the average length of the molecules they contain were to be shorter or longer (for simplicity, don't worry about branched molecules). How would this change the product's properties and performance?

MAIN ACTIVITY

1. Show **slide 5**, which briefs students on what they are going to do, and review **activity sheet 1**, which shows a range of formulae.
2. Share out the two components between groups. Give students a moment or two to see what each one is like and discuss how their molecular lengths might differ.
3. Explain that beeswax and sunflower oil are both mixtures of compounds with varying molecular lengths, but on average the molecules in the beeswax are longer than those in the oil.
4. Ask students if they can explain why beeswax is solid, while vegetable oil is liquid (each at room temperature), based on what their molecular lengths might be like, and how this influences how the molecules can pack together?
   - The longer beeswax molecules twist and tangle together more and also experience stronger forces attracting them to one another.
   - The shorter oil molecules are more easily able to move around one another and experience somewhat weaker forces attracting them to one another.
5. Briefly discuss what students think will happen when they mix different ratios of these together. Can they predict a ratio that will give the best qualities for their hair styling wax?
6. Use **slide 6** to review how to prepare a sample. Use questions to help students identify how they will need to melt the beeswax so they can add the oil and then mix the two together, and then cool their mixture to test it at room temperature.
7. Split students into groups of ten, and then into five pairs within that. Assign each pair in the groups one formula from **activity sheet 1**. Students should not share their formula letter with the other pairs in their group.
8. Students mix and prepare their product sample.
9. Ask groups to feel and then arrange their products, from the 'thinnest' to the 'thickest' and identify which formula would make the best hair styling wax or lip balm. Can students explain how the ratio of each polymer in their samples changes as they go from the 'thinnest' to the 'thickest' sample?
10. Write answers on **activity sheet 1**.

PLENARY

1. Ask pairs to share their formula letter with the rest of their group. See if these correspond with how they have arranged their samples and their predictions for how the formula varies. Write answers on **activity sheet 1**.
2. Share opinions on which formula would be best for a hair styling wax or lip balm, helping students link their opinions to the properties of their preferred sample.
3. Ask students to try and explain their ideas by thinking about how molecules in the oil are able to move between molecules in the wax.
   - Oil molecules are able to move more easily in the mixture and 'slip' between wax molecules, so the more oil molecules are present, the thinner and more pliable the mixture.
4. Ask students to think of other products that might be based on waxes and oils, such as lipstick. **Slide 7** has some examples.
5. Discuss their properties and see if students can identify whether the molecules that make up the bulk of these products would need to be longer or shorter. For example, lipsticks tend to be firmer than balms and so are likely to contain longer chain molecules.

DIFFERENTIATION IDEAS

EASIER

Less able students in each group could be given formulae from each extreme (eg the 90% / 10% ratio and vice versa), so their differences are most clear, with more able students in their group making up the other formulae.

Use simple molecular models or pipe cleaner in two colours and lengths to help students understand the differences between molecular lengths and shapes. Students could twist them together to create branched molecules.

EXTENSION IDEAS

Students could identify these types of molecules in the ingredients list of a range of toiletries.

Students can use molecular modelling kits or similar to create models of the materials used in this experiment, comparing their lengths and shapes.