FONDATION
La main à la pâte
POUR L'ÉDUCATION À LA SCIENCE

Chemistry - Mixtures and solutions
4th – 6th grade

Classroom Sequence

Step 2: The concept of density

Discovering mixtures (2/4)

Introduction

Topics covered	**Chemistry, mixture, solution, mass, volume, matter, separation techniques.**
Summary and objectives	In this step, the students try to understand why oil always floats on water.
Discipline engaged	Science and Technology
Duration	1 hour 45 minutes approx.

This sequence compiles older resources, produced by the teachers of the *La main à la pâte* networks, on the subject of mixtures of liquids and solids.

The four steps of the sequence on mixtures can be carried out independently. We encourage teachers to create their own progression, adapted to their students and the time available. To help teachers choose from the proposals, here is the order in which the activities have been designed:

Step 1: Mixtures of solids and simple liquids
Step 2: The concept of density
Step 3: Challenge - The Liquid Tower
Step 4: Complex mixtures in everyday life

Getting started

Do not hesitate to watch the videos Billes de Sciences #7 : Tania Louis - *Mélanges de liquides* (Mixtures of liquids), and Billes de Sciences #3 : Tamar Saison - *La dissolution* (Dissolution).

Disclaimer: These videos are in French. But we encourage you to activate the English subtitles. Just be aware that is an automatic translation.

Activity 1: Influence of experimental parameters on the water-oil mixture

General objectives: Identify and understand cause and effect relationships. Observe the influence of an experimental parameter on a mixture. Follow a protocol.

Summary	
Discipline	Science and Technology
Procedure and modalities	The students follow a detailed protocol, which will allow them to test the influence of different experimental parameters on the formation of the water-oil mixture.
Duration	1 hour approx.
Material	For the class: • Water, oil, wooden sticks for mixing. For each group of students: • Containers. For each student: • Worksheet 1.
Takeaway	
The order of pouring, the quantity of liquids and stirring do not affect the result of mixing several components.	

Suggested procedure

Phase 1: Familiarization with the protocol (15 to 20 min)

The teacher asks the pupils to look in their science notebook for the diagram representing the water-oil mixture (step 1 of the sequence) or to draw it, if the activity has not been carried out. The teacher summarizes the characteristics of this mixture, in order to review the vocabulary: the water-oil mixture is a heterogeneous mixture. Water and oil are two immiscible liquids.

The teacher then distributes the protocol on Worksheet 1 to the students and gives them time to read it. If they have any questions about understanding the protocol, he/she answers them. Then the pupils form pairs to carry out the experiments. The teacher reminds them that all the observations must be recorded in the experiment notebook, so as not to forget them for the assessment at the end of the session.

Phase 2: Experiment guided by the protocol (30 min)

The pupils in pairs follow the instructions in the protocol and carry out the experiments independently. The teacher moves around between the groups and helps the children who are having difficulty. The teacher also ensures that the pupils share the work within the pair. It is important that the same pupil does not do all the experiments.

Educational note:

- It is important to explain to the students that in order to see the influence of a parameter, only that parameter should be varied during the experiments. Otherwise, they cannot be sure what caused the results obtained and do not know to which variable they can be attributed.

Conclusion (10 min)

The teacher shares with the class what seems to be important to remember at the end of this activity. The students answer the initial question. Here is an example of a possible written record following this discussion: "*We tried to vary the position of the water and oil in our mixture. Our conclusion is that we can't do it. We have tested three parameters: the amount of liquid, the order of pouring of the liquids and the stirring of the mixture. We conclude that the respective positions of the oil and the water depend on another parameter that is unknown for now.*"

Activity 2: Discovering the concept of density

General Objective: Introduce the concepts of specific mass and density.

Summary	
Discipline	Science and Technology
Procedure and methods	Following the questions raised in the previous activity, the students try to find out why the oil sits on the water. To do this, they link the concept of mass of the same volume to the relative position of two immiscible liquids.
Duration	45 minutes
Material	For the class: • Liquid soap, water, oil, cordial (optional) For each group of students: • Three labeled containers, a wooden stick or spoon for mixing, a scale.
Takeaway	
The relative position of the liquids depends on their **density (or specific mass)**.	

Lexicon (see also the scientific overview at the end of the resources)

Mass: fundamental physical property of a body. Unit: kilogram (kg).
Weight: force resulting from the action of gravity on a body. Unit: newton (N).
Volume: quantity of space occupied by an object. Unit: cubic metre (m^3), litre (L).
Density: relationship between the mass of a body and that of the same volume of water. Unit: none.
Specific mass: physical quantity defining the mass per unit volume. Unit: kilogram per cubic metre (kg/m^3).

Suggested procedure

Phase 1: Formulating hypotheses (10 min)

The teacher recalls the conclusion of the previous activity: the respective positions of the oil and water depend on an unknown parameter. This activity will allow us to understand this parameter.

He/she asks the students, "*If I take the same quantity of water, oil or soap, which liquid is heavier?*" It is difficult to predict the result without using a scale. The teacher then asks the students to draw a diagram of the experiment they are going to carry out in their experiment notebooks. Then, after a few minutes, the whole class pools their ideas. The teacher should make sure that the pupils plan to weigh the same volume of liquid. In this way, **mass** and density can be associated.

Phase 2: Experimentation (10 min)

Students form groups of four. One pair will be responsible for comparing the mass of water and soap, and the other pair will be responsible for comparing the mass of oil and water. The use of the scale does not come immediately to the students. The teacher should explain the importance of setting an electronic scale to zero or balancing the pans on a Roberval balance ("setting the tare"). To do this, the teacher can have the pupils weigh the empty containers so that they become aware of their mass and understand the importance of the tare. The children do the weighing. Then, again in groups, they classify the liquids from lightest to heaviest for the same volume.

Educational note:

- Although weight and mass are two different physical quantities, in this first approach, the common malapropism of using "weight" instead of "mass" will be allowed. The difference between weight and mass will be worked on in the 8th grade.

Phase 3: Pooling of ideas, followed by experimentation (10 to 15 min)

The teacher asks the students to answer the first question they were asked, *"Which liquid is heavier when the volume is equal?"* The answer is soap, then water, and finally oil, which is the lightest. The pupils now mix soap, water and oil and observe that the liquids settle in the container from the heaviest (which "sinks") to the lightest (which "floats"), provided that they do not shake so as not to mix the soap and water, which are two miscible liquids. You can still manage to put them on top of each other by pouring them gently, because soap is more viscous than water. Thus, the two liquids do not mix too quickly.

Conclusion (5 to 10 min)

The teacher discusses with the class what seems important to remember at the end of this activity. Here is an example of a possible written record following this exchange: "*We weighed the same quantity of soap, water and oil, then we added them without stirring them. We noticed that the order in the mixture follows the order of the masses. Phases are distinguished if the liquids are immiscible. So, if the oil is always on top of the water, it is because it is lighter than the water.*"

Practice:

The teacher can propose the following experimental exercises:

1. Do the soap and cordial form a homogeneous or heterogeneous mixture? Do an experiment to test your hypothesis and draw a diagram of it.

2. How do you know if the soap is above or below the cordial? Do an experiment to test your hypothesis and draw a diagram of it.

Worksheet 1: Test protocol for water-oil mixture

The Tuesday Chemists Association is asking for your help in answering their question. Members of the association, like you, attended the session on mixing liquids and, of course, noticed that water and oil never stay mixed for very long. However, some association members wondered why the oil was on top of the water. Other members wondered if the opposite was possible. So an argument broke out because of this debate and to resolve this conflict we need your help!

In your laboratory, you have access to **water** and **oil**. On your bench[1], you will find:

- Transparent jars to make your own mixture;
- spoons for stirring ;
- two measuring cups (one for water and one for oil) to measure a specific amount of liquid.

As a "great chemist", you will be very focused, in order to perform the experiments with precision.

Each experiment allows you to check the influence of one parameter. This is why you should not stir the mixture in the first two experiments and follow the protocol to the letter.

(1) Bench: name of the work surface in chemistry.

1st experiment:

The purpose of this experiment is to answer the question "Does the order of pouring of the liquids matter in the final order of the liquids in the mixture?"

Measure 10 cL of oil with the measuring cup and pour it into a transparent container. Measure 10 cL of water using the measuring cup and pour it into the container with the oil. Observe what happens and record it in your experiment notebook.
Now measure 10 cL of water with the measuring cup and pour it into another clear container. Measure 10 cL of oil using the measuring cup and pour it into the container with the water. Observe what happens and record it in your experiment notebook.

Conclusion: answer the question in your experiment notebook.
Don't forget to empty the containers at the end of your experiment and to wipe clean the bench, if necessary.

2nd experiment:

The purpose of this experiment is to answer the question, "Does the amount of water or oil matter in the final order of the mixture?"

Measure 5 cL of oil with the measuring cup and pour it into a transparent container. Then measure 20 cL of water and add it to the oil. Observe what happens and write it down in your experiment notebook.
Measure 20 cL of oil with the measuring cup and pour it into a transparent container. Then measure 5 cL of water and add it to the oil. Observe what happens and write it down in your experiment notebook.

Conclusion: answer the question in your experiment notebook.
Do not forget to empty the containers at the end of your experiment and to wipe clean the bench, if necessary.

3rd experiment:

The purpose of this experiment is to answer the question "Does the stirring of the mixture matter in the final order of the mixture?".

Measure 10 cL of oil with the measuring cup and pour it into a transparent container. Measure 10 cL of water with the measuring cup and pour it into the container with the oil. **Do not stir.** Observe what happens and write it down in your experiment notebook.
Measure 10 cL of oil with the measuring cup and pour it into a transparent container. Measure 10 cL of water with the measuring cup and pour it into the container with the oil. Stir vigorously for a few minutes. Observe what happens and write it down in your experiment notebook.

Conclusion: answer the question in your experiment notebook.
Remember to empty the containers after the experiment and wipe down the bench if necessary.

General conclusion and debriefing: write an email to the Tuesday Chemists Association to share your findings and end the argument!

To: Tuesday Chemists Association
Subject: Debate on position of water and oil

Dear friends,

We have conducted our experiments to answer your question on the relative position of water and oil in a mixture. Here are our conclusions.

"Does the order in which the liquids are poured have an effect on the final order of the liquids in the mixture?"
……
"Does the quantity of water or oil have an effect on the final order of the mixture?"
……
"Does stirring the mixture have an effect on the final order of the mixture?"
……
"Why does oil float on top of water?"
……
……

Your chemist friends,

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