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

Classroom Sequence

Step 1: Mixtures of solids and simple liquids

Discovering mixtures (1/4)

Chemistry - mixtures and solutions
4th – 6th grade

Introduction

Topics covered	**Chemistry, mixture, solution, mass, volume, matter, separation techniques.**
Summary and objectives	During this step, students discover and make different types of mixtures. They observe and describe them with specific vocabulary.
Discipline engaged	Science and Technology
Duration	About 3 hours

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: Mixtures of Solid Ingredients

General objective: Learn about homogeneous and heterogeneous mixtures and a technique to separate a mixture.

Summary	
Discipline	Science and Technology
Procedure and methods	Students are asked to observe different solid components, create a mixture, and then find a simple way to separate the components.
Duration	1 hour approx.
Material	For the class: • Solid ingredients: semolina, rice, lentils, beans, pasta, pepper, coarse salt, baking soda, chalk, gravel, beads, Styrofoam beads, caster sugar, flour, ground spices, etc. (see preliminary note for preparing ingredient collections). • Wire mesh, fruit netting, canvas, etc. (see preliminary note for preparing sieves). For each group of students: • Two transparent containers labeled according to the collection, spoons to serve the ingredients.

Takeaways

1. The components of a **homogeneous mixture** are not visible to the naked eye, unlike the components of a **heterogeneous** mixture.

2. A sieve is used to separate a heterogeneous mixture containing components of different sizes. The mesh size of the sieve can be adjusted to separate a particular component.

Lexicon (see also the scientific overview of the sequence)

Homogeneous mixture: mixture in which the components cannot be distinguished with the naked eye.
Heterogeneous mixture: mixture in which the components can be distinguished with the naked eye.
Phases: homogeneous parts of a heterogeneous system forming layers.
Clear: we can see through it. Synonym: transparent.
Cloudy: the opposite of clear, containing particles in suspension.
Colorless: having no color.
Dissolve: to disintegrate by means of a liquid in which the molecules disperse.
Soluble/solubility: having the ability to dissolve.
Precipitate: a solid deposit in a liquid.
Solution: a mixture of components in a solvent (in this case, water).

Suggested procedure

Preliminary notes:

- The teacher will have prepared two collections of samples before the session:
  - 1st collection: semolina, beans, rice, lentils, beans, pasta, peppercorns, coarse salt, baking soda, crushed chalk, sand, gravel, Styrofoam balls, beads of all sizes (the teacher may use the samples of his/her choice).
  - 2nd collection: flour, ground spices, baking soda or fine salt, and caster sugar (the teacher may use the samples of his/her choice).

- The sieve may be found in stores (colander, storage bins, etc.) or it can be made by the teacher and students using materials such as wire mesh, plastic mesh, vegetable sack netting or textiles (tulle, hessian). If the material is stiff, thick adhesive tape should be stuck to its edge to avoid any risk of injury. If the material is soft, the sieve can be attached to the container with adhesive tape or elastic. The mesh size of these sieves should be adapted to the size of the particles they are designed to extract.

Phase 1: Observation of solid ingredients (10 to 15 min)

The teacher presents the collection of ingredients to the students. In groups of two, they choose three ingredients from the first collection, then two ingredients from the second collection.

It is important that students record in their experiment notebooks the colour, appearance, consistency and, where possible, the particle size and shape of the ingredients before mixing. They can also draw diagrams.

Phase 2: Observation after mixing (15 to 20 min)

The teacher asks the students to mix the three ingredients from the first collection in one container and then the two ingredients from the second collection in a second container. The children carry out the experiment.

Students discuss their observations with the teacher as a class.
In the following discussion, the ingredients in the first collection are lentils, kidney beans and peanuts. The ingredients in the second collection are salt and caster sugar. The teacher's questions help the students to describe the mixture correctly: "Can *you see the ingredients in both mixtures?*" Children easily

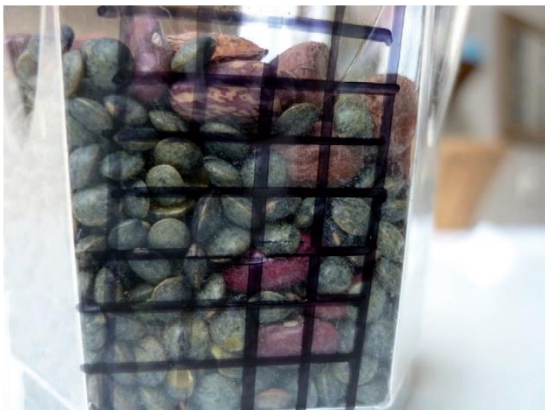
find the difference between the two types of mixtures, "*In the first one, you can see the ingredients, but in the second one you can't. We cannot tell between the salt and the sugar.*"

The professor explains that our eye cannot distinguish between the two components. Indeed, our eye is our basic sensor. It allows us to see the world around us, but it has limits. It is capable of observing details to a tenth of a millimetre at a distance of one metre. However, it is not capable of observing at the microscopic or nanoscopic scale. This is why we sometimes use a magnifying instrument such as a magnifying glass or a microscope to observe what the eye alone is not able to see.

A mixture that is homogeneous to the naked eye may, with a more powerful sensor, be heterogeneous. If we were to observe the mixture of components in the second collection with such an instrument, we would see the salt and sugar particles clearly.

The teacher asks the students about the distribution of the particles in the first mixture: "*Do the ingredients mix well?*", "*Are there places in the glass where there are more lentils?"* To help them, the teacher draws a grid with a felt-tip pen on the transparent container and asks if the same thing can be seen in all the squares of the grid, if they all contain the same number of lentils, for example.

The teacher then orally restates the main idea of this session using appropriate vocabulary. "*In the first mixture, we do not see the same elements everywhere. The mixture is said to be heterogeneous. In the mixture of salt and sugar, you can see the same thing everywhere with the naked eye because the salt and the sugar blend together. The mixture is homogeneous.*"



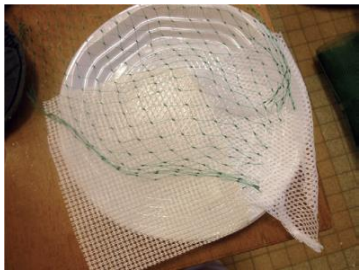
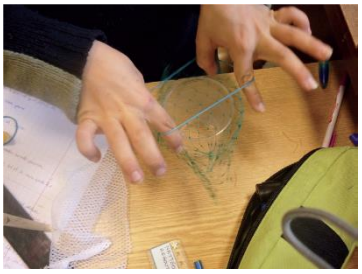
Grid drawn on the container to see the heterogeneity of the mixture.

Phase 3: Separation of one of the ingredients from the first mixture (15 min)

The teacher asks the question "*How can you separate one of the ingredients in the mixture, for example the lentils?"*

Students suggest ways to separate the lentils from the beans and peanuts. They may suggest sorting by hand, blowing, shaking, straining, or sifting. The class discusses the feasibility of these different suggestions. The students are encouraged to argue their opinion by giving, for example, the negative points of one or other of the solutions. If they do not propose sieving, the teacher can show them the mesh or net sieves, and ask them to test whether these objects are effective in separating the components of the mixture.

To facilitate separation, the teacher should make sure that the students shake the sieve well, but without spilling any of the components.

Students make the sieve using recycled materials and rubber bands.

The teacher can ask the students about the effectiveness of using a sieve to separate the components of the mixture in which the components cannot be distinguished with the naked eye (homogeneous mixture of samples from the second collection). If the students are not convinced, they can try the experiment with the finest sieve and realize that it does not work.

Educational note:

- The teacher will make sure to use appropriate vocabulary, even if the definitions are not given/retained by the students. For example, the word "grain" should be used to mean "small piece". Similarly, the words "ingredient" or "component" are preferable to the word "substance", which has a real chemical meaning.

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 discussion: "*A mixture in which the components can be distinguished with the naked eye is a heterogeneous mixture. A mixture in which the components cannot be distinguished with the naked eye, because they blend together, is a homogeneous mixture. If the large sieve is used, the small components pass through and the large components left on the sieve can be recovered (and vice versa). On the other hand, a sieve is not effective in separating a homogeneous mixture or a heterogeneous mixture in which the components are the same size.*"

Activity 2: Mixing solid ingredients in a liquid

General aim: Acquire the vocabulary needed to describe a mixture.

Summary	
Discipline	Science and Technology
Procedure and methods	Students mix a variety of solid ingredients with water to observe and describe the perceived changes.
Duration	1 hour approx.
Material	For the class: • Water, sugar, salt, cocoa powder, instant coffee, flour, chalk, ground pepper, sand, etc. For each group of students: • Labelled transparent containers, a wooden stick for stirring or spoons, syringes without needles. For each student: • Worksheet 1.

Takeaways
1. Not all materials are water **soluble.** 2. Color, **cloudiness**, **clarity**, and **solubility** are good parameters to describe a solid-liquid mixture.

Activities 2 and 3 deal with similar concepts. The teacher can choose to carry out just one of these activities.

Scientific notes:

- A substance behaves differently in water than in other solvents (oil, alcohol, etc.). In the following activities, only the solvent "water" will be used.
- The word "solution" defined in the lexicon is not required at the end of the 6th grade. The use of the word "mixture" is correct.

Educational note:

- So that the pupils can observe all the possible scenarios, at least two ingredients must be totally soluble in water: the solution obtained with the first will be colourless (sugar, salt, provided that it does not get too close to the **solubility limit***, at the risk of obtaining a cloudy solution or a **precipitate**). The solution obtained with the second will be coloured (cocoa powder, soluble or freeze-dried coffee). In addition, at least one other ingredient must be insoluble in water (pepper, sand) or partially soluble (chalk). The latter ingredients may lead to some discussion. Some students may have difficulty grasping the concept of solubility. In the following experiments, we recommend adding about one tablespoon of solid in one cup of liquid.

***Solubility limit:** the point at which the solid can no longer dissolve in the mixture. The solution is said to be saturated. A deposit of solid is observed at the bottom of the container. This deposit is called a **precipitate**. For salt, the solubility limit is about 300 g per litre of water. The solubility of salt or sugar in water is greater when hot than when cold.

Suggested procedure

Phase 1: Starting the conversation (10 to 15 minutes)

The teacher asks the students: "*What happens when you mix a solid with water? Are there any changes that can be seen with the naked eye?*" The children write their hypotheses in their experiment notebooks and try to find out by anticipation what will happen. The teacher moves around the class to see what hypotheses they propose: "*Water becomes coloured if a coloured solid is mixed*", "*Sometimes the solid does not mix well*". The teacher then writes the main ideas given by the pupils on the board.

We can observe:
- a change of color;
- that we can no longer see through the mixture;
- whether or not the solid has dissolved in the liquid.

Phase 2: Experimentation and confirmation or refutation of hypotheses (10 to 15 min)

In groups of two or four, depending on the number of pupils in the class, the children make one or two mixtures. Possible mixtures are for example: water + cocoa powder, water + caster sugar, water + ground pepper, water + chalk, etc. The use of a syringe (or a measuring cup or a measuring cylinder) may be introduced, in order to add the same amount of water to each mixture. The pupils' attention should be drawn to the fact that the syringe should be fully immersed in the water, so that it does not take in air at the same time and the reading of the graduation is correct. If the teacher does not have this material, he or she can make measuring cups by marking one or more graduations on a glass with a felt-tip pen (for example, for a whiteboard). It is also possible to use reusable plastic glasses, which are distributed at cultural events and associations, or at festivals, and which often have graduations.

The teacher organizes the work of the class so that all possible mixtures are made at least twice. The experiment is drawn in diagrams in the experiment notebook. During this time, the teacher prepares a large table on an A3 sheet or on the class board, to group the pupils' answers.

Educational note:

- Depending on the pupils' level and the skills the teacher is working on, the teacher can either have the children make the double entry table or distribute the proposed table (sheet 1).

Water-chocolate mixture: homogeneous, coloured and cloudy.

Water-pepper mixture: heterogeneous and clear.

Phase 3: Pooling and introduction of vocabulary (15 to 20 min)

Before the students go to write down their results, the teacher calls the class together and introduces the appropriate vocabulary. He/she explains that "*if you can see through the mixture, even if it is slightly coloured, the mixture is clear. The solid has dissolved in the liquid. On the other hand, if you can't see through it, the mixture is cloudy. Cloudy is the opposite of clear.*" The pupils then fill in the table on Worksheet 1 or their table in their experiment notebook individually, in order to acquire the new vocabulary.

Conclusion (5 to 10 min)

The teacher corrects the description of the mixtures by discussing them with the class. He/she asks the pupils what seems important to remember at the end of this activity. Here is an example of a possible written record following this exchange: "*A solid may or may not **dissolve** in a liquid. Colour, homogeneity, and whether the solution is cloudy or **clear** are characteristics of a mixture of a solid and a liquid. The opposite of cloudy is clear.*"

Activity 3: Mixing different liquids

General objective: Introduce the notions of miscible and immiscible liquids.

Summary	
Discipline	Science and Technology
Procedure and methods	Students make several mixtures of everyday liquids (water, oil, vinegar, household alcohol, cordial) in pairs.
Duration	1 hour approx.
Material	For the class: • Water, oil, vinegar or household alcohol, cordial. Food colouring can be used to distinguish vinegar from water, for example. For each group of students: • Transparent containers for mixing, a wooden stick or other object for mixing. For each student: • Worksheet 2.
Takeaway	
Two liquids are **miscible** when, after mixing, they form a single **phase** (homogeneous mixture). On the contrary, two liquids are **immiscible** when, after mixing, they form two phases (heterogeneous mixture).	

Activities 2 and 3 deal with similar concepts. The teacher can choose to carry out just one of these activities.

Lexicon (see also the scientific overview for this sequence)

Miscible: ability of liquids to form a homogeneous mixture.
Non-miscible: capacity of liquids to form a heterogeneous mixture.
Decanting: separation technique in which the mixture is left to rest.

Suggested procedure

Phase 1: Starting the conversation (10 to 15 minutes)

The teacher asks the students, "*What liquid mixtures do you know?*" Children can name fruit cordial, salad dressing, a mixture of fruit juices (multivitamin juice), etc. However, this question is quite difficult for them. The teacher then suggests that they observe a salad dressing and a fruit cordial, in order to describe them and cite a difference between the two mixtures. The teacher can guide them by asking the question "*Do all liquids mix?*"

Observation of a fruit cordial (homogeneous mixture) and a vinaigrette (heterogeneous mixture).

Phase 2: Experimentation (15 min)

In groups of two or four, the pupils will carry out the different experiments which consist of mixing two by two the liquids proposed by the teacher: water, oil, vinegar or household alcohol, cordial. The order in which the liquids are poured is not important. Absorbent paper will be available for the children to wipe up any spills, in order to keep the work surface clean. The mixtures will be systematically stirred. The teacher should draw the pupils' attention to the need to observe at different times: before stirring, during mixing and after a few minutes' rest. Indeed, a heterogeneous mixture needs to **settle so** that the two phases can be clearly distinguished. First, the students take notes in their experiment notebooks.

Educational note:

- Wiping up the table as soon as a drop is spilled is important for the cleanliness of the premises, of course, but it is also part of experimenters' habits. Indeed, if several products are handled and spilled, strange (and sometimes dangerous) mixtures can be created on the lab bench. Even if this does not concern the students, it is a good habit to acquire.

Oil-water mixture immediately after stirring.

Oil-water mixture after resting.

Phase 3: Conclusion and answer to the question (10 to 15 min)

Students volunteer to take the floor to describe each experiment. If there is a disagreement about an observation, the teacher can repeat the experiment to confirm the correct answer.

The teacher introduces the appropriate vocabulary. A homogeneous mixture of liquids after stirring is composed of miscible components. A mixture of liquids that is heterogeneous after stirring is made up of immiscible components.

The pupils, with the help of the teacher, then fill in the double entry table on Worksheet 2. A diagram is drawn in the science notebook to illustrate each case. For the mixture of immiscible liquids, oil and water will be used as an example. For the mixture of miscible liquids, take water and cordial, for example.

Conclusion (5 to 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: "*Not all liquids mix. A mixture that, after stirring, forms a single phase is a homogeneous mixture: the liquids are then said to be miscible. This is the case with cordial and water. A mixture forming two distinct phases is a heterogeneous mixture: the liquids are said to be immiscible. This is the case with oil and water.*

Skill-building (20 min for five individual practices)

During another session, the teacher can propose one or more practice exercises to consolidate the knowledge and skills worked on.

This practice can take the form of a handling exercise to be done in groups or individually. If the exercise is carried out individually, it may be appropriate to have only five students go through the exercise at a time, in order to be able to really assess what the student has understood. The rest of the class can work, for example, on a documentary activity independently. In this way, the teacher concentrates on the pupils in the handling exercise.

Here is a possible instruction for this practice phase:
"You must make a mixture of miscible liquids and a mixture of immiscible liquids. You have cordial, alcohol, water and oil.
Perform the experiments and make a diagram of the result each time."

Worksheet 1: Describing "solid + liquid" mixtures

Instructions: Fill in the table below.

Description of the mixture	Color	Cloudy/clear	Number of phases (homogeneous/heterogeneous)
Water + ...			
Water + ...			
Water + ...			

Rows can be added according to the number of mixes the teacher plans for the class.

Correction of the table:

Description of the mixture	Color	Cloudy/clear	Number of phases (homogeneous/heterogeneous)
Water + cocoa powder	Brown	Cloudy	Homogeneous (1 phase)
Water + sugar	Transparent	Clear	Homogeneous (1 phase)
Water + pepper	Pale yellow	Clear	Heterogeneous (2 phases)

The mixtures are given as an example and allow the different cases to be covered.

Worksheet 2: Describing mixtures of liquids

Instructions: Fill in the table and describe the mixtures: the liquids are **miscible** or **immiscible** depending on the case.

	Water	Vinegar	Oil	Cordial
Water				
Vinegar				
Oil				
Cordial				

Correction of the table:

	Water	Vinegar	Oil	Cordial
Water		Miscible	Immiscible	Miscible
Vinegar			Immiscible	Miscible
Oil				Immiscible
Cordial				

Author
Ève Montier-Sorkine, using resources from the Fondation *La main à la pâte*

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Fondation *La main à la pâte*
43 rue de Rennes
75006 Paris
01 85 08 71 79
contact@fondation-lamap.org

Site : www.fondation-lamap.org

FONDATION La main à la pâte
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