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

Classroom sequence

Step 2: Discovering how a wastewater treatment plant works

Water, a rare resource to be protected (2/3)

Chemistry - mixtures and solutions
4th – 6th grade

Introduction

Topics covered	**Chemistry, mixtures, separation techniques (filtration, decantation, distillation), dissolution, wastewater treatment plant.**
Summary and objectives	During this stage, the students learn how a wastewater treatment plant works.
Discipline engaged	Science and Technology
Duration	1 hr 30 approx.

This resource compiles work done by teachers in the *La main à la pâte* networks. The three stages of the water sequence can be carried out independently. We encourage teachers to create their own progression, adapted to their students and the time available.

To help choose from the proposals, the order in which the activities have been designed is as follows:

Step 1: How to clean a dirty water sample
Step 2: Discovering how a wastewater treatment plant works
Step 3: Is clear water safe to drink? Is it pure?

Getting started

This resource is a follow-up to the compiled resource "Discovering Mixtures". Do not hesitate to watch the videos Billes de science #7: Tania Louis- Mélanges de liquides (Mixtures of liquids), and Billes de science #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 this is an automatic translation.

Activity: Discovering how a wastewater treatment plant works

General objective: Discover how a technical structure works and make a model of it.

Summary	
Discipline	Science and Technology
Procedure and methods	During this session, the children watch an extract from a documentary, which explains how a water treatment plant works and how water travels. They answer the questions on Worksheet 1 and then model how a water treatment plant works by building a filtration system.
Duration	1 h 30
Material	For the class: • A video projector and a computer. For each group of students: • Gravel, cotton, filter paper (such as coffee filters), charcoal or activated charcoal, sand, funnel or water bottle cut out for this purpose, transparent containers, dirty water samples, large sheets of paper for posters, felt pens and coloured pencils. For each student: • Worksheet 1.

Takeaways

The purification of water in a **wastewater treatment plant** involves several key steps: filtration, decantation, chemical treatments (such as ozonation or chlorination) and biological treatments (with the addition of bacteria).

Lexicon

Filtration: separation of the components of a mixture using a filter.
Decantation: the heavier components of a mixture fall to the bottom of the container under the effect of gravity. This creates two phases that can be separated.
Distillation: the mixture is heated. The vapors that escape from the mixture are collected and cooled to obtain a liquid.
Separation techniques: allow a mixture to be transformed into several distinct components. Examples include filtration, decantation and distillation.
Wastewater treatment plant: a facility designed to purify (clean) water before it is released into the environment. This water will be collected again downstream for distribution.
Porous: having a multitude of small holes called pores**.**

Suggested procedure

Phase 1: Analysis of the documentary (20 min)

Students and teacher watch the video: https://www.youtube.com/watch?v=s8IVjQg7yno. The teacher pauses in the extract to give the students time to take notes about the process. He/she can play it twice to the students. Once the viewing is over, the children take the floor to summarise the points they think are essential to remember. The teacher writes them on the board.

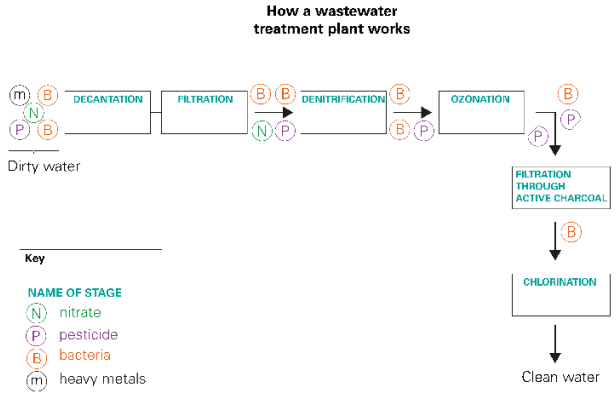
Teacher's notes:

- If the school is equipped, it is possible to carry out this work in a computer room or with the help of tablets. The children can analyse the video at their own pace (if the room is equipped with a computer for each student) or at the pace of their work group (if the room is equipped with fewer computers). This solution allows the students who need it to have time to become familiar with the analysis work.

Phase 2: Creation of a summary poster (30 min)

The teacher asks the students to form their working groups. After a short period pooling answers, the teacher briefly summarizes the step of the water treatment to make sure that all the pupils have the right answers.

The teacher then asks them to make a poster presenting the principle of a wastewater treatment plant. The teacher distributes large sheets of paper, felt pens and colored pencils. The teacher lets the students design the wastewater treatment plant as they wish. The teacher asks them to assign the following vocabulary to each of the stages of water treatment in the wastewater treatment plant: decantation, distillation and filtration. Students notice that there is no distillation in the wastewater treatment process. Instead, settling and filtration are very important.



Example of a poster (Worksheet 4).

Phase 3: Modeling a wastewater treatment plant (30 min)

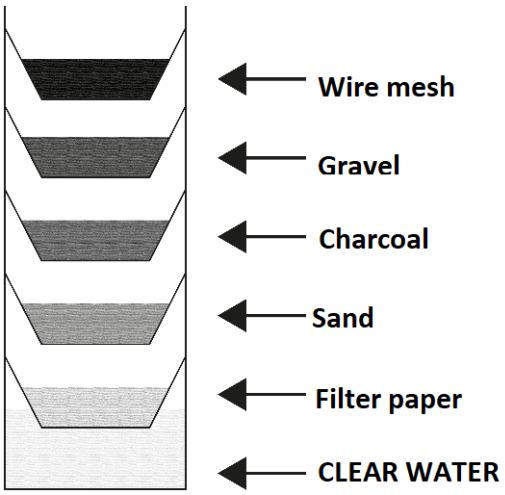
The teacher now asks the students, in groups of four, to create a model wastewater treatment plant. The teacher emphasizes that they will have to simplify the operation of a wastewater treatment plant, since ozone, chlorine and bacteria are not available in the classroom. To do this, he/she explains to the students

that they will concentrate on the filtration stage, making a vertical filter with many layers to filter the water properly.

The teacher then presents the materials available to the students: gravel, cotton, filter paper (coffee filter), charcoal or activated charcoal, sand and fine wire mesh. The teacher then asks the question "*How can you filter water using all the materials at your disposal?*" Students test their dirty water sample to see how much or how little water passes through the materials.

The teacher explains that the property of a material to allow water to pass through it is called *porosity*. Students rank the materials from most **porous** to least porous. At the end of this phase, the children create a filter by stacking the following materials from bottom to top: coffee filter, sand, cotton, coal, gravel, wire mesh. The dirty water is then poured into the filter and the children quickly realize that the filtration process will take quite a long time.

The teacher can ask the students about the speed of filtration in the chosen order, to draw their attention to the obstruction of the pores. At the end of this phase, the students return to their poster and complete it by drawing a diagram of the vertical filter they have created. They display their work on the board. The teacher helps to summarize the ideas and checks that the pupils have followed the rules of the scientific diagram, if this was requested (see teaching notes).



Example of a vertical filter with different materials.

Teaching notes:

- There are many rules to drawing a scientific diagram. It must be drawn using only a ruler and pencil. It must also be labelled with non-intersecting arrows drawn with a ruler and pencil. A diagram should also have a title. A realistic drawing can also be used to illustrate an experiment, as long as it is not overloaded with details, so as to remain clear and legible. A scientific illustration should be to the point.
- Depending on the difficulties encountered by the students, this part can be simplified by using only three materials. For example, chicken wire, cotton and a coffee filter. In this case, an evaluation exercise could be to repeat this experiment, but with other materials such as sand, gravel and a wire mesh sieve.
- The order of the materials may not be respected by the students. As long as they put the finest filter last, the result will be satisfactory.

Alternative:

- The teacher may ask the pupils to draw the vertical filter freely, initially. Then the teacher and the students analyze the drawings in order to deduce the main rules of a scientific diagram, as stated

previously in the teaching notes. The pupils will then be invited to exchange their diagram with that of a classmate, in order to step back and "correct" their classmate in a friendly manner.

Lesson review and conclusion (10 min)

Students observe the water that has been filtered through their vertical filter. The results are quite positive. The water is much clearer when it comes out of the filters, although it may still be slightly colored. The teacher discusses with the class the important things to remember at the end of this activity. Here is an example of a possible written record following this exchange: "*To be cleaned and purified, dirty water goes to a wastewater treatment plant where it is filtered, decanted and treated chemically (i.e. with chemicals) and biologically (i.e. with bacteria). A filter made up of different materials in the correct order (from coarsest to finest) is a good way to model a treatment plant and clean water in the classroom.*"

Possible extension:

- To go further with this lesson, the teacher can organize a school visit to a wastewater treatment plant near the school.

Evaluation exercise

Use filter paper with pores (holes) that form circles of 0.03 mm in diameter.

Particles	Particle diameter (in mm)
Yeast	0.001
Fine sand	0.1
Gravel	10
Clay	0.01
Bacteria	0.0001
Sand	1

1. According to the table, which particles will it stop? Explain your answer.

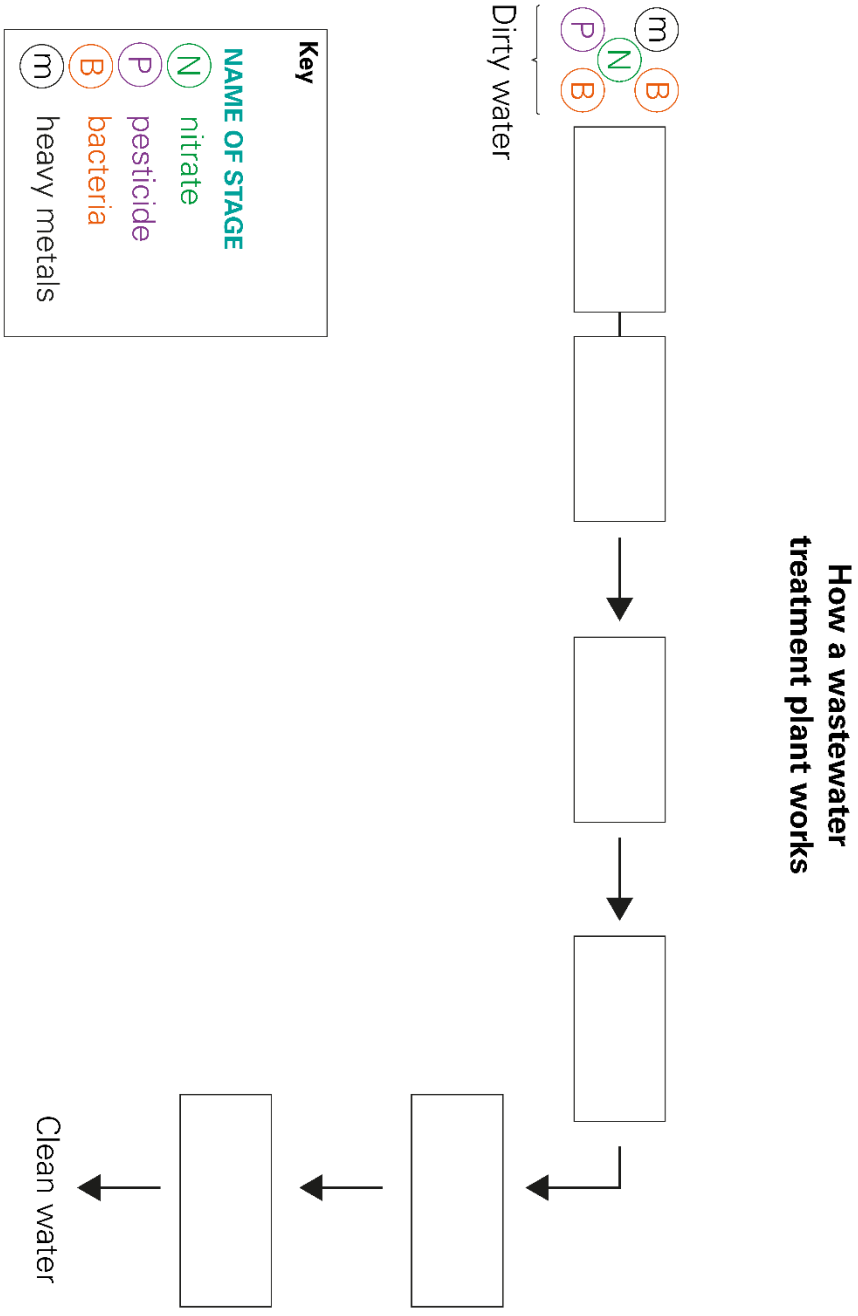
2. Which particles will end up in the filtrate? Explain your answer.

Credits

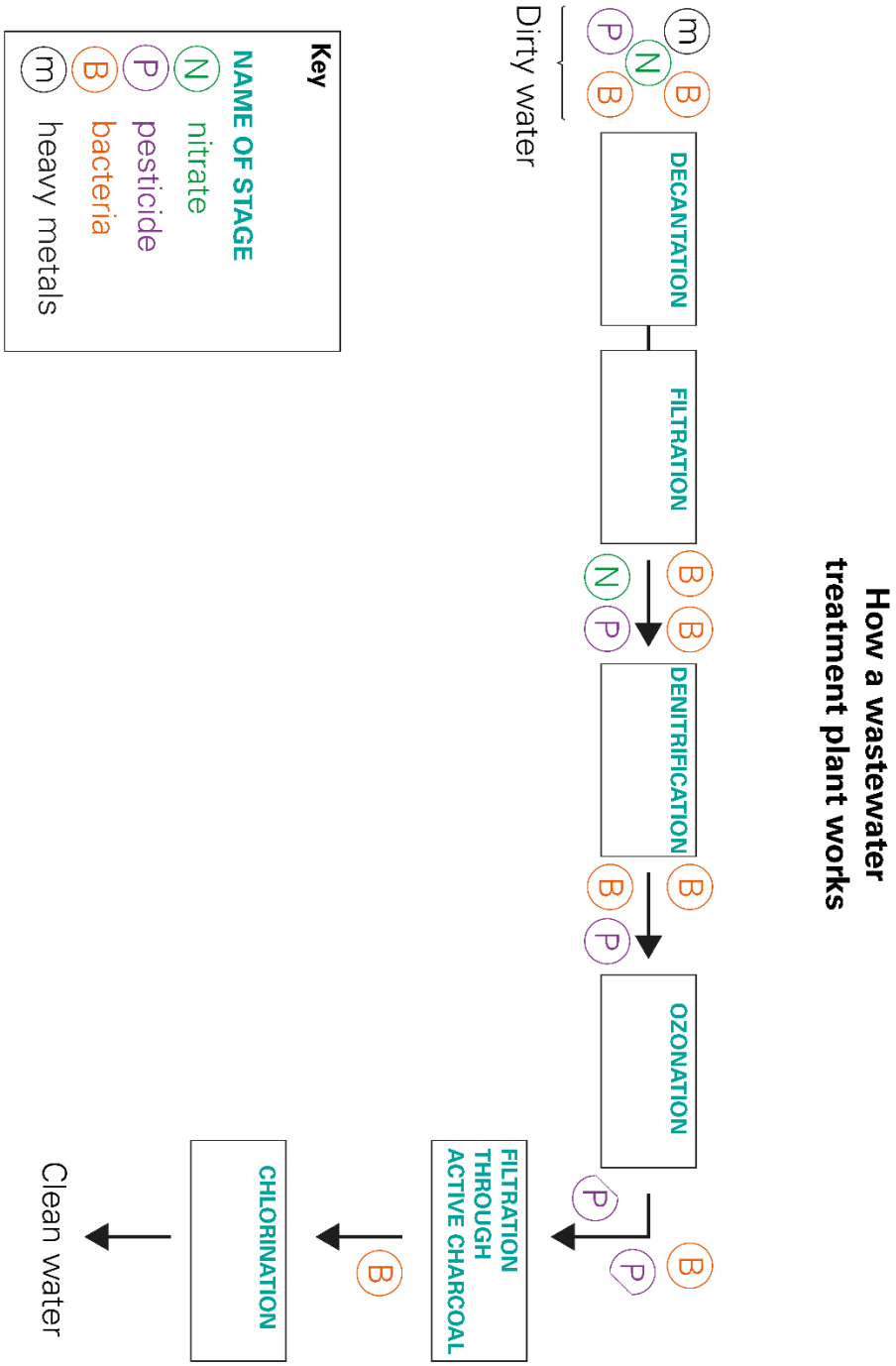
The definition of a model is taken from the "Scientific Mind, Critical Mind" project (only in French), available here.

Worksheet 1: Diagram of a wastewater treatment plant

Complete the following diagram:



Worksheet 2: Correction of Worksheet 1



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Acknowledgements
Fatima Rahmoun, Kévin Faix, Marie-Lise Roux, Antoine Éloi

This resource was produced with the support of the Fondation de la Maison de la Chimie

Fondation de la Maison de la Chimie

In partnership with Mediachimie

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Release date
March 2021

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