

Teacher notes – Evaporation

By Doaa George

Aim

Evaporation is a physical change where a substance changes from the liquid state to the gaseous state. Evaporation of water plays a crucial role in the water cycle which is responsible for maintaining life on planet Earth. Many disciplines depend on the process of evaporation, one important example is in the field of cosmetics and pharmaceuticals, where alcohol is used as a solvent. The fast rate of evaporation of alcohol allows it to evaporate, leaving only the active ingredients in action over the skin.

Another important application of the process of evaporation is fractional distillation where different materials can be separated on the basis of their boiling point. Some industries depend on the process of evaporation such as the salt industry where water evaporates leaving salt behind.

It is important to make the students aware of why they are studying a certain topic, relating the topic to their daily life makes it more engaging and interesting.

In this experiment, students will conduct an experiment to compare between the evaporation rate of water and alcohol.



Figure 1: Salt evaporation pond

Plan

Evaporation depends on a number of factors, this includes the type of fluid, the temperature of the fluid and the surface area of the fluid. Discuss with the students the variables which should be kept constant if they want to conduct a fair experiment to test for the rate of evaporation of different

fluids. You may prefer to make them watch a clip on the effect of surface area on evaporation, <https://www.youtube.com/watch?v=BHmUxOylg-A> to help them with their thinking.

Allow some time to discuss the safety issues with the students, the experiment involves the use of alcohol which is toxic and students have to be aware not to smell or taste it. They also have to wear safety goggles and gloves at all times. Alcohol is very flammable and students have to make sure to keep it away from flames. They have to report any glassware breakage to the teacher once it happens.

Conduct

Although students are given a recipe to conduct the experiment, it can be modified in a way where students can study the change of different variables. They can use the recipe as a base for their experiment and change it to an open inquiry depending on their ability to do this sort of study.

Students will be comparing the evaporation rate of water and alcohol. Before starting the experiment, they will make their hypothesis on which liquid will evaporate first.

The experiment has two parts, in **part A** they will paint a streak of water and a streak of alcohol on a paper towel using a cotton bud. Care must be taken to have identical streaks otherwise the comparison will not be fair. Ask students what would they do to ensure they have identical amounts of both liquids. You may wish to write down their ideas on the board and discuss it with them. One way is to dip the cotton bud in both liquids for an equal amount of time and having the same person drawing the streaks on the paper towel to ensure reducing human error. They will watch the streaks disappear and take a note which streak disappears first. You may like to ask them to use a stopwatch and measure the exact time for each streak to disappear.

For **part B** students will use another technique to test for the liquid that has a faster evaporation rate. This time they will have two beakers each containing one of the liquids in question (water and alcohol) and they will dip one strip of paper (strips should be identical) in each beaker. They will wait for a certain time until the strip is fully soaked and then they will remove the strip and place each strip on one end of a ruler as shown in figure 3 of the student notes. Make sure, students have the papers labelled with the type of fluid in order to be confident of their results. They will observe what happens to the ruler and write their observation. It would be good if students measure the time taken for the ruler to fall using a stopwatch.

The experiment can be extended to more than one session by giving students the choice to change more variables such as the temperature or the surface area of the exposed liquid.

To test for the effect of temperature:

Measure 2 x 10 ml of alcohol in a measuring cylinder and place each 10 ml in two similar test tubes. One test tube will be placed in a water bath (making sure you measure the temperature of the water in the water bath) and the other will be left at room temperature for the same amount of time. By the end of the class, the volume of both tubes will be measured using a measuring cylinder and will be compared.

To test for the effect of surface area:

Measure 2 x 10 ml of alcohol in a measuring cylinder. Place one of the volumes in a test tube and the other in a beaker. Leave them until the end of the class and then measure the volume remaining in each container using a measuring cylinder.

Analyse

Students will analyse their results and write down their observations. For **part A**, it is best if the teacher draws a table on the board comparing the time measured by each group and take the average. For more advanced classes they might also calculate the uncertainty by finding the standard deviation.

Team number	Time taken for water to disappear (s)	Time taken for alcohol to disappear (s)
Average		
Standard deviation		

$$\mu = \frac{\sum x}{n}$$

Where μ = the average

Σ = the sum or the total

x = each value in the population (the individual measurements taken)

n = number of measurements taken

$$\sigma = \sqrt{\frac{\sum(x - \mu)^2}{n}}$$

Where σ is the standard deviation of the entire population

X = each value in the population

μ = the average

Σ = the sum or the total

n = number of measurements taken

For **part B**, students can find how longer it took water to evaporate by measuring the time taken for the ruler to fall. Students will observe to which side did the ruler fall, it should fall towards the heavier side which is water which evaporates at a slower rate than alcohol.

The teacher may like to discuss with students how accurate their results are and whether it is appropriate to compare the results of the whole class or not. It would be appropriate because even though students may have different amounts of fluid on the paper yet the paper will not fall until the difference in the fluid weights between the two sides is about the same. These discussions will enhance students' critical thinking and research skills, it will also make the experiment interesting and enjoyable.

For the temperature experiment, the one with the higher temperature will evaporate first. The same will happen for the one with larger surface area.

Problem solving and discussion

According to the level of students the discussion can involve different depths of knowledge. For younger classes, they will discuss whether their results agree with their hypothesis or not. They will explain on what basis they made their hypothesis, some can explain that they know from their life experience that alcohol evaporates faster than water. Other students can mention that water is denser than alcohol.

For senior and advanced classes, they will explain that the process of evaporation involves the breaking of intermolecular bonds to change form the liquid state to the gaseous state. This explanation shows what happens on the molecular level and how some intermolecular bonds are stronger than others and they are harder to break. Water has got stronger intermolecular bonds than alcohol and this is why it requires more energy to break these bonds and it takes a longer time to evaporate. When heated, the bonds can break easier because they have access to the energy required to break them.

If the results do not agree with the hypothesis, students can discuss if there were any mistakes in their measurements or in the setup of the experiment. Mistakes can include writing the wrong labels on the paper or making a wrong hypothesis.

Conclusion

Students will state whether their hypothesis is supported or not and will present their work in a suitable format. They can take photos of the steps of their experiment and include them in their preferred method of presentation.

References:

Figure 1: <https://www.flickr.com/photos/121476474@N04/24013108450/in/photolist-ooHGPU-pqUoZH-s15L2P-oEKno3-oKiidv-jtV6Cr-j9FLyK-hR51cu-Qy9ngE-oEyyGj-hR29q7-oEyyuf-oKxfXm-oEyyi3-oKxetE-hSEdVt-UTb6B5-oEM6KP-ooi76T-S611nt-iFva6v-CzXsxd-fxDfHv-Aw7o-qQtTts-HGir5N-XH9JL4-dmqjh1-XnTjgo-hSAE56-WUQrE7-9WrrJA-fXmZZu-X2Heo5-7eYKZ2-5tW8C3-9i2LKJ-c7yXS-oHxexJ-6G6FVt-nTDqMn-dpBakQ-dpB1C4-dmqjL7-dpB1tp-fCXqur-dmqhKV-35Kb3e-4CxSHR-RQBqa8/> Author Julian Wishahi Licence <https://creativecommons.org/licenses/by-sa/2.0/>