

Evaporation and distillation

This resource is from the **Johnstone's triangle** series which can be viewed at: rsc.li/4j14bfW. In this series you will also find our **Separating mixtures: Johnstone's triangle worksheet** which introduces the triangle in the context of distilling copper sulfate solution and can be viewed at: rsc.li/4wb7qml.

Learning objectives

LO	Objective	Where assessed
1	Explain the gradual evaporation of a puddle of water in terms of particles.	Q1
2	Link surface area to rate of evaporation.	Q2
3	Explain the separation of a solution using evaporation.	Q3
4	Describe the changes of state of water that occur during distillation.	Q4
5	Explain observations of the distillation of a coloured solution.	Q5

How to use this resource

This resource aims to develop learners' understanding of evaporation and distillation. The questions encourage learners explain observations of distillation in terms of particles and to think carefully about what is happening at each stage of the distillation process. As a result, learners should develop more secure mental models to support their thinking about this topic.

When to use?	 Introduce	 Develop	 Revise	 Assess
	Use after initial teaching or discussion of this topic to develop ideas further. You can also use as a revision activity.			
Group size?	 Independent	 Small group	 Whole class	 Homework
	Suitable for independent work either in class or at home. Or use the questions for group or class discussions.			
How long?			15–30 mins	

Johnstone's triangle

Johnstone's triangle is a model of the three different conceptual levels in chemistry: macroscopic, sub-microscopic and symbolic. You can use Johnstone's triangle to build a secure understanding of chemical ideas for your learners.

Find further reading about Johnstone's triangle and how to use it in your teaching at rsc.li/4vW4HNo.

Johnstone's triangle and this resource

The icons in the margin indicate which level of understanding each question is developing to help prompt learners in their thinking.



Macroscopic: what we can see. Think about the properties that we can observe, measure and record.



Sub-microscopic: smaller than we can see. Think about the particle or atomic level.



Symbolic: representations. Think about how we represent chemical ideas including symbols and diagrams.

The levels are interrelated, for example, learners need visual representation of the sub-microscopic to develop mental models of the particle or atomic level. Our approach has been to apply icons to questions based on what the learners should be thinking about.

Questions may be marked with two or all three icons, indicating that learners will be thinking at more than one level. However, individual parts of the question may require learners to think about only one or two specific levels at a time.

Support

This worksheet is ramped so that the earlier questions are more accessible. The activity becomes more challenging in the later questions. You can give extra explanations for the more challenging questions. If completing as an in-class activity, pause and check understanding at intervals, as often one question builds on the previous one.

Sharing a simulation that shows movement of particles may be beneficial to support learner understanding of the evaporation process.

Answers



1. *Guidance note:* This question develops learners' understanding by connecting everyday observations of a puddle 'drying' (macroscopic understanding) to a particle-level explanation (sub-microscopic understanding).

Particles of **water** leave the puddle and mix with particles that make up the **air**. This process is called **evaporation**.



2. *Guidance note:* This question develops learners' understanding of how evaporation occurs faster when there is a greater surface area (macroscopic understanding) and how this can be explained in terms of particles (sub-microscopic understanding).

(a)

- i. The diagrams should show a clear decrease in the water level over time. The learner may either show no water present after 2 days or a very low level.



after 12 hours

after 2 days

- ii. Particles of water leave the surface and mix with particles in the air. Gradually the water level/volume decrease until none/very little is left. The written answer should match the diagram.

(b)

- i. The water level would still decrease but more slowly.
ii. The surface area of the water is smaller so fewer water particles can leave in the same period of time.

- (c) The salt pans are wide and shallow to ensure that they have a very large surface area so the water can evaporate quickly.



3. *Guidance note:* This question develops learners' understanding of evaporation process by using observations of the evaporation of water from copper sulfate solution (macroscopic understanding) and encouraging learners to explain these observations using the idea of particles (sub-microscopic understanding).

- (a) The learner should draw blue copper sulfate crystals at the bottom of the dish.
(b) Over time, the water particles evaporate from the surface of the water. When all the water particles have evaporated solid copper sulfate/copper sulfate crystals will be left at the bottom of the dish.



4. *Guidance note:* This question develops learners' understanding of distillation by encouraging deeper thought about the state of water at different points in the apparatus and the changes of state that occur (macroscopic understanding).

(a)

- At V water changes from the **liquid** state to the **gas** state because it is **heated**. This process is called **evaporation**.
- At Q water changes from the **gas** state to the **liquid** state because it is being **cooled**. This process is called **condensation**.

(b)

V liquid and gas

W gas

X gas

Q gas and liquid

Y liquid

Z liquid

(c) distillate

(d) Evaporation occurs at any temperature. Boiling happens at the boiling point.



5. *Guidance note:* This question develops learners' understanding of distillation further encouraging explanation of observations at different points of the apparatus during the distillation of blue ink and water (macroscopic understanding).

(a) The volume of solution in the flask will decrease because the liquid water boils and changes into the gas state. There will be some evaporation as well so accept this as an answer.

(b) The water vapour condenses as it passes through the condenser/is cooled by the water on the outside of the tube. The water vapour changes state back to a liquid and drips out of the tube and into the beaker. The volume of water in the beaker therefore gradually increases.

(c) The liquid in the beaker will remain colourless because the blue ink does not change into the gas state and remains in the round bottomed flask. Only the water changes into the gas state and passes through the apparatus before condensing and forming a colourless distillate in the beaker.