Filtration

This resource is from the **Johnstone's triangle** series which can be viewed at: rsc.li/4jI4bfW. In this series you will also find our **Separating mixtures: Johnstone's triangle worksheet** which introduces the triangle in the context of filtering muddy water and can be viewed at: rsc.li/4pIDZq2.

Learning objectives

LO	Objective	Where assessed
1	Recall key vocabulary relating to the process of filtration.	Q1
2	Recognise that kitchen equipment can separate different foods from water due to the relative size of the holes in the equipment and the smallest pieces of the food.	Q2
3	Explain why mixtures of some substances with water can be separated using filter paper and why some substances cannot.	Q3
4	Identify whether a mixture of an unfamiliar substance with water can be separated, based on information on whether that substance is soluble or insoluble.	Q4
5	Name the residue and filtrate when a given mixture is poured through filter paper.	Q4
6	Recognise that filtration cannot remove dissolved impurities.	Q5

How to use this resource

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	

This resource aims to develop learners' understanding of filtration. The questions encourage learners to think about the relative size of the holes in filter paper compared with visible small pieces of undissolved material and invisible particles. As a result, learners should develop more secure mental models to support their thinking about this topic.

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/3TixOgg.

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.

Answers

1. *Guidance note:* This question develops learners' understanding of filtration in connection with a real-life example (macroscopic understanding).

(a) residue
(b) filtrate

2. *Guidance note:* This question develops learners' understanding of how filtration works by considering the relative size of holes in kitchen separation equipment compared with the size of pieces that will or will not pass through (macroscopic understanding). The question also includes the idea that water is made up of particles which are smaller than the holes in all the examples, including filter paper (sub-microscopic understanding).

(a)
i. colander > sieve > filter paper
ii. peas > rice grains > coffee grounds > water particles

(b)
i. colander, sieve or filter paper
ii. filter paper

(c) A sieve can be used to separate rice from water because the grains of rice are larger than the holes in the sieve. The water particles are smaller than the holes in the sieve and can pass through.

(d) A sieve cannot be used to separate coffee grounds from the dissolved coffee because both the coffee grounds and the water particles are smaller than the holes in the sieve. They can both pass through.

3. *Guidance note:* This question develops learners' understanding of the difference in size of observable specks of materials such as mud compared with particles of water or dissolved substances (macroscopic and sub-microscopic understanding). The question then relates these sizes to the size of holes in filter paper to support student understanding of how filtering works as a separation technique. Please note that the word 'particle' has been specifically avoided when referring to tiny pieces of undissolved substances such as powdered chalk. Whilst this is common in everyday language there is a risk of confusing students as in chemistry particle is a word used to refer to atoms or molecules.

(a)
i. visible
ii. visible
iii. visible
iv. invisible
v. invisible

(b)
i. larger
ii. larger
iii. larger
iv. smaller
v. smaller

(c)
i. insoluble
ii. soluble

(d) A mixture of water and chalk can be separated by filter paper because a particle of water is smaller than a hole in the filter paper and can pass through. A speck of powdered chalk is larger than a hole in the filter paper and cannot pass through.

(e) Salt solution cannot be separated using filter paper because both the water particles and the dissolved salt particles are smaller than the holes in the filter paper. They both pass through.

4. *Guidance note:* This question develops learners' understanding of typical laboratory equipment used for filtering and the expected observations following the filtering of mixtures of soluble or insoluble substances with water (macroscopic understanding).

(a)

Substance mixed with water	Soluble or insoluble?	Can mixture be separated using filtration? (yes/no)
copper carbonate	insoluble	**yes**
copper sulfate	soluble	**no**
copper oxide	insoluble	**yes**
copper chloride	soluble	**no**

(b)
i. copper carbonate
ii. water

(c)
i. copper sulfate solution
ii. All the dissolved copper sulfate and the water passes through the filter. Nothing remains in the filter so there is no residue.

(d)
i. copper chloride (undissolved/excess)
ii. copper chloride (dissolved) or copper chloride solution

5. *Guidance note:* This question develops learners' understanding of filtration by considering more deeply what passes through a filter when muddy lake water is filtered (macroscopic understanding). Learners also recap that water contains dissolved minerals (sub-microscopic understanding). The idea of microorganisms may also be included to support an understanding of scale.

The water that passes through the filter will still contain dissolved minerals (and microorganisms). The water is therefore still a mixture and is not a chemically pure.