THE ROYAL SOCIETY

Brian Cox school experiments

How can we clean our dirty water?

Water covers most of the Earth and is vital for creating and sustaining life. Of all the world's water, approximately 97% is found as salt water in the seas and oceans. Although it may look clean, the seas are becoming more polluted with rubbish. There are large and small items being dumped in the sea, from pieces of wood to tiny beads of plastic from products such as face creams. All of this makes sea water a mixture that is unsafe to drink.

As well as this, salt is dissolved in sea water making it a solution. Land animals need to drink water every day to stay healthy but cannot drink sea water. Can we turn dirty, salty water into something that animals can drink?

In this activity students will investigate the natural substances and pollutants often found in sea water. The aim of the experiment is to obtain clean water from dirty salty water.

Introduction to Brian Cox school experiments

The Brian Cox school experiments are designed to support teachers to carry out experimental science in the classroom, and relate it to real world experiences. Creative and experimental approaches are particularly important for keeping students interested and engaged in science, and for equipping them well for the future, whether or not they pursue a career in science.

Each written resource is accompanied by four videos; two with extra information on how to carry out the experiment and two on how the experiment relates to the real world.

Learning outcomes

- Use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating.
- Know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution.
- Plan a scientific enquiry to answer a question, including recognising and controlling variables where necessary.

Based on resources from the Royal Society of Chemistry

How can we clean our dirty water?

Students are challenged to produce clean water from dirty water they are given, using a range of filters to achieve their goal. The filters suggested in this experiment are a sieve, a sand filter and filter paper but you may choose to use other items.

Students can try using the filters in different orders to see what happens but the most effective approach is to use the sieve first, as this has the largest holes and will remove the bigger pieces of rubbish, the sand filter second to remove smaller items and the filter paper or cloth last as this has the smallest holes.

You will need to create a mixture of items to represent dirty sea water, such as sand, stones, grass and plastic, which can be prepared in advance, or in front of the class.

Once the students have filtered out what materials they can, you could then evaporate and collect the water, to show the salt and any other dissolved materials left behind. It is recommended that this is done as a teacher demonstration as a heat source is required to evaporate the water.

Health and safety considerations:

- Students should wash their hands thoroughly after activity;
- the solution is not to be tasted or drunk; and
- have paper towels readily available to clear up any spillages in case of slips or trips.

For up-to-date advice on health and safety please refer to CLEAPSS (England, Wales or Northern Ireland) or SSERC (Scotland) guidelines.

Suggested sequence of events:

45/60 minutes

- Discuss with students what substances you might expect to find in the sea and prepare a jug of dirty water. This can be done some days before the activity to give you time to collect the items, such as sand, grass and plastic, or you can prepare a collection in advance and as they suggest each substance add some of it to the jug of water, stirring thoroughly. If creatures are mentioned discuss but do not add!
- Each group will be given a tray and three filters; a sieve, a sieve with scourer pad holding sand and a sieve holding a piece of filter paper or material.
- The first task is for each group to decide the best order to use the filters in and explain their sequence of filters. The students then fill in their predictions of what they think each filter may remove in the results table.
- Give each group a plastic cup of dirty salt water. Students will stir this and slowly pour about three-quarters through filter 1 so it collects in a clean plastic cup underneath. They should compare this filtered water to the quarter of dirty salt water left behind in the beaker and note any changes in the results table (is it cleaner/dirtier/clean?).
- Students take the water that has passed through filter 1 and pour three-quarters of it through filter 2. Compare the water that has passed through filter 2 to the water left from filter 1.
- Students take the water that has passed through filter 2 and pour three-quarters of it through filter 3. Compare the water that has passed through filter 3 to the water left from filter 2.
- Students should discuss what the different filters have removed and whether the filtered water is clean.

Optional demonstration

The water that has been passed through all the filters will still have salt dissolved in it. This cannot be removed through filtration and one way of removing it is to evaporate the water and then collect it. The salt will not be evaporated and will be left behind.

Students should pour some of the water that has passed through all the filters into a foil pie case, about half a centimetre deep (a smaller amount of water will give a rapid result). These foil cases will be collected by staff.

The foil cases with filtered water are placed on the warmer a safe distance from the students. A cold metal tray is held at an angle, about 45 degrees, over the foil cases facing the students. This will soon collect some condensed water which can be pushed into a clean tray. Following a careful check, this water will be cool enough for the students to touch.

Possible extensions:

- Small pieces of iron or steel, no smaller than 1cm^2, can be added to be removed by a magnet.
- Food colouring can be added to represent chemicals dissolved in sea water from ships/industry/etc. Approximately 2-4 drops of colouring to 1 litre of water is recommended. The food colouring can be removed by passing it through a paper filter containing Granular Activated Carbon (GAC). This is safe and easily available online.

How can we clean our dirty water?

Activity toolbox:

Resources per group:

- 4 clear plastic disposable cups;
- 1 lollipop stick (to stir the water);
- 1 foil pie case;
- a tray to catch any spillages;
- 3 small sieves;
- sand;
- a piece of scourer pad to line one sieve (enough to hold a dessert spoonful of sand); and
- a paper filter (a coffee filter is ideal) or a small piece of cloth (eg cotton/muslin/tights).

For teacher preparation:

- A range of objects that may be found in sea water such as sand, stones, salt, plants, silt/soil, small pieces of plastic;
- a large jug of clean tap water (each group needs enough of this water to three-quarters fill one plastic cup); and
- some way of safely heating the aluminium pie cases (eg a table top 'plate warmer' with t-light candles and matches), a small metal baking tray (cooled in a fridge) and a clean tray to catch water droplets. If lit t-lights are used ensure that no flammable items are nearby, the students are kept at a safe distance, a large heatproof tray is used in case of spillage and consideration is given to the location of smoke detector devices. For advice on the use of t-lights see the CLEAPSS (for England, Wales or Northern Ireland) or SSERC (for Scotland) guidelines.

Homework or cross-curricular activities

Students could visit a waste water treatment works to discover what is in rivers that flow into the sea

Plastic in our oceans

Study the current problem with plastic microbeads in the ocean. Students can investigate how they get in the food chain and the effects on humans. What other kinds of item can be found in the sea? What is the effect of this on the wildlife?

Scaling up

Can the filtering methods used in the activity be used on a larger scale? If not, why not? Students can design a device that can filter sea water without filtering out the plants/animals and ruining the ecosystem. Can they help clean up an oil spill (vegetable oil on some water)?

ACTIVITY

Name ..... Date .....

How can we clean our dirty water?

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Of all the world's water, approximately 97% is found as salt water in the seas and oceans. Although it may look clean, the seas are becoming more polluted with rubbish. There are large and small items being dumped in the sea, from pieces of wood to tiny beads of plastic from products such as face creams. All of this makes sea water a mixture that is unsafe to drink. As well as this, salt is dissolved in sea water making it a solution.

Land animals need to drink water every day to stay healthy but cannot drink sea water. Do you think we can turn dirty, salty water into something that animals can drink?

Your task

Use the filters given to you to remove as much dirt and other material as you can from the dirty salty water you have been given.

You will need:

- 4 clear plastic disposable cups;
- 1 lollipop stick (to stir the water);
- a tray to catch any spillages;
- 3 small sieves;
- sand;
- a piece of scourer pad to line one sieve (enough to hold a dessert spoonful of sand); and
- a paper filter.

ACTIVITY

Do your experiment on the tray to catch anything that gets spilt

1. You will be given a clear plastic cup with some dirty salty water.
2. You have three different types of filter. You will be passing the dirty salty water through each filter in turn, one after the other. You have to decide the best order to make the water clean and keep the filters working for as long as possible. Write your predictions in the results box.
3. Stir your dirty water, then hold your first filter above a clean plastic cup and pour three-quarters of it through. Compare the filtered water to the unfiltered water. Record the result.
4. Take the water you have filtered. Hold your second filter above a new plastic cup and pour three-quarters through. Compare this filtered water to the water that came through the first filter.
5. Take the water you have filtered through filter two. Hold your third filter above a new plastic cup and pour three-quarters through. Compare this filtered water to the water that came through the second filter. Record your result.

What have the different filters removed? Is the water at the end clean?

Results

Filter name	Which order for filters?	Prediction I predict this filter will remove . . .	Results What substances has this filter removed?

After filtering, I predict the water is/is not safe to drink because

. . . . . .

. . . . . .

. . . . . .

After evaporating, I predict the water is/is not safe to drink because

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