

Water Treatment

Northumbrian Water treats waste water from the sewage system to clean it. The water can then be safely returned to the environment.

These processes are monitored by water quality scientists.

Waste water contains dissolved solutes and insoluble substances. Most of these must be removed before the water can be put back into the water system.



Northumbrian Water sewage works, Howden.

Know

1. Write down definitions for the following terms:

solute; solvent; insoluble; filtration.

Substance	Pure	Mixture
air		
carbon dioxide		
distilled water		
milk		
orange juice		
oxygen		
urine		
rain water		
sea water		
tap water		

2. Tick the correct category for each substance in the list below.

Apply

The first stage of cleaning waste water is called *clarification*. This removes the largest pieces of dirt and debris. Then the water is *filtered* into large tanks. This removes any smaller solids that are still in the water. The large tanks contain layers of charcoal, gravel and sand.

The charcoal helps to remove organic material and toxins (poisons). The sand and gravel layers filter out particles of different sizes. Solids that are about the same size, or larger, than the filter material will be removed. The table shows the size ranges of sand and gravel particles:

	Size Range
gravel	2 mm - 64 mm
sand	<2 mm <i>but</i> >0.0625 mm

3. Complete the table below to show which of the following objects found in waste water would be filtered by the gravel and sand layers

	Gravel	Sand	Neither Layer
leaves			
bacteria			
pollen			
insects			

4. To make a model of how water treatment works, a student mixes tap water, salt (sodium chloride), and chalk (calcium carbonate) together.
- (i.) Describe how the student could separate the three substances using equipment found in a school lab. Use the physical properties of the three substances to explain your process.
- (ii.) Discuss whether this is a good model of water treatment.

Extend

Northumbrian Water use reservoirs to store water. These are large, artificially-created lakes.

Many reservoirs contain fish, which require oxygen in order to live. They use gills to obtain oxygen which is dissolved in the water.

5. The table shows the amount of oxygen (in mg per litre) which will dissolve in water at different temperatures.

Temperature (°C)	Dissolved oxygen (mg/l)
0	14.6
5	12.8
10	11.3
15	10.2
20	9.2
25	8.6
30	7.9
40	6.7



Brown Trout

image credit: Eric Engbretson
via Wikimedia Commons

- (i.) Use the data in the table to plot a graph to show the amount of oxygen dissolved in water against temperature.
- (ii.) Use your graph to work out the temperature of water when the amount of dissolved oxygen is 10.0 mg/l.
6. Many reservoirs contain fish, an example being Brown trout. Trout require a dissolved oxygen level of at least 7 mg/l to survive.

During hot summers, these reservoirs may have a 'gusher fountain' installed. The fountain shoots a column of water high into the air.

Suggest how the gusher fountain will improve the conditions for the trout living in the lake. Use data from the question to explain your answer.



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Mark Scheme: Water Treatment

Know

1. Example definitions:

solute	A substance dissolved in another (usually a liquid).
solvent	A substance, normally a liquid, which dissolves another substance.
insoluble	A substance which will not dissolve in a given solvent.
filtration	The process of separating solid matter and fluid using a filter, passing the liquid filtrate and retaining the solid residue.

- 2.

Substance	Pure	Mixture
air		✓
carbon dioxide	✓	
distilled water	✓	
milk		✓
orange juice		✓
oxygen	✓	
urine		✓
rain water		✓
sea water		✓
tap water		✓

Apply

- 3.

	Gravel	Sand	Neither Layer
leaves	✓		
bacteria			✓
pollen			✓
insects		✓	

4. To make a model of a water treatment works, a student mixes up tap water, salt (sodium chloride) and chalk (calcium carbonate).
- (i.) Describe how the student could separate the three substances using equipment found in a school lab. Use the physical properties of the three substances to explain your process

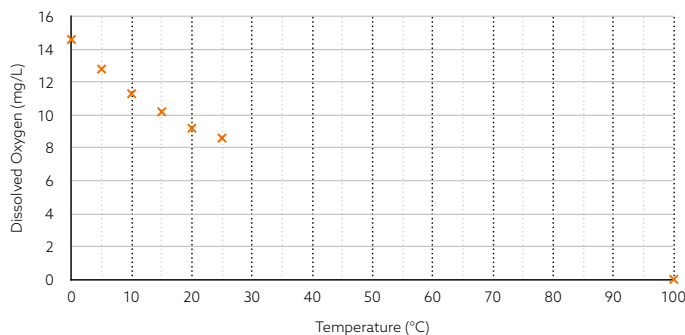
Add hot water to mixture to dissolve salt.
Filter to separate out the calcium carbonate residue.
Distill (evaporate and recondense the steam) to get pure water and salt residue.

- (ii.) Discuss whether this is a good model of water treatment.

Yes: solid particles are removed; the filter acts like the charcoal, gravel and sand.
No: Water treatment plants don't boil water to remove dissolved solids.

Extend

5. Temperature vs. dissolved oxygen graph similar to:



For (ii.), water temperature for dissolved oxygen of 10.0 mg/l would be around 16 °C.

6. From the graph above, ambient temperature would have to reach around 40 °C for dissolved oxygen concentrations to fall to trout-threatening levels. However, oxygen distribution through the reservoir would not be uniform, with surface water likely having the highest oxygen concentrations.

A gusher fountain would forcibly mix water and air, increasing dissolved oxygen concentration towards the temperature solubility limit. It would also help circulate water around the reservoir, providing a more even distribution of dissolved oxygen.



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