

Potable water and water treatment

Mark Scheme



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1. Water is essential for life on Earth, but as natural water sources often contain dangerous bacteria and pollutants, they must be treated to become potable.

- a) The diagram shows water passing through layers of sand and gravel.
Which statement correctly describes this process?

D – is the only correct answer.	1 mark
	Total: 1 mark

- b) Which process is used to produce drinking water from sea water?

A – is the only correct answer.	1 mark
	Total: 1 mark

- c) In the treatment of waste water, what is the specific purpose of the screening process?

B – is the only correct answer.	1 mark
	Total: 1 mark

- d) The diagram shows the uses and treatment processes of muddy river water.
Which row identifies uses 1 and 2 and processes A and B?

B – is the only correct answer.	1 mark
	Total: 1 mark

- e) During the sedimentation stage of waste water treatment, waste water separates into two distinct components. What are they called?

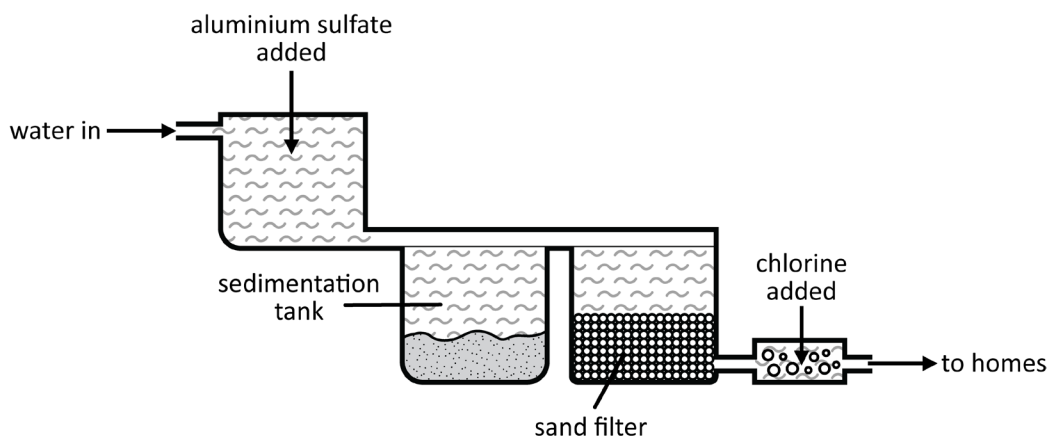
B – is the only correct answer.	1 mark
	Total: 1 mark

- f) What are the useful by-products produced during the anaerobic digestion of the solid sewage sludge?

C – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 6 marks)

2. Water from a reservoir is treated at a water works to make it potable.
The figure below shows a simplified model of a water treatment works.



- a) In the first stage, the water passes through a sedimentation tank and then through fine sand and gravel. Explain why the sand and gravel filters are necessary.

An explanation to include:	
To filter or remove remaining solids.	1 mark
Which are too small to settle in the sedimentation tank.	1 mark
	Total: 2 marks

- b) After filtering, chlorine gas is bubbled into the water.

State why it is not safe to drink the water before this stage is completed.

It contains microbes / bacteria / pathogens.	1 mark
Allow: to avoid disease or it is not sterilised yet.	
	Total: 1 mark

- c) Aluminium sulfate, which is also called 'Alum' is added to the water to help fine particles clump together. This compound is made by reacting aluminium oxide with sulfuric acid.

Write a **balanced** symbol equation for this reaction.

$\text{Al}_2\text{O}_3 + 3\text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{H}_2\text{O}$	
Award 1 mark for the correct formulae of reactants.	1 mark
Award 1 mark for the correct formula of aluminium sulfate.	1 mark
Award 1 mark for the correct balancing.	1 mark
	Total: 3 marks

- d) A student wants to check if a sample of untreated water contains aluminium ions (Al^{3+}).
Describe a test for aluminium ions.

A description to include:	
Add sodium hydroxide solution. Allow: NaOH	1 mark
White precipitate forms which dissolves in excess NaOH.	1 mark
	Total: 2 marks

(Total for Question 2 is 8 marks)

3. A sample of water is taken from a river. The water is cloudy and has a pH of 5.

a) Describe how the student would use universal indicator paper to find the pH of the water sample.

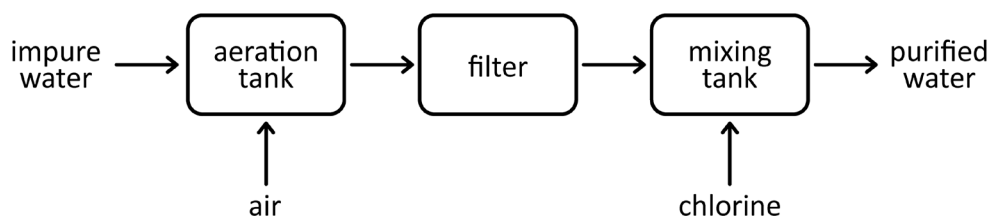
A description to include the following:	
Add a drop of the water to the paper or dip the paper into the water.	1 mark
Allow: add universal indicator solution.	
Compare the colour change to the pH chart / scale.	1 mark
	Total: 2 marks

b) The student could also have used Litmus paper for this.

Identify **one** limitation of using Litmus paper for testing this sample of water.

It does not give a pH number / value.	1 mark
Allow: it only tells you if it is acid or alkali or it is not precise enough.	
	Total: 1 mark

The diagram below shows the process used to turn the river water into potable drinking water.



During the aeration stage, air is bubbled through the water.

c) Name the gas that makes up the largest percentage of the air.

Nitrogen. Allow: N ₂	1 mark
	Total: 1 mark

The filtration tank contains layers of sand and grit.

d) Explain how this stage removes insoluble solids from the river water.

An explanation to include the following:	
(the sand acts as a) <u>filter</u> .	1 mark
solid particles are too large to pass through (the gaps).	1 mark
Allow: traps solid particles.	
	Total: 2 marks

e) Explain the purpose of the chlorination stage.

To <u>sterilise</u> (the water).	1 mark
Accept: to kill microorganisms.	
to make it safe to drink	1 mark
	Total: 2 marks

The student is given another clear liquid in a beaker. They need to do a test to prove that this liquid is water. They use anhydrous cobalt(II) chloride paper.

- f) State the **colour change** that would be observed if water is present.

(from) Blue	1 mark
(to) Pink	1 mark
	Total: 2 marks

The student argues that because the test in part (f) was positive, the water must be pure.

- g) State why the student is **incorrect**.

The chemical tests only show that water molecules are present.	1 mark
Allow: impurities / dissolved salts may still be present.	
Allow: pure water is determined by melting/boiling point.	
	Total: 1 mark

(Total for Question 3 is 11 marks)

4. Waste water, often called sewage, from homes, agriculture and industries contains organic matter, harmful microbes, and toxic chemicals.

This water must be treated before it can be safely released back into rivers or the sea.

Describe the main stages of treating **waste water**.

In your answer, explain how the liquid effluent and the solid sludge are treated differently.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Simple statements are made about the treatment (e.g., "filter the water" or "add bacteria"). The steps may be out of order or conflated with potable water treatment.
Level 2	3 - 4	The main stages are described, but some details may be missing or the distinction between the treatment of sludge and effluent is less clear. The logic of the process is generally correct.
Level 3	5 - 6	A detailed and coherent description of the entire waste water treatment process is given. The distinction between how sludge and effluent are treated is clear and chemically/biologically accurate (mentioning aerobic vs anaerobic).

Indicative content:	
Stage 1: Screening - Waste water passes through a mesh or screen. - This removes large solid objects like grit, twigs, and plastic. Stage 2: Sedimentation - The water stands in a settlement tank. - Heavier solids sink to the bottom to form sludge. - Lighter liquid floats to the top to form effluent. Stage 3: Aerobic Digestion (Effluent Treatment) - The liquid effluent is removed from the top. - Air is pumped through the effluent (aeration). Aerobic bacteria digest and break down organic matter and harmful microbes in the presence of oxygen. - The treated water is safe to be released back into rivers. Stage 4: Anaerobic Digestion (Sludge Treatment) - The solid sludge is removed from the bottom. - It is broken down by bacteria in the absence of oxygen (anaerobic digestion). - This produces methane gas (which can be used as fuel/energy). - The remaining waste can be used as fertiliser for farming.	
	Total: 6 marks

(Total for Question 4 is 6 marks)