Waste water treatment

5.10.1.3 · Chemistry · revision notes

How sewage and industrial waste water are treated before they are released into the environment, and how the ease of getting potable water from waste water, ground water and salt water compares. Expect 'describe the stages' questions and short comparisons on Paper 2.

Key facts

- Sewage and agricultural waste water: remove organic matter and harmful microbes
- Stages: screening and grit removal → sedimentation → sludge: anaerobic digestion; effluent: aerobic treatment
- Anaerobic = without oxygen (produces biogas, mainly methane)
- Ground water: least treatment. Waste water: many stages. Salt water: desalination (large energy use)
- Industrial waste water: remove organic matter and harmful chemicals
- Sludge = solids that settle at the bottom; effluent = the liquid above
- Aerobic = with oxygen (air bubbled through the effluent)

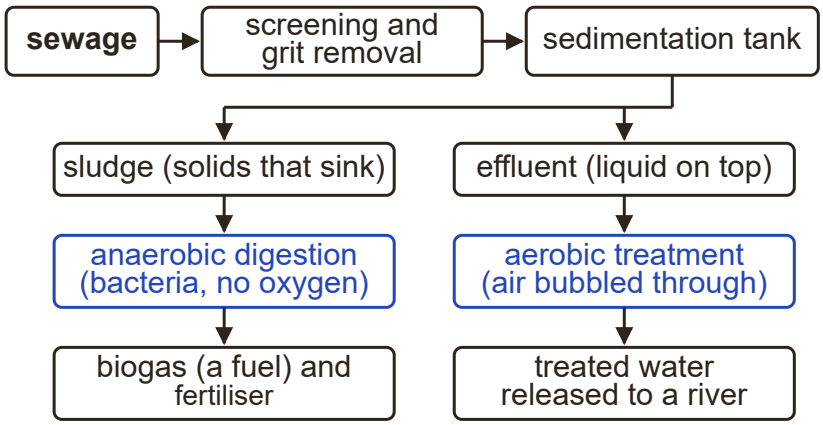
Notes

Why waste water is treated

- Urban lifestyles and industrial processes produce large amounts of **waste water**. It must be treated before it is released into rivers or the sea.
- **Sewage** and **agricultural** waste water need **organic matter** and **harmful microbes** removed.
- **Industrial** waste water may need organic matter and **harmful chemicals** (e.g. toxic metal compounds) removed, which can need extra stages.

The stages of sewage treatment

- 1. **Screening and grit removal**: screens remove large objects (e.g. rags, plastic, twigs) and grit is allowed to settle out.
- 2. **Sedimentation**: in settlement tanks, heavier solids sink to form **sewage sludge**. The liquid above is called **effluent**.
- 3. **Anaerobic digestion** of the sludge: bacteria break down the organic matter **without oxygen**. This produces **biogas** (mainly methane), which can be used as a fuel, and digested sludge, which can be used as a fertiliser.
- 4. **Aerobic biological treatment** of the effluent: air is bubbled through it, so bacteria break down the remaining organic matter **using oxygen**. The treated water can then be released safely.



Sludge is digested without oxygen; the effluent is treated with oxygen.

Comparing sources of potable water

- **Ground water** is fresh water with low levels of dissolved substances, so it usually needs only filtering and sterilising.
- **Waste water** needs many stages (screening, sedimentation, biological treatment) to remove organic matter and microbes, and would still need sterilising before people could drink it.
- **Salt water** must be desalinated by distillation or reverse osmosis, which needs large amounts of energy.
- So in the UK most potable water comes from fresh water, because it is the easiest and cheapest to treat.

How to answer each type of question

Describe how sewage is treated

4 to 6 marks | Grade 5

1. Write the stages in the correct order.
2. For each stage, say what happens and what is removed.
3. Use the key words: screening, sedimentation, sludge, effluent, anaerobic, aerobic.
4. Say which part (sludge or effluent) each biological treatment is used on.

Example. Describe how sewage is treated so that the water can be released into a river. (4 marks)

Model answer. Screening removes large objects, and grit is removed (1). In sedimentation tanks the solids settle to form sludge, leaving liquid effluent (1). The sludge is broken down by anaerobic digestion (bacteria, without oxygen) (1). The effluent is treated aerobically: air is bubbled through so that bacteria break down the remaining organic matter (1).

Explain why industrial waste water needs different treatment

2 marks | Grade 5

1. Say what sewage treatment removes: organic matter and harmful microbes.
2. Say that industrial waste water may also contain harmful chemicals, which must be removed too.

Example. Waste water from a factory contains toxic metal compounds.
Explain why this waste water may need extra treatment compared with sewage. (2 marks)

Model answer. Sewage treatment is designed to remove organic matter and harmful microbes (1). The factory waste water also contains harmful chemicals (the toxic metal compounds), which must be removed before the water is released (1).

Compare obtaining potable water from different sources

4 to 6 marks | Grade 5

1. Cover every source named in the question.
2. For each source, say what treatment it needs.
3. Compare the number of stages and the energy needed.
4. Finish with a judgement about which is easiest, with a reason.

Example. A town could obtain potable water from ground water, from treated waste water or from sea water.
Compare the treatment needed for each source. (4 marks)

Model answer. Any four from: ground water has low levels of dissolved substances, so it only needs filtering and sterilising (1); waste water must first go through screening, sedimentation and biological treatment to remove organic matter and microbes (1); it would then still need to be sterilised (1); sea water must be desalinated by distillation or reverse osmosis, which needs large amounts of energy (1); so ground water is the easiest and cheapest source (1).

Don’t lose marks

- Mixing up sludge (the settled solids) and effluent (the liquid).
- Swapping anaerobic and aerobic: sludge is digested anaerobically; effluent is treated aerobically.
- Describing potable water treatment (filter beds and chlorine) when the question asks about sewage treatment.
- Forgetting that industrial waste water needs harmful chemicals removed, not just organic matter and microbes.

More tips

Memory tricks

- Order of stages: 'screen, settle, then bacteria'.
- Sludge sinks; the liquid on top is the effluent.
- An-aerobic means 'no air'. Sludge goes to the sealed anaerobic tank; the effluent gets the air bubbles.
- Biogas from sludge is mainly methane, so a sewage works can make some of its own fuel.

Exam technique

- Keep the stages in order: screening and grit removal come first, then sedimentation, then the biological stages.
- Use the exact terms sludge, effluent, anaerobic and aerobic. Vague words such as 'dirty bits' do not score.
- In 'compare' questions, make a point about each source and use comparative words such as 'fewer stages' or 'more energy'.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Say why waste water must be treated**
Towns and industry produce large amounts of waste water that must be treated before it is released into the environment.

Grade 4 — **State what sewage treatment must remove**
Sewage and agricultural waste water need organic matter and harmful microbes removed.

Grade 5 — **List the stages of sewage treatment in order**
Screening and grit removal, sedimentation, anaerobic digestion of the sludge, and aerobic biological treatment of the effluent.

Grade 5 — **Describe what happens at each stage**
For example, in sedimentation solids settle to form sludge, leaving the liquid effluent on top.

Grade 5 — **Compare treating waste, ground and salt water**
Ground water needs the least treatment; waste water needs many stages; salt water needs desalination, which uses large amounts of energy.

Grade 6 — **State what industrial waste water needs**
Removal of organic matter and harmful chemicals.

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