

Water: practice questions

This set of practice questions covers the water topic (section 10.1 Water, in the chemistry of the environment topic) from Cambridge O Level Chemistry 5070 and Cambridge IGCSE Chemistry 0620. It tests the chemical tests for water, how to check whether water is pure, what natural water contains, which of those substances are useful and which are harmful, how water is treated for homes, and why distilled water is used in practical work. There are 60 marks in total: Section A (8 marks), Section B (20 marks) and Section C (32 marks). A full answer scheme is at the end.

Note: Q16 and Q17(b) to (d) also use skills from other topics: mole calculations (stoichiometry) and reversible reactions (hydrated and anhydrous copper(II) sulfate).

Key ideas

- **Anhydrous copper(II) sulfate** turns from **white to blue** when water is added.
- **Anhydrous cobalt(II) chloride** (often used as test paper) turns from **blue to pink** when water is added.
- These tests show that water is **present**. They do **not** show that the water is pure.
- **Pure water** melts at exactly 0 °C and boils at exactly 100 °C (at standard atmospheric pressure). Impurities **lower the melting point** and **raise the boiling point**, and the change happens over a range of temperatures.
- Natural water can contain dissolved oxygen, metal compounds, plastics, sewage, harmful microbes, and nitrates and phosphates from fertilisers (phosphates can also come from detergents).
- **Beneficial:** dissolved oxygen (aquatic life needs it to respire); some metal compounds (they supply minerals that living things need).
- **Harmful:** some metal compounds are toxic; plastics can harm aquatic life; sewage contains harmful microbes; harmful microbes (e.g. from sewage) cause disease; nitrates and phosphates lead to deoxygenation of the water and damage to aquatic life.
- **Domestic water treatment:** sedimentation and filtration remove solids; carbon removes tastes and odours; chlorination kills microbes.
- **Distilled water** is used in practical chemistry instead of tap water because it contains fewer chemical impurities.

Section A: multiple choice

Choose one answer, A, B, C or D, for each question. Each question is worth 1 mark.

1. A few drops of a colourless liquid are added to anhydrous copper(II) sulfate. The liquid contains water. What colour change is seen? [1]

- A: blue to white
- B: white to blue
- C: blue to pink
- D: pink to blue

2. A piece of blue cobalt(II) chloride paper turns pink when it is dipped into a liquid. What does this result show? [1]

- A: The liquid is pure water.
- B: The liquid is acidic.
- C: The liquid contains water.
- D: The liquid contains chloride ions.

3. Which observation shows that a colourless liquid is pure water? [1]

- A: It turns anhydrous copper(II) sulfate blue.
- B: It has a pH of 7.
- C: It leaves no smell when it is warmed.
- D: It melts at exactly 0 °C and boils at exactly 100 °C at standard atmospheric pressure.

4. A student heats a sample of sea water at standard atmospheric pressure. Which statement about the sea water is correct? [1]

- A: It boils above 100 °C.
- B: It boils at exactly 100 °C.
- C: It boils below 100 °C.
- D: It freezes above 0 °C.

5. Which stage of domestic water treatment kills microbes? [1]

- A: sedimentation
- B: filtration
- C: passing through carbon
- D: chlorination

6. Why is water passed through carbon during treatment? [1]

- A: to kill bacteria
- B: to remove dissolved salts
- C: to remove tastes and odours
- D: to let large solid particles settle

7. Which substance found in a river is beneficial to fish? [1]

- A: dissolved oxygen
- B: nitrates washed off farmland
- C: small pieces of plastic
- D: untreated sewage

8. Why is distilled water, rather than tap water, used to make up solutions in a school laboratory? [1]

- A: It has a higher boiling point than tap water.
- B: It contains fewer chemical impurities that could affect results.
- C: It turns anhydrous copper(II) sulfate a darker blue.
- D: It contains more dissolved oxygen than tap water.

Section B: short answer

9. Describe how anhydrous copper(II) sulfate is used to test a liquid for the presence of water. Include

the result for a positive test. [2]

10. A student says: "The liquid turned my cobalt(II) chloride paper pink, so it must be pure water." Explain why the student is wrong. [2]

11. A student measures the melting point and boiling point of two colourless liquids, P and Q. The results are shown in the table.

Liquid	Melting point / °C	Boiling point / °C
P	0	100
Q	-2	100.6

(i) State which liquid is pure water. [1]

(ii) Use the data to explain your answer, stating how an impurity affects the melting point and the boiling point of water. [2]

12. Nitrates from fertilisers can wash off farmland into a lake. Explain how this can lead to the death of fish in the lake. [3]

13. (i) State why untreated sewage in drinking water is harmful to humans. [1]

(ii) Some metal compounds in natural water are beneficial, but others are harmful. Give one reason why a metal compound in water may be harmful. [1]

14. Copy and complete the table to show the purpose of each stage of domestic water treatment. [3]

Stage	Purpose
filtration	
passing through carbon	
chlorination	

15. A student tests a solution for chloride ions by adding dilute nitric acid and aqueous silver nitrate. The student dissolves the sample in tap water instead of distilled water. Suggest why this could give a misleading result. [2]

16. A sample of river water contains 8.0 mg of dissolved oxygen, O₂, in every 1 dm³. Calculate the concentration of dissolved oxygen in mol/dm³. Show your working. [A_r: O, 16] [3]

Section C: structured questions

17. Anhydrous copper(II) sulfate and anhydrous cobalt(II) chloride are both used to test for water.

(a) State the colour of anhydrous cobalt(II) chloride and its colour after water is added. [2]

(b) Anhydrous copper(II) sulfate reacts with water to form hydrated copper(II) sulfate, CuSO₄·5H₂O. Write a balanced equation for this reaction. [1]

(c) Blue hydrated copper(II) sulfate is heated gently in a boiling tube. State what is seen in the tube and what this shows about the reaction in (b). [2]

(d) A student heats 7.50 g of hydrated copper(II) sulfate, CuSO₄·5H₂O, until all the water has been removed. Calculate the mass of anhydrous copper(II) sulfate, CuSO₄, left. Show your working. [A_r: H,

1; O, 16; S, 32; Cu, 64] [3]

18. A town takes its water from a river. The water passes through these stages in order: a sedimentation tank, a sand and gravel filter, a carbon bed, and a chlorination tank. It is then pumped to homes.

- Explain why the water is passed through the sedimentation tank before it reaches the filter. [2]
- State which stage makes the water safe to drink, and explain why the water is not safe to drink after filtration alone. [2]
- Tests show that the treated water still contains nitrate ions. Explain why these stages do not remove nitrate ions. [2]
- Suggest why the amount of chlorine added must be carefully controlled. Give one reason for not adding too little and one reason for not adding too much. [2]

19. An environmental group tested water at three sites along a river that flows past a large area of farmland. Site 1 is upstream of the farms. Site 2 is where drainage water from the farms enters the river. Site 3 is 10 km downstream of Site 2.

Site	Dissolved oxygen / mg/dm ³	Nitrate / mg/dm ³	Number of fish species found
1	9.5	3	11
2	3.0	42	2
3	6.5	15	6

- Identify the site with the highest nitrate concentration and suggest the source of the nitrate. [2]
- Describe the relationship between nitrate concentration and dissolved oxygen shown by the data. [1]
- Use the data to explain why fewer fish species are found at Site 2 than at Site 1. [3]
- Name one other substance that can enter rivers and cause the same problem, and state one source of it. [2]

20. A technician has three unlabelled bottles of colourless liquid. One contains distilled water, one contains concentrated aqueous sodium chloride and one contains concentrated aqueous sugar solution.

- Describe a chemical test that would show that all three liquids contain water. Give the result. [2]
- Describe how the technician could use boiling points to identify the distilled water. State the expected result. [2]
- The technician uses distilled water, not tap water, to make up solutions for practical work. Explain why. [2]
- River water can contain plastics and dissolved oxygen. For each one, state whether it is beneficial or harmful to aquatic life and give a reason. [2]

Total: 60 marks

Answers

1. B [1]

Anhydrous copper(II) sulfate is white; hydrated copper(II) sulfate is blue. C is the cobalt(II) chloride change.

2. C [1]

The test only shows water is present. An aqueous solution such as salt water also gives a positive result, so A is wrong.

3. D [1]

A, B and C are also true of many solutions, for example aqueous sodium chloride (it contains water, is neutral and has no smell), so they do not prove purity.

4. A [1]

Dissolved salts raise the boiling point and lower the freezing point, so B, C and D are wrong.

5. D [1]

6. C [1]

7. A [1]

8. B [1]

9.

- Add a few drops of the liquid to (white) anhydrous copper(II) sulfate [1]
- It turns from white to blue if water is present [1]

The second mark needs the colour change white → blue. "Turns blue" alone scores only if the first marking point already states that the anhydrous solid is white.

10.

- Cobalt(II) chloride only shows that water is present [1]
- Any liquid or solution containing water (e.g. salt solution) would also turn it pink, so purity must be checked by measuring melting point or boiling point [1]

11.

(i) P [1]

(ii)

- P melts at exactly 0 °C and boils at exactly 100 °C, the values for pure water [1]
- An impurity lowers the melting point and raises the boiling point, as seen for Q (−2 °C and

100.6 °C) [1]

12. Any three from the following, but one mark must be for the last point (fish cannot respire):

- Nitrates act as nutrients, so algae / water plants grow rapidly [1]
- The algae and plants die, and bacteria decompose them, using up dissolved oxygen [1]
- Nitrates lead to deoxygenation of the water / the dissolved oxygen concentration falls [1]
- Fish cannot get enough oxygen to respire, so they suffocate / die [1]

Maximum 3 marks. A syllabus-level answer such as "nitrates lead to deoxygenation of the water, so fish cannot get enough oxygen for respiration" scores 2 marks; the third mark needs a reason why the oxygen is used up (algae growth, death and decomposition by bacteria).

13.

(i) Sewage contains harmful microbes / bacteria that cause disease (e.g. cholera, typhoid) [1]

(ii) Some metal compounds are toxic / poisonous (e.g. lead or mercury compounds) [1]

14.

Stage	Purpose
filtration	removes (small) insoluble solid particles [1]
passing through carbon	removes tastes and odours [1]
chlorination	kills microbes / bacteria [1]

Do not accept "removes all impurities" for filtration, or "cleans the water" for chlorination.

15.

- Tap water contains dissolved impurities, including chloride ions (for example from chlorination or dissolved salts) [1]
- These chloride ions would form a white precipitate with silver nitrate, so the test could be positive even if the sample itself had no chloride ions [1]

16. Worked answer:

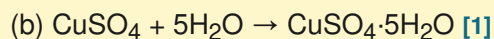
- Step 1: convert mass to grams. $8.0 \text{ mg} = 8.0 \div 1000 = 0.0080 \text{ g}$ [1]
- Step 2: find M_r of O_2 . $2 \times 16 = 32$ [1]
- Step 3: moles in $1 \text{ dm}^3 = \text{mass} \div M_r = 0.0080 \div 32 = 0.00025$, so the concentration = $2.5 \times 10^{-4} \text{ mol/dm}^3$ [1]

An error carried forward is allowed: for example, using $M_r = 16$ gives $5.0 \times 10^{-4} \text{ mol/dm}^3$, which scores the first and third marks.

17.

(a)

- Anhydrous: blue [1]
- After water is added: pink [1]



Also accept $\rightleftharpoons$ in place of $\rightarrow$.

(c)

- The blue solid turns white, and droplets of (colourless) liquid / water form near the top of the tube [1]
- The reaction is reversible [1]

(d) Worked answer:

- M_r of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} = 64 + 32 + (4 \times 16) + 5 \times (2 + 16) = 160 + 90 = 250$; moles = $7.50 \div 250 = 0.0300$ mol [1]
- 1 mol of hydrated salt gives 1 mol of CuSO_4 , so 0.0300 mol of CuSO_4 forms; M_r of $\text{CuSO}_4 = 160$ [1]
- Mass = $0.0300 \times 160 = 4.80$ g [1]

Another correct method: the mass fraction of CuSO_4 is $160/250$, so $7.50 \times 160 \div 250 = 4.80$ g, which scores full marks. The mass of water lost is 2.70 g.

18.

(a)

- In the sedimentation tank, large / heavy insoluble particles (such as sand and mud) settle to the bottom [1]
- This removes most of the solid first, so the filter does not get blocked / clogged quickly and only has to remove the smaller particles [1]

(b)

- Chlorination (the chlorination tank) [1]
- Filtration does not kill microbes / bacteria; many are small enough to pass through the filter, so the water could still cause disease [1]

(c)

- Nitrates are soluble, so they are dissolved in the water [1]
- Sedimentation and filtration only remove insoluble solids, so dissolved ions pass through the filter; carbon and chlorine do not remove them either [1]

(d)

- Too little: not all the microbes would be killed, so the water could still spread disease [1]
- Too much: chlorine is toxic / harmful to health, or it gives the water an unpleasant taste or smell [1]

19.

(a)

- Site 2 [1]
- Fertilisers used on the farmland, dissolved in rainwater that drains into the river [1]

(b) The higher the nitrate concentration, the lower the dissolved oxygen concentration [1]

Accept a comparison using data, e.g. Site 2 has the most nitrate (42 mg/dm³) and the least oxygen (3.0 mg/dm³).

(c)

- Use of data: nitrate rises from 3 mg/dm³ at Site 1 to 42 mg/dm³ at Site 2, and dissolved oxygen falls from 9.5 mg/dm³ to 3.0 mg/dm³ [1]
- Nitrates lead to deoxygenation of the water (they cause rapid growth of algae, which die and are decomposed by bacteria that use up the dissolved oxygen) [1]
- Most fish species cannot get enough oxygen to respire at Site 2, so they cannot survive there [1]

The data mark needs at least one pair of figures quoted with units or a clear comparison. The mechanism in brackets is not required for the second mark.

(d)

- Phosphates [1]; source: fertilisers or detergents [1]

Also accept: (untreated) sewage [1]; source: sewage works / drains / farm animal waste [1]. Do not accept nitrates, because the question asks for another substance.

20.

(a)

- Add a few drops of each liquid to anhydrous copper(II) sulfate / cobalt(II) chloride [1]
- Copper(II) sulfate turns white to blue, or cobalt(II) chloride turns blue to pink, for all three [1]

The colour change must match the reagent named.

(b)

- Heat each liquid until it boils and measure the temperature of the boiling liquid with a thermometer [1]
- Distilled water boils at 100 °C and the temperature stays constant while it boils; the two solutions boil above 100 °C (and the temperature rises as they boil) [1]

The thermometer must be accurate, and air pressure affects boiling points, so the three liquids should be compared under the same conditions.

(c)

- Tap water contains dissolved substances / ions (chemical impurities), but distilled water contains fewer [1]
- These impurities could react with the chemicals used or interfere with tests, giving wrong / unreliable results [1]

(d)

- Plastics: harmful, because animals can swallow them or get tangled in them / they build up in food chains [1]

- Dissolved oxygen: beneficial, because fish and other aquatic organisms need it for respiration [1]