C3 Revision - Water

Q1. Most water contains dissolved compounds.

The concentrations of these dissolved compounds are higher in sea water than in drinking water.

(a) (i) Draw a ring around the correct answer to complete the sentence.

	Pure water can be obtained from sea water by	distillation. filtration. neutralisation.

(1)

(ii) What is the boiling point of pure water? ..... °C **(1)**

(b) A student wanted to find out how much solid was dissolved in sea water.

This is the method the student used:

- measure the mass of an empty evaporating basin
- measure 25 cm^3 of sea water and pour it into the evaporating basin
- heat the evaporating basin gently until all of the water has evaporated
- measure the mass of the evaporating basin containing the solid residue.

(i) What piece of apparatus would be suitable for measuring 25 cm^3 of sea water?

..... **(1)**

(ii) How could the student check that all of the water had evaporated?

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..... **(2)**

(iii) The results the student obtained using 25 cm^3 of sea water are:

mass of empty evaporating basin = 23.21 g
mass of evaporating basin and dry solid residue = 24.04 g

Calculate the mass of solid dissolved in 1000 cm^3 of the sea water.

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Mass dissolved in 1000 cm^3 = ... g

(2)

(c) In many countries chlorine is added to drinking water supplies.

Why is chlorine added to drinking water?

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..... **(1)**

(d) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Compounds containing fluoride ions are added to some drinking water supplies.

Many scientists have done research into the effects of fluoride ions in drinking water.

Graphs 1, **2** and **3** show some of the results obtained.

Evaluate the advantages and disadvantages of adding fluoride ions to drinking water.

You should support your answer with evidence from **all three** graphs.

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(6)
(Total 14 marks)

Q2. Water is a natural resource. Drinking water in some parts of the UK is soft, but in other parts drinking water is hard. Calcium ions in water cause water to be hard.

There are two types of hard water, permanent hard water and temporary hard water.

- Permanent hard water can be caused by calcium sulfate ($CaSO_4$) dissolved in the water
- Temporary hard water can be caused by calcium hydrogencarbonate ($Ca(HCO_3)_2$) dissolved in the water

(a) Temporary hard water causes the formation of scale on heating elements.

Photograph © Steve Gorton / Getty Images

(i) Explain how scale forms on heating elements.

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..... **(2)**

(ii) Suggest why scale on heating elements causes problems.

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..... **(1)**

(b) Permanent hard water can be softened.

(i) Explain how adding sodium carbonate (Na_2CO_3) softens permanent hard water.

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..... **(2)**

(ii) Explain how a water filter containing carbon, silver and ion exchange resin softens permanent hard water.

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.....**(2)** **(Total 7 marks)**

Q3. These labels have been taken from two bottles of spring water.

(a) Mountain View and Valley Croft spring waters are hard because they contain calcium and magnesium ions.

(i) Mountain View spring water is about **three** times as hard as Valley Croft spring water.

Use the information on the labels to explain why.

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(2)

(ii) Describe how a student could use soap solution to show that Mountain View spring water is about **three** times as hard as Valley Croft spring water.

You should state how the experiment is made fair and give the expected result.

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..... **(3)**

(b) Why is hard water good for health?

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..... **(1)**

(c) Give **one** disadvantage of hard water.

..... **(1)**

(d) (i) Suggest why people should be concerned about the claim that Valley Croft spring water "contains no chemicals".

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..... **(1)**

(ii) Suggest why people should be concerned that Valley Croft spring water has only been

tested by their own scientists.

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.....**(1) (Total 9 marks)**

Q4. Two problems of hard water are *scale* and *scum*, as shown in the pictures of a heating element and a wash basin.

(a) Explain the difference between *scale* and *scum*

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.....**(2)**

(b) Explain how hard water can be made soft using an ion-exchange column.

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.....**(2)(Total 4 marks)**

Q5. The diagram shows three stages in the treatment of reservoir water.

(a) (i) What is separated from the reservoir water during filtration?

Tick (✔) **one** box.

	Bacteria	
	Dissolved nitrates	
	Solids	

(1)

(ii) What is added to sterilise the water?

Tick (✔) **one** box.

	Calcium	
	Chlorine	
	Magnesium	

(1)

(iii) State **one** advantage of adding fluoride to drinking water.

.....

..... **(1)**

(b) The diagram shows a water filter used in the home.

Water in

A student collected a sample of water from the filter.

The student could show that the filtered water contains dissolved salts without using a chemical test.

Describe how.

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(2)

(c) Seawater contains dissolved sodium chloride.

(i) Describe a test that could be used to show the presence of **<u>sodium</u>** ions in seawater.

Test .....

.....

Result with seawater .....

..... **(2)**

(ii) Seawater is forced through a membrane to make drinking water.

Seawater

Drinking water

Suggest why water molecules can pass through the membrane, but sodium ions and chloride ions cannot.

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.....**(1) (Total 8 marks)**

Q6.(a) A campsite has a spring, where hard water flows out of limestone rock.

A student compared the hardness of the spring water with two other samples of water.

The student measured 20 cm^3 of water into a boiling tube.

The student then:

- added a drop of soap solution
- shook the boiling tube for 10 seconds
- looked to see if a permanent lather had formed.

The student repeated the procedure until a permanent lather formed.

The results are shown in the table.

	Water sample	**Number of drops of soap solution needed to form a permanent lather**			
		Test 1	**Test 2**	**Test 3**	**Mean**
	Spring water (from the campsite)	13	11	6	
	Tap water	7	5	6	6
	Distilled water	1	1	1	1

(i) Calculate the correct mean for spring water.

.....

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Mean = ... drops **(2)**

(ii) What conclusion could the student make from her results?

Use the results in the table to give a reason for your answer.

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.....**(2)**

(iii) Another student at the campsite boils some of the hard spring water in a pan. The inside of the pan becomes coated with a white solid.

Explain how the white solid is produced.

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.....**(3)**

(b) Ion exchange columns can be used to soften hard water.

(i) Describe how an ion exchange column softens water.

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..... **(3)**

(ii) An ion exchange column is used for a few weeks.

Sodium chloride solution now needs to be passed through the ion exchange column.

Suggest why.

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..... **(1)**

(c) Tap water in the UK is safe to drink because water companies add chlorine to sterilise the water.

Suggest **one** argument for and **one** argument against water companies adding chlorine to sterilise water.

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.....**(2) (Total 13 marks)**

Q7. Good quality water is needed for a healthy life.

In the United Kingdom, obtaining safe water for drinking is as simple as turning on a tap. The water is made safe to drink by water companies.

However, in many parts of Africa and Asia, water used for drinking is contaminated and untreated. It is estimated that 2.2 million people die each year as a result of drinking contaminated water.

Efforts are being made to solve this problem and more water is being treated.

Describe how water in the United Kingdom is treated.

Explain how this makes it safe to drink.

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(Total 3 marks)

Q8. In the United Kingdom, water companies supply drinking water to our homes. However, some people are concerned about the taste and quality of the water that is supplied.

Describe one method that people can use at home to improve the taste and quality of the tap water supplied. Explain how this method works.

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(4)
(Total 4 marks)

M1.(a) (i) distillation

1

(ii) 100 / one hundred

1

(b) (i) measuring cylinder **or** pipette **or** burette

allow phonetic spelling

*do **not** accept teat pipette*

ignore any additional words or volumes

1

(ii) (re)heat the evaporating basin

*accept heat to constant mass for **2** marks*

1

weigh (again) **or** mass will not change

*if no other mark awarded allow **1** mark for a chemical test for water*

1

(iii) 33.2 (g)

*correct answer with or without working scores **2** marks*

*allow mass of residue = (24.04 g − 23.21 g) = 0.83 for **1** mark*

*allow ecf (mass of residue × 40) for **1** mark*

2

(c) to kill microbes / bacteria **or** to sterilise / disinfect water

allow to prevent disease

ignore 'to make it safe to drink'

1

(d) Marks awarded for this answer will be determined by the Quality of Communication (QoC) as well as the standard of the scientific response. Examiners should also refer to the information on page 4, and apply a 'best−fit' approach to the marking.

0 marks
No relevant content

Level 1 (1 − 2 marks)
A simple relevant comment has been made on the data from at least one of the graphs.

Level 2 (3 − 4 marks)
At least two of the graphs have been considered with a relevant comment made.

Level 3 (5 − 6 marks)
All the graphs have been considered and relevant comments made about each.
A justified conclusion may be given.

examples of chemistry points made in the response:

extra information

- (graph 1 shows) fluoride ions reduce the amount of tooth decay
- (graph 1 shows) the effect in reducing tooth decay is greatest for 55−64 year olds
  accept any in range 55 − 64
- (graph 2 shows) the fluoride ions reduce percentage with decayed teeth
- (graph 2 shows) effect is greatest at 2.5 to 3 mg per 1000 g of water then decay increases if more than 2.5 to 3 mg of fluoride ions per 1000 g water
  accept any in range 2.5 − 3
- (graph 2 shows percentage) decay decreases from 0 to 2.5 / 3 mg per 1000 g
- (graph 3 shows) more marked / brittle teeth as fluoride level increases
- above points linked together to draw a justified conclusion

6

[14]

M2. (a) (i) on heating, the calcium hydrogencarbonate decomposes

1

forming a scale of insoluble calcium carbonate

1

(ii) the scale reduces the efficiency of the heating element
or the scale increases energy costs / uses more energy

1

(b) (i) the sodium carbonate / carbonate ions react with calcium / magnesium ions, forming a precipitate of calcium carbonate / magnesium carbonate

1

therefore the water is softened because this removes the calcium / magnesium ions, which cause hardness, from the water

1

(ii) sodium / hydrogen ions are present in the ion exchange resin

1

therefore the water is softened because these ions take the place of calcium / magnesium ions that cause hardness in the water

1

[7]

M3. (a) (i) Mountain View: (65+35 =)100

1

Valley Croft: (16+14 =) 30

OR

Mountain View Ca (65) is about 4 times Valley Croft (Ca 16) (1)

Mountain View Mg (35) is about twice Valley Croft (Mg 14) (1)

ignore other ions unless used in another calculation or calculations. In this case the list principle applies

if no other mark awarded either:

Ca 65 compared with Ca 16 ***and*** *Mg 35 compared with Mg 14 gains* ***1*** *mark*

or

difference in Ca (65 – 16) = 49 ***and*** *Mg (35 – 14) = 21 gains* ***1*** *mark*

1

(ii) shake / stir / swirl (water with soap)

allow mix

ignore add / use soap / titrate

1

(about) 3 × the scum / precipitate / solid (compared with Valley Croft)

accept (about) 3 × volume / drops / amount / quantity of soap solution for (permanent) lather (compared with Valley Croft)

ignore scale / time

1

fair test: eg same volume / amount of water **or** shake for same amount of time **or** use same type / concentration of soap

allow same temperature

do ***not*** *accept same volume of soap*

ignore repeat the experiment

1

(b) strong(er) teeth / bones

allow contains calcium (ions / compounds)

or

good for heart

*ignore magnesium **or** charge on the calcium ion*

*do **not** accept any other ions*

1

(c) any **one** from:

ignore health effects

- produces scale / limescale / calcium carbonate / magnesium carbonate

  allow fur for scale

- produces scum

- more soap needed

  allow doesn't lather easily

  ignore detergent

- costs more to soften water

  allow costs if qualified

- (scale) lowers efficiency of appliances

  ignore just damage to pipes

1

(d) (i) water / everything is made of / contains chemicals
or water contains named ion from the label

accept company (probably) means water contains no added substances

ignore water has not been treated

1

(ii) Valley Croft scientists may be biased / vested interest

accept Food Standards Agency / independent scientists (more likely to be) unbiased

allow Valley Croft scientists may falsify results

ignore accuracy / reliability / fairness / validity

1

[9]

M4. (a) scale – (solid) formed when <u>heat</u> decomposes dissolved calcium / magnesium compounds owtte

allow: scale is formed when <u>hard</u> water is heated / boiled (to leave magnesium / calcium compounds)

scale is calcium carbonate / $CaCO_3$ or magnesium carbonate / $MgCO_3$

ignore evaporate

1

scum – (ppt) formed when soap reacts with calcium / magnesium (ions) owtte

allow scum is formed when <u>hard</u> water reacts with soap

scum is calcium stearate / magnesium stearate

1

(b) calcium (ions) / Ca^{2+} / magnesium (ions) / Mg^{2+}

1

replaced by hydrogen ions / H^+ / sodium ions / Na^+

1

[4]

M5.(a) (i) Solids

1

(ii) Chlorine

1

(iii) improves dental health **or** reduces tooth decay

1

(b) put a sample of the filtered water in an evaporating basin **or** leave to evaporate

accept any description of evaporation (using a Bunsen or leaving on the windowsill)

1

there will be crystals of salt left

1

(c) (i) **Test** – flame test

1

Result – yellow / orange / persistent orange flame

1

(ii) sodium and / or chloride ions are bigger than water (molecules) **or** ions are charged **or** molecules are not charged

*do **not** accept sodium chloride molecules as ions is given in the*

question

1

[8]

M6.(a) (i) 12

*correct answer with or without working gains **2 marks***
*if answer incorrect allow (13+11) / 2 for **1 mark***
*allow 10 for **1 mark***

2

Spring water is hardest

***must** be comparative for each marking point*
2nd mark must refer to amount of soap added

1

because it takes the most drops (of soap solution)

or

distilled water is softest (1)

because it takes the fewest drops (of soap solution) (1)

accept correct comparison of tap water with either spring or distilled water

1

(iii) water contains (calcium) hydrogencarbonate

allow magnesium instead of calcium
accept HCO_3^-

1

which decomposes (on heating)

allow breaks down

1

to (calcium) carbonate

accept CO_3^{2-}
allow (lime)scale
*do **not** accept scum*
correct complete equation = 2 marks

1

(b) (i) calcium ions (in water)

accept Ca^{2+}
allow magnesium ions / Mg^{2+} ignore Ca^{+} / Mg^{+}

1

replaced by / exchanged for

any reference to reaction or reactivity series negates this mark

1

sodium ions (in resin)

accept Na^{+}
allow hydrogen ions / H^{+}

1

(ii) to replenish sodium ions (in resin)

accept Na_{+}

allow 'to top up the sodium ions'

allow 'so sodium ions do not run out'

allow 'to remove calcium / magnesium ions'

1

(c) Argument for:

any **one** from:

- prevents disease

  ignore sterilise / disinfect

  allow prevents illness

- kills microbes / microorganisms / bacteria / pathogens

  ignore removes

- only small amounts needed

1

Argument against:

any **one** from:

ignore cost / taste / corrosive

- toxic / poisonous

  *ignore harmful **or** causes health problems **or** specific illnesses /*

diseases

- no consumer choice

  allow unethical

1

[13]

M7. **two** methods and **1 linked** explanation **or 1** method and **two** explanations, **1** linked = **3** marks

no linking of method and explanation then max **2** marks

ignore references to removal of hardness

method 1:

filter

ignore screening / sedimentation

explanation 1:

remove insoluble substances / remove solids / small bits / dirt / mud/ soil / sand / silt

method 2:

precipitate / flocculate / add eg. alum

allow other named substances

explanation 2:

removes (some) soluble material as solids / removes (some) metal ions

method 3:

add chlorine / chlorine dioxide / ozone

explanation 3:

sterilise / kill bacteria / microorganisms / microbes

ignore 'remove bacteria'

ignore disinfect

[3]

M8. use of (water) filters / ion exchange

1

containing carbon / charcoal / silver / resins

ignore other substances

1

any **two** from:

- carbon / charcoal removes chlorine
- carbon / charcoal removes soluble / dissolved substances
- silver kills / prevents growth of microorganisms
- ion exchange removes calcium ions / magnesium ions / metal ions
- ion exchange replaces (metal ions) with H_+ / Na_+

  allow exchange for replace
- ion exchange removes hardness

2

[4]