

Table 1 shows data from a life cycle assessment (LCA) for the disposal of 10 000 biodegradable plastic bags.

Table 1

	Burning and using the energy to generate electricity	Landfill
Mass of carbon dioxide produced in kg	25	15
Mass of solid residue in kg	0.050	0.070
Mass of sulfur dioxide produced in kg	0.20	0.30

1.1

Why are life cycle assessments (LCA) done?

[1 mark]

1.2

Compare the **two** methods for the disposal of biodegradable plastic bags.
Use information from **Table 1**

[4 marks]

03

A student investigated the mass of dissolved solids in 5 cm³ samples of water.

Figure 3 shows the apparatus.

Figure 3

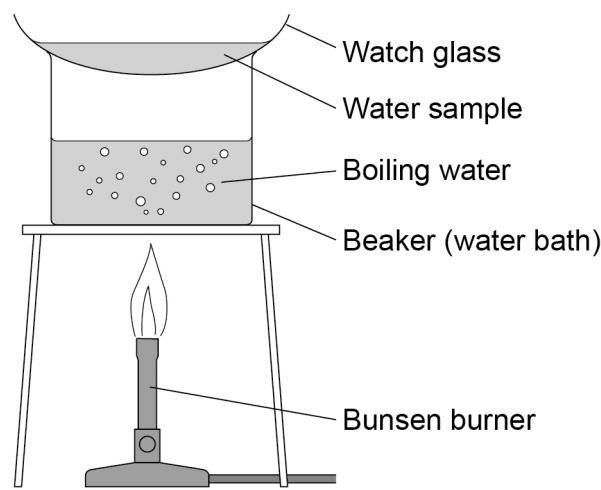


Table 2 shows the student's results.

Table 2

Type of water	Mass in g			
	Watch glass	Watch glass and dissolved solids	Dissolved solids in 5 cm ³ of water	Dissolved solids in 1000 cm ³ of water
Sea water	9.34	9.48	0.14	28.00
River water	9.15	9.23	0.08	X
Rainwater	8.93	8.93	0.00	0.00

2.1 5 cm³ is a small volume of water for each experiment.

Give **one** advantage and **one** disadvantage of using a larger volume.

[2 marks]

Advantage _____

Disadvantage _____

2.2 Potable water is **not** pure water.

Describe the difference between potable water and pure water.

[1 mark]

2.3 Potable water is obtained from both groundwater **and** from sea water.

Describe how groundwater and sea water are treated to produce potable water.

[3 marks]

3.1

Carpets are made from:

- poly(propene)
- wool
- a mixture of poly(propene) and wool.

Poly(propene) wears out more slowly than wool.

A mixture of poly(propene) and wool to make carpets is more sustainable than using just poly(propene) or just wool.

Suggest why.

[2 marks]

1 0

Disposable cups are made from coated paper or poly(styrene).

Table 6 shows information on the life cycle assessments (LCAs) of disposable cups.

Table 6

	Coated paper cups	Poly(styrene) cups
Raw materials	Wood	Crude oil
Mass of 1 cup in g	8.3	1.9
Energy to produce 1 cup in kJ	550	200
Energy released when 1 cup is burned in kJ	166	76
Biodegradable	Yes	No
Recyclable	No	Yes

4.1

Evaluate the use of coated paper compared with poly(styrene) to make disposable cups.

Use **Table 6** and your knowledge and understanding of LCAs.

[6 marks]

0 1

Water that is safe to drink contains dissolved substances.

5.1 What do we call water that is safe to drink?

[1 mark]

Tick (✓) **one** box.

Desalinated

☐

Filtered

☐

Fresh

☐

Potable

☐

5.2 Describe a test for pure water.

Give the result of the test if the water is pure.

[2 marks]

Test _____

Result _____

6.1	Describe a method to determine the mass of dissolved solids in a 100 cm ³ sample of river water.	[4 marks]

0	4
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This question is about copper and fuels.

7.1

Copper is extracted from low-grade ores by phytomining.

Describe how copper metal is produced by phytomining.

[4 marks]

8.1 Copper is a catalyst in a reaction to produce ethanol from carbon dioxide.

Ethanol ($\text{C}_2\text{H}_5\text{OH}$) is used as a fuel.

Suggest why producing ethanol from carbon dioxide is sustainable.

[2 marks]

8.2 Chemistry plays an important role in sustainable development.

What is sustainable development?

[2 marks]

9.1

Some central heating boilers use wood as a fuel.

Suggest **two** reasons why wood is more sustainable than natural gas as a fuel for central heating boilers.

[2 marks]

1 _____

2 _____

10.1 How is sewage sludge treated before being released into the environment?

[1 mark]

Tick (✓) **one** box.

Aerobic biological treatment

☐

Anaerobic digestion

☐

Grit removal

☐

Screening

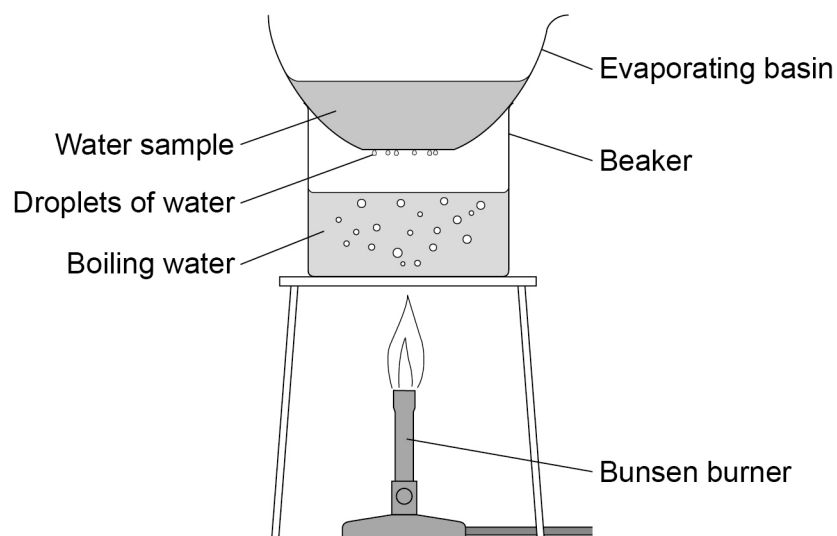
☐

0	4
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A student investigated the mass of dissolved solids in four water samples **A**, **B**, **C** and **D**.

Figure 4 shows the apparatus used.

Figure 4



This is the method used.

1. Record the mass of a dry evaporating basin.
2. Pour 25 cm³ of water sample **A** into the evaporating basin.
3. Place the evaporating basin on the beaker for 10 minutes.
4. Record the mass of the evaporating basin and contents.
5. Repeat steps 1 to 4 with water sample **A** three more times.
6. Repeat steps 1 to 5 with water samples **B**, **C** and **D**.

11.1

The method produced an error in the mass recorded in step 4.

Suggest what caused the error.

How could the error be avoided?

[2 marks]

Error _____

Avoided by _____

0	2
---	---

This question is about water.

12.1

In the UK, potable (drinking) water is produced from different sources of fresh water.

Explain how potable water is produced from fresh water.

[4 marks]

12.2

A different country has:

- very little rainfall
- a long coastline
- plentiful energy supplies.

Suggest **one** process this country could use to obtain most of its potable water.

[1 mark]

13.1 Waste water is not fit to drink.

Treatment of waste water produces two substances:

- liquid effluent
- solid sewage sludge.

Draw **one** line from each substance to the way the substance is processed.

[2 marks]

Substance

Process

	Aerobic biological treatment
Liquid effluent	Anaerobic digestion
	Grit removal
Solid sewage sludge	Screening
	Sedimentation

Table 1 shows information about the disposal of processed solid sewage sludge in the UK in 1992 and in 2010.

Table 1

Year	Mass of processed solid sewage sludge in millions of kilograms				
	Used as fertiliser	Sent to landfill	Burned	Other methods	Total
1992	440	130	90	338	998
2010	1118	9	260	26	1413

- 14.1 Between 1992 and 2010 the proportion of processed solid sewage sludge used as fertiliser increased.

Suggest **two** reasons why.

[2 marks]

1 _____

2 _____

0 5

This question is about materials used to make food plates.

Food plates are made from paper, polymers or ceramics.

Table 2 shows information about plates of the same diameter made from each of these materials.

Table 2

	Food plate material		
	Paper	Polymers	Ceramics
Raw material	Wood	Crude oil	Mined clay
Number packaged in 10 dm ³ cardboard box	500	100	50
Average number of times used	1	400	1000
Biodegradable?	Yes	No	No
Recyclable?	Yes	Yes	No

15.1

Table 2 does **not** show information about energy usage.

Suggest **two** pieces of information about energy usage which would help to produce a complete life cycle assessment (LCA) for the three food plate materials.

[2 marks]

1 _____

2 _____

15.2

Evaluate the use of these materials for making food plates.

You should use features of life cycle assessments (LCAs).

Use Table 2.

[4 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

The boiling point is used to check the purity of a sample of water.

16.1

In chemistry, what is meant by a 'pure substance'?

[1 mark]

17.1	Explain how distillation is used to obtain potable water from salty water.	[4 marks]

18.1

Obtaining potable water from salty water is more expensive than obtaining potable water from ground water.

Explain why.

Refer to the processes used in both methods in your answer.

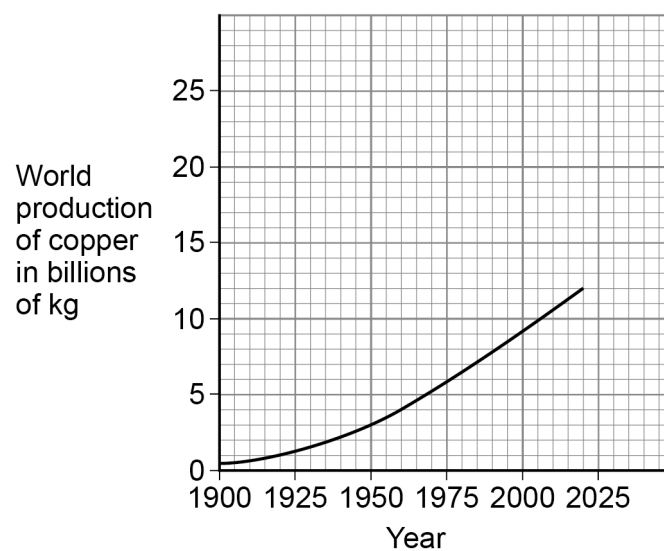
[2 marks]

0	4
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Industries use the Earth's natural copper resources to produce useful products.

Figure 4 shows the world production of copper from 1900 to 2020.

Figure 4



19.1

Suggest **one** reason why the trend cannot be used to accurately predict the future world production of copper.

[1 mark]

20.1

High-grade copper resources are now difficult to find.

Phytomining is used to extract copper from low-grade ores.

There are five stages, **A**, **B**, **C**, **D** and **E**, in phytomining.

The stages are **not** in the correct order.

Stage **A** Copper compounds from ash are dissolved in acid.

Stage **B** Plants absorb metal compounds.

Stage **C** Plants are burned.

Stage **D** Plants are harvested.

Stage **E** Solution of copper compound is electrolysed.

What is the correct order of stages **A**, **B**, **C**, **D**, and **E**?

[1 mark]

Tick (✓) **one** box.

B, C, D, E, A

☐

B, D, C, A, E

☐

D, B, C, E, A

☐

D, C, B, A, E

☐

21.1

Give **two** disadvantages of phytomining compared with traditional mining methods.

Do **not** refer to cost in your answer.

[2 marks]

1 _____

2 _____

22.1 The catalyst in a catalytic converter contains platinum.

Platinum is a finite resource.

What is meant by a 'finite resource'?

[1 mark]

22.2 Emissions from cars contain carbon dioxide.

Explain why carbon dioxide emissions during use and operation are **not** the total carbon footprint for a car.

Refer to the stages of the life cycle assessment of a car in your answer.

[3 marks]

- 23.1 Suggest **one** reason why using solar energy is a more sustainable way of generating electricity than burning oil.

[1 mark]

- 23.2 Solar energy may **not** be able to replace the generation of electricity from fossil fuels completely.

Suggest **two** reasons why.

[2 marks]

1

2

Copper can be obtained by:

- processing copper ores
- recycling scrap copper.

24.1

Suggest **three** reasons why recycling scrap copper is a more sustainable way of obtaining copper than processing copper ores.

[3 marks]

1 _____

2 _____

3 _____

Copper is extracted from low-grade ores by phytomining.

25.1

Describe how copper is extracted from low-grade ores by phytomining.

[4 marks]

25.2

Phytomining has **not** been widely used to extract copper.

Suggest **two** reasons why.

[2 marks]

1

2

26.1

Water that is safe to drink is called potable water.

Compare how easily potable water can be obtained from:

- waste water (sewage)
- ground water (fresh water).

[6 marks]

[illegible]

A scientist produced potable water from 150 cm³ of salty water.

27.1

Which process can be used to produce potable water from salty water?

[1 mark]

Tick (✓) **one** box.

Distillation

☐

Electrolysis

☐

Filtration

☐

Sterilisation

☐

28.1

Window frames can be manufactured from wood or from plastic.

Table 2 shows data from a life cycle assessment (LCA) for a wooden window frame and a plastic window frame.

Both window frames are the same size.

Table 2

	Wood	Plastic
Sources of hydrocarbons used for production in kg	5.37	18.23
Greenhouse gases released during production, use and disposal in kg equivalent of CO ₂	457	487
Oxides of nitrogen and sulfur dioxide produced in arbitrary units	29.6	37.7
Waste materials in kg	16.5	28.8
Total energy consumption in production, use and disposal in MJ	9150	9713
Lifetime cost to customer to buy and maintain in £	147	102

Evaluate the sustainability of wooden and plastic window frames.

You should include environmental and economic factors.

[6 marks]

[illegible]

Metals are extracted from metal ores found in the Earth.

29.1

Describe how bioleaching is used to extract copper from low grade ores.

[3 marks]

Copper can be obtained by recycling scrap copper wire.

- 30.1 Suggest why poly(butene) insulation must be removed from scrap copper wire before the copper is recycled.

[1 mark]

- 30.2 Describe how scrap copper wire can be recycled to make new copper water pipes.

[2 marks]

- 30.3 Suggest **two** reasons why recycling scrap copper is more sustainable than extracting copper from copper ores.

[2 marks]

1

2

0 3

This question is about life cycle assessments (LCAs).

31.1

Milk bottles can be made from glass or from a polymer.

Table 2 shows information about milk bottles of equal volume.**Table 2**

	Glass	Polymer
Raw materials	Limestone Sand Sodium carbonate	Crude oil
Energy needed to process raw materials in kilojoules	6750	1710
Energy needed to manufacture bottle in kilojoules	750	90
Mass of bottle in grams	200	20
Mean number of times used during lifetime of bottle	25	1
One disposal method at end of useful life	Recycled to make different glass products	Recycled to make different polymer products

Evaluate the use of glass for milk bottles compared with the use of a polymer for milk bottles.

Use features of life cycle assessments (LCAs) in your answer.

Use **Table 2**.

[6 marks]

0	5
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This question is about water.

32.1

Sewage is waste water.

Sewage contains organic matter.

Describe how sewage is treated to remove organic matter.

[4 marks]

Sea water and ground water are treated to make them potable.

Table 5 shows information about the composition and treatment of sea water and of ground water.

Table 5

	Sea water	Ground water
Concentration of sodium ions and chloride ions before Process 1	Na ⁺ : 0.5 mol/dm ³ Cl ⁻ : 0.5 mol/dm ³	Na ⁺ : 0.001 mol/dm ³ Cl ⁻ : 0.001 mol/dm ³
Process 1	Reverse osmosis	Filtration
Concentration of sodium ions and chloride ions after Process 1	X	Na ⁺ : 0.001 mol/dm ³ Cl ⁻ : 0.001 mol/dm ³
Process 2	Add ozone	Expose to ultraviolet light

33.1 Sea water is desalinated during **Process 1**.

Which pair of concentrations could represent **X** in **Table 5**?

[1 mark]

Tick (✓) **one** box.

Na⁺ : 0.003 mol/dm³

Cl⁻ : 0.003 mol/dm³

☐

Na⁺ : 0.003 mol/dm³

Cl⁻ : 0.5 mol/dm³

☐

Na⁺ : 0.5 mol/dm³

Cl⁻ : 0.003 mol/dm³

☐

Na⁺ : 0.5 mol/dm³

Cl⁻ : 0.5 mol/dm³

☐

33.2 Explain why the concentrations of sodium ions and of chloride ions in the ground water in **Table 5** are unchanged by **Process 1**.

[2 marks]

- 33.3 Explain why the ground water in **Table 5** requires **Process 2** before the water is safe to drink.

[2 marks]

- 33.4 After treatment the ground water in **Table 5** is sold by a company as pure water.

The ground water in **Table 5** is not chemically pure because the water contains sodium ions and chloride ions.

Suggest what the company means by 'pure'.

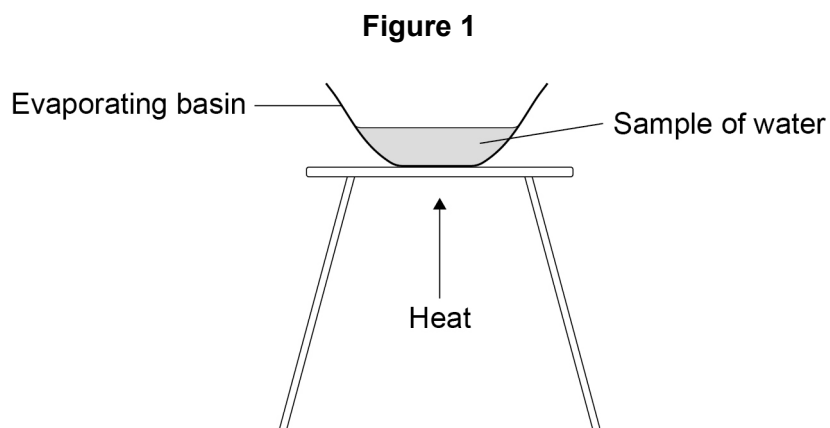
[1 mark]

0	4
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Some types of water contain dissolved substances.

A student investigated the mass of dissolved solids in distilled water and in sea water.

Figure 1 shows the apparatus.



This is the method used.

1. Weigh an evaporating basin.
2. Add 20 cm³ of distilled water to the evaporating basin.
3. Weigh the evaporating basin and the water sample.
4. Heat the water sample for 2 minutes.
5. Weigh the evaporating basin and contents.
6. Repeat steps 1 to 5 two more times.
7. Repeat steps 1 to 6 with sea water.

34.1

The method used by the student did **not** give valid results.

Describe **one** improvement the student could make to obtain valid results.

[1 mark]

35.1

The student concludes that distilled water is pure.

Describe a test to confirm that distilled water is pure.

[2 marks]

Test

Result

36.1

Another stage in the production of potable water is filtering.

Explain why potable water contains dissolved solids after filtering.

[2 marks]

37.1

Copper can be extracted from low-grade ores by bioleaching.

Describe what is meant by bioleaching.

[2 marks]
