# C10: Using Resources 1

ANSWER KEY

| | | |
|---|---|---|
| 24.1 | What do humans typically use resources for? | Warmth, shelter and food |
| 24.2 | **What are finite resources?** | **Resources that will run out e.g. fossil fuels, metal ores** |
| 24.3 | **What is sustainable development?** | **Using resources sensibly, to meet the needs of the current generation without compromising the needs of future generations** |
| 24.4 | Give an example of a natural product that has been replaced by a synthetic product | • Paper replaced by polyethene (bags)<br>• Wood replaced by pvc (window frames)<br>• Cotton replaced by polyester (clothing) |
| 24.5 | **What is potable water?** | **Water that is safe to drink** |
| 24.6 | **How is potable water produced from fresh water/ground water?** | • **Filtering (to remove solid materials)**<br>• **Sterilising (to kill bacteria/microbes)** |
| 24.7 | **How is water sterilised?** | **Using chlorine, ozone or ultraviolet light** |
| 24.8 | **What is pure water?** | **Water that contains no dissolved substances, and is made up from only water molecules** |
| 24.9 | **How can we test that water is pure?** | **Test its boiling point, and it should boil at exactly 100°C** |
| 24.10 | **What is the difference between pure water and potable water?** | **Potable water may still contain dissolved substances** |
| 24.11 | What is desalination? | Removal of dissolved salt from water |
| 24.12 | **In what two ways can desalination be carried out?** | **Distillation and reverse osmosis** |
| 24.13 | **What is the main disadvantage of desalination methods?** | **They both requires a large amount of energy** |
| 24.14 | **What is the purpose of the semi-permeable membrane in reverse osmosis?** | **The small holes only let the small water molecules pass through (and trap the salt)** |
| 24.15 | In what kinds of locations is desalination carried out? | Ones where there is limited supply of fresh water |

## C10: Using Resources 2

ANSWER KEY

| | | |
|---|---|---|
| 25.1 | What needs to be removed from sewage, agricultural waste water and industrial waste water? | Organic matter and harmful microbes and harmful chemicals |
| 25.2 | How is sewage treated? | • Screening<br>• Sedimentation<br>• Anaerobic digestion<br>• Aerobic biological treatment |
| 25.3 | **Why is sewage and waste water more difficult to treat?** | **The water is more heavily contaminated, and the treatment requires more steps** |
| 25.4 | **(HT) Name two ways of extracting copper from low-grade ores** | **Phytomining and bioleaching** |
| 25.5 | (HT) What is a low grade ore? | Rock with only a small amount of metal compound in it |
| 25.6 | **(HT) How is phytomining carried out?** | **Plants absorb metal compounds, are harvested and then burned to produce ash which is treated with sulfuric acid** |
| 25.7 | **(HT) How is bioleaching carried out?** | **Bacteria are used to produce a leachate solution** |
| 25.8 | **(HT) How can copper be produced from the products of phytomining or bioleaching?** | **Electrolysis or displacement with scrap iron** |
| 25.9 | What is a life cycle assessment (LCA)? | A way of assessing the environmental impact of a product across its entire life cycle |
| 25.10 | What are the four stages in a product's life cycle? | • Extracting and processing raw materials<br>• Manufacturing<br>• Use and operation<br>• Method of disposal |
| 25.11 | **Why is it important to recycle and reuse products?** | • **Reduces the use of limited resources**<br>• **Lowers energy requirements**<br>• **Lowers environmental impact**<br>• **Less waste** |
| 25.12 | Give an example of a product that can be reused | Glass |
| 25.13 | Give an example of a product that can be recycled | Metal, glass, plastics |

# C10: Using Resources (Triple Content)

ANSWER KEY

| | | |
|---|---|---|
| 1 | What is corrosion? | The destruction of materials by chemical reaction |
| 2 | **What is necessary for rusting to occur?** | **Presence of oxygen and water** |
| 3 | **How can corrosion be prevented?** | **Using a barrier coating or sacrificial protection** |
| 4 | **Give three examples of barrier coatings to prevent rusting** | **Greasing, painting, electroplating** |
| 5 | How does sacrificial protection work? | A more reactive metal is corroded rather than the iron |
| 6 | **Which metal is used to galvanize iron and steel?** | **Zinc** |
| 7 | **What is an alloy?** | **A mixture of a metal with another element** |
| 8 | What is the alloy bronze made from? | Copper and tin |
| 9 | State a use for bronze | Statues, medals |
| 10 | What is the alloy brass made from? | Copper and zinc |
| 11 | State a use for brass | Musical instruments |
| 12 | What is the alloy steel made from? | Iron and carbon (plus some other metals) |
| 13 | **What are the differences in properties between high carbon steel and low carbon steel?** | • **High carbon: strong but brittle**<br>• **Low carbon: softer and more malleable** |
| 14 | **How many carats is pure gold?** | **24** |
| 15 | **What % purity will 18 carat gold be?** | **$\frac{18}{24} \times 100 = 75\%$** |
| 16 | Name two types of glass | Soda-lime glass and borosilicate glass (which has a higher melting point) |
| 17 | How are clay ceramics made? | Shaping wet clay and heating in a furnace |
| 18 | **What is the difference between thermosetting and thermosoftening polymers?** | • **Thermo<u>softening</u> melt when heated**<br>• **Thermo<u>setting</u> do not melt** |

| | | |
|---|---|---|
| 19 | **Why do thermosetting polymers not melt when heated?** | **They have strong cross-links between the polymer chains** |
| 20 | What is composite? | A substance made from two different materials |
| 21 | **Generally, what are the two types of materials in composites?** | **A matrix (normally fibres or fragments) and a reinforcement (to bind them together)** |
| 22 | **Give an example of a composite** | **Reinforced concrete, plywood, fibreglass** |
| 23 | What is the Haber process? | A reaction making ammonia, from hydrogen and nitrogen |
| 24 | **Where do the reactants for the Haber process come from?** | • **Nitrogen: the air**<br>• **Hydrogen: natural gas (methane, $CH_4$)** |
| 25 | Write a balanced equation showing the formation of ammonia, $NH_3$ from nitrogen and hydrogen | $N_2 + 3\,H_2 \rightarrow 2\,NH_3$ |
| 26 | What conditions are used in the Haber process? | • High temperature (450°C)<br>• High pressure (200 atmospheres)<br>• Iron catalyst |
| 27 | **The reaction that makes ammonia is exothermic. Explain why there is a higher yield of ammonia at lower temperatures** | • **Equilibrium moves in the exothermic direction (L → R)**<br>• **so oppose the low temperature, making more $NH_3$** |
| 28 | **Explain why there is a higher yield of ammonia at higher pressures** | • **Increased pressure moves equilibrium to right**<br>• **to reduce number of gas molecules** |
| 29 | **The ideal conditions for a high yield of ammonia are a low temperature and a high pressure.**<br><br>**Explain why the conditions used are a compromise** | • **Low temperatures give a higher yield but give slow reactions**<br>• **so higher temp is used to increase rate**<br>• **High pressures give a fast reaction and a high yield**<br>• **but are expensive and dangerous to maintain, so a lower pressure is used** |
| 30 | **What is an NPK fertiliser?** | **A fertiliser with nitrogen (N), phosphorous (P) and potassium (K) compounds in it** |
| 31 | How must phosphate rock be treated before it can be used as a fertiliser? | Reacted with acid |
| 32 | **What is the product of a reaction between phosphate rock and nitric, phosphoric or sulfuric acid?** | • **Nitric acid: calcium nitrate**<br>• **Phosphoric acid: calcium phosphate**<br>• **Sulfuric acid: calcium sulfate** |

## FOUNDATION TIER

**Q1.** A student tested a sea water sample for dissolved solids. **Figure 1** shows the apparatus.

(a) What is apparatus **X** on **Figure 1**?

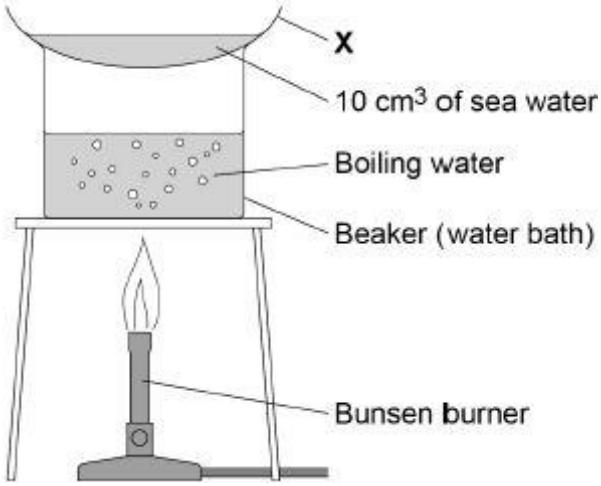
Tick **one** box.

Boiling tube ☐

Condenser ☐

Funnel ☐

Watch glass ☐




**(1)**

(b) The student did the test four times.

The student calculated the mass of solid on apparatus **X** after heating.

The table below shows the student's results.

| | **Test 1** | **Test 2** | **Test 3** | **Test 4** |
|---|---|---|---|---|
| **Mass of solid in grams** | 0.12 | 0.29 | 0.14 | 0.15 |

Calculate the mean mass of solid.

Do not include the anomalous result in your calculation.

Give your answer to 2 significant figures.

_____

_____

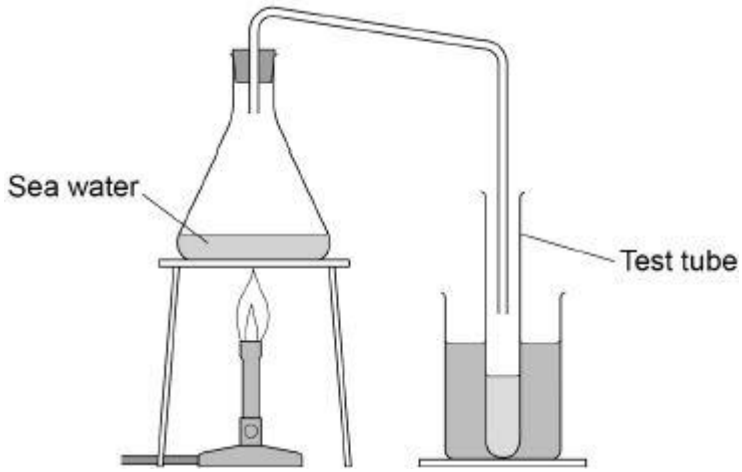
_____

Mean mass = _____ g

**(3)**

The student distilled a sample of sea water in the apparatus shown in **Figure 2**

**Figure 2**




(c) What change of state is happening at the surface of the sea water in **Figure 2**?

_____

**(1)**

(d) Describe how the water in the test tube in **Figure 2** is different from the sea water.

_____

_____

**(1)**

(e) Why does producing drinking water from sea water using distillation cost a lot of money?

_____

_____

**(1)**

(f) River water is filtered then sterilised to make drinking water.

Why are these **two** processes done?

Filtering _____

_____

Sterilising _____

_____

**(2)**

**(Total 9 marks)**

**Q2.** Industries use the Earth's resources to produce useful products.

Copper is produced from copper ore and from recycling waste copper.

(a) The energy needed to produce 1 kg of copper from copper ore is 70 MJ.

The energy needed to produce 1 kg of recycled copper is 27 MJ.

Calculate the energy saved if 100 kg of copper is produced from recycled copper and **not** from copper ore.

Energy saved = _____ MJ

**(3)**

(b) Producing copper from recycling waste copper reduces emissions of sulfur dioxide.

Why is reducing emissions of sulfur dioxide important?

**(1)**

(c) Copper is used to make coins.

A coin of mass 8 g contains 75% copper.

Calculate the mass of copper in the coin.

Mass of copper = _____ g

**(2)**

(d) Iron and glass are both produced from the Earth's resources.

Some processes can reduce the use of limited resources.

Draw **one** line from the description of the process to the name of the process.

| **Description of process** | **Name of process** |
|---|---|
| | Extraction |
| Scrap steel is added to iron from a blast furnace | Quarrying |
| | Reacting |
| A glass bottle is refilled | Recycling |
| | Reusing |

**(2)**

(e) Life cycle assessments are used to assess the environmental impact of producing iron nails and glass bottles.

There are four stages, **A**, **B**, **C** and **D**, in a life cycle assessment.

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

| | |
|---|---|
| Stage **A** | Disposal |
| Stage **B** | Extracting and processing raw materials |
| Stage **C** | Manufacturing and packaging |
| Stage **D** | Use and operation |

What is the correct order of stages **A**, **B**, **C**, and **D**? Tick (✓) **one** box.

**C**, **D**, **B**, **A** ☐

**D**, **B**, **C**, **A** ☐

**B**, **C**, **D**, **A** ☐

**(1)**

**(Total 9 marks)**

**Q3.** Water that is safe to drink contains dissolved substances.

(a) What do we call water that is safe to drink?

Tick (✓) **one** box.

Desalinated ☐

Filtered ☐

Fresh ☐

Potable ☐

**(1)**

(b) Describe a test for pure water.

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

Test _____

Result _____

_____

_____

**(2)**

(c) Describe a method to determine the mass of dissolved solids in a 100 $cm^3$ sample of river water.

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(d) A sample of river water contains 125 mg per $dm^3$ of dissolved solids.

Calculate the mass of dissolved solids in grams in 250 $cm^3$ of this sample of river water.

Give your answer to 2 significant figures.

Mass of dissolved solids = _____ g

**(4)**

(e) A water company allows a maximum of 500 mg per $dm^3$ of sulfate ions in drinking water.

A sample of drinking water contains 44 mg per $dm^3$ of sulfate ions.

Calculate the percentage (%) of the maximum allowed mass of sulfate ions in the sample of drinking water.

Percentage (%) of the maximum allowed mass = _____ %

**(2)**

**(Total 13 marks)**

**Q4.** Ethene is used to make poly(ethene).

Poly(ethene) is used to make plastic bags.

the table below shows data from a Life Cycle Assessment (LCA) for a plastic bag and a paper bag.

| | **Plastic bag** | **Paper bag** |
|---|---|---|
| Raw materials | Crude oil or natural gas | Wood |
| Energy used in MJ | 1.5 | 1.7 |
| Mass of solid waste in g | 14 | 50 |
| Mass of $CO_2$ produced in kg | 0.23 | 0.53 |
| Volume of fresh water used in $dm^3$ | 255 | 4 520 |

A company stated: 'A Life Cycle Assessment shows that using plastic bags has less environmental impact than using paper bags'.

Evaluate this statement. Use your knowledge and the information from above the table above.

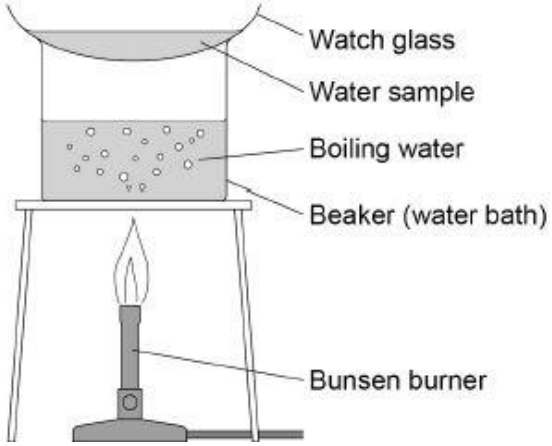
**(6)**

**(Total 6 marks)**

## HIGHER TIER

**Q5.** A student investigated the mass of dissolved solids in 5 $cm^3$ samples of water.

The diagram below shows the apparatus.




The table below shows the student's results.

| 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 |

(a) Calculate mass **X** in the table above.

_____

_____

Mass **X** = _____ g

**(1)**

(b) 5 $cm^3$ is a small volume of water for each experiment.

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

Advantage _____

_____

Disadvantage _____

_____

**(2)**

(c) Potable water is **not** pure water.

Describe the difference between potable water and pure water.

_____

_____

_____

**(1)**

(d) Potable water is obtained from both groundwater **and** from sea water.

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

_____

_____

_____

_____

_____

_____

**(3)**

(e) The percentage by mass of dissolved solids in a 6.50 g sample is 2.2%

Calculate the mass of the dissolved solids.

_____

_____

_____

_____

Mass of dissolved solids = _____ g

**(2)**

**(Total 9 marks)**

**Q6.** This question is about copper and fuels.

(a) Copper is extracted from low-grade ores by phytomining.

Describe how copper metal is produced by phytomining.

**(4)**

(b) Another method of extracting copper from low-grade ores is bioleaching.

A solution of copper sulfate ($CuSO_4$) produced by bioleaching has a concentration of 0.319 g/dm$^3$

Relative atomic masses ($A_r$): Cu = 63.5 O = 16 S = 32

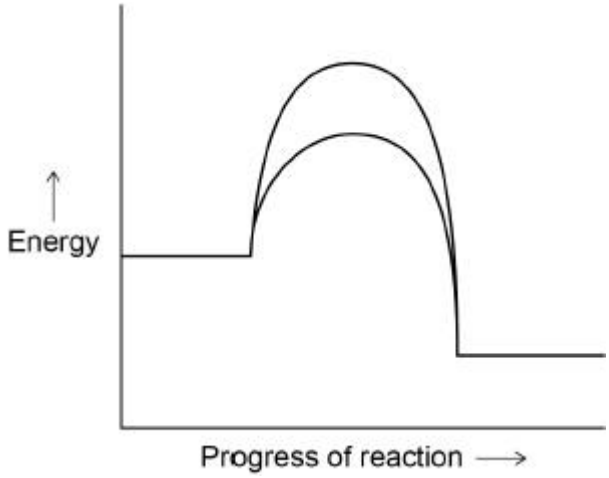
Calculate the number of moles of copper that can be produced from 1 dm$^3$ of this solution.

Number of moles of copper = _____ mol

**(3)**

Copper is used as a catalyst.

The diagram shows reaction profiles for a reaction with and without a catalyst.




(c) How do the reaction profiles show that using a catalyst does not affect the overall energy change for the reaction?

Tick (✓) **one** box.

Both reaction profiles show exothermic reactions. ☐

Both reaction profiles start at the same energy level and end at the same energy level. ☐

Both reaction profiles show the activation energy. ☐

The activation energy for the uncatalysed reaction is much lower than for the catalysed reaction. ☐

**(1)**

(d) Copper is a catalyst in a reaction to produce ethanol from carbon dioxide.

Ethanol ($C_2H_5OH$) is used as a fuel.

Suggest why producing ethanol from carbon dioxide is sustainable.

_____

_____

_____

_____

**(2)**

(e) Chemistry plays an important role in sustainable development.

What is sustainable development?

_____

_____

_____

_____

**(2)**

**(Total 12 marks)**

## SEPARATE SCIENCE

**Q7.** This question is about the corrosion of metals.

The corrosion of iron is called rusting.

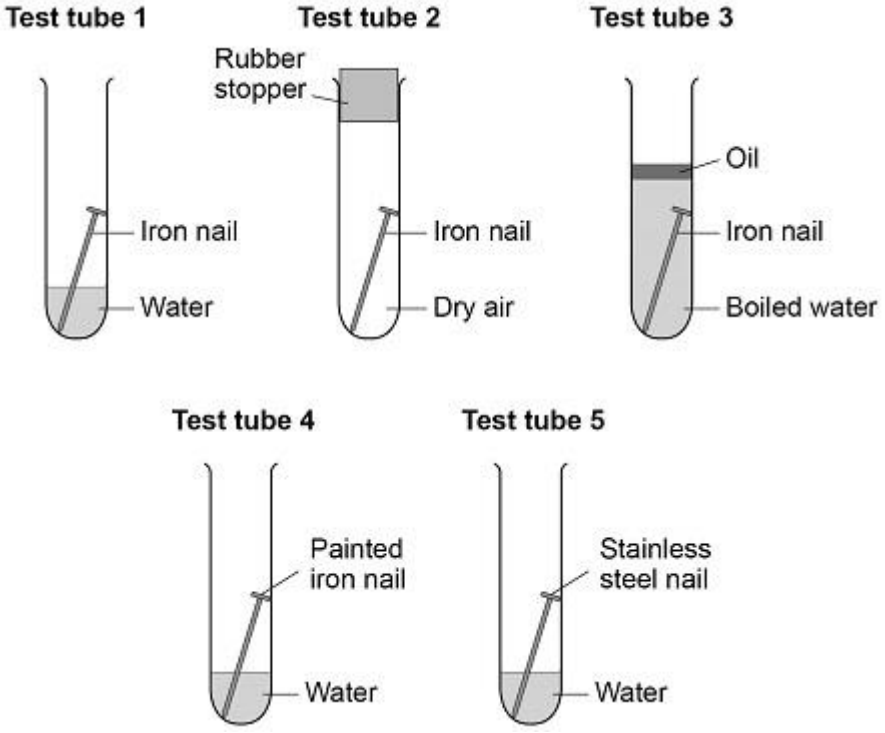
(a) A student investigated the rusting of iron.

This is the method used.

1. Set up the test tubes as shown in the figure below.

2. Leave the test tubes for 1 week.

3. Examine the nails for signs of rust.



Explain what would happen to the nails in each of the test tubes.

**(5)**

(b) Magnesium is fixed to some steel ships.

Explain how this prevents the steel from rusting.

**(2)**

(c) Explain why aluminium window frames do **not** corrode after they are made.

**(2)**

**(Total 9 marks)**

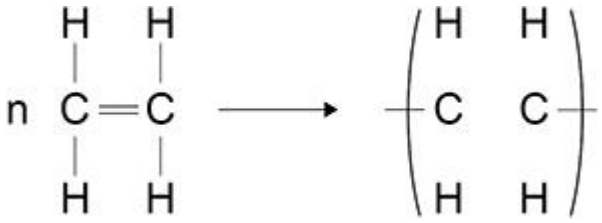
**Q8.** This question is about poly(ethene) and polyesters.

(a) Poly(ethene) is produced from ethene.

**Figure 1** shows part of the displayed structural formula equation for the reaction.

Complete **Figure 1**.

**Figure 1**



**(2)**

(b) Poly(ethene) is a thermosoftening polymer.

Suggest why poly(ethene) is easier to recycle than thermosetting polymers.

_____

_____

_____

_____

**(2)**

(c) Ethene produces different forms of poly(ethene).

How can different forms of poly(ethene) be produced from ethene?

_____

_____

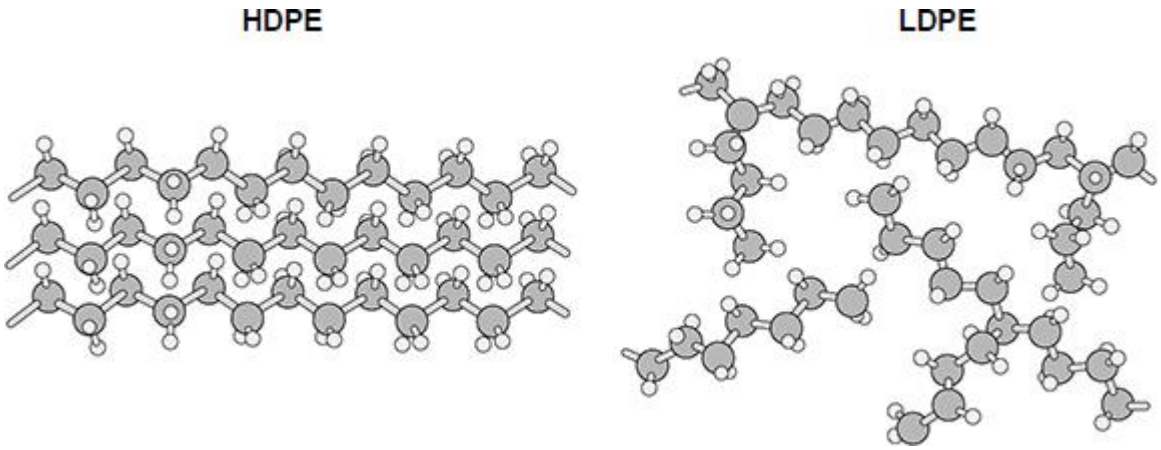
**(1)**

(d) Two different forms of poly(ethene) are:

- high density poly(ethene) (HDPE)
- low density poly(ethene) (LDPE).

**Figure 2** represents part of the structures of HDPE and LDPE.

**Figure 2**




Explain why HDPE has a higher density than LDPE.

_____

_____

_____

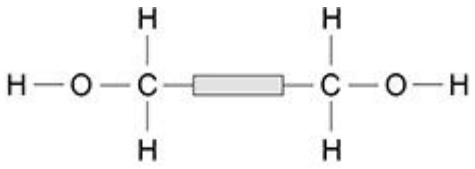
_____

**(2)**

**Figure 3** shows three monomers, **A**, **B** and **C**.

Monomer **A** can react with monomer **B** and with monomer **C** to produce polyesters.

**Figure 3**



Monomer **A**

Monomer **B**

Monomer **C**

(e) Draw a circle on **Figure 3** around an alcohol functional group.

**(1)**

(f) Complete the table below to show the formula of the small molecule produced when:

- monomer **A** reacts with monomer **B**
- monomer **A** reacts with monomer **C**.

| **Reacting monomers** | **Formula of small molecule produced** |
|---|---|
| **A** and **B** | |
| **A** and **C** | |

**(1)**

**(Total 9 marks)**

**Q9.** **Figure 1** shows a surfer on a surfboard.

Surfboards are made from polymers.

Surfboards have a poly(styrene) core and an outer skin.

(a) **Figure 2** shows the displayed structural formula of poly(styrene).

**Figure 2**

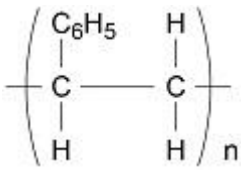
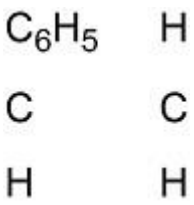



**Figure 3** shows an incomplete displayed structural formula of the monomer styrene.

Complete **Figure 3**.

**Figure 3**




**(2)**

The outer skin of surfboards contains a polyester.

Two monomers, **A** and **B**, are needed to make the polyester.

**Figure 4** shows how these two monomers are represented.

**Figure 4**


(b) Name the functional group in monomer **B**.

_____

**(1)**

(c) Monomers **A** and **B** join together to produce a polyester and a small molecule.

Name the small molecule.

_____

**(1)**

(d) Why does this type of polyester melt when it is heated?

_____

_____

_____

**(2)**

The outer skin of surfboards is a composite material.

The composite material contains glass fibres surrounded by a polyester.

(e) Draw **one** line from each material to the description of that material.

| Material | Description of the material |
|---|---|
| | Hydrocarbon |
| Glass fibres | Matrix |
| | Monomer |
| Polyester | Polypeptide |
| | Reinforcement |

**(2)**

(f) The outer skin makes the surfboard more expensive.

Suggest **two** reasons why an outer skin is added to the poly(styrene) core.

1 _____

_____

2 _____

_____

**(2)**

**(Total 10 marks)**

**Q10.** This question is about reversible reactions and equilibrium.

Hydrogen is used to produce ammonia in the Haber process.

The hydrogen is made in two stages.

**Stage 1** is the reaction of methane and steam to produce carbon monoxide and hydrogen.

The equation for the reaction is:

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3\ H_2(g)$$

(a) Calculate the atom economy for the formation of hydrogen in **stage 1**.

Relative atomic masses ($A_r$): H = 1 C = 12 O = 16

Atom economy = _____%

**(2)**

(b) Explain why a low pressure is used in **stage 1**.

Give your answer in terms of equilibrium.

**(2)**

(c) **Stage 2** uses the carbon monoxide produced in **stage 1**.

The carbon monoxide is reacted with more steam to produce carbon dioxide and more hydrogen.

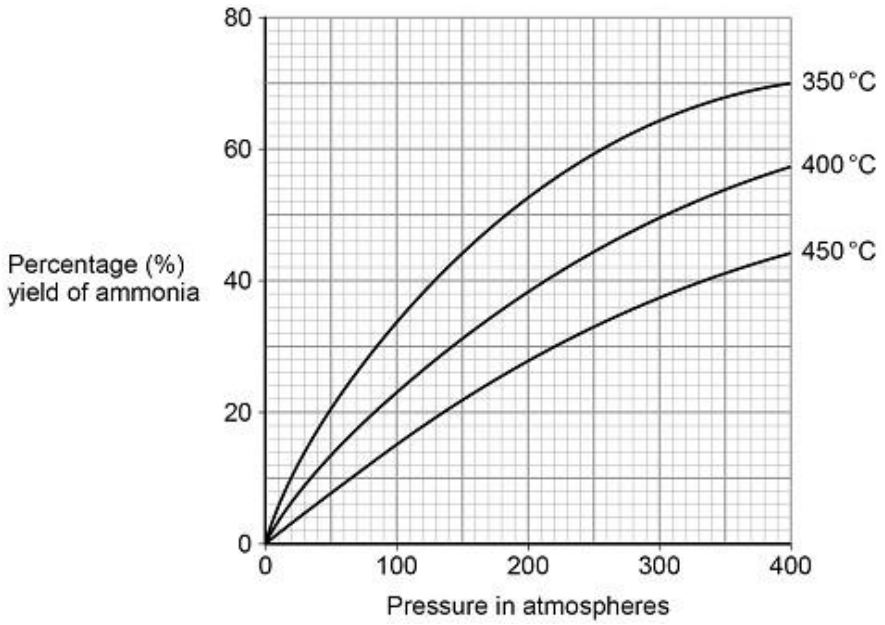
The equation for the reaction in **stage 2** is:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

What is the effect of increasing the pressure on the equilibrium yield of hydrogen in **stage 2**?

**(1)**

The graph below shows the percentage yield of ammonia produced at different temperatures and pressures in the Haber process.




A temperature of 450 °C and a pressure of 200 atmospheres are used in the Haber process.

(d) A student suggested that a temperature of 350 °C and a pressure of 285 atmospheres could be used instead of those used in the Haber process.

Determine how many times greater the percentage yield of ammonia obtained would be.

Use the graph.

_____

_____

_____

Percentage yield = _____ times greater

**(3)**

(e) A pressure of 285 atmospheres is **not** used in the Haber process instead of 200 atmospheres.

Give **one** reason why.

_____

_____

**(1)**

(f) How does the graph above show that the forward reaction in the Haber process is exothermic?

_____

_____

**(1)**

(g) World production of ammonia is now about 30 times greater than it was in 1950.

Suggest why the demand for ammonia has increased.

_____

_____

_____

_____

**(2)**

**(Total 12 marks)**

**Q11.** This question is about fertilisers.

Some fertilisers are described as NPK fertilisers because they contain three elements needed for healthy plant growth.

(a) Which **two** compounds each contain **two** of these elements?

Tick (✓) **two** boxes.

| | |
|---|---|
| Ammonium nitrate | ☐ |
| Ammonium phosphate | ☐ |
| Calcium chloride | ☐ |
| Calcium phosphate | ☐ |
| Potassium chloride | ☐ |
| Potassium nitrate | ☐ |

**(2)**

(b) Rocks containing calcium phosphate are treated with acid to produce soluble salts that can be used as fertilisers.

Name the soluble salts produced when calcium phosphate reacts with:

- nitric acid
- phosphoric acid.

Nitric acid _____

Phosphoric acid _____

**(2)**

(c) Ammonium sulfate is a compound in fertilisers.

Ammonium sulfate can be made using an industrial process or in the laboratory.

In the industrial process, the following steps are used.

1. React streams of ammonia solution and sulfuric acid together.
2. Evaporate the water by passing the solution down a warm column.
3. Collect dry crystals continuously at the bottom of the column.

In the laboratory, the following steps are used.

1. React ammonia solution and sulfuric acid in a conical flask.
2. Evaporate water from the solution until crystals start to form.
3. Leave to cool and crystallise further.
4. Separate the crystals using filtration.
5. Dry the crystals between pieces of filter paper.

Evaluate the two methods for producing a large mass of ammonium sulfate.

**(4)**

**(Total 8 marks)**

## Q1.

(a) watch glass

**1**

(b) identify 0.29 as anomaly

**1**

$$\frac{0.12 + 0.14 + 0.15}{3}$$

**or**

$$\frac{0.41}{3}$$

*allow* $\frac{0.12 + 0.29 + 0.14 + 0.15}{4}$

***or***

$\frac{0.70}{4}$

**1**

(=) 0.14 (g)

*allow 0.18 (g) if first marking point not awarded*

**1**

*an answer of 0.14 (g) scores **3** marks*

(c) evaporating **or** vaporisation

*allow from liquid to vapour / gas*

*do **not** accept boiling*

**1**

(d) pure **or** no salt

*allow converse answers relating to seawater*
*allow not a mixture*
*allow desalinated*

*do **not** accept less salt*
*do **not** accept filtered*

**1**

(e) uses (a lot of) energy

*allow needs heating*
*allow needs electricity*
*allow needs fuel **or** any suitable fuel*

*ignore references to equipment*
*ignore references to time*

**1**

(f) filtering removes particles

*allow solids **or** suitable named solids*

**1**

sterilising kills bacteria / microbes

*allow destroys viruses*
*allow kills viruses*

1

**[9]**

## Q2.

(a) (copper ore)
(70 × 100 =) 7000

1

(recycled copper)
(27×100 =) 2700

1

(7000 – 2700 =) 4300 (MJ)

*allow correct use of incorrectly determined values for MP1 (copper ore) and/or MP2 (recycled copper)*

1

(b) any **one** from:

- reduces acid rain

  *allow sulfur dioxide causes acid rain*

- reduces respiratory problems (in humans)

  *allow sulfur dioxide causes respiratory problems (in humans)*

1

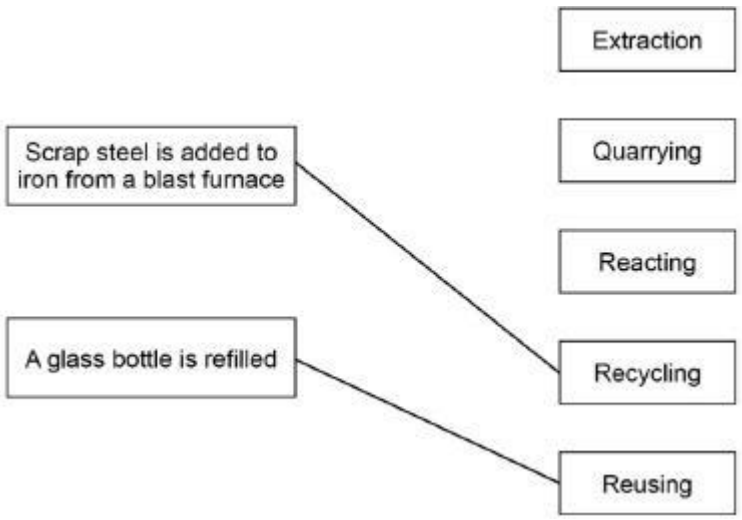
(c) $\frac{75}{100} \times 8$

1

= 6 (g)

1

(d)




do **not** accept more than one line from a box on the left

1
1

(e) **B**, **C**, **D**, **A**

**1**

**[9]**

## Q3.

(a) potable

**1**

(b) boil (water)

*ignore heat*

*do **not** accept filter*

*do **not** accept incorrect test*

**1**

(boils) at 100°C

***alternative approach** freeze (water) (1)*

*(freezes) at 0°C (1)*

*if no other mark awarded, allow 1 mark for evaporate or distil water **and** no solid left*

**1**

*allow boils at 100°C for **2** marks*

(c) **Level 2:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

**3–4**

**Level 1:** The design/plan would not necessarily lead to a valid outcome. Some steps are identified, but the plan may not be logically sequenced.

**1–2**

**No relevant content**

**0**

**Indicative content**

- weigh container.
- measure volume (100 $cm^3$) of water into container.
- evaporate / heat until dry.
- weigh container and remaining solids.
- determine mass of dissolved solids

to access Level 2 there should be an indication of using a known volume of water, heating until dry and determining the mass of solid.

(d)

*an answer of 0.031 (g) scores **4** marks*

(conversion of $cm^3$ to $dm^3$)

(250 $cm^3$ =) $\frac{250}{1000}$ or 0.25 ($dm^3$)

**1**

(conversion of mg to g)

(125 mg =) $\frac{125}{1000}$ or 0.125 (g)

**1**

(0.25 × 0.125) = 0.03125

*allow correct calculation from incorrect attempt(s) at conversion*

**1**

=0.031 (g)

*allow an answer correctly rounded to 2 significant figures from an incorrect calculation that uses the values in the question*

**1**

(e) $\frac{44}{500} \times 100$

**1**

= 8.8 (%)

*allow 9 (%)*

**1**

*an answer of 8.8 (%) or 9 (%) scores **2** marks*

**[13]**

## Q4.

**Level 3 (5–6 marks):**
A logically structured evaluation with links involving several comparisons. Nearly all points made are relevant and correct.

**Level 2 (3–4 marks):**
Some valid comparisons made between the two types of bag. There may be some incorrect or irrelevant points.

**Level 1 (1–2 marks):**
A vague response with few correct and relevant points and with no direct comparisons.

**0 marks:**
No relevant content

**Indicative content**

Accept converse in terms of plastic bags for all statements

- Paper bags are made from a renewable resource
- Plastic bags are made from a finite resource
- Paper bags require more energy to manufacture
- Paper bags produce more waste
- Paper bags are biodegradable
- Paper bags create more $CO_2$
- $CO_2$ created by paper bags offset by photosynthesis in growing wood
- Paper bag requires much more fresh water
- Paper bags cannot be recycled
- Agree because non-renewability less important than other factors **or** disagree because of converse **or** can't say because data inconclusive / incomplete

**6**

**[10]**

## Q5.

(a) 16(.0)

**1**

(b) advantage: more accurate result

*do **not** accept reliable*

**1**

disadvantage: takes a long(er) time, more energy needed (to heat more water)

*ignore expensive*

**1**

(c) pure: no dissolved solids / impurities
**or** no (dissolved) chlorine

*allow only water / $H_2O$*
*ignore safe to drink*

**and**
potable: has dissolved solids / impurities
**or** has (dissolved) chlorine

*ignore safe to drink*

**1**

*a clear comparative statement referring to solutes gains the mark*

(d) groundwater:
- filtered

*allow acceptable method of filtration*

**1**

- sterilised

*allow acceptable method of sterilisation*

**1**

groundwater:
- distilled **or** reverse osmosis

*allow desalination*
*ignore salt removed*
*ignore boiling alone*
*ignore filtering*
*do **not** accept fractional distillation*

**1**

(e) $\frac{2.2}{100} \times 6.50$

**1**

(=) 0.143 (g)

**1**

*an answer of 0.143 (g)*
***or** 0.14 (g) scores **2** marks*

**[9]**

## Q6.

(a) growing plants (on low-grade ore)

*allow named plant*

1

plants are burnt (to produce ash)

1

(ash dissolved in acid to produce) solution of a copper compound

*allow named copper compound*

1

electrolysis (of solution of a copper compound)
**or**
displacement (by adding scrap iron to a solution of a copper compound)

*allow addition of scrap iron (to a solution of a copper compound)*

1

(b)

*an answer of 0.002 or 2 × $10^{-3}$ (mol) scores **3** marks*

$M_r$ $CuSO_4$ = 159.5

1

$$\frac{0.319}{159.5}$$

*allow correct use of incorrectly calculated value for $M_r$*

1

= 0.002 (mol)

*allow 2 × $10^{-3}$ (mol)*

1

(c) both reaction profiles start at the same energy level and end at the same energy level.

1

(d) the amount of carbon dioxide used to produce the ethanol

1

is the same as the amount of carbon dioxide given off when the ethanol is burned

1

***alternative approach***

*there is sufficient carbon dioxide (in the atmosphere) (1)*

*because carbon dioxide is constantly produced from burning fossil fuels (1)*

*if no other mark awarded allow for 1 mark burning ethanol produces carbon dioxide*

(e) meets needs of current generation

1

without compromising needs of future generations

*allow so there are enough resources for future generations*

*ignore references to harming / damaging planet / environment*

**1**

**[12]**

## Q7.

(a) Tube 1: (nail) rusts because air / oxygen **and** water present

**1**

Tube 2: (nail) does not rust because no water

*allow Tube 2: (nail) does not rust because only air / oxygen*

**1**

Tube 3: (nail) does not rust because no air / oxygen

*allow Tube 3: (nail) does not rust because only water*

**1**

Tube 4: (nail) does not rust because paint is a barrier (to water / air / oxygen)

*allow Tube 4: (nail) does not rust because paint is a protective layer / coating (against water / air / oxygen)*
***or***
*allow Tube 4: (nail) does not rust because paint protects it from water / air / oxygen*

**1**

Tube 5: (nail) does not rust because stainless steel resistant to corrosion

*allow Tube 5: (nail) does not rust because stainless steel does not corrode*
*allow Tube 5: (nail) does not rust because stainless steel contains nickel / chromium*

**1**

*If no other mark awarded allow 1 mark for correct rusting pattern in all 5 tubes*

(b)

*allow converse*

magnesium is more reactive (than iron)

*allow magnesium is more reactive (than steel)*

**1**

(so magnesium) provides sacrificial protection

*allow (so magnesium) corrodes / reacts instead of iron / steel*
*allow (so magnesium) corrodes / reacts before iron / steel*
*ignore references to protective layers*
*ignore references to magnesium rusting*

**1**

(c) (aluminium has a coating of) aluminium oxide

**1**

(so the aluminium oxide) protects the metal (from further corrosion)

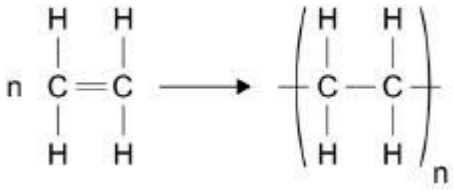
*allow (so aluminium oxide) prevents water / air / oxygen from reaching the metal*

1

**[9]**

## Q8.

(a)



*if equation incorrect*

*allow **1** mark for 5 single bonds*

***or***

*allow **1** mark for n*

2

(b) (poly(ethene)) melts

*allow converse statements about thermosetting polymers*

*allow thermosoftening polymers melt*

1

(so) can be reshaped (into new products)

1

(c) use different (reaction) conditions

*allow use different temperatures / pressures*

1

(d) (in HDPE) polymer chains / molecules are closer together

*allow converse statements about LDPE*

*allow (HDPE has) unbranched polymer chains / molecules*

1

(so) more atoms per unit volume

*allow (so) more molecules per unit volume*

1

(e) circle around HO– **or** –OH on monomer **A**

1

(f) $H_2O$
**and**
HCl

*must be in this order*

1

**[9]**

## Q9.

(a) C=C bond in correct position

1

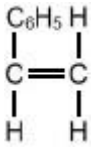
3× C-H **and** 1× C-C bond in correct positions

*do **not** accept any additional bonds or atoms*

*ignore brackets and n before and after displayed structural formula*

1

*an answer of*



*scores **2** marks*

(b) carboxylic acid (group)

*allow carboxyl (group)*

1

(c) water

*allow $H_2O$*

1

(d) (polyester is) thermosoftening

*allow (polyester is) thermoplastic*

*ignore thermoforming*

1

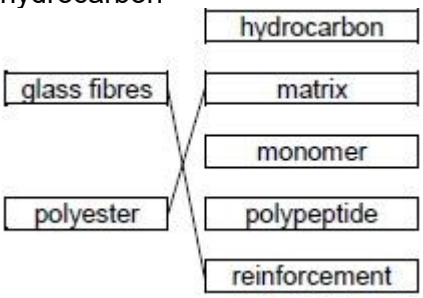
(polyester has) no cross-links

*allow intermolecular forces are weak*

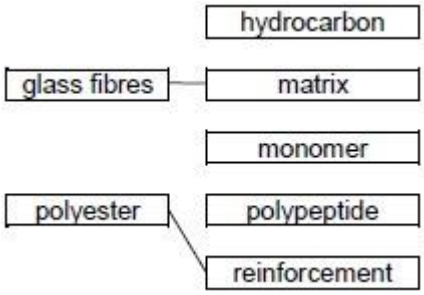
*do **not** accept references to breaking covalent bonds or breaking chains*

1

(e) hydrocarbon




*allow for 1 mark:*




2

(f) any **two** from:

(to make the board)
- harder
- stronger
- tougher
- more rigid

*must be implied comparative statements*
- waterproof

**2**

**[10]**

## Q10.

(a)

*an answer of 17.6470588 (%) correctly rounded to at least 2 significant figures scores 2 marks*

$\frac{6}{34} \times 100$

**1**

= 17.6 (%)

*allow 17.6470588 (%) correctly rounded to at least 2 significant figures*

**1**

(b)

*allow converse arguments in terms of higher pressure*
*ignore references to rate*

higher yield (of hydrogen or carbon monoxide or product)

*allow more hydrogen or more carbon monoxide or more product*
*allow equilibrium moves to the right*
*allow equilibrium moves in the forward direction*

**1**

(because) fewer moles / molecules / particles on left hand side
**or**
(because) more moles / molecules / particles on right hand side

*allow (because) the reverse reaction produces fewer moles / molecules / particles*
***or***
*allow (because) the forward reaction produces more moles / molecules / particles*
*do **not** accept fewer / more atoms*

**1**

(c) no effect (on yield of hydrogen)

*allow position of equilibrium unaffected by pressure*
*ignore references to rate of reaction*

**1**

(d)

*an answer of 2.25 scores **3** marks*

350 (°C) and 285 (atmospheres) = 63 (%)

**and**

450 (°C) and 200 (atmospheres) = 28 (%)

*allow a value between 62 (%) and 64 (%) inclusive*

**1**

$\frac{63}{28}$

*allow a correct expression using incorrectly determined value(s) for percentage yield*

**1**

= 2.25 (times greater)

*allow a correct calculation using incorrectly determined value(s) for percentage yield correctly evaluated and rounded to at least 2 significant figures*

**1**

(e)

*allow converse arguments in terms of low(er) pressure*

any **one** from:

- the energy costs would be high(er)
  *ignore energy / cost unqualified*
- the equipment would need to be strong(er)
  *allow the equipment would be (more) expensive (to build / maintain)*
- high(er) pressures are (more) dangerous
  *allow (more) dangerous because (greater) risk of explosion*

**1**

(f) higher temperatures produce a lower (percentage) yield (of ammonia)

*allow converse*

*allow correct reference to shift in equilibrium*

*ignore references to pressure*

**1**

(g) world population has increased

**1**

any **one** from:

- demand for fertiliser has increased
  *allow more food needed*
- increased demand for other specified ammonia-based products e.g. nitric acid, drugs, dyes, explosives

**1**

**[12]**

## Q11.

(a) ammonium phosphate

**1**

potassium nitrate

**1**

(b) (nitric acid) calcium nitrate

1

(phosphoric acid)
(calcium) triple superphosphate
**or**
calcium dihydrogenphosphate

1

(c) (industrial process)
(is) large(er) scale

*allow converse for laboratory process*
*ignore references to cost / energy*
*ignore large mass produced*

1

(is) quicker

1

(is a) continuous process

*allow does not need to be repeated*

1

reasoned judgement

1

**[8]**