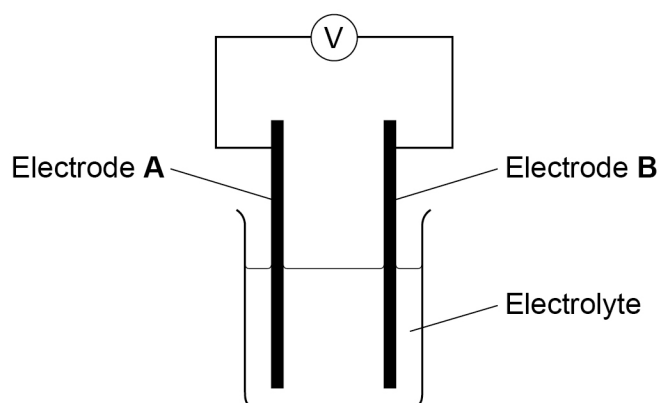


1

Chemical reactions can produce electricity.

1.1

Figure 2 shows a simple cell.**Figure 2**

Which of these combinations would **not** give a zero reading on the voltmeter in **Figure 2**?

[1 mark]Tick **one** box.

Electrode A	Electrode B	Electrolyte	
Copper	Copper	Sodium chloride solution	☐
Zinc	Zinc	Water	☐
Copper	Zinc	Sodium chloride solution	☐
Copper	Zinc	Water	☐

Alkaline batteries are non-rechargeable.

1.2

Why do alkaline batteries eventually stop working?

[1 mark]

1.3

Why can alkaline batteries **not** be recharged?

[1 mark]

Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars.

1.4

Complete the balanced equation for the overall reaction in a hydrogen fuel cell.

[2 marks]

1.5

Table 1 shows data about different ways to power electric cars.

Table 1

	Hydrogen fuel cell	Rechargeable lithium-ion battery
Time taken to refuel or recharge in minutes	5	30
Distance travelled before refuelling or recharging in miles	Up to 415	Up to 240
Distance travelled per unit of energy in km	22	66
Cost of refuelling or recharging in £	50	3
Minimum cost of car in £	60 000	18 000

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.

Use **Table 1** and your own knowledge.

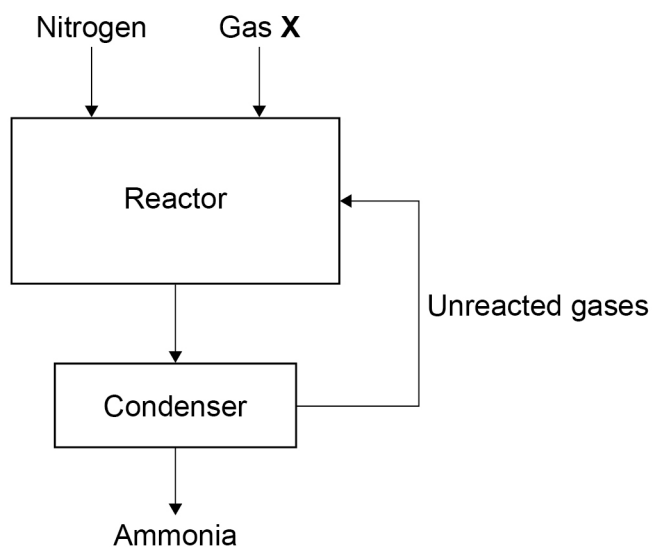
[6 marks]

2

This question is about gases.

Figure 3 shows how nitrogen is used in the Haber Process to produce ammonia.

Figure 3



2.1

Give the approximate temperature and pressure used in the reactor.

[2 marks]

Temperature _____

Pressure _____

3.1

Melamine is a polymer used to make non-disposable cups.

Melamine does **not** melt when it is heated.

Explain why.

[2 marks]

Table 4 shows the student's results.

Table 4

Electrode X	Voltage of cell in volts
cobalt	+0.62
copper	0.00
magnesium	+2.71
nickel	+0.59
silver	−0.46
tin	+0.48

4.1

Write the six metals used for electrode **X** in order of reactivity.

Use **Table 4**.

Justify your order of reactivity.

[4 marks]

Most reactive _____

Least reactive _____

Justification _____

4.2

Which of the following pairs of metals would produce the greatest voltage when used as the electrodes in the cell?

Use **Table 4**.

[1 mark]

Tick (✓) **one** box.

Magnesium and cobalt

☐

Magnesium and tin

☐

Nickel and cobalt

☐

Nickel and tin

☐

4.3

Hydrogen fuel cells can be used to power different forms of transport.

Some diesel trains are being converted to run on hydrogen fuel cells.

A newspaper article referred to the converted trains as the new 'steam trains'.

Suggest why.

[2 marks]

5

This question is about the corrosion of metals.

The corrosion of iron is called rusting.

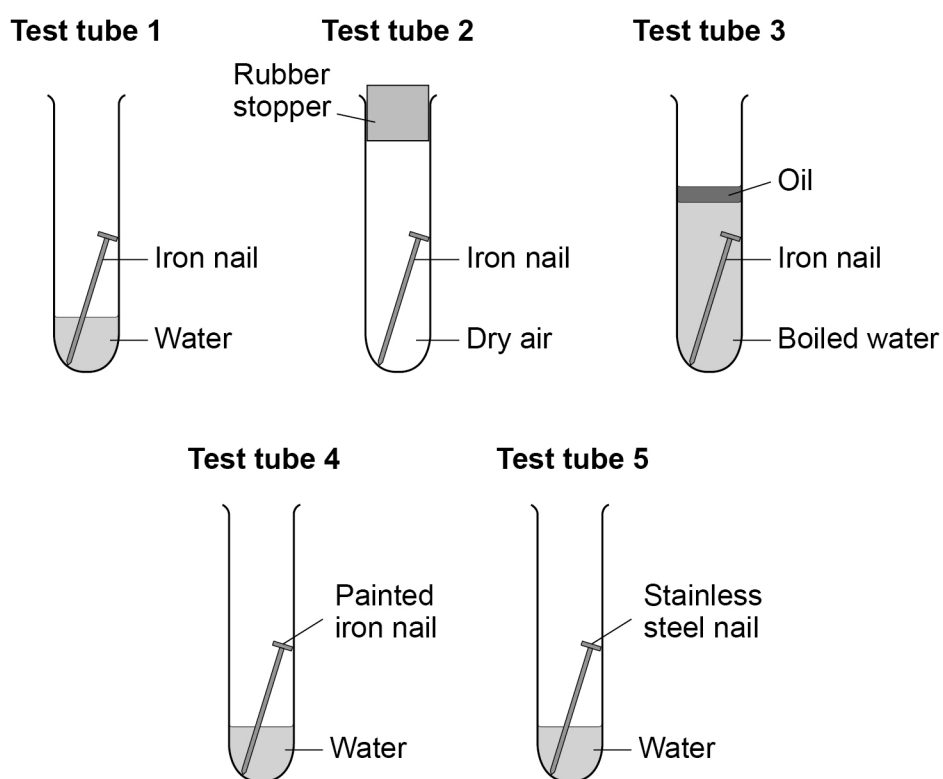
5.1

A student investigated the rusting of iron.

This is the method used.

1. Set up the test tubes as shown in **Figure 4**.
2. Leave the test tubes for 1 week.
3. Examine the nails for signs of rust.

Figure 4



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

[5 marks]

5.2

Magnesium is fixed to some steel ships.

Explain how this prevents the steel from rusting.

[2 marks]

5.3

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

[2 marks]

The outer skin of surfboards contains a polyester.

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

Figure 8 shows how these two monomers are represented.

6.1

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

[2 marks]

The outer skin of surfboards is a composite material.
The composite material contains glass fibres surrounded by a polyester.

6.2 Draw **one** line from each material to the description of that material. [2 marks]

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

6.3 The outer skin makes the surfboard more expensive.
Suggest **two** reasons why an outer skin is added to the poly(styrene) core. [2 marks]

1 _____

2 _____

7.1

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

Give **one** reason why.

[1 mark]

8.1

The reaction between hydrogen and oxygen in a hydrogen fuel cell is used to produce electricity.

Hydrogen fuel cells and rechargeable cells are used to power some cars.

Give **two** advantages of using hydrogen fuel cells instead of using rechargeable cells to power cars.

[2 marks]

1 _____

2 _____

8.2

Reactions occur at the positive electrode and at the negative electrode in a hydrogen fuel cell.

Write a half equation for **one** of these reactions.

[1 mark]

9

This question is about chemical reactions and electricity.

9.1

Electrolysis and chemical cells both involve chemical reactions and electricity.

Explain the difference between the processes in electrolysis and in a chemical cell.

[2 marks]

10.1

Poly(ethene) is a thermosoftening polymer.

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

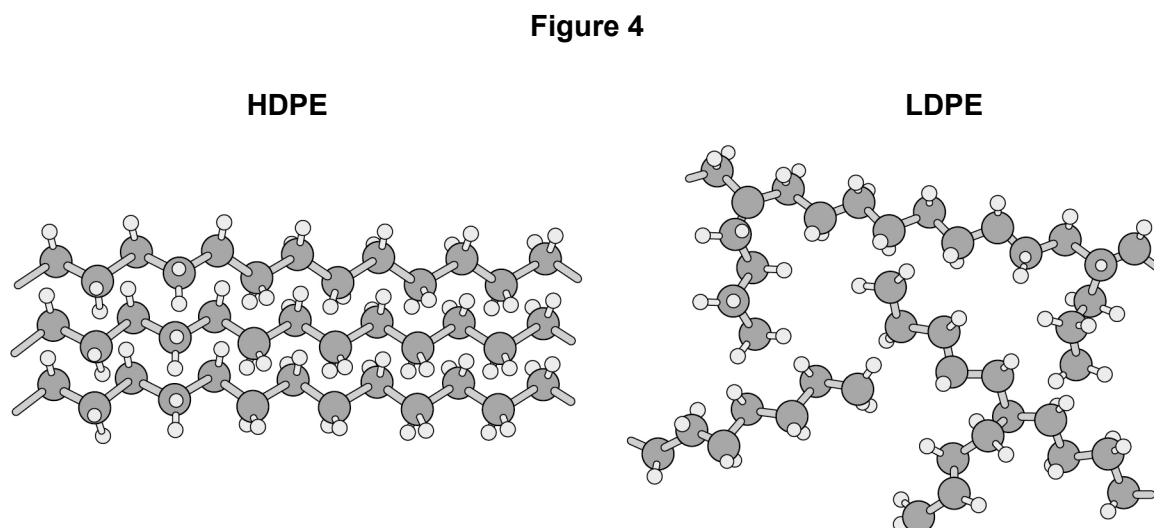
[2 marks]

10.2

Two different forms of poly(ethene) are:

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

Figure 4 represents part of the structures of HDPE and LDPE.



Explain why HDPE has a higher density than LDPE.

[2 marks]

11

This question is about fertilisers.

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

11.1

Which **two** compounds each contain **two** of these elements?

[2 marks]

Tick (✓) **two** boxes.

Ammonium nitrate

☐

Ammonium phosphate

☐

Calcium chloride

☐

Calcium phosphate

☐

Potassium chloride

☐

Potassium nitrate

☐

11.2

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.

[2 marks]

Nitric acid _____

Phosphoric acid _____

$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$$

The conditions used are:

- Explain why these conditions are chosen for economical production of ammonia in the Haber process.

You should include references to the rate of reaction and the position of equilibrium.

[6 marks]

[illegible]

13.1

Poly(ethene) can be strengthened with wood particles to make a building material.

The building material consists of a wood particle reinforcement embedded in a poly(ethene) matrix.

What general name is given to materials like this?

[1 mark]

14

This question is about fertilisers.

Compounds of nitrogen (N), phosphorus (P) and potassium (K) are used as fertilisers to improve agricultural productivity.

Table 4 shows information about three compounds, **A**, **B** and **C**, that can be used as fertilisers.

Table 4

	Compound A	Compound B	Compound C
Name	potassium chloride	ammonium nitrate	diammonium hydrogen phosphate
Formula	KCl	NH ₄ NO ₃	(NH ₄) ₂ HPO ₄
Percentage (%) of N, P and K by mass	K: 52%	N: 35%	N: 21% P: 23%
Cost in £/kg	0.24	0.23	0.35

14.1

A scientist analysed the percentages of nitrogen, phosphorus and potassium in a soil.

The percentages of nitrogen and of potassium in the soil were lower than the percentages needed for high agricultural productivity.

There was sufficient phosphorus in the soil for high agricultural productivity.

Evaluate the use of the compounds in **Table 4** to improve the agricultural productivity of this soil.

[4 marks]

14.2

How is potassium chloride (compound **A**) obtained from the Earth?

[1 mark]

14.3

Name **one** other compound that could be used instead of potassium chloride (compound **A**) to give a similar improvement in agricultural productivity.

[1 mark]

14.4

Nitric acid is needed to produce ammonium nitrate (compound **B**).

Name a compound needed to produce nitric acid.

[1 mark]

14.5

Phosphate rock contains phosphorus compounds.

Plants absorb phosphorus from compounds dissolved in rainwater.

Suggest why phosphate rock **cannot** be used directly as a fertiliser.

[1 mark]

14.6

Phosphate rock can be treated with different acids to produce salts useful as fertilisers.

Name the salts which are produced by treating phosphate rock with:

- sulfuric acid
- phosphoric acid.

[2 marks]

Sulfuric acid _____

Phosphoric acid _____