GCSE Chemistry

ATOMS

AQA (Trilogy) Topic C1

C1 Atomic Structure Key knowledge

1) Explain why it is difficult to separate a compound, compared to an element.
2) Describe the method used to collect the salt from a mixture of sand and salt.
3) What process is used to purify seawater to obtain usable water?
4) Which subatomic particle did JJ. Thomson discover?
5) Name Rutherford's experiment.
6) State two ways in which Rutherford's experiment changed Thomson's model of the atom.
7) How did Bohr adapt the nuclear model?
8) Name three subatomic particles and their charges.
9) What does the atomic number and mass number tell us about an atom?
10) How is an isotope different to an atom?
11) What is the electron configuration for sodium?
12) Why is the overall charge of an atom zero?
13) Draw the electron configuration for a chlorine atom.
14) How are elements arranged in the periodic table?
15) What are the columns and rows of the periodic table called?
16) How were elements classified before the discovery of subatomic particles?
17) What was the problem with early periodic tables?
18) How did Mendeleev overcome these problems?
19) Why is the order based on atomic masses not always correct?
20) What do we call elements that tend to form positive ions?
21) What are the elements in Group 0,1 and 7 are called?
22) What happens to the boiling point of elements in Group 0 as you go down the group?
23) Why are the elements in Group 0 so unreactive?
24) What happens to the reactivity of the elements as you go down Group 1?
25) Write a word equation for the reaction between sodium and oxygen.
26) Halogens are diatomic. What does the word 'diatomic' mean?
27) What happens to the reactivity as you go down Group 7?
28) What happens to the melting point and boiling point as you go down Group 7?
29) Write a word equation for the reaction between lithium and chlorine.
30) Where are transition metals found on the periodic table?
31) State two typical properties of transition metals.
32) State one use of transition metals.
33) Explain why copper is used for plumbing.

C1 Atomic Structure ANSWERS

1) Explain why it is difficult to separate a compound, compared to an element. **A compounds elements are chemically joined together.**
2) Describe the method used to collect the salt from a mixture of sand and salt. **Add water and stir to dissolve the salt. Use filtration to remove the sand. Heat the water (gently) to allow the salt to crystallise (to avoid dryness).**
3) What process is used to purify seawater to obtain usable water? **Simple distillation.**
4) Which subatomic particle did JJ. Thomson discover? **The electron**
5) Name Rutherford's experiment. **Alpha particle scattering.**
6) State two ways in which Rutherford's experiment changed Thomson's model of the atom. **He said the positive charge was concentrated into very small volume at centre of atom (nucleus) and the electrons orbit nucleus.**
7) How did Bohr adapt the nuclear model? **Suggesting electrons orbit the nucleus at different distances.**
8) Name three subatomic particles and their charges. **Proton – positive; neutron – no charge; electron – negative.**
9) What does the atomic number and mass number tell us about an atom? **Atomic number = number of protons. Mass Number = Number of protons + number of neutrons.**
10) How is an isotope different to an atom? **Different number of neutrons, same number of protons**
11) What is the electron configuration for sodium? **2,8,1**
12) Why is the overall charge of an atom zero? **Number of protons (positive) = number electrons (negative).**
13) Draw the electron configuration for a chlorine atom.
14) How are elements arranged in the periodic table? **Increasing atomic number.**
15) What are the columns and rows of the periodic table called? **Columns = Groups.   Rows = Periods**
16) How were elements classified before the discovery of subatomic particles? **Arranging in order of their atomic weights.**
17) What was the problem with early periodic tables? **Incomplete; some elements placed in inappropriate groups.**
18) How did Mendeleev overcome these problems? **Left gaps for elements he thought had not yet been discovered; changed the order based on atomic weights for some elements if they did not fit the pattern.**
19) Why is the order based on atomic masses not always correct? **The presence of isotopes.**
20) What do we call elements that tend to form positive ions? **Metals.**
21) What are the elements in Group 0,1 and 7 are called? **Group 0 = Noble gases. Group 1 – Alkali metals. Group 7 - Halogens**
22) What happens to the boiling point of elements in Group 0 as you go down the group? **Increase.**
23) Why are the elements in Group 0 so unreactive? **Full outer shell of electrons.**
24) What happens to the reactivity of the elements as you go down Group 1? **Increases.**
Write a word equation for the reaction between sodium and oxygen. **sodium + oxygen → sodium oxide**
25) Halogens are diatomic. What does the word 'diatomic' mean? **There molecules contain 2 atoms.**
26) What happens to the reactivity as you go down Group 7? **Decreases.**
27) What happens to the melting point and boiling point as you go down Group 7? **Increases.**
28) Write a word equation for the reaction between lithium and chlorine. **lithium + chlorine → lithium chloride**
29) State two typical chemical properties of transition metals. **Have ions with different charges; form coloured compounds.**
30) State one use of transition metals. **Transition metals can be used as catalysts**
31) Explain why copper is used for plumbing. **It has a high melting point, it conducts heat and is strong and malleable. It also does not react with water.**
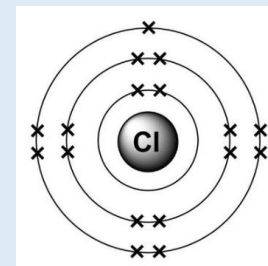
Question 1

b) The model of the atom has changed over time as new experimental evidence arises.

State the order in which the subatomic particles were discovered by writing numbers 1,2 and 3 in the left-hand column.
1 being the first discovery.

[2 marks]

Order discovered	Subatomic particles	
	Protons	**2**
	Neutrons	**3**
	Electrons	**1**

c) State who suggested the location of electrons.

Tick **one** box only.

[1 mark]

Bohr	✔
Chadwick	
Rutherford	

d) State who discovered neutrons.

Tick **one** box only.

[1 mark]

Bohr	
Chadwick	✓
Rutherford	

e) Rutherford wanted to study the plum pudding model of the atom, by running an alpha scattering experiment.
Describe what Rutherford found and explain how this changed the model of the atom.

[4 marks]

-Some alpha particles were deflected (as expected)
-most alpha particles went straight through
-most of the mass of the atom is concentrated in a small area
-(called) the nucleus

Question 2

Iron oxide is used as a catalyst in the Haber process.

a) Transition metals can be used as catalysts.
State the properties that leads to this.

Tick **one** box only.

[1 mark]

Variety of different charged ions	✔
A range of different colours	
They are ductile	
Malleability	

f) Compare how iron and lithium react with oxygen.

[2 marks]

_____

_____

_____

_____

Question 3

Describe how the process of distillation shown in **Figure 2** produces pure water from salt solution.

any **four** from:

- solution is heated

- water evaporates
  allow water boils / vaporises

- the vapour cools in the condenser

- the vapour condenses

  or

  the vapour turns to a liquid

- (pure) water collects in the beaker

(4)

This question is about the structure of the atom.

(a)   Complete the sentences.

Choose answers from the box.

Each word may be used once, more than once, or not at all.

electron	ion	neutron
nucleus	proton	

The centre of the atom is the _____ .

The two types of particle in the centre of the atom are the proton

and the _____ .

James Chadwick proved the existence of the _____ .

Niels Bohr suggested particles orbit the centre of the atom. This type of particle

is the _____ .

The two types of particle with the same mass are the neutron

and the _____ .

nucleus

neutron

neutron

electron

proton

must be in this order

The table below shows information about two isotopes of element **X**.

	Mass number	**Percentage (%) abundance**
Isotope 1	63	70
Isotope 2	65	30

(b)   Calculate the relative atomic mass (A_r) of element **X** using the equation:

$$A_r = \frac{\text{(mass number} \times \text{percentage) of isotope 1} + \text{(mass number} \times \text{percentage) of isotope 2}}{100}$$

Use the table above.

Give your answer to 1 decimal place.

$$(A_r)\frac{(63 \times 70) + (65 \times 30)}{100}$$

$$= 63.6$$

*an answer of 63.6 scores **2** marks*

$A_r =$ _____

This question is about models of the atom.

(a)   Atoms were first thought to be tiny spheres that could not be divided.

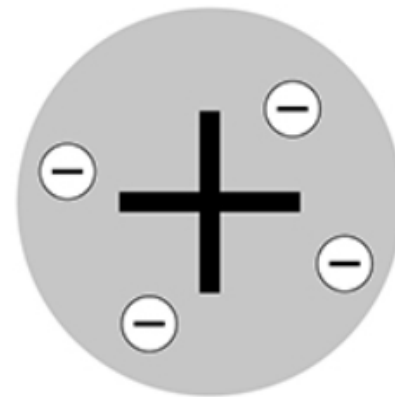Which particle was discovered to change this model of the atom?

Tick (✓) **one** box.

Electron   ✓

Neutron   ☐

Proton   ☐

(b)   The diagram below shows another model of the atom.

What is the name of this model of the atom?

_____ plum pudding _____

(1)

(c) A scientist fired particles at gold atoms.

Some of these particles were scattered.

The results led to a different model of the atom.

Which type of particle was fired at the gold atoms?

Tick (✓) **one** box.

Alpha ✓

Electron ☐

Neutron ☐

Proton ☐

(d) Which scientist first suggested that electrons orbit the nucleus at specific distances?

Tick (✓) **one** box.

Bohr ✓

Chadwick ☐

Mendeleev ☐

(f) The radius of a nucleus is approximately 1×10^{-14} m

The radius of an atom is approximately 1×10^{-10} m

A teacher uses a ball of radius 1 cm to represent the nucleus.

What could represent the atom on the same scale?

Tick (✓) **one** box.

A ball of radius 10 cm ☐

A sports arena of radius 100 m ✓

An island of radius 10 km ☐

A planet of radius 1000 km ☐

GCSE Chemistry

BONDING

AQA (Trilogy) Topic C2

C2 Bonding Key Knowledge

1) Which type of bonds occurs when metals combine with non-metals?
2) What happens to the electrons in ionic bonding?
3) What is the link between the charge number on the ions in groups 1, 2 and 3 and their group number ?
4) What is an ionic compound?
5) How are ionic compounds held together?
6) How are atoms arranged in a metal?
7) Why are metallic bonds so strong?
8) Describe the arrangement of particles in a metal.
9) Why are the particles that make up a metal described as positively charged?
10) What are delocalised electrons?
11) In chemical equations, what symbols are used to show the states of matter?
12) In what state of matter do particles have the most energy?
13) What would eventually happen to a gas if pressure is increased?
14) Describe the structure of ionic compounds.
15) Why do ionic compounds have high melting and boiling points?
16) Why can ionic compounds conduct electricity when melted or dissolved in water?
17) Why do small molecules have low melting and boiling points?
18) Why don't small molecules conduct electricity?
19) What are polymers?
20) Give an example of a giant covalent structure.
21) In a diamond, how many covalent bonds does each carbon make?
22) Diamond does not conduct electricity. Why?
23) Name 2 other properties of diamond.
24) In graphite, how many covalent bonds does each carbon make?
25) Describe the structure of graphite.
26) Why is graphite soft?
27) Why does graphite conduct electricity?
28) How is graphite similar to metals?
29) What is graphene and fullerenes?
30) What was the first fullerene to be discovered?
31) What are nanoparticles?
32) Why do nanoparticles have different properties from those for the same materials in bulk?
33) Name 5 uses of nanoparticles.

C2 Bonding ANSWERS

1) Which type of bonds occurs when metals combine with non-metals? **Ionic, covalent, metallic.**
2) What happens to the electrons in ionic bonding? **Transferred.**
3) What is the link between the charge number on the ions in groups 1, 2 and 3 and their group number ? **Charge number is same as Group number.**
4) What is an ionic compound? **Giant structure of ions (positive and negative).**
5) How are ionic compounds held together? **Strong electrostatic forces of attraction; between oppositely charged ions.**
6) How are atoms arranged in a metal? **Giant structures of atoms, arranged in a regular pattern, delocalised electrons.**
7) Why are metallic bonds so strong? **Sharing of delocalised electrons.**
8) Describe the arrangement of particles in a metal. **Atoms arranged neatly in rows; sea of delocalised electrons.**
9) Why are the particles that make up a metal described as positively charged? **The metal atoms lose outer shell electrons and therefore there are more protons (+) than electrons (−).**
10) What are delocalised electrons? **They are free-moving electrons within structure; not associated with a particular atom.**
11) In chemical equations, what symbols are used to show the states of matter? **Solid = (s); liquid = (l); gas = (g); aqueous = (aq)**
12) In what state of matter do particles have the most energy? **Gas.**
13) What would eventually happen to a gas if pressure is increased? **Condense into a liquid.**
14) Describe the structure of ionic compounds. **Regular, giant ionic lattice.**
15) Why do ionic compounds have high melting and boiling points? **Strong electrostatic forces of attraction between ions.**
16) Why can ionic compounds conduct electricity when melted or dissolved in water? **Ions are free to move, carry the charge.**
17) Why do small molecules have low melting and boiling points? **Weak forces between molecules/ intermolecular forces.**
18) Why don't small molecules conduct electricity? **Do not have an overall electric charge.**
19) What are polymers? **Very large molecules made of repeating units.**
20) Give an example of a giant covalent structure. **Diamond, graphite, silicon dioxide.**
21) In a diamond, how many covalent bonds does each carbon make? **4**
22) Diamond does not conduct electricity. Why? **No delocalised electrons.**
23) Name 2 other properties of diamond. **Hard, very high melting point.**
24) In graphite, how many covalent bonds does each carbon make? **3**
25) Describe the structure of graphite. **Layers of hexagonal rings.**
26) Why is graphite soft? **Layers can slide over each other, weak forces between layers, no covalent bonds between layers.**
27) Why does graphite conduct electricity? **delocalised electron.**
28) How is graphite similar to metals? **It contains delocalised electrons.**
29) What is graphene and fullerenes? **Graphene - single layer of graphite, 1 atom thick. Fullerene - Molecules of carbon atoms with hollow shapes.**
30) What was the first fullerene to be discovered? **Buckminsterfullerene.**
31) What are nanoparticles? **Smaller than fine particles.**
32) Why do nanoparticles have different properties from those for the same materials in bulk? **They have a high surface area to volume ratio. Smaller quantities are needed to be effective.**
33) Name 5 uses of nanoparticles. **Medicine, electronics, cosmetics, sunscreens, deodorants, catalysts.**
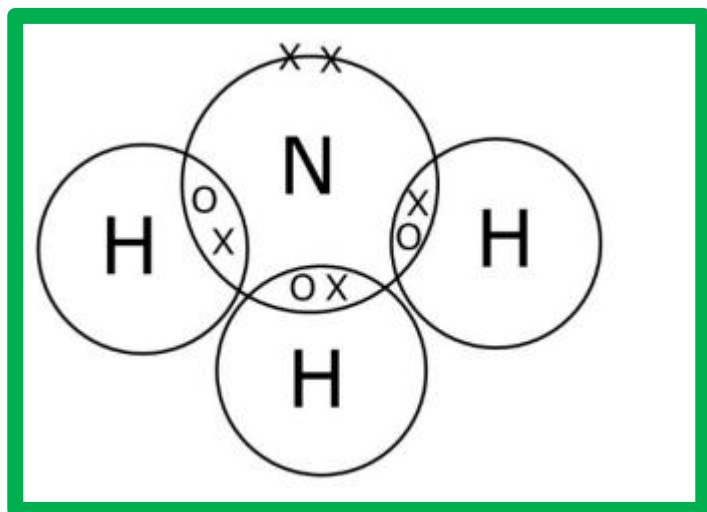
Question 1

Ammonia has the formula NH_3.

a) State the bonding seen in ammonia.

Tick **one** box only.

[1 mark]

Ionic	
Covalent	✓
Metallic	

b) Draw the bonding in ammonia by completing the dot and cross diagram below.

[3 marks]

d) Ammonia is a small molecule that is a liquid at -35°C and a gas at -30°C.
When ammonia boils bonds are broken, and it turns from a liquid to a gas.
Describe which bonds are broken and why and which ones are not broken and why.

[4 marks]

- intramolecular bonds are not broken
- very strong covalent bonds
- intermolecular bonds are broken
- requires less energy to overcome these attractions

d) Both iron and lithium can form compounds with oxygen to form oxides.
State the type of bonding that is seen in both iron and lithium oxide.
Tick **one** box only.

[1 mark]

Ionic	✓
Covalent	
Metallic	

Question 2

Nanoparticles are very small.

a) Compare the volume of a cube that has side of 10nm with the volume of a cube that has side of 2nm.

Volume of a cube= width x length x depth

[2 marks]

$10 \times 10 \times 10 = 1,000nm^3$

$2 \times 2 \times 2 = 8nm^3$

b) 125 of the smaller cubes could fit inside the larger cube, compare the surface areas of two sets of cubes with the same volume.

Surface area of a side = width x length
A cube has six sides.

[2 marks]

$10 \times 10 \times 6 \times 1 = 600nm^2$

$2 \times 2 \times 6 \times 125 = 3,000nm^2$

c) Comment on the surface area to volume ratio of the cubes.

[1 mark]

-Smaller particles have a higher surface area to volume ratio

e) Titanium dioxide is used in sun creams as it is very effective at reflecting UV rays away from the skins and preventing damage.

This is partly responsible for the white colour and thick consistency of sun creams; these can sometimes leave a thin film over the skin as they can't easily penetrate the skin.

Modern sun creams use nanoparticles of titanium dioxide, that resolve

Discuss
in sun c

Advantages
-rubs in easier
-not white so looks better
-can get deeper into skin
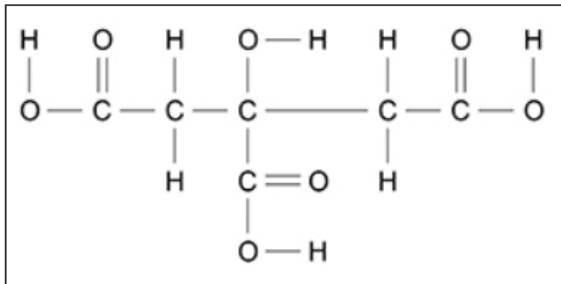-no need to reapply after water contact

Disadvantages
-hard to see areas that might have been missed
-long terms effects of nanoparticles on cells is unknown
-could damage environment

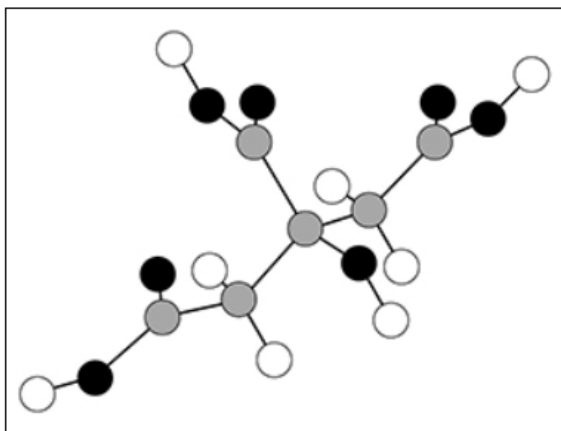**Figure 2** shows two representations of one molecule of citric acid, **A** and **B**.

Figure 2

A

```
H    O    H    O—H   H    O    H
|    ||   |    |     |    ||   |
O — C — C — C ——————— C — C — O
          |    |     |
          H    C=O   H
               |
               O—H
```

B

Give **two** advantages of representation **A** compared with representation **B**.
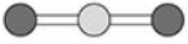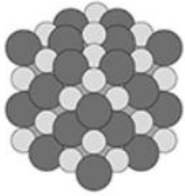
Advantages of **A**:

1 _____

_____

2 _____

_____

(c)   shows (single and) double bonds

shows which atoms are which element

Question 4

Compound	Structure
Carbon dioxide	Key ● O ○ C
Magnesium oxide	Key ● O^{2-} ○ Mg^{2+}
Silicon dioxide	Key ● O ○ Si

Compare the structure and bonding of the three compounds:

- carbon dioxide
- magnesium oxide
- silicon dioxide.

- (both) carbon dioxide and silicon dioxide are made up of atoms
- (but) magnesium oxide is made up of ions

- (both) silicon dioxide and magnesium oxide are giant structures
- (but) carbon dioxide is small molecules
- with weak intermolecular forces

- all three compounds have strong bonds
- (both) carbon dioxide and silicon dioxide are formed from two non-metals
- (so) bonds formed are covalent
- (so) electron (pairs) are shared (between atoms)
- (but) magnesium oxide is formed from a metal and a non-metal
- (so) bonds in magnesium oxide are ionic
- (so) electrons are transferred
- from magnesium to oxygen
- two electrons are transferred

- bonds in silicon dioxide are single bonds
- (where) each silicon forms four bonds
- (and) each oxygen forms two bonds
- (but) in carbon dioxide the bonds are double bonds
- (where) carbon forms two double bonds
- (and) oxygen forms one double bond

ignore properties e.g. melting point, electrical conductivity

GCSE Chemistry

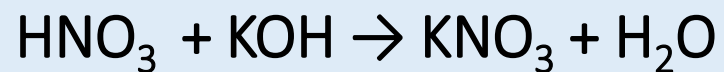# QUANTITATIVE CHEMISTRY

AQA (Trilogy) Topic C3

C3 Quantitive chemistry Key knowledge

1) What is the law of conservation of mass?
2) Why might some reactions appear to show a change in mass?
3) Give two examples of a reaction where a change in mass may appear to take place.
4) Balance the following equations:
   a) $H_2 + O_2 \rightarrow H_2O$
   b) $Ca + HCl \rightarrow CaCl_2 + H_2$
5) How many atoms and elements are in the compound sodium aluminate, $NaAl(OH)_4$?
6) An aqueous solution of hydrogen peroxide (H_2O_2) decomposes to form water and oxygen.
   a) Write a balanced symbol equation for this reaction. Include the state symbols.
   b) Why does the water, produced during the reaction, have a lower mass than the original hydrogen peroxide?
7) What is the relative formula mass of NaCl?
8) Why can you have relative atomic masses which are not whole numbers e.g. chlorine is 35.5?
9) What units can be used for the concentration of a solution?
10) What does dm^3 mean?
11) Give the equation for calculating concentration from the mass of substance and volume of solution.
12) Calculate the concentration in g/dm^3 for 50g of sodium chloride in 2.5 dm^3 of water.
13) Calculate the concentration in g/dm^3 of 1.4g of potassium carbonate in 855cm^3 of water.
14) What is meant by the term 'yield'?
15) What is the equation for calculating percentage yield?
16) Give 2 reasons why it is not always possible to obtain the expected amount of product from a reaction.
17) What is meant by the term 'atom economy'?
18) Why is it important to use reactions with high atom economy?
19) What is the equation for calculating the percentage atom economy from a balanced chemical equation?
20) In the neutralisation of sulfuric acid with sodium hydroxide, the theoretical yield from 13.8g of sulfuric acid is 20g. In a synthesis, the actual yield is 17.4g. What is the percentage yield for this synthesis?

C3 Quantitive chemistry ANSWERS

1) What is the law of conservation of mass? **Mass of reactants = mass products.**
2) Why might some reactions appear to show a change in mass? **A reactant or a product is a gas.**
3) Give two examples of a reaction where a change in mass may appear to take place. **Metal reacting with oxygen or an acid. Thermal decomposition.**
4) Balance the following equations:
   a) $2H_2 + O_2 \rightarrow 2H_2O$
   b) $Ca + 2HCl \rightarrow CaCl_2 + H_2$
5) How many atoms and elements are in the compound sodium aluminate, $NaAl(OH)_4$? **Four elements and ten atoms.**
6) An aqueous solution of hydrogen peroxide (H_2O_2) decomposes to form water and oxygen.
   a) Write a balanced symbol equation for this reaction. Include the state symbols. **$2H_2O_2$ (aq) $\rightarrow 2H_2O$ (l) + O_2(g)**
   b) Why does the water, produced during the reaction, have a lower mass than the original hydrogen peroxide? **Because the oxygen gas produced during the reaction escaped into the atmosphere.**
7) What is the relative formula mass of NaCl? **23.0 + 35.5 = 58.5**
8) Why can you have relative atomic masses which are not whole numbers e.g. chlorine is 35.5? **Isotopes.**
9) What units can be used for the concentration of a solution? **g/dm³**
10) What does dm³ mean? **1000cm³**
11) Give the equation for calculating concentration from the mass of substance and volume of solution. **Concentration = mass ÷ volume**
12) Calculate the concentration in g/dm³ for 50g of sodium chloride in 2.5 dm³ of water. **50/2.5 = 20g/dm³**
13) Calculate the concentration in g/dm³ of 1.4g of potassium carbonate in 855cm³ of water. **(1.4/855) x 1000 = 1.64 g/dm³**
14) What is meant by the term 'yield'? **Amount of product obtained.**
15) What is the equation for calculating percentage yield?

$$\% \text{ yield} = \frac{\text{mass of product actually made}}{\text{Maximum theoretical mass of product}} \times 100$$

16) Give 2 reasons why it is not always possible to obtain the expected amount of product from a reaction. **Reaction may not go to completion as it is reversible; some product may be lost; some reactants may react differently to expected.**
17) What is meant by the term 'atom economy'? **Measure of the amount of starting materials that end up as useful products.**
18) Why is it important to use reactions with high atom economy? **Sustainable development; less waste products produced; economically viable; cheaper.**
19) What is the equation for calculating the percentage atom economy from a balanced chemical equation?
20) In the neutralisation of sulfuric acid with sodium hydroxide, the theoretical yield from 13.8g of sulfuric acid is 20g. In a synthesis, the actual yield is 17.4g. What is the percentage yield for this synthesis? **Percentage yield = (17.4 ÷ 20) x 100 = 87%**
21) It takes 28.0cm³ of potassium hydroxide to neutralise 25.00cm³ of nitric acid at a concentration of 0.50 mol/dm³.
$$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$
Calculate the concentration of the potassium hydroxide.

It takes 28.0cm^3 of potassium hydroxide to neutralise 25.00cm^3 of nitric acid at a concentration of 0.50 mol/dm^3.

$HNO_3 + KOH \rightarrow KNO_3 + H_2O$

Calculate the concentration of the potassium hydroxide.

	KOH	HNO$_3$
volume	28/1000 = 0.028 dm^3	25/1000 = 0.025 dm^3
Concentration	0.45 mol/dm^3	0.50 mol/dm^3
Moles	0.0125 mol	0.0125 mol
Ratio	1	1

Question 1

b) Iron oxide can have the formula Fe_2O_3 or Fe_3O_2.
Determine which has the greater molecular mass.

[3 marks]

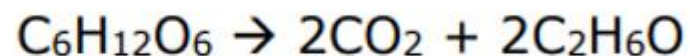-Fe_2O_3 = (56x2) + (16x3) = 160
-Fe_3O_2 = (56x3) + (16x2) = 200
-Fe_3O_2 is greatest in mass

Question 2

Ethanol can be produced in two different ways:

By fermentation

Glucose → carbon dioxide + ethanol

$$C_6H_{12}O_6 → 2CO_2 + 2C_2H_6O$$

By hydration

Ethene + water → ethanol

$$C_2H_4 + H_2O → C_2H_6O$$

a) Calculate the atom economy of producing ethanol by fermentation using the equation provided.

[3 marks]

M_r of glucose = 180

M_r of carbon dioxide = 44

M_r or ethanol = 46

(2x46)/(44+44+46+46)

=51.1%

b) Identify which reaction has the highest atom economy and explain why you chose that reaction.

[2 marks]

-hydration
-no waste products

c) The percentage yield of a fermentation reaction is very low. Describe what the term percentage yield means and give one reason why a yield may not be 100%.

[3 marks]

-mass of product actually made
-compared to expected mass of product

1 from:
-reaction may not go to completion
-other products could be made
-some product could be lost
-reversible reaction

Question 3

The student used a pipette to measure 25.0 cm^3 of hydrochloric acid.

Figure 2 shows a pipette.

Figure 2

Pipette

The pipette is labelled 25.0 ± 0.06 cm^3

Calculate the percentage uncertainty in the volume measured using this pipette.

Use the equation:

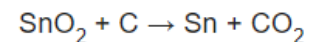$$\text{percentage uncertainty} = \frac{\text{uncertainty}}{\text{volume measured}} \times 100$$

$$\frac{0.06}{25(.0)} \times 100$$

$$= 0.24\ (\%)$$

= _____ %

Question 4

Carbon is used to extract tin (Sn) from tin oxide (SnO_2).

The equation for the reaction is:

$$SnO_2 + C \rightarrow Sn + CO_2$$

Calculate the percentage atom economy for extracting tin in this reaction.

Relative atomic masses (A_r): C = 12   O = 16   Sn = 119

(total M_r of reactants) = 163

(% atom economy =) $\frac{119}{163}$ (×100)

allow correct use of an incorrectly calculated value of total M_r

= 73 (%)

allow 73.00613 (%) correctly rounded to at least 2 significant figures

__ %

(3)

GCSE Chemistry

CHEMICAL CHANGES

AQA (Trilogy) Topic C4

C4 Chemical changes Key knowledge

1) What is produced when metals react with oxygen?
2) What is this process called and why?
3) What is reduction in terms of oxygen?
4) Which is more reactive potassium or iron?
5) Which two non-metals can be included in the reactivity series?
6) How are metals, less reactive than carbon, extracted from their ores?
7) What is produced when acids react with metals?
8) What is produced when an acid reacts with a carbonate?
9) What salt is produced by the following acids?
   a) Hydrochloric acid
   b) Sulfuric acid
   c) Nitric acid
10) How are soluble salts made from acids and insoluble substances?
11) Name the process of producing solid salts from salt solution.
12) Complete the following equations:
   a) sodium hydroxide + hydrochloric acid →
   b) lithium carbonate + nitric acid →
13) What ions do aqueous acids contain?
14) What ions do aqueous alkalis contain?
15) Write a balanced symbol equation for the reaction between hydrogen ions and hydroxide ions.
16) Why can a molten or dissolved ionic compound conduct electricity?
17) What is the name of the electrode that positive ions move to?
18) What is the name of the electrode that the negative ions move to?
19) What is produced at the cathode when lead bromide is electrolysed?
20) What is produced at the anode when lead bromide is electrolysed?
21) What is produced at the cathode is the metal in the solution is more reactive than hydrogen?
22) What is produced at the anode if the solution does not contain halide ions?
23) Why is electrolysis used to extract aluminium form its ore?
24) Why is electrolysis an expensive way to extract metal from its ore?
25) Name the compound from which aluminium is extracted.
26) What is this compound dissolved in before electrolysis?
27) What is the anode made of?
28) Describe what happens at the positive electrode during the electrolysis of aluminium oxide.

C4 Chemical changes ANSWERS

1) What is produced when metals react with oxygen? **Metal oxide.**
2) What is this process called and why? **Oxidation, gain of oxygen.**
3) What is reduction in terms of oxygen? **Loss of oxygen.**
4) Which is more reactive potassium or iron? **Potassium.**
5) Which two non-metals can be included in the reactivity series? **Carbon and hydrogen.**
6) How are metals, less reactive than carbon, extracted from their ores? **Reduction with carbon.**
7) What is produced when acids react with metals? **Salt + water.**
8) What is produced when an acid reacts with a carbonate? **Salt + water + carbon dioxide.**
9) What salt is produced by the following acids?
   a) Hydrochloric acid **Chloride**
   b) Sulfuric acid **Sulfate**
   c) Nitric acid **Nitrate**
10) How are soluble salts made from acids and insoluble substances? **Solid added to acid until no more reacts; excess solid filtered off.**
11) Name the process of producing solid salts from salt solution. **Crystallisation.**
12) Complete the following equations:
    a) sodium hydroxide + hydrochloric acid → **sodium chloride + water**
    b) lithium carbonate + nitric acid → **lithium nitrate + water + carbon dioxide**
13) What ions do aqueous acids contain? **H^+**
14) What ions do aqueous alkalis contain? **OH^-**
15) Write a balanced symbol equation for the reaction between hydrogen ions and hydroxide ions. **$H^+(aq) + OH^-(aq)$ → $H_2O(l)$**
16) Why can a molten or dissolved ionic compound conduct electricity? **Free moving ions.**
17) What is the name of the electrode that positive ions move to? **Cathode.**
18) What is the name of the electrode that the negative ions move to? **Anode.**
19) What is produced at the cathode when lead bromide is electrolysed? **Lead.**
20) What is produced at the anode when lead bromide is electrolysed? **Bromine.**
21) What is produced at the cathode is the metal in the solution is more reactive than hydrogen? **Hydrogen.**
22) What is produced at the anode if the solution does not contain halide ions? **Oxygen.**
23) Why is electrolysis used to extract aluminium form its ore? **Aluminium is more reactive than carbon.**
24) Why is electrolysis an expensive way to extract metal from its ore? **Large amounts of energy needed.**
25) Name the compound from which aluminium is extracted. **Aluminium oxide/ bauxite.**
26) What is this compound dissolved in before electrolysis? **Cryolite.**
27) What is the anode made of? **Carbon.**
28) Describe what happens at the positive electrode during the electrolysis of aluminium oxide. **Oxide ions give up their electrons to form oxygen atoms, these join together in pairs to form oxygen gas, the oxygen reacts with the carbon electrode to make carbon dioxide gas.**

Question 1

Sulfuric acid is a common solution that is used in the manufacture of fertilisers and salts.

a) Suggest a pH for sulfuric acid.

[1 mark]

-Any value between 1 and 6

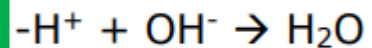**b)** Describe the general reaction by selecting the name of the reaction.
Tick **one** box only.

[1 mark]

✓

Neutralisation	✓
Exothermic	
Displacement	

c) Give an equation for the reaction between the ions produced from an aqueous acid (H^+) and the ions produced from an aqueous alkali (OH^-).
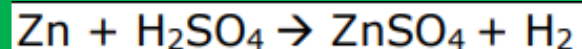
[2 marks]
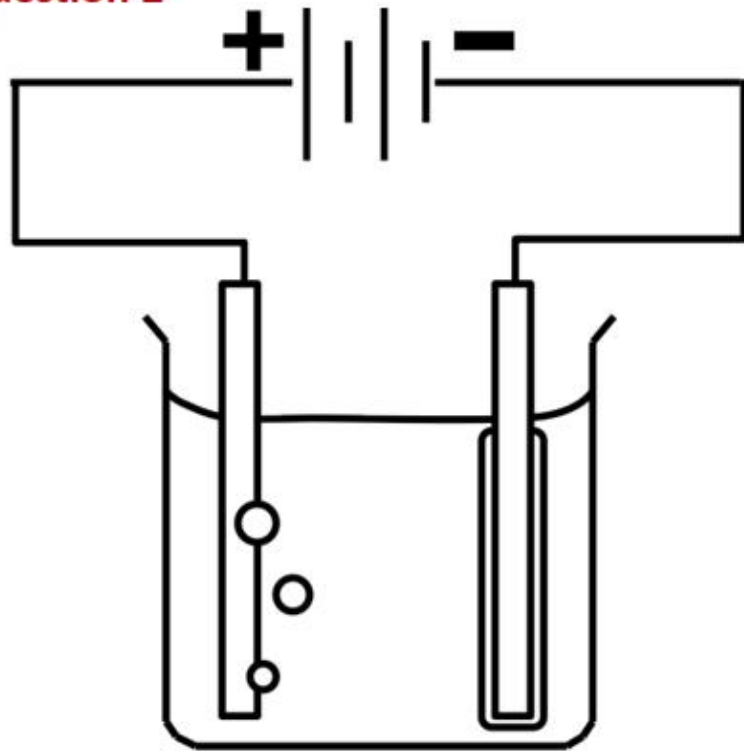
$-H^+ + OH^- \rightarrow H_2O$

d) Zinc metal (Zn) reacts with sulfuric acid (H_2SO_4) to give two products, zinc sulfate ($ZnSO_4$) and hydrogen gas (H_2).
Write the balanced chemical equation for this reaction.

[2 marks]

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

Question 2

a) A student carried out electrolysis of a solution of copper (II) chloride.

Give the expected products at each electrode:

i. At the negative electrode__ -Copper (metal) __ [1mark]

ii. At the positive electrode__ -Chlorine (gas) __ [1 mark]

b) One of the products was chlorine gas, state how you could determine the identity of this gas.

[1 mark]

-Bleaches **damp** litmus paper

c) State the role of the power pack in this experiment.

[1 mark]

-Flow of electrons/electricity

d) No bubbles of gas were seen.
Suggest a modification that would show the circuit had been set up correctly.

[1 mark]

-Addition of a bulb or voltmeter to check for flow of electricity

A student makes crystals of magnesium sulfate.

This is the method used.

1.   Add sulfuric acid to a beaker.

2.   Warm the sulfuric acid.

3.   Add a spatula of magnesium oxide to the beaker.

4.   Stir the mixture.

5.   Repeat steps 3 and 4 until there is magnesium oxide remaining in the beaker.

6.   Filter the mixture.

7.   Evaporate the filtrate gently until crystals start to form.

8.   Leave the solution to finish crystallising.

(d)   Give **one** reason for:
- step 2
- step 5
- step 6.

Step 2 _____

_____

Step 5 _____

_____

Step 6 _____

_____

(Step 2) to speed up the reaction

(Step 5) to make sure all the (hydrochloric) acid reacts

(Step 6) to remove the excess magnesium oxide

ignore to remove impurities

Question 4

This question is about acids and alkalis.

(a)   Which ion do all acids produce in aqueous solution?

Tick (✓) **one** box.

H^+ ✓

H^- ☐

O^{2-} ☐

OH^- ☐

(b)   Calcium hydroxide solution reacts with an acid to form calcium chloride.

Complete the word equation for the reaction.
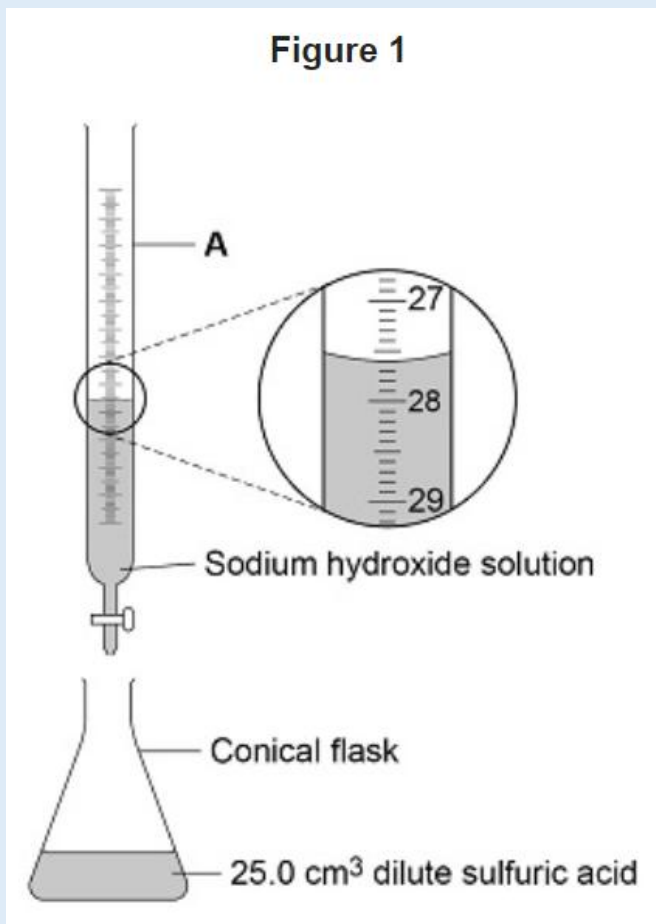
calcium hydroxide + _____ acid → calcium chloride + _____

(b)   hydrochloric (acid)
          allow HCl

      water
          allow H_2O

A student investigates the volume of sodium hydroxide solution that reacts with 25.0 cm^3 of dilute sulfuric acid.

Figure 1 shows the apparatus the student uses.

Figure 1

- A
- 27
- 28
- 29
- Sodium hydroxide solution
- Conical flask
- 25.0 cm^3 dilute sulfuric acid

Use **Figure 1** to answer parts (c) and (d).

(c)   Name apparatus **A**.

_____

(c)   burette

*do **not** accept biuret*

(1)

(d)   What is the reading on apparatus A?

(d)   27.6 (cm^3)

allow 27.60 (cm^3)

_____ cm^3

(1)

(e)   The higher the concentration of a sample of dilute sulfuric acid, the greater the volume of sodium hydroxide needed to neutralise the acid.

The student tested two samples of dilute sulfuric acid, **P** and **Q**.

Describe how the student could use titrations to find which sample, **P** or **Q**, is more concentrated.

Key steps
- measure the volume of acid
- add indicator to the acid
- add sodium hydroxide solution
- until the colour changes
- record volume of sodium hydroxide solution added
- repeat procedure with the other acid

Use of results
- compare the two volumes of sodium hydroxide solution to find which sample **P** or **Q** is more concentrated

Other points

- pipette to measure volume of acid
- use a few drops of indicator
- swirl
- use a white tile
- rough titration to find approximate end point
- add dropwise near the endpoint
- read volume from bottom of meniscus
- repeat and take a mean

Question 5

This question is about electrolysis.

A student investigated the hypothesis:

'The electrolysis of a salt solution produces a metal at the negative electrode and a gas at the positive electrode.'

(a)   What observation would be made at each electrode if the hypothesis is correct?

Observation if metal produced at the negative electrode

(a)   (negative electrode) solid produced

allow the electrode changes colour

ignore metal produced

(positive electrode) bubbles / fizzing / effervescence

ignore gas produced

(2)

The table below shows the student's results.

Salt solution	Product at the negative electrode	Product at the positive electrode
Copper chloride	Copper	Chlorine
Potassium nitrate	Hydrogen	Oxygen
Silver nitrate	Silver	Oxygen

(b)   Which salt solution in table above does **not** match the student's hypothesis?

Give **one** reason why.

(b)   potassium nitrate

hydrogen is not a metal

allow hydrogen is a gas
allow hydrogen is not a solid
allow the products at both electrodes are gases
allow the product at the negative electrode is not potassium
*allow potassium is more reactive than hydrogen*

(2)

GCSE Chemistry

ENERGY CHANGES

AQA (Trilogy) Topic C5

1) How would you know if an exothermic reaction had occurred?

2) How would you know if an endothermic reaction had occurred?

3) What is meant by the term activation energy?

4) On the reaction profile below what is shown by the letters?

      A
      B
      C
      D

5) What two things are needed for a chemical reaction to occur?

6) What is an exothermic reaction?

7) What is an endothermic reaction?

8) Give two factors which may affect the voltage given out by a battery.

9) Why do non-renewable batteries stop producing a voltage after a certain time?

10) How are rechargeable batteries recharged?

11) What chemical is the fuel in a fuel cell ?

12) What happens to this fuel inside the fuel cell to produce a potential difference?

13) Write the overall balanced symbol equation for the reaction in a fuel cell.

14) Write the half equation for the reaction that happens at the cathode in a fuel cell.

15) Write the half equation for the reaction that happens at the anode in a fuel cell.
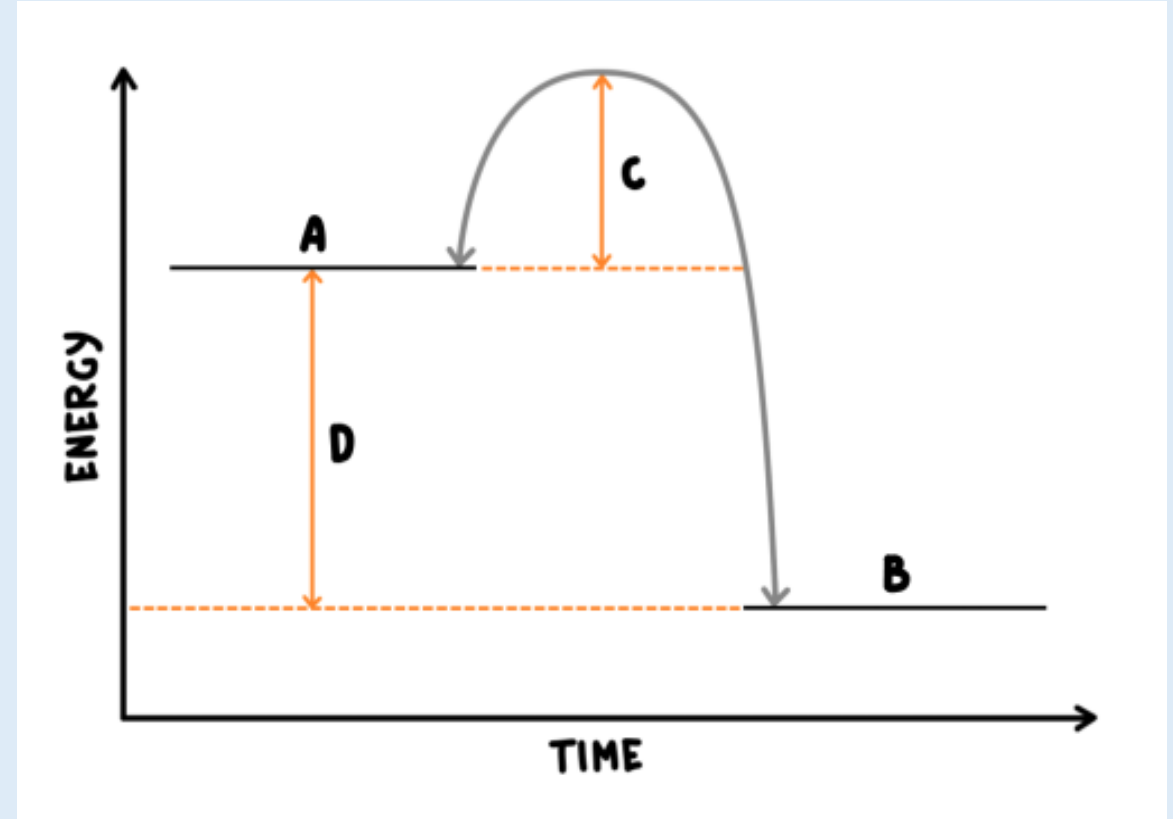
# C5 Energy changes ANSWERS

1) How would you know if an exothermic reaction had occurred? **The reaction would give out heat/get warmer/ temperature increase**.

2) How would you know if an endothermic reaction had occurred? **The reaction would take in heat/get colder/ temperature decrease**

3) What is meant by the term activation energy? **The minimum amount of energy that particles must have to react**.

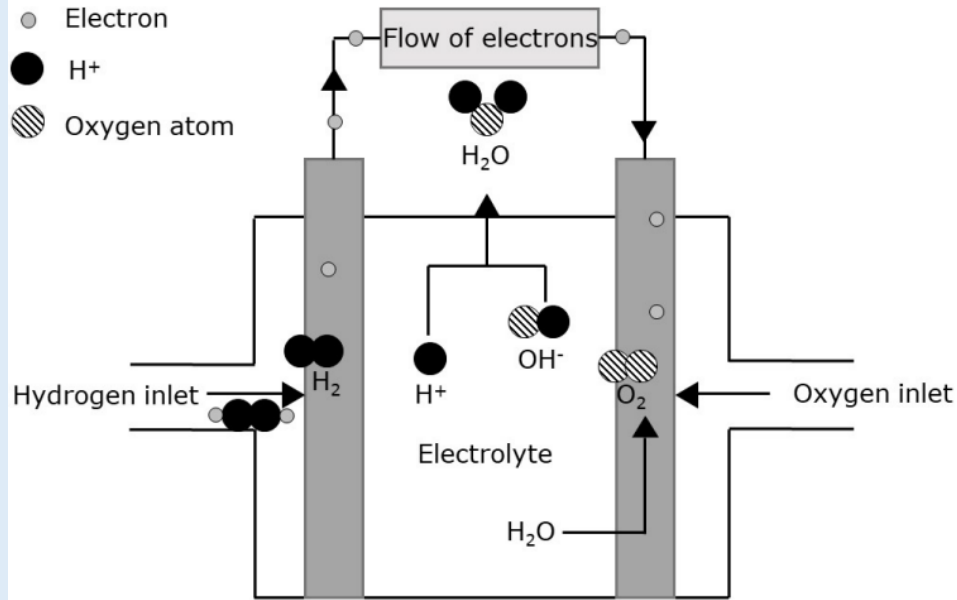4) On the reaction profile below what is shown by the letters?

   A   **Reactants**
   B   **Products**
   C   **Activation energy**
   D   **Overall energy change/that the reaction is exothermic**
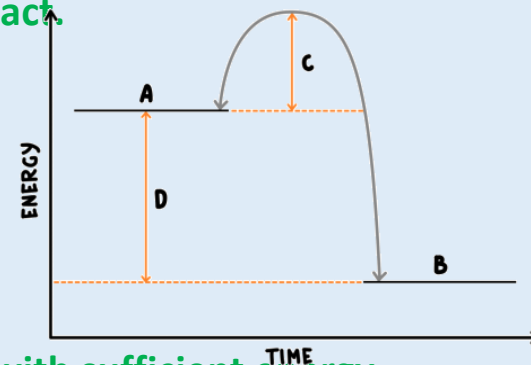
5) What two things are needed for a chemical reaction to occur? **Reacting particles collide with each other and with sufficient energy.**

6) What is an exothermic reaction? **Heat energy given out/energy lost to the surroundings**

7) What is an endothermic reaction? **Heat energy taken in/energy taken in from the surroundings**

8) Give two factors which may affect the voltage given out by a battery. **The type of electrode and the electrolyte**

9) Why do non-renewable batteries stop producing a voltage after a certain time? **The chemical reactions stop when one of the reactants has been used up**

10) How are rechargeable batteries recharged? **The chemical reactions are reversed by an external electrical current**

11) What chemical is the fuel in a fuel cell ? Hydrogen.

12) What happens to this fuel inside the fuel cell to produce a potential difference? It is oxidised electrochemically.

13) Write the overall balanced symbol equation for the reaction in a fuel cell. $2H_2 (g) + O_2 (g) \rightarrow 2H_2O (g)$

Question 1

Hydrogen-oxygen fuel cells are suggested as an alternative to rechargeable batteries.

○ Electron

● H+

◎ Oxygen atom

Flow of electrons

H₂O

Hydrogen inlet — H₂ H+

OH⁻

O₂ ← Oxygen inlet

Electrolyte

H₂O

a) The overall reaction occurring within a hydrogen oxygen fuel cell is shown below:

Hydrogen + Oxygen → Water

2H₂(g) + O₂(g) → 2H₂O(l)

Give the states of matter for each substance in the equation.

[2 marks]

b) Describe how a simple cell can be set up.

[2 marks]

c) Select one word to complete this sentence:

[1 mark]

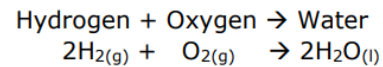Alkaline batteries are **rechargeable / non-rechargeable**.

d) Discuss the advantages of using rechargeable batteries.

[3 marks]

e) Use the information given in the question and your prior knowledge to evaluate the use of hydrogen-oxygen fuels cells.

[6 marks]

Question 2

The figure below shows a reaction profile for the reaction of magnesium with hydrochloric acid.
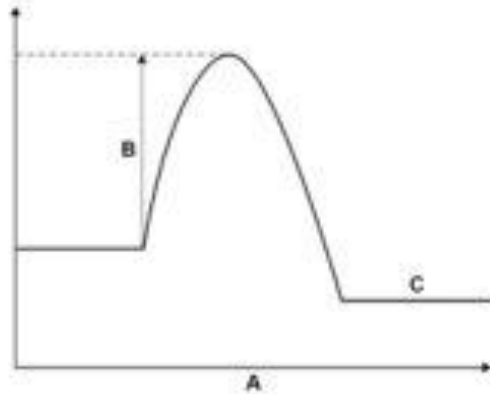
What do labels **A**, **B** and **C** represent on the figure above?

What do labels **A**, **B** and **C** represent on the figure above?

Choose answers from the box.

| activation energy	energy	overall energy change
products	progress of reaction	reactants

A _____

B _____

C _____

Question 3

f) A student wanted to look at the reaction between a strip of zinc metal and sulfuric acid. They set up the equipment as shown in the image below.

Method

1) Place a conical flask on a mass balance
2) Measure out 20cm³ of sulfuric acid and add it to the conical flask
3) Measure 2cm strip of zinc ribbon
4) Add the ribbon to the conical flask
5) Record the initial mass
6) Record the mass every 30 seconds
7) Repeat to obtain 3 sets of results
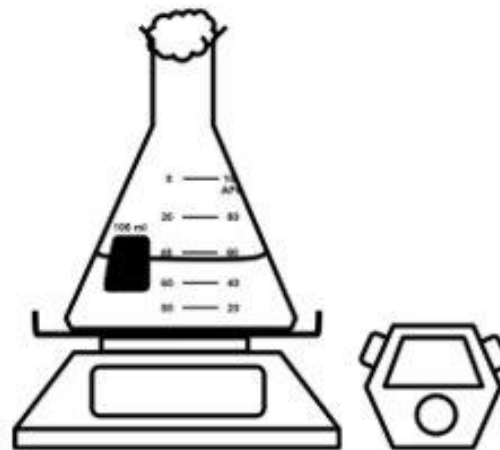
(3)

The student recorded this data in the table below:

Time (seconds)	Change in mass(g)			
	Test 1	Test 2	Test 3	Mean
0	0	0	0	0
30	15	19	20	18
60	25	27	29	27
90	29	45	31	
120	33	34	35	34

i. Calculate the mean value for change in mass at 90 seconds.

[2 marks]

_____
_____
_____

ii. Use the image to help you describe and explain the change in mass.

[2 marks]

_____
_____
_____
_____

iii. Identify a control variable, and how they measured it.

[2 marks]

_____
_____

iv. The table shows a loss of mass. Explain why this is not what the student measured.

[2 marks]

_____
_____
_____

Question 1

a) The overall reaction occurring within a hydrogen oxygen fuel cell is shown below:

Hydrogen + Oxygen → Water
$2H_{2(g)}$ + $O_{2(g)}$ → $2H_2O_{(l)}$
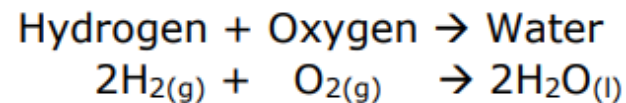
Give the states of matter for each substance in the equation.

[2 marks]

-hydrogen and oxygen are gases
-water is a liquid

b) Describe how a simple cell can be set up.

[2 marks]

-two different metals (electrodes)
-electrolyte

c) Select one word to complete this sentence:

[1 mark]

Alkaline batteries are **rechargeable** / **non-rechargeable**.

d) Discuss the advantages of using rechargeable batteries.

[3 marks]

-less sent to landfill
-less chemicals used
-better for environment
-can be reused
-less energy used
-cheaper

e) Use the information given in the question and your prior knowledge to evaluate the use of hydrogen-oxygen fuels cells.

[6 marks]

Points for;

-water is the only waste product
-no combustion products
-reaction happens at a lower temperature
-small and light
-no moving parts

Points against.

-water is a greenhouse gas
-high manufacture cost
-hydrogen is a very flammable gas
-hydrogen is difficult to store
-expensive to manufacture

c) Select one word to complete this sentence:

[1 mark]

Alkaline batteries are **rechargeable / non-rechargeable**.

d) Discuss the advantages of using rechargeable batteries.

[3 marks]

-less sent to landfill
-less chemicals used
-better for environment
-can be reused
-less energy used
-cheaper

e) Use the information given in the question and your prior knowledge to evaluate the use of hydrogen-oxygen fuels cells.

[6 marks]

Points for;

-water is the only waste product
-no combustion products
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-small and light
-no moving parts

Points against.

-water is a greenhouse gas
-high manufacture cost
-hydrogen is a very flammable gas
-hydrogen is difficult to store
-expensive to manufacture

Question 2

The figure below shows a reaction profile for the reaction of magnesium with hydrochloric acid.
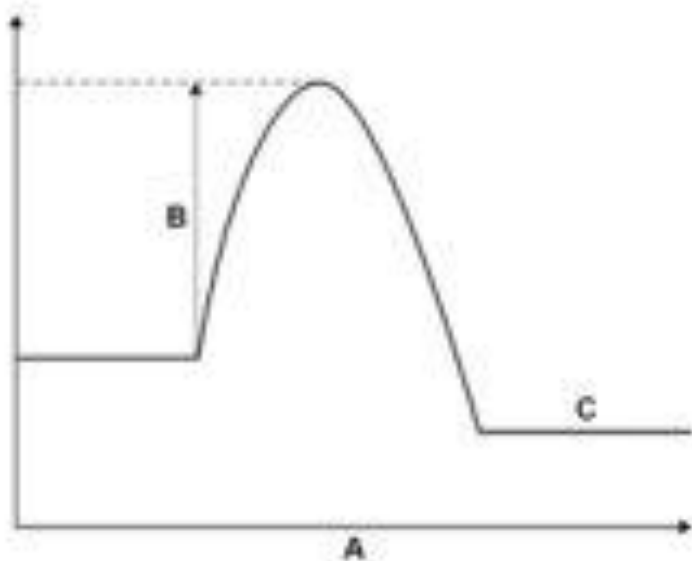
What do labels **A**, **B** and **C** represent on the figure above?

What do labels **A**, **B** and **C** represent on the figure above?

Choose answers from the box.

activation energy	energy	overall energy change
products	progress of reaction	reactants

A ___Progress of reaction___

B ___Activation energy___

C ___Products___

(3)

f) A student wanted to look at the reaction between a strip of zinc metal and sulfuric acid. They set up the equipment as shown in the image below.

Method

1) Place a conical flask on a mass balance
2) Measure out 20cm³ of sulfuric acid and add it to the conical ~~flask~~
3) Measure 2cm strip of zinc ribbon
4) Add the ribbon to the conical flask
5) Record the initial mass
6) Record the mass every 30 seconds
7) Repeat to obtain 3 sets of results

-constant volume of acid
-measuring cylinder

OR

-Constant width of ribbon
-ruler

OR

-constant time
-Stop watch

The student recorded this data in the table below:

Time (seconds)	Change in mass(g)			
	Test 1	Test 2	Test 3	Mean
0	0	0	0	0
30	15	19	20	18
60	25	27	29	27
90	29	45	31	
120	33	34	35	34

i. Calculate the mean value for change in mass at 90 seconds.

[2 marks]

(29+ 31)/2
=30

~~the~~ image to help you describe and explain the change in

[2 marks]

-decreased
-gas was lost

~~b~~y a control variable, and how they measured it.

[2 marks]

~~tab~~le shows a loss of mass. Explain why this is not what the student measured.

[2 marks]

-mass was measured
-change in mass is calculated
-change in mass would not be shown on balance