WORKBOOK

Online Chem Tuition

Using Resources

TOPIC TEN

12TH APRIL

HELLO!

Welcome to your AQA GCSE Chemistry revision session. This workbook is designed to be straightforward and directly aligned with what I'll cover in the live lesson, it offers a practical way to apply your knowledge as you learn.

What's in the Workbook:

- **Questions**: These are selected to match the lesson topic, providing you with a chance to practice and solidify your understanding.
- **Symbols Guide**:
  HT - Indicates advanced content aimed at **Higher Tier** students.

  - Signifies material for **GCSE Chemistry** students only.

Using the Workbook During Lesson:

- **Stay Engaged**: Be ready to participate and use the workbook alongside the lesson. You can use the chat to ask questions or get help.
- **Peer Learning**: Take advantage of the group setting. Your classmates' questions can provide additional insights.

Zoom Lesson:

Make sure you have your workbook and a pen ready and join us here.

See you on Zoom!

ALISON GREEN

Online Chem Tuition

USING EARTH'S RESOURCES

SUSTAINABLE DEVELOPMENT

Humans use the Earth's resources to provide warmth, shelter, food and transport. Natural resources, supplemented by agriculture, provide food, timber, clothing and fuels. Finite resources from the Earth, oceans and atmosphere are processed to provide energy and materials.

Chemistry plays an important role in improving agricultural and industrial processes to provide new products and in sustainable development, which is development that **meets the needs of current generations** without compromising the **ability of future generations to meet their own need**s.

POTABLE WATER

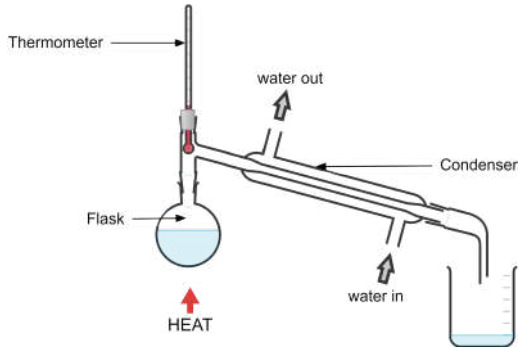
Water of appropriate quality is essential for life. For humans, drinking water should have sufficiently low levels of dissolved salts and microbes. **Water that is safe to drink** is called **potable water**. Potable water is not pure water in the chemical sense because it **contains dissolved substances**. The methods used to produce potable water depend on available supplies of water and local conditions.

In the UK, rain provides water with low levels of dissolved substances (fresh water) that collects in the ground and in lakes and rivers, and most potable water is produced by:

- choosing an appropriate source of fresh water
- passing the water through filter beds to remove any solids
- sterilising to kill microbes with chlorine, ozone or ultra-violet light.

TURNING SEA WATER INTO DRINKING WATER

If supplies of fresh water are limited, desalination of salty water or sea water may be required. Desalination can be done by distillation or by processes that use membranes such as reverse osmosis. These processes require large amounts of energy.



ANALYSIS AND PURIFICATION OF WATER - REQUIRED PRACTICAL 8

Can measure the pH and dissolved solids in water samples using the methods below

pH

Can use a pH meter (needs to be calibrated first, or can estimate pH using universal indicator. and matching colour to pH using a colour chart.

Mass of dissolved solids

1. weigh container.
2. measure volume (100 cm3) of water using a measuring cylinder
3. pour water into container.
4. heat and evaporate water until dry.
5. weigh container and remaining solids.
6. determine mass of dissolved solids

WASTE WATER TREATMENT

Urban lifestyles and industrial processes produce large amounts of waste water that require treatment before being released into the environment. **Sewage and agricultural waste** water require removal of **organic matter** and **harmful microbes**. **Industrial waste** water may require removal of **organic matter** and **harmful chemicals**.

SEWAGE TREATMENT

Sewage treatment includes the following stages:
1. screening and grit removal
2. sedimentation to produce sewage sludge and effluent
3. **anaerobic digestion** of sewage **sludge**
4. **aerobic** biological treatment of **effluent**

HT ALTERNATE METHODS OF EXTRACTING METALS

The Earth's resources of metal ores are limited. Copper ores are becoming scarce and new ways of extracting copper from low-grade ores include phytomining, and bioleaching. These methods avoid traditional mining methods of digging, moving and disposing of large amounts of rock.

PHYTOMINING

Uses plants to absorb metal compounds. The plants are harvested and then burned to produce ash that contains metal compounds.

BIOLEACHING

Bioleaching uses bacteria to produce leachate solutions that contain metal compounds.

The metal compounds can be processed to obtain the metal. For example, copper can be obtained from solutions of copper compounds by displacement using scrap iron or by electrolysis.

ADVANTAGES

- need less energy than traditional methods
- can extract from low grade/ concentration ores
- mining not required
- avoid the disadvantages of traditional mining methods of digging, moving and disposing of large amounts of rock.

DISADVANTAGES

- Reactions slow to carry out.
- Land not available
- Will produce small amounts of metal

Q1.a) Carpets are made from:

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

Poly(propene) wears out more slowly than wool. A mixture of poly(propene) and wool to make carpets is more sustainable than using just poly(propene) or just wool. Suggest why.

[2 marks]

AQA June 18 H Q6.3

Polymer fibres are used to make firefighter uniforms. The table shows some properties of two polymer fibres.

	Polymer fibres	
Property	**Poly(propene)**	**Polyester**
Density in g/cm^3	0.90	1.38
Melting point in °C	165	260
Flame resistance	Poor	Good
Water absorption	Low	High

Q1.b) Evaluate the suitability of poly(propene) and polyester for firefighter uniforms.

[4 marks]

AQA June 18 H Q6.4

Q2. Plan an investigation to find the total mass of dissolved solids in a 100 cm^3 sample of the drinking water. Your investigation should produce valid results.

[4 marks]

AQA June 19 H Q7.3

Q3.a) In the UK, potable (drinking) water is produced from different sources of fresh water. Explain how potable water is produced from fresh water.

[4 marks]

AQA June 20 H Q2.1

Q3.b) A different country has:

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

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

[1 mark]

AQA June 20 H Q2.2

Q3.c) Waste water is not fit to drink. Treatment of waste water produces two substances:

- liquid effluent
- solid sewage sludge.

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

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

[2 marks]

AQA June 20 H Q2.3

Q4. Copper is extracted from low-grade ores by phytomining.
Describe how copper is extracted from low-grade ores by phytomining

[4 marks]

AQA June 21 H Q8.4

LIFE CYCLE ASSESSMENT AND RECYCLING

LIFE CYCLE ASSESSMENT

Life cycle assessments (LCAs) are carried out to assess the environmental impact of products in each of these stages:

- extracting and processing raw materials
- manufacturing and packaging
- use and operation during its lifetime
- disposal at the end of its useful life, including transport and distribution at each stage.

Use of water, resources, energy sources and production of some wastes can be fairly easily quantified. Allocating numerical values to pollutant effects is less straightforward and requires value judgements, so LCA is not a purely objective process.

Selective or abbreviated LCAs can be devised to evaluate a product but these can be misused to reach pre-determined conclusions, eg in support of claims for advertising purposes.

WAYS OF REDUCING THE USE OF RESOURCES

The reduction in use, reuse and recycling of materials by end users reduces the use of limited resources, energy consumption, waste and environmental impacts. Metals, glass, building materials, clay ceramics and most plastics are produced from limited raw materials. Much of the energy used in the processes comes from limited resources. Obtaining raw materials from the Earth by quarrying and mining causes environmental impacts.

REUSING OR RECYCLING?

Some products, such as glass bottles, can be reused. Other products cannot be reused and so are recycled for a different use. Glass bottles can be crushed and melted to make different glass products. Metals can be recycled by melting and recasting or reforming into different products. The amount of separation required for recycling depends on the material and the properties required of the final product. For example, some scrap steel can be added to iron from a blast furnace to reduce the amount of iron that needs to be extracted from iron ore.

ADVANTAGES OF RECYCLING

- less acid rain (pollution)
- metal ore reserves last longer / conserved
- energy for extraction saved
- less mining / quarrying
- less waste □ less landfill
- creates local employment

DISADVANTAGES OF RECYCLING

- collection problems
- transport problems/ cost of transport
- difficult to separate metal from appliances/sort

Disposable cups are made from coated paper or poly(styrene). The table shows information on the life cycle assessments (LCAs) of disposable cups.

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

Q5. Evaluate the use of coated paper compared with poly(styrene) to make disposable cups. Use the table and your knowledge and understanding of LCAs

[6 marks]

AQA June 18 H Q10.1

Food plates are made from paper, polymers or ceramics. The table shows information about plates of the same diameter made from each of these materials.

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

Q6.a) The table does not show information about energy usage. Suggest two pieces of information about energy usage which would help to produce a complete life cycle assessment (LCA) for the three food plate materials.

[2 marks]

AQA June 20 H Q5.1

Q6.b) Evaluate the use of these materials for making food plates. You should use features of life cycle assessments (LCAs). Use the table.

[4 marks]

AQA June 20 H Q5.2

Q6.c) Describe how ceramic food plates are produced from clay

[2 marks]

AQA June 20 H Q5.3

Q7.a) Copper can be obtained by recycling scrap copper wire. Suggest why poly(butene) insulation must be removed from scrap copper wire before the copper is recycled.

[1 mark]

AQA June 22 H Q1.2

Q7.b) Describe how scrap copper wire can be recycled to make new copper water pipes.

[2 marks]

AQA June 22 H Q1.3

Q7.c) Suggest two reasons why recycling scrap copper is more sustainable than extracting copper from copper ores.

[2 marks]

AQA June 22 H Q1.4

Q8. Milk bottles can be made from glass or from a polymer. The table shows information about milk bottles of equal volume.

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

Evaluate the use of glass for milk bottles compared with the use of a polymer for milk bottles. Use features of life cycle assessments (LCAs) in your answer. Use the table.

[6 marks]

AQA June 22 H Q3.1

USING MATERIALS

CORROSION AND ITS PREVENTION

Corrosion is the destruction of materials by chemical reactions with substances in the environment. Rusting is an example of corrosion. Both air and water are necessary for iron to rust.

Corrosion can be prevented by applying a coating that acts as a barrier, such as greasing, painting or electroplating. Aluminium has an oxide coating that protects the metal from further corrosion. Some coatings are reactive and contain a more reactive metal to provide sacrificial protection, eg zinc is used to galvanise iron.

ALLOYS AS USEFUL MATERIALS

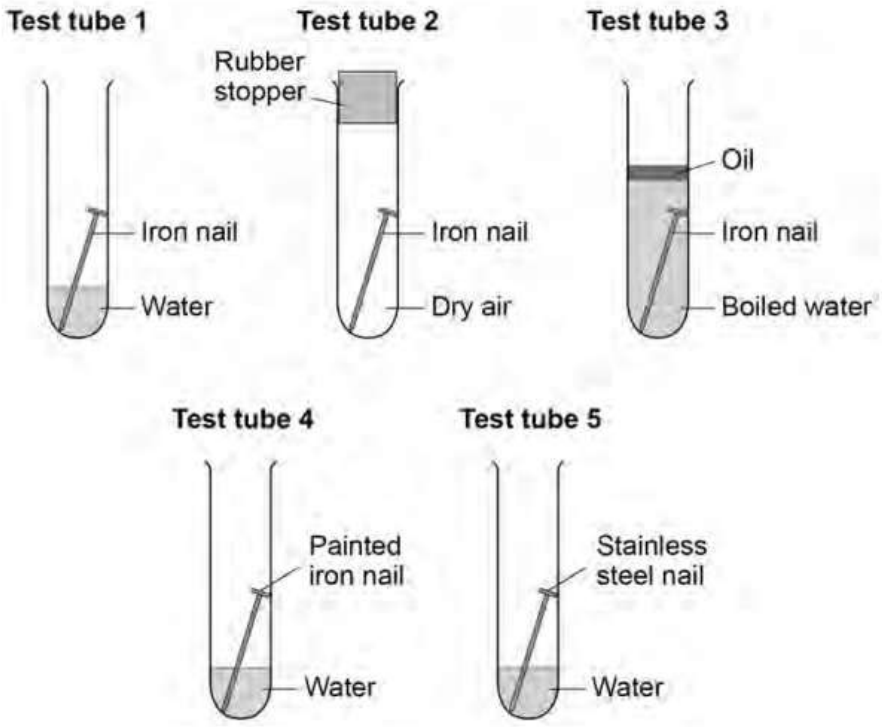
Most metals in everyday use are alloys. Bronze is an alloy of copper and tin. Brass is an alloy of copper and zinc. Gold used as jewellery is usually an alloy with silver, copper and zinc. The proportion of gold in the alloy is measured in carats. 24 carat being 100% (pure gold), and 18 carat being 75% gold.
Steels are alloys of iron that contain specific amounts of carbon and other metals. High carbon steel is strong but brittle. Low carbon steel is softer and more easily shaped. Steels containing chromium and nickel (stainless steels) are hard and resistant to corrosion. Aluminium alloys are low density.

CERAMICS, POLYMERS AND COMPOSITES

Most of the glass we use is soda-lime glass, made by heating a mixture of sand, sodium carbonate and limestone. Borosilicate glass, made from sand and boron trioxide, melts at higher temperatures than soda-lime glass. Clay ceramics, including pottery and bricks, are made by shaping wet clay and then heating in a furnace.

The properties of polymers depend on what monomers they are made from and the conditions under which they are made. For example, low density (LD) and high density (HD) poly(ethene) are produced from ethene. Thermosoftening polymers melt when they are heated.
Thermosetting polymers do not melt when they are heated.

Q9.a) The corrosion of iron is called rusting.
A student investigated the rusting of iron. This is the method used.
1. Set up the test tubes as shown in diagram.
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 marks]

AQA June 19 H Q4.1

Q9.b) Magnesium is fixed to some steel ships. Explain how this prevents the steel from rusting.

[2 marks]

AQA June 19 H Q4.2

Q9.c) Explain why aluminium window frames do not corrode after they are made.

[2 marks]

AQA June 19 H Q4.3

Q10. a) The outer skin of surfboards is a composite material. The composite material contains glass fibres surrounded by a polyester. 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 marks]

AQA June 19 H Q6.4

Q10.b) The outer skin makes the surfboard more expensive. Suggest two reasons why an outer skin is added to the poly(styrene) core

[2 marks]

AQA June 19 H Q6.6

Q11. Melamine is a polymer used to make non-disposable cups. Melamine does not melt when it is heated. Explain why.

[2 marks]

AQA June 18 H Q10.3

Q12. Why do some types of polyester melt when it is heated?

[2 marks]

AQA June 19 H Q6.4

Q13. Poly(ethene) is a thermosoftening polymer. Suggest why poly(ethene) is easier to recycle than thermosetting polymers.

[2 marks]

AQA June 21 H Q4.2

Q14.a) Ethene produces different forms of poly(ethene). How can different forms of poly(ethene) be produced from ethene?

[1 mark]

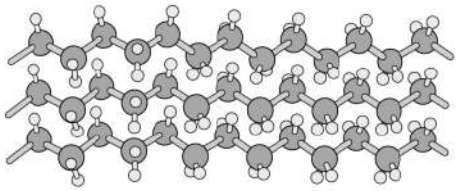
AQA June 21 H Q4.3

Q14.b) Two different forms of poly(ethene) are:

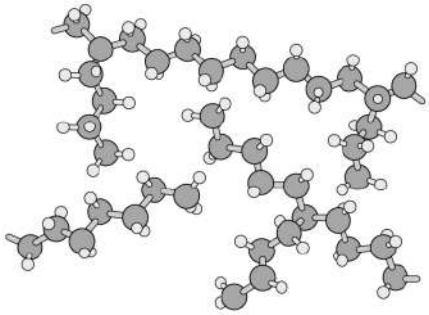
- high density poly(ethene) (HDPE)
- low density poly(ethene) (LDPE).

The diagrams below represents part of the structures of HDPE and LDPE

HDPE



LDPE



Explain why HDPE has a higher density than LDPE.

[2 marks]

AQA June 21 H Q4.4

Solders are alloys used to join metals together. Some solders contain copper. The table shows information about three solders, A, B and C.

Solder	Melting point in °C	Metals in solder
A	183	tin, copper, lead
B	228	tin, copper, silver
C	217	tin, copper, silver

Q15.a) Solder B and solder C are now used more frequently than solder A for health reasons. Suggest one reason why. Use the table.

[1 mark]

AQA June 21 H Q8.1

Q15.b) Suggest one reason why solders B and C have different melting points. Use the table.

[1 mark]

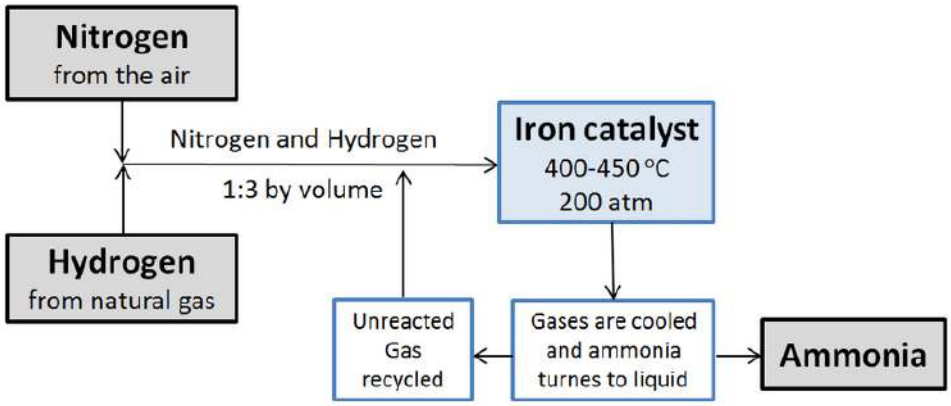
AQA June 21 H Q8.2

THE HABER PROCESS

THE HABER PROCESS

The Haber process is used to manufacture ammonia, which can be used to produce nitrogen-based fertilisers. The raw materials for the Haber process are nitrogen and hydrogen.

The reaction is reversible so some of the ammonia produced breaks down into nitrogen and hydrogen:
nitrogen + hydrogen → ammonia
On cooling, the ammonia liquefies and is removed. The remaining hydrogen and nitrogen are recycled.



For the Haber process ·

- An optimum temperature of 450°C is used. **Using a lower temperature would give a higher yield but the rate would be too slow.**
- A pressure of 200atm is used. **Using a higher pressure would give a higher yield but would be too expensive because the cost of energy to produce the pressure would be high**.
- The catalyst speeds up the rate of reaction and saves money by allowing a lower temperature to be used.
- The recycling of gases saves money because no raw materials are wasted.

PRODUCTION AND USES OF NPK FERTILISERS

Compounds of nitrogen, phosphorus and potassium are used as fertilisers to improve agricultural productivity. NPK fertilisers contain compounds of all three elements.

Industrial production of NPK fertilisers can be achieved using a variety of raw materials in several integrated processes. NPK fertilisers are formulations of various salts containing appropriate
percentages of the elements.

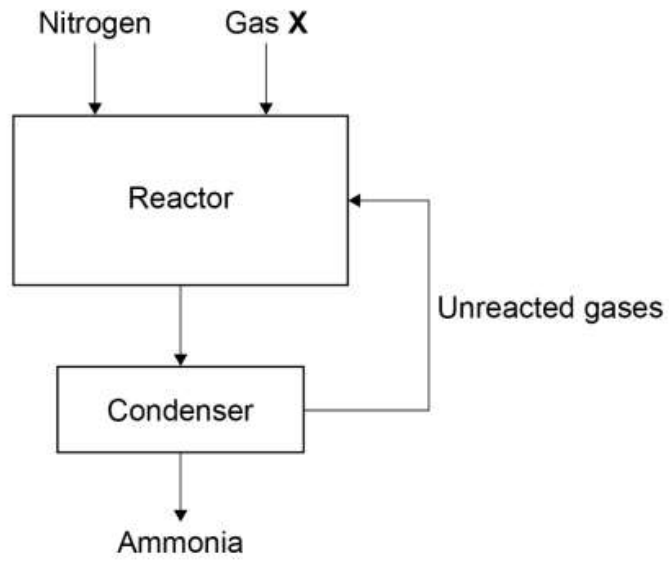
Ammonia can be used to manufacture ammonium salts and nitric acid.
$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$
Ammonia + sulfuric acid → ammonium sulfate
$NH_3 + HNO_3 \rightarrow NH_4NO_3$
Ammonia + nitric acid → ammonium nitrate

Potassium chloride, potassium sulfate and phosphate rock are obtained by **mining**, but phosphate rock cannot be used directly as a fertiliser because it is insoluble in water.

- Phosphate rock is treated with nitric acid or sulfuric acid to produce soluble salts that can be used as fertilisers.
- Phosphate rock is reacted with nitric acid to produce phosphoric acid and **calcium nitrate**.
- Phosphate rock can be reacted with sulfuric acid to produce **single superphosphate** which is a mixture of calcium phosphate and calcium sulfate
- Phosphate rock can be reacted with phosphoric acid to produce **triple superphosphate** which is calcium phosphate.

THE HABER PROCESS

The diagram below shows how nitrogen is used in the Haber Process to produce ammonia.



Q16.a) Gas X in the diagram is obtained from methane. Name gas X.

[1 mark]

AQA June 18 H Q3.1

Q16.b) Give the approximate temperature and pressure used in the reactor.

[2 marks]

AQA June 18 H Q3.2

Q16.c) The mixture of gases from the reactor cools in the condenser. Suggest why ammonia condenses but the other gases do not.

[1 mark]

AQA June 18 H Q3.3

Q17. World production of ammonia is now about 30 times greater than it was in 1950. Suggest why the demand for ammonia has increased.

[2 marks]

AQA June 19 H Q10.7

Q18.a) Some fertilisers are described as NPK fertilisers because they contain three elements needed for healthy plant growth.

Ammonium nitrate	☐
Ammonium phosphate	☐
Calcium chloride	☐
Calcium phosphate	☐
Potassium chloride	☐
Potassium nitrate	☐

[2 marks]

AQA June 21 H Q5.1

Q18.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.

[2 marks]

AQA June 21 H Q5.2

Q18.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 marks]

AQA June 21 H Q5.3