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GCSE (9–1) Chemistry B (Twenty First Century Science) F

J258/01 Breadth in chemistry (Foundation Tier)

Sample Question Paper

Date – Morning/Afternoon

Version 2

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet

You may use:
- a scientific or graphical calculator

First name									
Last name									
Centre number						Candidate number				

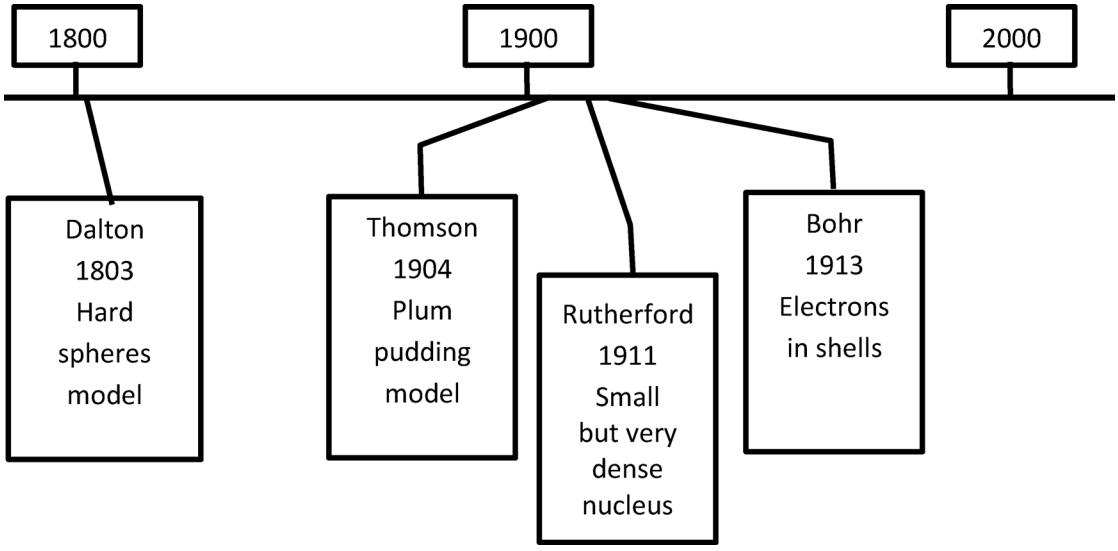
INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **24** pages.

Answer **all** the questions.

1 The models scientists use to describe atoms have changed over the last 200 years.

This timeline shows some of the main ideas.



(a) Which scientist's model could be represented by a ball?

Put a (ring) around the correct answer.

Bohr **Dalton** **Rutherford** **Thomson** **[1]**

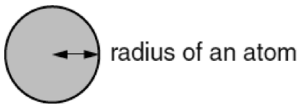
(b) Which scientist's model could be represented by this diagram?

Put a (ring) around the correct answer.

Bohr **Dalton** **Rutherford** **Thomson** **[1]**

2 Jack does some research about Group 1 elements of the Periodic Table.

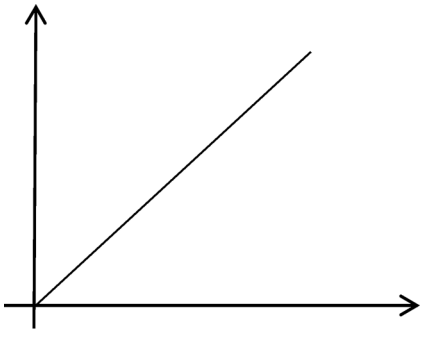
(a) He finds out the radius of the atoms of the first three elements in the group.

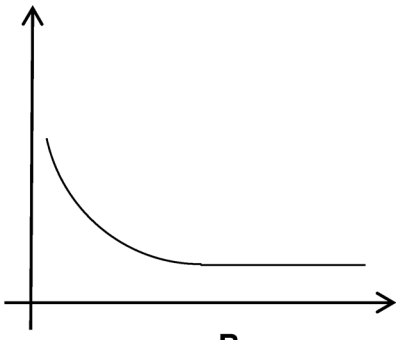


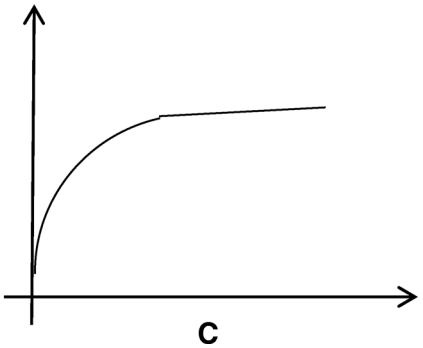
Element	Total number of electrons in each atom	Radius of atom (pm)
lithium	3	152
sodium	11	186
potassium	19	231

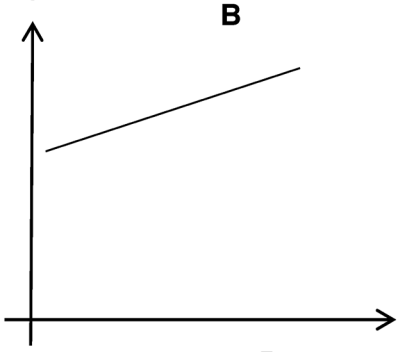
Which sketch graph, **A, B, C** or **D,** is the best representation of the trend shown by the data?

Explain how you used the data to make your choice.









Graph .....

Explanation .....

.....

.....

..... **[3]**

(b) Jack finds out the electron arrangement for the atoms of these elements.

Element	Electron arrangement
lithium	2.1
sodium	2.8.1
potassium	2.8.8.1

Describe the similarities and differences between the electron arrangement in the atoms of these elements.

.....

.....

.....

..... **[3]**

(c) Jack uses the Periodic Table to make a prediction about the order of reactivity of the three elements.

Which order of reactivity for the three elements is correct?

Put a tick (✓) in the box next to the correct answer.

lithium > sodium > potassium ☐

lithium < potassium < sodium ☐

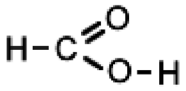
potassium > sodium > lithium ☐

lithium < sodium > potassium ☐ **[1]**

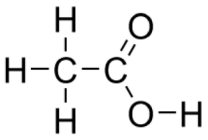
3 Some people have warts on their skin.

Warts can be removed by treating them with a corrosive solution of acids.

Two of the acids in the medicine are from the same family of compounds (homologous series).



methanoic acid



ethanoic acid

(a) The molecular formula of methanoic acid is CH_2O_2.

What is the molecular formula of ethanoic acid?

..... **[2]**

(b) How do the structures of the acids show that they belong to the same homologous series?

Put a tick (✓) in the box next to the correct answer.

Both are hydrocarbons. ☐

Both contain a double bond. ☐

Both contain carbon atoms. ☐

Both contain the same functional group. ☐ **[1]**

(c) Strong acids are **not** used in the medicine.

Methanoic acid and ethanoic acid are weak acids.

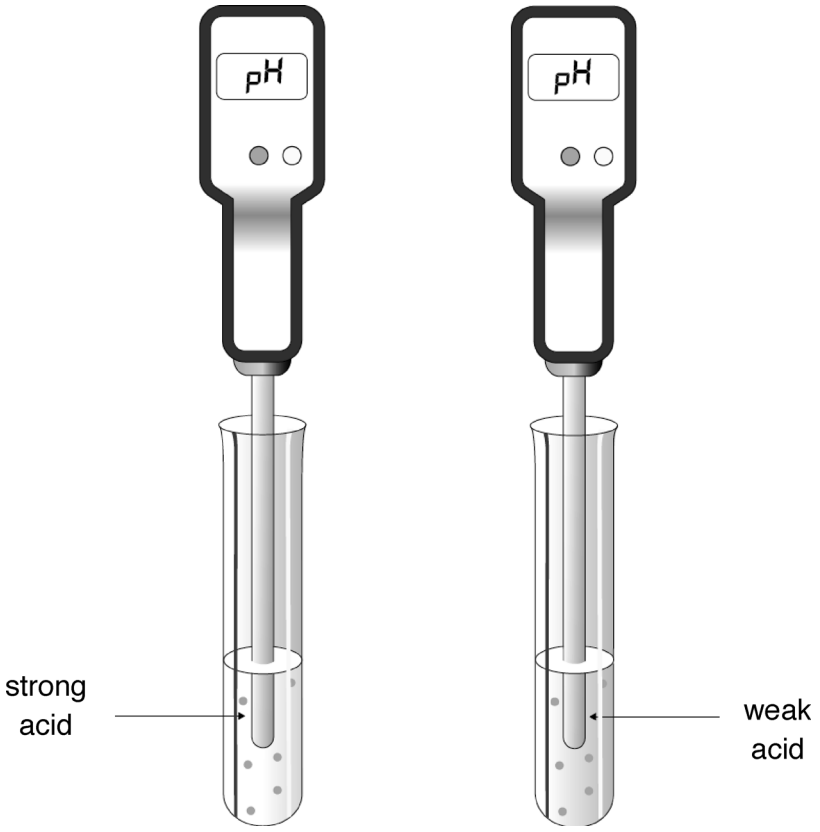
(i) What is the formula for a hydrogen ion?

Put a (ring) around the correct answer.

H_2 **H^-** **OH^-** **HCl** **H^+** **[1]**

(ii) Strong acids are more acidic than weak acids.

One way of telling the difference between a strong and a weak acid is testing the pH with a pH meter.



What results would you expect the pH meter to give for each acid?

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.....

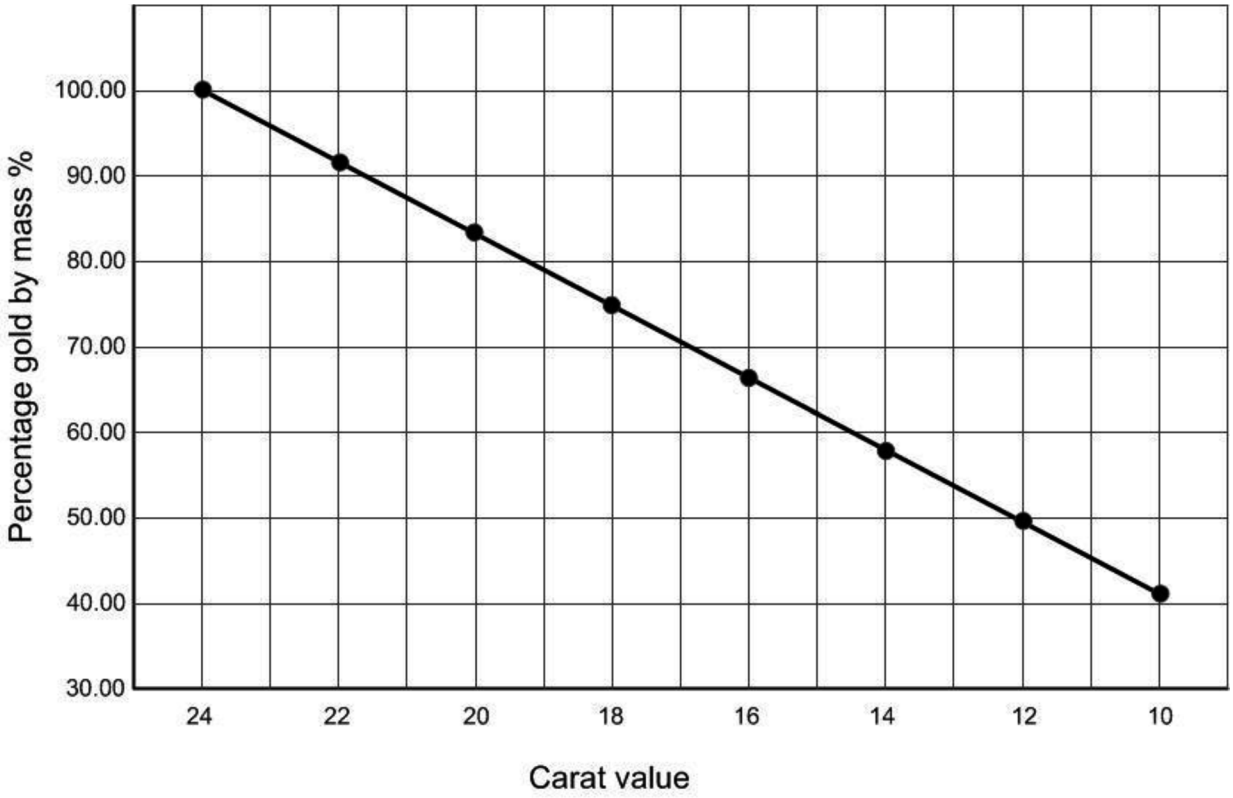
..... **[2]**

4 The purity of gold is measured in carats.

24 carat gold is almost pure gold.

Gold with lower carat values contains other metals.

The graph shows how the percentage of gold by mass is related to its carat value.



(a) A 2.5 g sample of gold contains 1.9 g of gold.

(i) What percentage of gold does the sample contain?

Show your working.

Percentage of gold = ... **[2]**

(ii) What is the sample's carat value?

Use your answer to part **(i)** and the graph to help you answer.

Carat value = ... **[1]**

(b) 22 carat gold is an alloy which contains approximately 92% gold atoms.

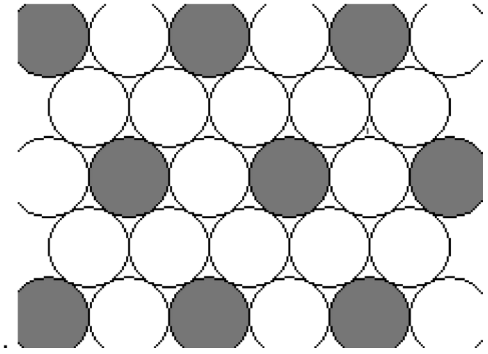
The other 8% contains silver atoms and copper atoms.

Mia finds this diagram of the atoms in an alloy on the internet.

Key

= element 1

= element 2



Explain why this diagram does **not** fit the arrangement of atoms in 22 carat gold.

Include a calculation in your answer.

.....

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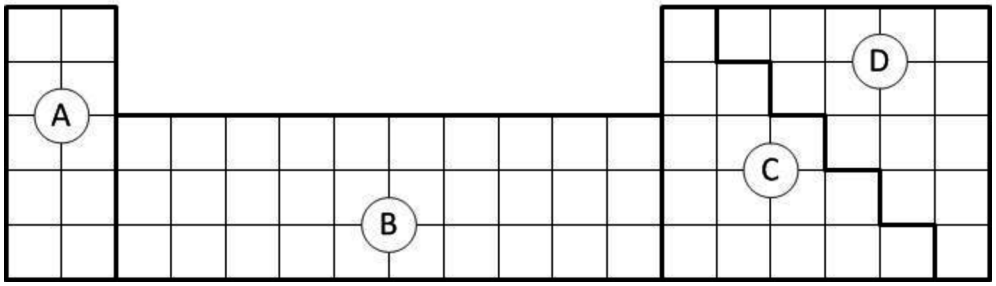
..... **[2]**

(c) Gold is a transition metal.

Which part of the Periodic Table, **A**, **B**, **C** or **D**, contains transition metals?

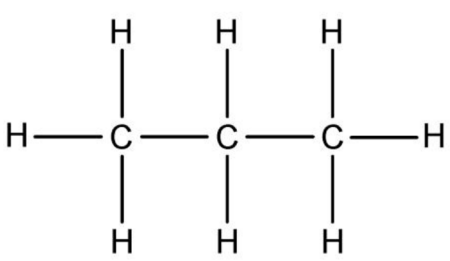


Answer ..... **[1]**

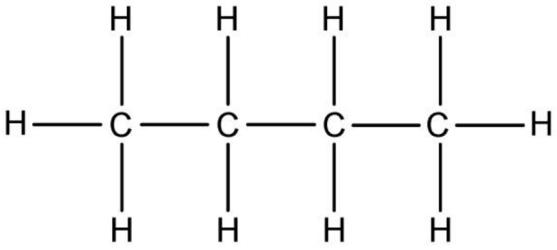
5 Crude oil is divided into fractions to make useful products.

One of the fractions in crude oil is LPG.

LPG contains propane and butane.



propane



butane

(a) What is the molecular formula of butane?

Answer ..... **[1]**

(b) Look at the displayed formulae of butane and propane.

Propane and butane are **hydrocarbons**.

They are also **alkanes**.

Explain why propane and butane are both hydrocarbons and alkanes.

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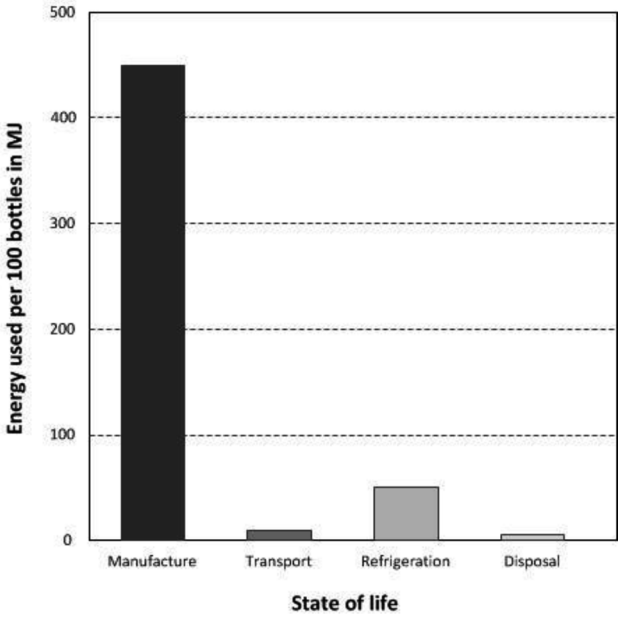
..... **[3]**

6 Disposable drink bottles are made from a polymer called PET.

This chart shows the energy used in millions of joules (MJ) for 100 PET bottles during their lifetime.



(a) Which statements about the chart are true and which are false?

Put a tick (✓) in the correct column for each statement.

	True (✓)	False (✓)
Five times as much energy is used for refrigeration as disposal.		
The energy of manufacture is more than 10 times greater than for transport.		
Refrigeration uses less than 15% of the energy used for manufacture.		

[3]

(b) One way of using waste PET bottles is to burn them as fuel.

Burning 100 bottles gives out 120 MJ of energy.

Does this provide enough energy to manufacture 100 new PET bottles?

Use data from the graph to support your answer.

.....

.....

..... **[2]**

7 100 years ago, Fritz Haber was the first scientist to successfully react nitrogen gas from the air with hydrogen to make a compound.

(a) Haber made sure his reaction was in a closed system, with no leaks.

What would happen to the yield if there were leaks in the system?

Explain your answer.

.....

.....

..... **[2]**

(b) A student repeats Haber's experiment.

He works out the theoretical yield for making some ammonia.

(i) 14.0 g of nitrogen was reacted with excess hydrogen to produce ammonia. Here is the equation for the reaction.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Calculate the theoretical yield of ammonia.

- Relative formula mass of N_2 = 28.0
- Relative formula mass of NH_3 = 17.0

Theoretical yield = ... g **[3]**

(ii) He separates the ammonia at the end of the reaction and measures its mass.

The table shows his results.

Mass of container and ammonia at the end (g)	59.5
Mass of container (g)	51.0
Mass of ammonia (g)	8.5

Calculate the **percentage yield** of ammonia.

Percentage yield ..... % **[2]**

(c) The reaction is very slow.

Haber used a catalyst to speed up the rate of reaction.

(i) Which statements about catalysts are true?

Put ticks (✓) in the boxes next to the **two** correct answers.

A catalyst changes the reaction temperature. ☐

A catalyst increases the time taken for the reaction. ☐

A catalyst is used up quickly. ☐

A catalyst lowers the activation energy. ☐

The same catalyst can be used in more than one reaction. ☐ **[2]**

(ii) Haber changed other conditions to make the reaction faster.

Suggest **two** other changes to conditions that would make the reaction faster.

.....

.....

..... **[2]**

(d) Ammonia is used to make fertilisers for agriculture.

Ammonia provides nitrogen compounds to make crops grow faster.

Which **two** other important elements do fertilisers provide?

Put (rings) around the **two** correct answers.

chlorine **phosphorus** **potassium** **sodium** **sulfur** **[2]**

8 Salts are made by reacting an acid with a metal or a metal compound.

(a) Draw lines to connect the **reactants** to the correct **salt formed**.

Reactants	**Salt formed**
	zinc sulfate
zinc hydroxide and nitric acid	magnesium sulfate
magnesium and hydrochloric acid	zinc nitrate
	magnesium chloride

[2]

(b) When magnesium reacts with hydrochloric acid, a gas is also made.

What is the name of the gas?

Put a (ring) around the correct answer.

chlorine **hydrogen** **nitrogen** **oxygen** **[1]**

(c) Sundip makes a solution of zinc chloride by reacting solid zinc carbonate with dilute hydrochloric acid.

She adds too much solid zinc carbonate to the reaction mixture.

She needs to remove the excess solid.

What separation technique should she use?

Put a (ring) around the correct answer.

crystallisation **distillation** **evaporation** **filtration** **[1]**

9 Beth has some solids without labels.

(a) Beth does some tests to find out what ions the solids contain.

She thinks the solids contain copper ions and chloride ions.

Draw lines to connect each **ion** with the correct **test and result.**

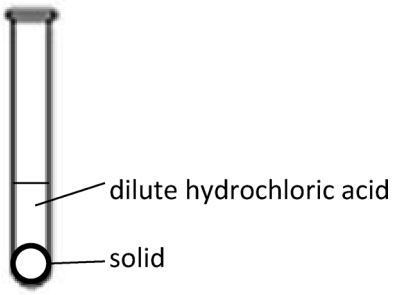
Ion	Test and result
	dilute sodium hydroxide gives a brown precipitate
chloride	dilute sodium hydroxide gives a green precipitate
copper	dilute sodium hydroxide gives a blue precipitate
	dilute silver nitrate gives a white precipitate
	dilute barium nitrate gives a yellow precipitate
	dilute barium sulfate gives carbon dioxide gas

[2]

(b) Beth uses this test to test for carbonate ions in a solid.

Test for carbonate ions: Add dilute hydrochloric acid, carbon dioxide is given off.

(i) Beth adds dilute hydrochloric acid to the solid in a test tube.



What will Beth **see** happen if carbon dioxide is made?

..... **[1]**

(ii) What should Beth use to test for carbon dioxide?

Put a (ring) around the correct answer.

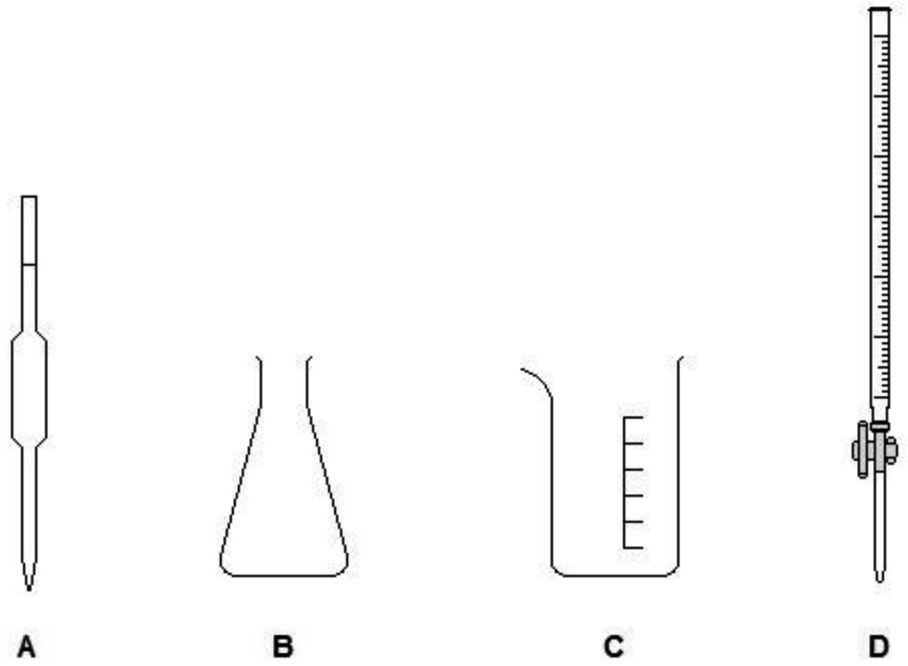
a glowing spill **lime water** **litmus paper** **universal indicator** **[1]**

10 Amir works in a lab that tests samples of vinegar to check their quality.

He finds out the concentration of the acid in some vinegar.

He uses a titration to find out how much dilute sodium hydroxide he needs to add to exactly react with 25.0 cm^3 of vinegar.

He has these pieces of apparatus, **A, B, C** and **D**.



(a) (i) Which piece of apparatus, **A, B, C** or **D**, should he use to measure the vinegar?

..... **[1]**

(ii) Which piece of apparatus, **A**, **B**, **C** or **D**, should he use to measure how much dilute sodium hydroxide he adds to the vinegar?

..... **[1]**

(b) Explain why Amir needs to use an indicator in the titration.

.....

.....

..... **[2]**

(c) Amir tests samples of vinegar from a vinegar factory,

The factory makes several batches of vinegar each week.
The batches are very large.

The vinegar is put into bottles.

Amir wants to make sure that the samples he tests are representative of all of the vinegar that the factory makes.

Describe how he should choose his samples to make sure they are representative of all the vinegar made.

.....

.....

..... **[2]**

(d) **(i)** Amir does another titration. This time he finds out how much dilute sodium hydroxide he needs to react with a sample of sulfuric acid.

He writes an equation for the reaction.

sodium hydroxide + sulfuric acid → sodium sulfate + water

Complete the balanced symbol equation for this reaction.

..... + ... H_2SO_4 → ..... + ...H_2O **[2]**

(ii) Amir finds that the concentration of the sulfuric acid is the same concentration as the sodium hydroxide.

Amir titrates the dilute sodium hydroxide with 25.0 cm^3 of the sulfuric acid.

Calculate the volume of dilute sodium hydroxide he uses to neutralise the sulfuric acid.

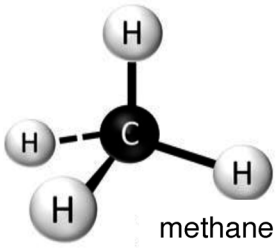
Use your answer from part **(i)**.

Volume of dilute sodium hydroxide = ... cm^3 **[2]**

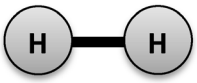
11 The surface of the planet Neptune is covered with clouds.

The clouds contain methane and hydrogen.

The diagrams show the arrangement of atoms in methane and hydrogen.



methane



hydrogen

(a) Compare the structures of methane and hydrogen.

Explain **one** similarity and **one** difference between methane and hydrogen.

Similarity .....

.....

Difference .....

..... **[2]**

(b) **(i)** The table shows the boiling point and melting point of methane.

melting point (°C)	–182.5
boiling point (°C)	–161.5

Put one tick (✓) underneath the state symbol for methane on Earth.

	(s)	**(l)**	**(g)**	**(aq)**
State of methane on Earth (✓)				

[1]

(ii) The clouds also contain hydrogen

energy needed to break forces between hydrogen molecules	<	energy needed to break forces between methane molecules

Use the information in the box to predict the boiling point of hydrogen.

Put a (ring) around the correct answer.

–253 °C **–161 °C** **–120 °C** **+52 °C** **[1]**

(c) Methane is an alkane.

Which statements about methane are true?

Put ticks (✓) in the boxes next to the **two** correct answers.

Methane contains single covalent bonds. ☐

Methane has a melting point above room temperature. ☐

Methane is a carboxylic acid. ☐

Methane is an ionic compound. ☐

Methane is in the same family of compounds as ethane and propane. ☐ **[2]**

12 Methane and hydrogen can both be used in fuel cells for cars.

The table shows information about the reactions in a hydrogen/oxygen fuel cell and in a methane/oxygen fuel cell.

Fuel	Source of fuel	Products of reaction in fuel cell	Energy given out per mole of fuel (in kJ)
hydrogen	High temperature industrial process.	only water vapour	286
methane	Fossil fuel.	carbon dioxide and water vapour	890

(a) Use the information in the table to evaluate the advantages and disadvantages of using hydrogen and methane as fuels for a car fuel cell.

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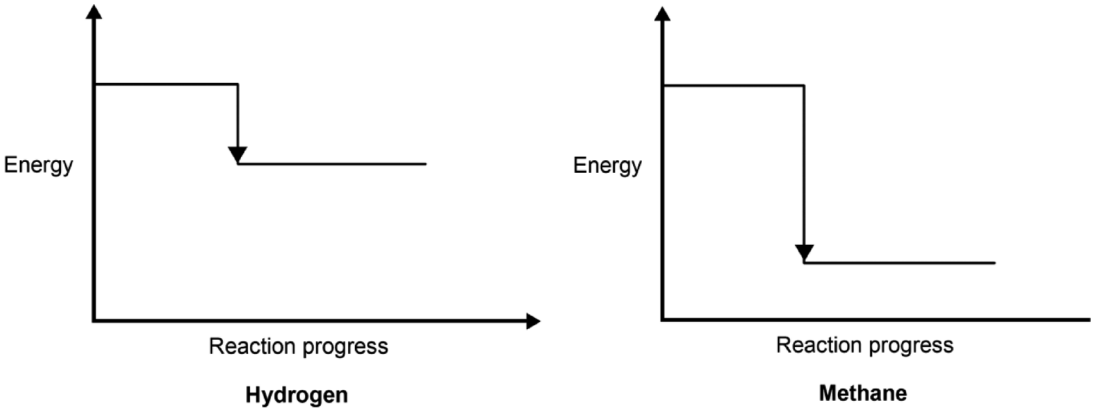
.....

.....

..... **[3]**

(b) The diagrams show the energy changes in the hydrogen and methane fuel cells.



Explain the shapes of the two diagrams.

Use the data in the table in your answer.

.....

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..... **[2]**

13 **(a)** Chlorine is used in the treatment of drinking water.

Describe how you would test a sample of gas to show that it is chlorine.

.....

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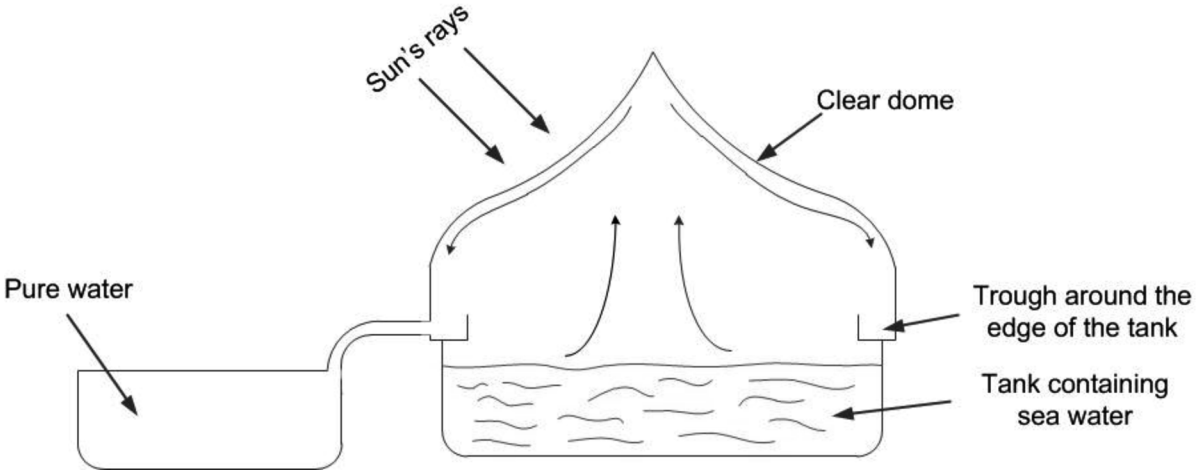
..... **[2]**

(b) A solar still can be used to make sea water safe to drink.

The diagram shows a cross-section through a solar still.



Describe how a solar still produces drinking water from sea water.

.....

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..... **[2]**

14 Scientists think that the composition of the early atmosphere changed slowly over many billions of years.

Scientists estimated the composition of the earliest atmosphere on Earth.

Earth's earliest atmosphere

Gas	Percentage composition (%)
carbon dioxide	1.9
water vapour	95.8
other gases	2.3

Estimated surface temperature = 700–1100 °C

Scientists also estimated the composition of the atmosphere shortly before the first plant life existed.

Atmosphere just before the first plant life

Gas	Percentage composition (%)
carbon dioxide	89.8
water vapour	2.1
other gases	

(a) Explain the change in the percentage of water vapour shown in the tables.

.....

.....

..... **[2]**

(b) Plants caused further changes to the composition of gases in the atmosphere.

Predict the effect that plants had on the percentage of carbon dioxide in the atmosphere.

Explain your reasoning.

.....

.....

..... **[2]**

15 Metal extraction produces a lot of waste. The zinc ions from this waste could leak into watercourses and contaminate soil.

Alpine Penny-cress is a plant that grows on waste heaps that contain toxic zinc ions. The cress plants take up the zinc ions and store them in their leaves.

(a) Explain how the planting of Alpine Penny-cress could be used to recycle zinc.

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..... **[1]**

(b) Explain how growing these plants could reduce risk.

.....

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..... **[2]**

(c) Alpine Penny-cress takes up zinc ions from contaminated soil very well. Oilseed rape cannot take up zinc.

The table shows data on Alpine Penny-cress and oilseed rape.

Plant	Height (cm)	Dry mass per plant (g)	Plants (per m^2)	Time to fully grown (days)
Alpine Penny-cress	25	1	20	100
Oilseed rape	125	2	50	85

Scientists have put genes from Alpine Penny-cress into the oilseed rape plant.

Explain what effect this modified oilseed rape plant could have on the uptake of zinc ions in contaminated soil.

.....

.....

..... **[2]**

(d) The Alpine Penny-cress contains toxic zinc ions.

Beth decides to do some experimental research to find out whether the Alpine Penny-cress can be used as grazing for sheep.

What research would she need to do to find out if the Alpine Penny-cress is safe for sheep to eat?

.....

.....

..... **[2]**

(e) Beth does some tests to find out which metal ions are in some other samples of mining waste, samples: **A, B** and **C**.

She adds dilute sodium hydroxide, NaOH, to a solution of the metal ions. These are her results.

Mining waste sample	After adding a few drops of NaOH	After adding excess NaOH
A	white precipitate	precipitate dissolves
B	blue precipitate	no further change.
C	no precipitate	

What conclusions can Beth make about the metal ions in the mining waste?

.....

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..... **[3]**

END OF QUESTION PAPER