Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
CHEMISTRY

H

Higher Tier Paper 2

Wednesday 10 June 2020 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions
- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

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0 1 This question is about chemical analysis.

A student tested copper sulfate solution and calcium iodide solution using flame tests.

This is the method used.

1. Dip a metal wire in copper sulfate solution.

2. Put the metal wire in a blue Bunsen burner flame.

3. Record the flame colour produced.

4. Repeat steps 1 to 3 using the same metal wire but using calcium iodide solution.

0 1 . 1 What flame colour is produced by copper sulfate solution?

[1 mark]

0 1 . 2 Calcium compounds produce an orange-red flame colour.

The student left out an important step before reusing the metal wire.

The student's method did **not** produce a distinct orange-red flame colour using calcium iodide solution.

Explain why.

[2 marks]

Do not write outside the box

0 1 . 3 The student added sodium hydroxide solution to:

- copper sulfate solution
- calcium iodide solution.

Give the results of the tests.

[2 marks]

Copper sulfate solution _____

_____

Calcium iodide solution _____

_____

0 1 . 4 To test for sulfate ions the student added dilute hydrochloric acid to copper sulfate solution.

Name the solution that would show the presence of sulfate ions when added to this mixture.

[1 mark]

_____

0 1 . 5 To test for iodide ions the student added dilute nitric acid to calcium iodide solution.

Name the solution that would show the presence of iodide ions when added to this mixture.

Give the result of the test.

[2 marks]

Solution _____

Result _____

_____

8

Do not write outside the box

0 2 This question is about water.

0 2 . 1 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]

0 2 . 2 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]

Do not write outside the box

0 2 . 3 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.

[2 marks]

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

Question 2 continues on the next page

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Table 1 shows information about the disposal of processed solid sewage sludge in the UK in 1992 and in 2010.

Table 1

Year	Mass of processed solid sewage sludge in millions of kilograms				
	Used as fertiliser	**Sent to landfill**	**Burned**	**Other methods**	**Total**
1992	440	130	90	338	998
2010	1118	9	260	26	1413

0 2 . 4 Calculate the percentage of processed solid sewage sludge that was burned in 2010.

Give your answer to 3 significant figures.

Use **Table 1**.

[3 marks]

Percentage (3 significant figures) = _____ %

Do not write outside the box

0 2 . 5 Suggest **one** reason why the total mass of processed solid sewage sludge increased between 1992 and 2010.

[1 mark]

0 2 . 6 Between 1992 and 2010 the proportion of processed solid sewage sludge used as fertiliser increased.

Suggest **two** reasons why.

[2 marks]

1

2

13

Turn over for the next question

Do not write outside the box

0 3 This question is about hydrocarbons.

Hexane and hexene are hydrocarbons containing six carbon atoms in each molecule.

Hexane is an alkane and hexene is an alkene.

0 3 . 1 Draw **one** line from each hydrocarbon to the formula of that hydrocarbon.

[2 marks]

Hydrocarbon	**Formula**
	C_6H_8
Hexane	C_6H_{10}
	C_6H_{12}
Hexene	C_6H_{14}
	C_6H_{16}

0 3 . 2 Bromine water is added to hexane and to hexene.

What would be observed when bromine water is added to hexane and to hexene?

[2 marks]

Hexane _____

_____

Hexene _____

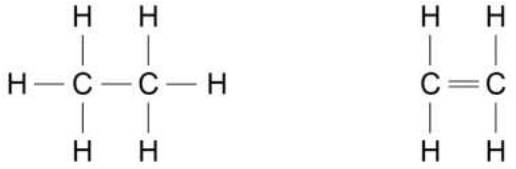
_____

Do not write outside the box

0 3 . 3 Ethane is an alkane and ethene is an alkene.

Figure 1 shows the displayed structural formulae of ethane and of ethene.

Figure 1



Ethane **Ethene**

Compare ethane with ethene.

You should refer to:

- their structure and bonding
- their reactions.

[6 marks]

10

Turn over ►

Do not write outside the box

0 4 This question is about ink.

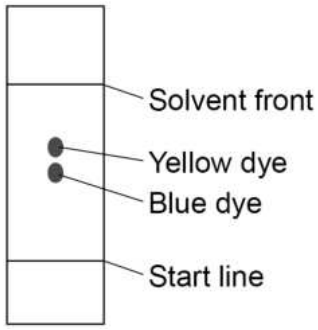
A student investigated green ink using paper chromatography in a beaker.

The student used water as the solvent.

Figure 2 shows the chromatogram obtained.

Figure 2

Diagram not to scale



0 4 . 1 The R_f value of the yellow dye = 0.60

The distance moved by the yellow dye = 5.7 cm

Calculate the distance moved by the solvent.

[3 marks]

Distance moved by the solvent = _____ cm

Do not write outside the box

0 4 . 2 The green ink contains more than two compounds.

Suggest **one** reason why only two spots are seen on **Figure 2**.

[1 mark]

0 4 . 3 On the student's chromatogram, the yellow and blue spots are very close together.

Which **two** ways could increase the distance between the spots?

[2 marks]

Tick (✓) **two** boxes.

Allow the solvent front to travel further. ☐

Dry the chromatogram more slowly. ☐

Use a different solvent. ☐

Use a larger beaker. ☐

Use a larger spot of green ink. ☐

0 4 . 4 The manufacturers of the green ink always use the same proportions of yellow dye and blue dye.

Suggest **one** reason why.

[1 mark]

Turn over ►

Do not write outside the box

0 4 . 5 The R_f value of a dye depends on:

- the solubility of the dye in the solvent
- the attraction of the dye to the paper.

Which will **definitely** produce a smaller R_f value if the solvent and paper are both changed?

[1 mark]

Tick (✓) **one** box.

The dye is less soluble in the new solvent and less attracted to the new paper. ☐

The dye is less soluble in the new solvent and more attracted to the new paper. ☐

The dye is more soluble in the new solvent and less attracted to the new paper. ☐

The dye is more soluble in the new solvent and more attracted to the new paper. ☐

8

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 5 This question is about materials used to make food plates.

Food plates are made from paper, polymers or ceramics.

Table 2 shows information about plates of the same diameter made from each of these materials.

Table 2

	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

0 5 . 1 **Table 2** 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]

1 _____

_____

2 _____

_____

Do not write outside the box

0 5 . 2 Evaluate the use of these materials for making food plates.

You should use features of life cycle assessments (LCAs).

Use **Table 2**.

[4 marks]

0 5 . 3 Describe how ceramic food plates are produced from clay.

[2 marks]

8

Do not write outside the box

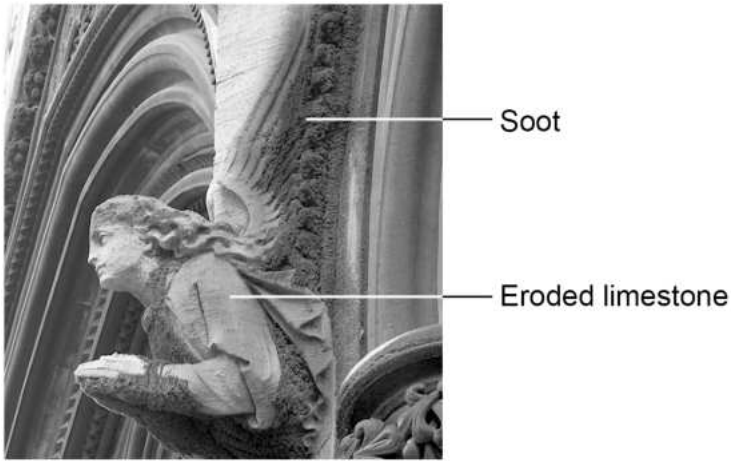
0 6 This question is about atmospheric pollution.

Figure 3 shows a limestone carving which has been damaged by atmospheric pollution.

The carving has been:

- blackened by soot
- eroded where the limestone has reacted with atmospheric pollutants.

Figure 3



0 6 . 1 Explain why soot is formed when some fossil fuels are burned.

[2 marks]

Do not write outside the box

0 6 . 2 Fossil fuels are burned in car engines.

Explain how reducing the amount of sulfur in fossil fuels reduces the erosion of limestone.

[4 marks]

0 6 . 3 Oxides of nitrogen are atmospheric pollutants which are formed in car engines.

Explain why oxides of nitrogen are formed in car engines.

[2 marks]

8

Turn over for the next question

Do not write outside the box

0 7 This question is about carboxylic acids.

Carboxylic acids belong to a homologous series.

Table 3 shows information about the first three carboxylic acids in this homologous series.

Table 3

Name	**Formula**	**pH of a 0.01 mol/dm^3 solution**
Methanoic acid		2.91
Ethanoic acid	CH_3COOH	3.39
	CH_3CH_2COOH	3.44

0 7 . 1 Complete **Table 3**.

[2 marks]

0 7 . 2 Ethanoic acid ionises in water.

The equation for the reaction is:

$$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

Explain how the equation shows that ethanoic acid is a weak acid.

[2 marks]

Do not write outside the box

0 7 . 3 A student adds a solution of ethanoic acid to zinc carbonate in an open flask on a balance.

Explain what happens to the mass of the flask and its contents during the reaction.

[3 marks]

0 7 . 4 The student compares the rates of the reaction of zinc carbonate with:

- 0.01 mol/dm^3 methanoic acid
- 0.01 mol/dm^3 ethanoic acid.

The rate of the reaction with methanoic acid is greater than the rate of the reaction with ethanoic acid.

Explain why.

You should refer to ions in your answer.

Use **Table 3**.

[3 marks]

Turn over ►

Do not write outside the box

Ethanoic acid reacts with ethanol to produce an ester.

0 7 . 5 Give the name of the ester produced when ethanoic acid reacts with ethanol.

[1 mark]

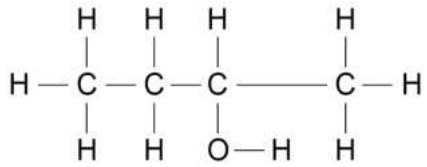
0 7 . 6 Hexanedioic acid and ethanediol join together to produce a polyester.

Ethanoic acid and ethanol join together in the same way to produce an ester.

Which is the displayed structural formula of the ester produced when ethanoic acid reacts with ethanol?

[1 mark]

Tick (✓) **one** box.



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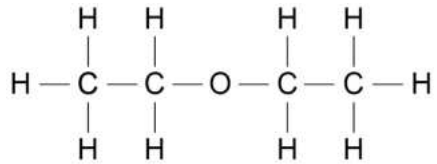

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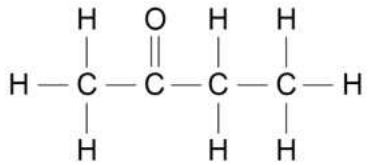

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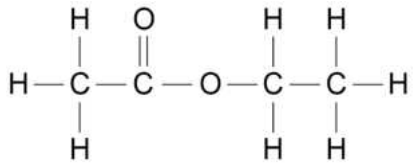

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12

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 8 This question is about the rate of the reaction between hydrochloric acid and calcium carbonate.

A student investigated the effect of changing the size of calcium carbonate lumps on the rate of this reaction.

This is the method used.

1. Pour 40 cm^3 of hydrochloric acid into a conical flask.

2. Add 10.0 g of small calcium carbonate lumps to the conical flask.

3. Attach a gas syringe to the conical flask.

4. Measure the volume of gas produced every 30 seconds for 180 seconds.

5. Repeat steps 1 to 4 using 10.0 g of large calcium carbonate lumps.

The student calculated the number of moles of gas from each volume of gas measured.

Table 4 shows the student's results for large calcium carbonate lumps.

Table 4

Time in seconds	Number of moles of gas
0	0.0000
30	0.0011
60	0.0020
90	0.0028
120	0.0034
150	0.0038
180	0.0040

The student plotted the results for small calcium carbonate lumps on **Figure 4**.

0 8 . 1 Complete **Figure 4**.

You should:

- plot the data for large calcium carbonate lumps from **Table 4**
- draw a line of best fit.

[3 marks]

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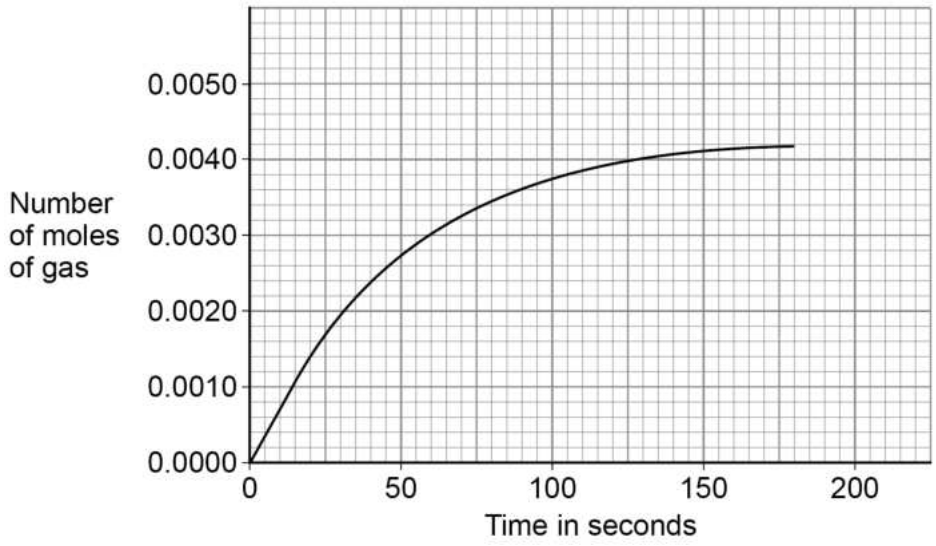
Figure 4



0 8 . 2 Determine the mean rate of reaction for **small** calcium carbonate lumps between 20 seconds and 105 seconds.

Give the unit.

Use **Figure 4**.

[4 marks]

Mean rate of reaction = _____ Unit _____

0 8 . 3 The student concluded that the large calcium carbonate lumps reacted more slowly than the small calcium carbonate lumps.

How do the student's results show that this conclusion is correct?

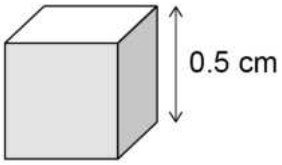
[1 mark]

Do not write outside the box

The difference in the rates of reaction of large lumps and of small lumps of calcium carbonate depends on the surface area to volume ratios of the lumps.

Figure 5 shows a cube of calcium carbonate.

Figure 5



0 8 . 4 Calculate the surface area to volume ratio of the cube in **Figure 5**.

Give your answer as the simplest whole number ratio.

[3 marks]

Surface area : volume = _____ : _____

0 8 . 5 A larger cube of calcium carbonate has sides of 5 cm

Describe how the surface area to volume ratio of this larger cube differs from that of the cube shown in **Figure 5**.

[1 mark]

12

Do not write outside the box

0 9 This question is about algae.

A student:

- placed algae in water containing dissolved carbon dioxide
- shone bright light on the algae.

Gas bubbles were collected as the algae photosynthesised.

0 9 . 1 Describe a test that would identify the gas collected.

Give the result of the test.

[2 marks]

Test _____

Result _____

_____

0 9 . 2 Glucose is produced when algae photosynthesise.

Name **two** naturally occurring polymers produced from glucose.

[2 marks]

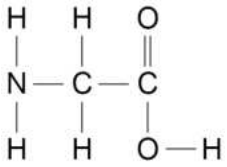
_____ and _____

Question 9 continues on the next page

Do not write outside the box

Figure 6 shows the displayed structural formula of an amino acid called glycine.

Figure 6



0 9 . 3 How many functional groups are there in the molecule in **Figure 6**?

[1 mark]

Tick (✓) **one** box.

1 ☐ 2 ☐ 3 ☐ 4 ☐

0 9 . 4 Glycine reacts by condensation polymerisation to produce a polypeptide and one other substance.

Name the other substance produced.

[1 mark]

_____

0 9 . 5 Scientists think that algae may have used gases in Earth's early atmosphere.

Algae need an element to produce the molecule in **Figure 6** which is **not** present in water or carbon dioxide.

Which **two** gases from Earth's early atmosphere could have provided this element?

[2 marks]

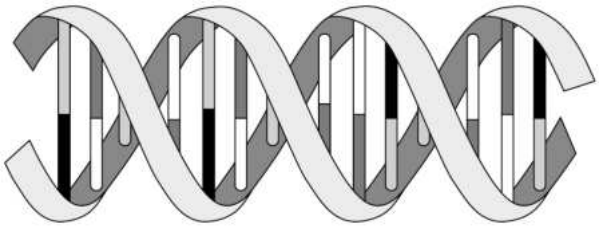
_____ and _____

Do not write outside the box

0 9 . 6 The development and function of algae are controlled by a naturally occurring polymer.

Figure 7 represents the shape and structure of this polymer.

Figure 7



Describe the shape and structure of this polymer.

[3 marks]

11

Turn over for the next question

Do not write outside the box

1 0 This question is about a reversible reaction.

The reaction between solutions of iron(III) ions (Fe^{3+}) and thiocyanate ions (SCN^-) is reversible.

The ionic equation for the reaction is:

	$Fe^{3+}(aq)$	+	$SCN^-(aq)$	$\rightleftharpoons$	$FeSCN^{2+}(aq)$
Colour of solution:	yellow		colourless		red

The colour of the equilibrium mixture is orange at room temperature.

1 0 . 1 Give the name of the solvent used to dissolve the ions in this reaction.

[1 mark]

1 0 . 2 A few drops of a colourless solution containing a high concentration of thiocyanate ions (SCN^-) are added to the orange equilibrium mixture.

Explain the colour change observed.

[3 marks]

Do not write outside the box

1 0 . 3 A water bath is set up at a temperature above room temperature.

When a test tube containing the orange equilibrium mixture is placed in the water bath, the mixture becomes more yellow.

Explain what this shows about the energy change for the forward reaction.

[3 marks]

1 0 . 4 Explain why a change in pressure does **not** affect the colour of the equilibrium mixture.

[2 marks]

1 0 . 5 Other metal ions form coloured equilibrium mixtures with thiocyanate ions.

Which metal ion could form a coloured equilibrium mixture with thiocyanate ions?

[1 mark]

Tick (✓) **one** box.

Al^{3+} ☐

Co^{2+} ☐

Mg^{2+} ☐

Na^{+} ☐

10

END OF QUESTIONS

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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