Please write clearly in block capitals.

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

Surname ______________________

Forename(s) ______________________

Candidate signature ______________________

GCSE CHEMISTRY

H

Higher Tier

Paper 1H

Specimen 2018 (set 2)

Time allowed: 1 hour 45 minutes

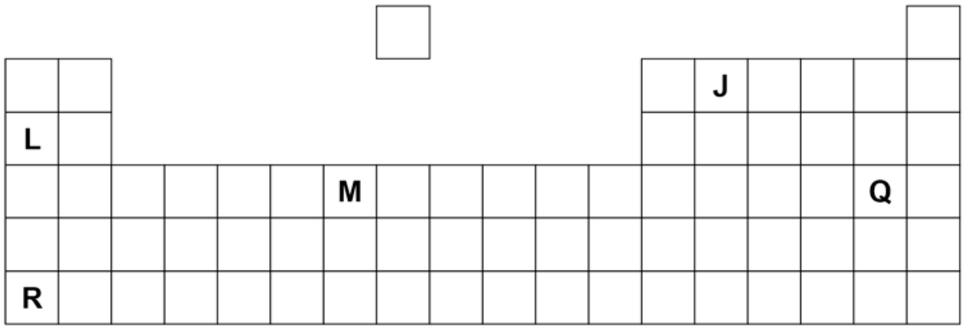
Materials
For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- 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.

0 1 **Figure 1** shows an outline of the modern periodic table.

Figure 1



J, **L**, **M**, **Q** and **R** represent elements in the Periodic Table.

0 1 . 1 Which element has four electrons in its outer shell?

[1 mark]

Tick **one** box.

J ☐ **L** ☐ **M** ☐ **Q** ☐ **R** ☐

0 1 . 2 Which **two** elements in **Figure 1** are in the same period?

[1 mark]

____________ and ____________

0 1 . 3 Which element reacts with potassium to form an ionic compound?

[1 mark]

Tick **one** box.

J ☐ **L** ☐ **M** ☐ **Q** ☐ **R** ☐

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0 1 . 4 Which element forms ions with different charges?

[1 mark]

Tick **one** box.

J ☐ **L** ☐ **M** ☐ **Q** ☐ **R** ☐

0 1 . 5 Which element has three electron shells?

[1 mark]

Tick **one** box.

J ☐ **L** ☐ **M** ☐ **Q** ☐ **R** ☐

Question 1 continues on the next page

In the 1860s scientists were trying to organise elements.

Figure 2 shows the table published by John Newlands in 1865.

The elements are arranged in order of their atomic weights.

Figure 2

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru
Pd	Ag	Cd	U	Sn	Sb	Te

Figure 3 shows the periodic table published by Dmitri Mendeleev in 1869.

Figure 3

H							
Li	Be	B	C	N	O	F	
Na	Mg	Al	Si	P	S	Cl	
K Cu	Ca Zn	? ?	Ti ?	V As	Cr Se	Mn Br	Fe Co Ni
Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	? I	Ru Rh Pd

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0 1 . 6 Mendeleev's table became accepted by other scientists whereas Newlands' table was not.

Evaluate Newlands' and Mendeleev's tables.

You should include:

- a comparison of the tables
- reasons why Mendeleev's table was more acceptable.

Use **Figure 2** and **Figure 3** and your own knowledge.

[6 marks]

11

Turn over ►

0 2 A student investigated the law of conservation of mass.

The law of conservation of mass states that the mass of the products is equal to the mass of the reactants.

This is the method used.

1. Pour lead nitrate solution into a beaker labelled **A**.
2. Pour potassium chromate solution into a beaker labelled **B**.
3. Measure the mass of both beakers and contents.
4. Pour the solution from beaker **B** into beaker **A**.
5. Measure the mass of both beakers and contents again.

When lead nitrate solution and potassium chromate solution are mixed, a reaction takes place.

This is the equation for the reaction:

$$Pb(NO_3)_2(aq) \quad + \quad K_2CrO_4(aq) \rightarrow PbCrO_4(s) \; + \; 2\,KNO_3(aq)$$

0 2 . 1 What would the student see when the reaction takes place?

[1 mark]

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0 2 . 2 **Table 1** shows the student's results.

Table 1

	Mass in g
Beaker **A** and contents before mixing	128.71
Beaker **B** and contents before mixing	128.97
Beaker **A** and contents after mixing	154.10
Beaker **B** after mixing	103.58

Show that the law of conservation of mass is true.

Use the data from **Table 1**.

[2 marks]

0 2 . 3 What is the resolution of the balance used to obtain the results in **Table 1**?

[1 mark]

Tick **one** box.

0.01 g ☐ 0.1g ☐ 1 g ☐ 100 g ☐

Question 2 continues on the next page

Turn over ►

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0 2 . 4 Calculate the relative formula mass (M_r) of lead nitrate $Pb(NO_3)_2$

[2 marks]

Relative atomic masses (A_r): N = 14 O = 16 Pb = 207

____

____

____

Relative formula mass = ____________________

0 2 . 5 The formula of potassium chromate is K_2CrO_4

The charge on the potassium ion is +1

What is the formula of the chromate ion?

[1 mark]

Tick **one** box.

CrO_4^{+} ☐

CrO_4^{2+} ☐

CrO_4^{-} ☐

CrO_4^{2-} ☐

Do not write outside the box

0 2 . 6 Another student also tests the law of conservation of mass using the same method.

The student uses a different reaction.

This is the equation for the reaction.

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

Explain why this student's results would **not** appear to support the law of conservation of mass.

[3 marks]

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10

Turn over for the next question

0 3 A student makes a hypothesis:

'When different salt solutions are electrolysed with inert electrodes, the product at the negative electrode is always a metal'.

0 3 . 1 Describe how you would test this hypothesis in the laboratory.

You should:

- draw a labelled diagram of the apparatus
- give the independent variable
- describe what you would see at the negative electrode if the hypothesis is true.

[5 marks]

Diagram

Independent variable ____

____

Observation ____

____

0 3 . 2 The student's hypothesis is only partially correct.

Explain why the product at the negative electrode is **not** always a metal.

[2 marks]

0 3 . 3 Predict the product at the **positive** electrode in the electrolysis of:

- sodium chloride solution
- copper sulfate solution.

[2 marks]

Sodium chloride solution ____________________

Copper sulfate solution ____________________

9

Turn over for the next question

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0 4 This question is about atoms.

0 4 . 1 What does the number 19 represent in ${}^{19}_{9}F$?

[1 mark]

____

0 4 . 2 How many atoms are present in one mole of fluorine atoms?

[1 mark]

Tick **one** box.

2.03×10^{26} ☐

2.06×10^{23} ☐

6.02×10^{23} ☐

6.02×10^{26} ☐

0 4 . 3 The plum pudding model of the atom was replaced by the nuclear model.

The nuclear model was developed after the alpha particle scattering experiment.

Compare the plum pudding model with the nuclear model of the atom.

[4 marks]

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0 4 . 4 An element has three isotopes.

Table 2 shows the mass numbers and percentage of each isotope.

Table 2

	Isotope 1	**Isotope 2**	**Isotope 3**
Mass number	24	25	26
Percentage (%)	78.6	10.1	11.3

Calculate the relative atomic mass (A_r) of the element.

Give your answer to 3 significant figures.

[2 marks]

Relative atomic mass = ____________________

8

Turn over for the next question

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0 5 Some students investigated the energy changes occurring in the reaction between potassium hydrogencarbonate and hydrochloric acid.

The equation for the reaction is:

$$KHCO_3(s) + HCl(aq) \rightarrow KCl(aq) + CO_2(g) + H_2O(l)$$

This is the method used.

1. Measure 50 cm^3 hydrochloric acid into a glass beaker.
2. Measure the temperature of the hydrochloric acid.
3. Measure a given mass of potassium hydrogencarbonate.
4. Add the potassium hydrogencarbonate to the hydrochloric acid.
5. Stir until all the potassium hydrogencarbonate has reacted.
6. Record the lowest temperature reached.
7. Repeat three more times, using the same mass of potassium hydrogencarbonate.

Each student used a different mass of potassium hydrogencarbonate.

0 5 . 1 The method described will not give very accurate results.

Suggest **one** change to the apparatus that would improve the accuracy of the results.

Give a reason for your answer.

[2 marks]

Do not write outside the box

0 5 . 2 The students controlled the volume of the hydrochloric acid.

Give **one** other control variable the students should use.

[1 mark]

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Table 3 shows one student's results.

Table 3

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Initial temperature in °C	21.2	21.1	21.0	21.1
Final temperature in °C	15.6	15.4	15.6	16.6
Temperature decrease in °C	5.6	5.7	5.4	4.5

0 5 . 3 Calculate the mean temperature decrease for the results shown in **Table 3**.

Ignore any anomalous results.

Give your answer to 1 decimal place.

Give the uncertainty in your answer.

[3 marks]

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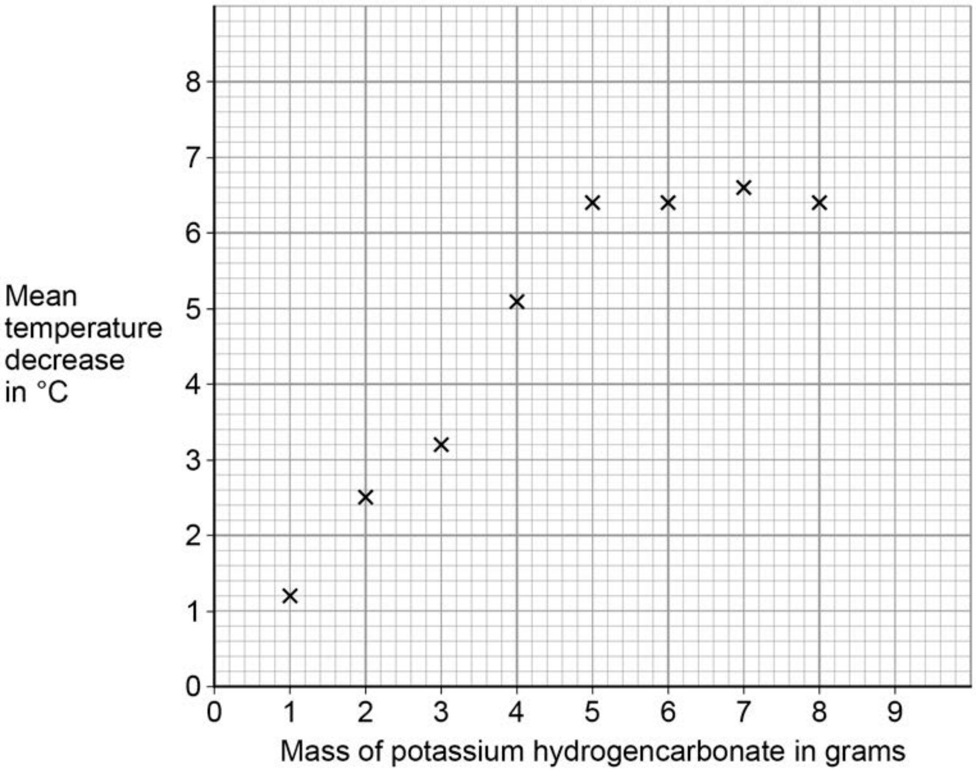
Mean = ____________ °C ± __________ °C

Question 5 continues on the next page

Turn over ►

Figure 4 shows the students' results.

Figure 4



0 5 . 4 Draw **two** intersecting straight lines of best fit on **Figure 4**.

[2 marks]

0 5 . 5 Explain why the graph has this shape.

Use data from the graph.

[3 marks]

0 5 . 6 Suggest a possible reason for the anomalous points.

Do **not** include errors in measuring.

[1 mark]

12

Turn over for the next question

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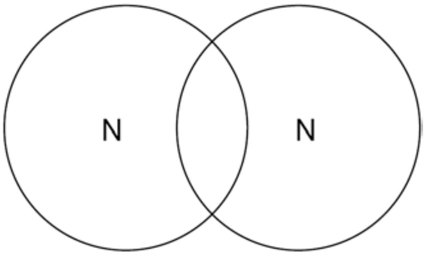
0 6 This question is about structure and bonding.

0 6 . 1 Complete the dot and cross diagram to show the covalent bonding in a nitrogen molecule, N_2

Show only the electrons in the outer shell.

[2 marks]



0 6 . 2 Explain why nitrogen is a gas at room temperature.

Answer in terms of nitrogen's structure.

[3 marks]

Question 6 continues on the next page

Do not write outside the box

Graphite and fullerenes are forms of carbon.

0 6 . 3 Graphite is soft and is a good conductor of electricity.

Explain why graphite has these properties.

Answer in terms of structure and bonding.

[4 marks]

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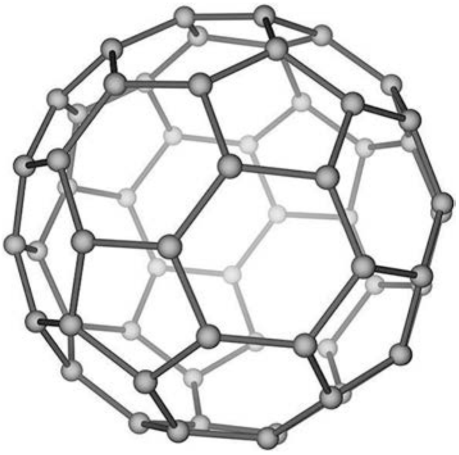
0 6 . 4 **Figure 5** shows a model of a Buckminsterfullerene molecule.

Figure 5



A lubricant is a substance that allows materials to move over each other easily.

Suggest why Buckminsterfullerene is a good lubricant.

Use **Figure 5**.

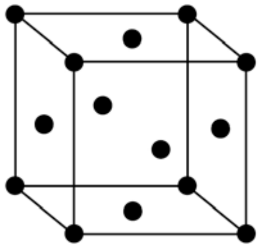
[2 marks]

Question 6 continues on the next page

Silver can form cubic nanocrystals.

Figure 6 represents a silver nanocrystal.

Figure 6



0 6 . 5 A silver nanocrystal is a cube of side 20 nm

Calculate the surface area to volume ratio of the nanocrystal.

[3 marks]

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Surface area to volume ratio = ____________________

0 6 . 6 Silver nanoparticles are sometimes used in socks to prevent foot odour.

Suggest why it is cheaper to use nanoparticles of silver rather than coarse particles of silver.

[2 marks]

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16

Turn over for the next question

0 7 A scientist produces zinc iodide (ZnI_2).

This is the method used.

1. Weigh 0.500 g of iodine.
2. Dissolve the iodine in ethanol.
3. Add an excess of zinc.
4. Stir the mixture until there is no further change.
5. Filter off the excess zinc.
6. Evaporate off the ethanol.

0 7 . 1 Ethanol is flammable.

Suggest how the scientist could carry out **Step 6** safely.

[1 mark]

0 7 . 2 Explain why the scientist adds excess zinc rather than excess iodine.

[3 marks]

Do not write outside the box

0 7 . 3 Calculate the minimum mass of zinc that needs to be added to 0.500 g of iodine so that the iodine fully reacts.

The equation for the reaction is:

$$Zn + I_2 \rightarrow ZnI_2$$

Relative atomic masses (A_r): Zn = 65 I = 127

[3 marks]

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Minimum mass of zinc = ____________________ g

Question 7 continues on the next page

A different scientist makes zinc iodide by the same method.

The scientist obtains 12.5 g of zinc iodide.

The percentage yield in this reaction is 92.0%.

0 7 . 4 What is the maximum theoretical mass of zinc iodide produced in this reaction?

[3 marks]

Maximum theoretical mass = ______________________ g

0 7 . 5 Suggest **one** reason why the percentage yield in this reaction is **not** 100%.

[1 mark]

Do not write outside the box

0 7 . 6 The scientist makes a solution of zinc iodide with a concentration of 0.100 mol/dm^3

Calculate the mass of zinc iodide (ZnI_2) required to make 250 cm^3 of this solution.

Relative atomic masses (A_r): Zn = 65 I = 127

[3 marks]

Mass = ____________________ g

14

Turn over for the next question

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0 8 Cells contain chemicals which react to produce electricity.

0 8 . 1 Why can a rechargeable cell be recharged?

[1 mark]

0 8 . 2 Give **two** factors that affect the voltage produced by a cell.

[2 marks]

1

2

0 8 . 3 Balance the half-equation for the reaction occurring at an electrode in one type of hydrogen fuel cell.

[1 mark]

$$H_2 \quad + \quad OH^- \quad \rightarrow \quad H_2O \quad + \quad e^-$$

0 8 . 4 Why is the fuel cell in Question **08.3** described as an alkaline fuel cell?

[1 mark]

0 8 . 5 Another type of fuel cell uses methanol instead of hydrogen.

Figure 7 represents the reaction in this fuel cell.

Figure 7

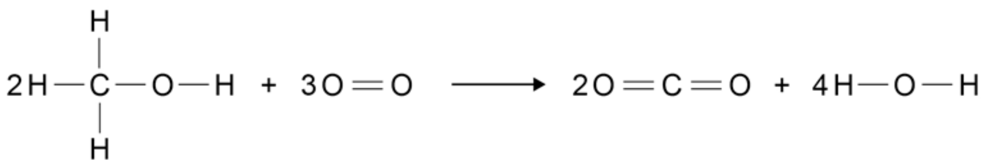

Table 4 shows the bond energies for the reaction.

Table 4

	C–H	C–O	O–H	O=O	C=O
Bond energy in kJ/mol	412	360	464	498	805

Calculate the overall energy change for the reaction.

Use **Figure 7** and **Table 4**.

[3 marks]

Overall energy change = ____________________ kJ/mol

8

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0 9 Citric acid is a weak acid.

0 9 . 1 Explain what is meant by a weak acid.

[2 marks]

Question 9 continues on the next page

A student titrated citric acid with sodium hydroxide solution.

This is the method used.

1. Pipette 25.0 cm^3 of sodium hydroxide solution into a conical flask.
2. Add a few drops of thymol blue indicator to the sodium hydroxide solution.

   Thymol blue is blue in alkali and yellow in acid.
3. Add citric acid solution from a burette until the end-point was reached.

0 9 . 2 Explain what would happen at the end-point of this titration.

Refer to the acid, the alkali and the indicator in your answer.

[3 marks]

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0 9 . 3 Explain why a pipette is used to measure the sodium hydroxide solution but a burette is used to measure the citric acid solution.

[2 marks]

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0 9 . 4 **Table 5** shows the student's results.

Table 5

	Titration 1	**Titration 2**	**Titration 3**	**Titration 4**	**Titration 5**
Volume of citric acid solution in cm^3	13.50	12.10	11.10	12.15	12.15

The equation for the reaction is:

$$C_6H_8O_7 \ + \ 3\,NaOH \ \rightarrow \ C_6H_5O_7Na_3 \ + \ 3\,H_2O$$

The concentration of the sodium hydroxide was 0.102 mol/dm^3

Concordant results are those within 0.10 cm^3 of each other.

Calculate the concentration of the citric acid in mol/dm^3

Use only the concordant results from **Table 5** in your calculation.

You must show your working.

[5 marks]

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Concentration = ____________________ mol/dm^3

12

END OF QUESTIONS

Turn over ►

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