Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
January 2019

GCSE Chemistry

Unit 2

Higher Tier

[GCH22]

GCH22

FRIDAY 25 JANUARY, AFTERNOON

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all seven** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 115.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in Questions **6(c)(iv)** and **7(a)(i)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

11712

1 **(a)** Using only the substances in the box below, answer the questions which follow. Each substance may be used once, more than once or not at all.

anhydrous calcium chloride	barium sulfate	washing soda
hydrated cobalt(II) chloride	hydrated copper(II) sulfate	

(i) Name one substance which is deliquescent.

_____ [1]

(ii) Name one substance which is coloured.

_____ [1]

(iii) Name one substance which is used as a drying agent.

_____ [1]

(b) In an experiment, the volume of soap needed to produce a lasting lather was recorded for samples of water from different towns. Samples were tested with soap before boiling and after boiling.

	Volume of soap required to produce a lather (cm^3)	
Town	**Before boiling**	**After boiling**
W	0.5	0.5
X	21.1	18.1
Y	18.2	0.5
Z	12.0	12.0

(i) Which town has the hardest water?

_____ [1]

(ii) In which town will limescale be the greatest problem?

_____ [1]

(iii) Which town has permanent hardness **only** in its water supply?

_____ [1]

(iv) Write a balanced symbol equation for the reaction which occurs when water from town Y is boiled.

_____ [2]

(c) Permanent hardness may be removed from water by the addition of washing soda.

(i) What is the chemical name for washing soda?

_____ [1]

(ii) Explain, in terms of ions, how washing soda can soften hard water.

_____

_____

_____

_____

_____ [3]

[Turn over

2 Apples produce ethene gas as they ripen.

(a) (i) Draw the structural formula of ethene.

[1]

(ii) Write the molecular formula of ethene.

_____ [1]

(iii) Write the general formula for the homologous series to which ethene belongs.

_____ [1]

(iv) A sample of gas was tested to confirm that it was ethene. Describe how this test would be carried out and state the results for a positive test.

_____

_____

_____

_____ [3]

(b) A recipe for pickled apples has the instruction below.

"Warm the apples with vinegar, sugar, water and cinnamon in a non-stick saucepan for ten minutes."

(i) Vinegar is a dilute solution of ethanoic acid. Draw the structural formula of ethanoic acid.

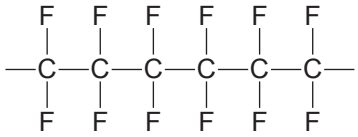
[1]

(ii) A non-stick saucepan is coated with the polymer PTFE. What is meant by the term polymer?

_____

_____ [1]

(iii) The structure of the polymer PTFE is shown below.



Draw the structure of the monomer from which PTFE is formed.

[1]

[Turn over

(c) Apples can undergo fermentation to make cider, a drink which contains ethanol.

(i) Describe the process of fermentation, stating the conditions used.

[4]

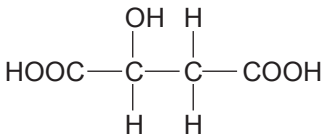
(ii) Draw the structural formula of ethanol.

[1]

(iii) Ethanol can also be used as a fuel. Write a balanced symbol equation for the complete combustion of ethanol.

[3]

(d) Malic acid is found in cider. Its structural formula is given below.



(i) State the functional groups in malic acid.

_____

_____ [2]

(ii) Write the empirical formula of malic acid.

_____

_____ [1]

(iii) A sample of solid sodium carbonate was added to a solution of malic acid. State two observations you would make.

_____

_____

_____ [2]

(iv) Malic acid is a weak acid. What is meant by the term weak acid?

_____

_____ [1]

[Turn over

3 The rate of reaction can be measured by monitoring the volume of gas produced during a reaction.

(a) Three reactions which produce a gas are given as word equations below labelled **A**, **B** and **C**.

A: magnesium + hydrochloric acid → magnesium chloride + hydrogen

B: hydrogen peroxide → water + oxygen

C: calcium carbonate + hydrochloric acid → calcium chloride + carbon dioxide + water

(i) **Circle** the gas produced in each of the reactions. [1]

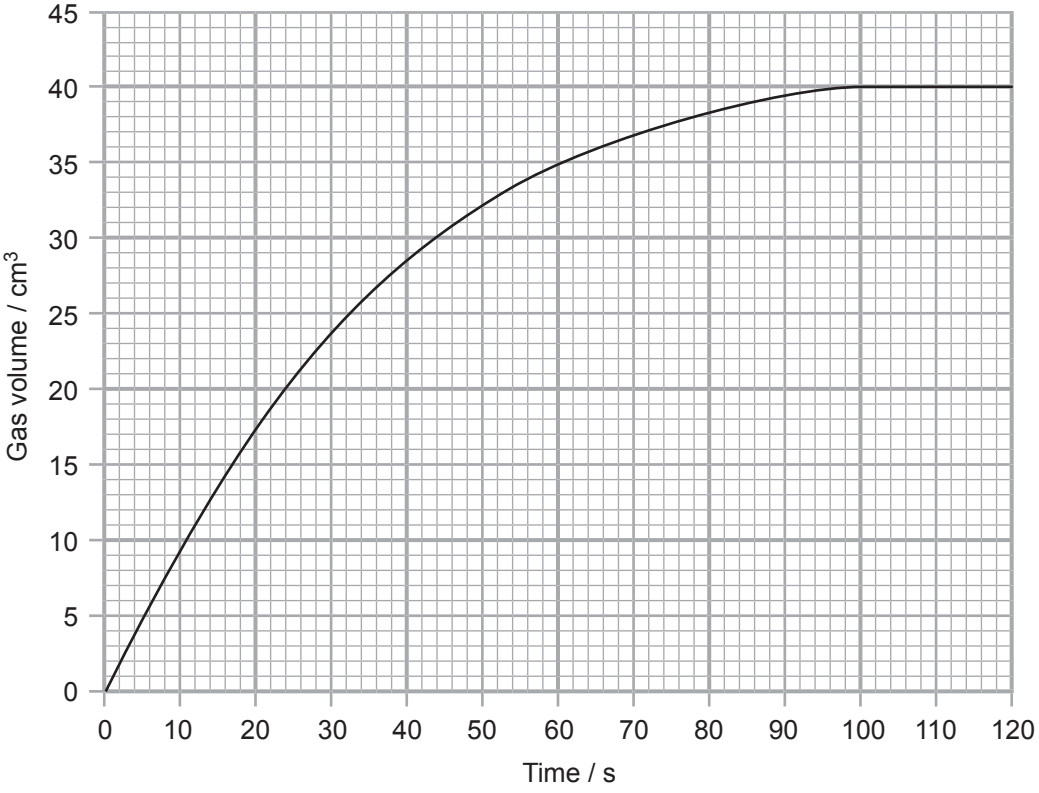
(ii) Write a balanced symbol equation for reaction **B**.

_____ [3]

(iii) Name the catalyst used in reaction **B**.

_____ [1]

(b) In a laboratory experiment 0.04 g of magnesium ribbon were reacted with **excess** dilute hydrochloric acid at 20 °C. The volume of gas produced was recorded every 20 seconds. The results obtained are shown in the graph below.



(i) From the graph, determine the time at which the reaction finishes.

_____ [1]

(ii) Calculate the rate of this reaction using the time in **(b)(i)**.

Rate = _____ s^{-1} [1]

(iii) On the graph above, sketch the curve obtained when the same mass of magnesium ribbon was reacted with an excess of dilute hydrochloric acid at 40 °C. The same volume and concentration of hydrochloric acid were used. [3]

[Turn over

(iv) State and explain, in terms of particles, the effect of increasing the concentration of hydrochloric acid on the rate of reaction with magnesium ribbon.

Effect: _____ [1]

Explanation: _____

_____

_____

_____ [3]

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[Turn over

4 In industry, nitrogen is used to make ammonia gas in the Haber process.

(a) **(i)** Name the other reactant in the Haber process.

_____ [1]

(ii) State the temperature and pressure used in the Haber process.

Temperature _____ °C

Pressure _____ atm [2]

(iii) Name the catalyst used in the Haber process.

_____ [1]

(b) One of the main uses of ammonia is in the manufacture of nitrogenous fertilisers. Nitrogenous fertilisers may contain ammonium nitrate and ammonium sulfate.

(i) Write a balanced symbol equation for the formation of ammonium sulfate from the reaction between ammonia and sulfuric acid.

_____ [3]

(ii) Name the acid that reacts with ammonia to form ammonium nitrate.

_____ [1]

(iii) Excessive use of nitrogenous fertilisers can lead to the environmental problem known as eutrophication. Explain how this problem occurs and the effects it has on the environment.

[4]

(c) Ammonia solution may be used to test for the presence of metal ions in aqueous solution. Complete the table below.

Observation on the addition of 1 cm^3 of ammonia solution	Observation on the addition of excess ammonia solution	Metal ion present in solution
white precipitate	white precipitate dissolves to form a colourless solution	
blue precipitate		Cu^{2+}
green precipitate	green precipitate remains	
white precipitate		Mg^{2+}

[4]

[Turn over

5 Chemical reactions may be classified as exothermic or endothermic.

(a) Complete the table below by placing a tick (✔) in the correct column to indicate if the reaction is exothermic or endothermic. The first one has been completed for you.

Reaction	Exothermic	Endothermic
Rusting	✔	
Combustion of methane		
Thermal decomposition of calcium carbonate		

[2]

(b) The rusting of iron can weaken structures.

(i) State the chemical name of rust.

_____ [1]

(ii) Describe the appearance of rust.

_____ [2]

(iii) The rusting of iron may be represented by the equation below.

$$4Fe + 3O_2 + 2H_2O \rightarrow 2Fe_2O_3.H_2O$$

Explain, in terms of electrons, why this reaction may be described as a redox reaction.

[5]

[Turn over

(c) **(i)** The rusting of iron may be prevented using a range of methods. Complete the table below by placing a tick (✔) in the box to show a method of rust prevention for each object.

Object	Oiling	Painting	Galvanising
Bridge			
Bicycle chain			

[2]

(ii) Name the metal used to galvanise iron.

_____ [1]

(d) Bars of magnesium metal are attached to ships to prevent rusting.

(i) What name is given to this method of rust prevention?

_____ [1]

(ii) Use the reactivity series of metals to explain how this method works.

_____

_____

_____ [2]

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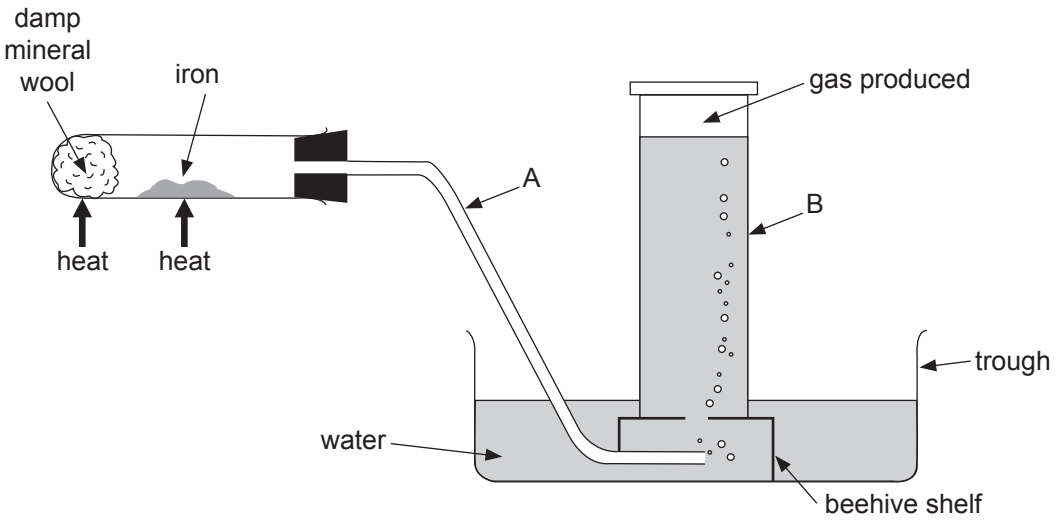
[Turn over

6 **(a)** Iron metal can be reacted with steam using the apparatus shown below.



(i) Name the pieces of apparatus labelled A and B.

A _____

B _____ [2]

(ii) Explain why the damp mineral wool is heated.

_____

_____ [1]

(iii) Name the gas produced in this experiment.

_____ [1]

(iv) Name a metal which does not react with steam.

_____ [1]

(b) When some iron filings are placed into a test tube containing copper(II) sulfate solution a reaction occurs. The products are iron(II) sulfate and copper.

(i) Write a balanced symbol equation for the reaction between iron and copper(II) sulfate.

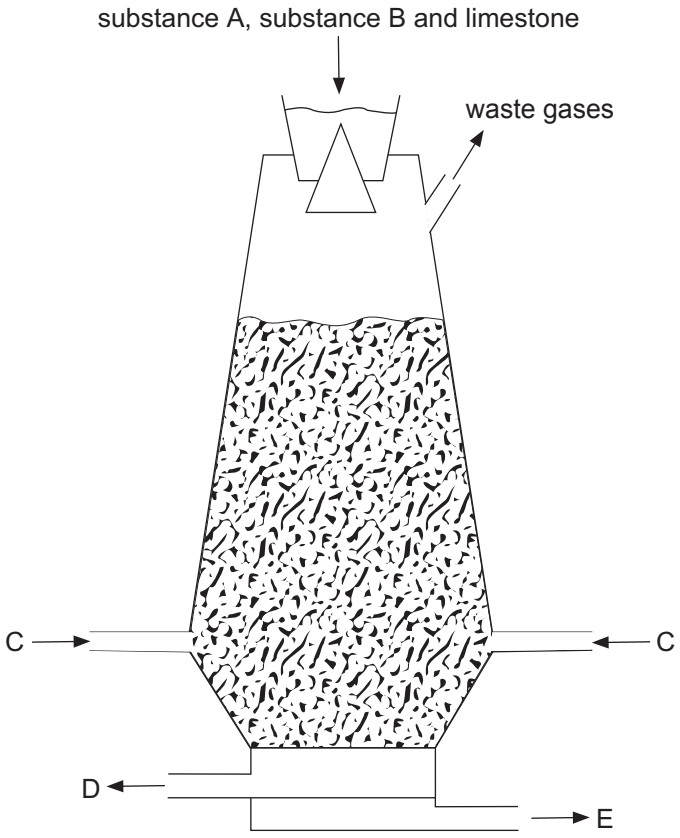
_____ [2]

(ii) State the type of reaction which occurs between iron and copper(II) sulfate.

_____ [1]

[Turn over

(c) Iron is manufactured in the Blast Furnace. In the Blast Furnace the raw materials limestone, substance A and substance B enter at the top of the furnace as shown in the diagram below.



(i) Name substances A and B.

_____

_____ [2]

(ii) What labels should be placed at C, D and E?

C _____

D _____

E _____ [3]

(iii) Name one waste gas emitted from the Blast Furnace.

_____ [1]

(iv) Limestone is used to remove acidic impurities in the Blast Furnace. Describe how the acidic impurities are removed. You must use balanced symbol equations in your answer.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

_____ [6]

[Turn over

7 Vinegar contains ethanoic acid which is a weak organic acid.

(a) A solution of vinegar was titrated against sodium hydroxide solution.

The following procedure was used:

- 25.0 cm^3 of vinegar solution were transferred to a clean, dry conical flask using a pipette
- A few drops of phenolphthalein indicator were added to the conical flask
- A burette was filled with 0.14 mol/dm^3 sodium hydroxide solution
- The sodium hydroxide solution was added to the conical flask slowly from the burette until one drop changed the colour of the indicator
- The volume of sodium hydroxide solution added to the conical flask was recorded
- The procedure was repeated.

(i) Describe in detail how you would prepare and use a pipette to transfer 25.0 cm^3 of the vinegar solution into a conical flask ensuring safety.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

[6]

(ii) State the colour change observed at the end-point.

From _____ to _____ [2]

[Turn over

(b) The student found that 22.5 cm^3 of 0.14 mol/dm^3 sodium hydroxide solution were required to neutralise the vinegar solution in the conical flask.

(i) Calculate the number of moles of sodium hydroxide used in the titration.

moles of sodium hydroxide = _____ [2]

The balanced symbol equation for the reaction is:

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

(ii) Calculate the number of moles of ethanoic acid present in 25.0 cm^3 of the vinegar solution.

moles of ethanoic acid = _____ [1]

(iii) Calculate the concentration of the ethanoic acid solution in mol/dm^3.

concentration = _____ mol/dm^3 [1]

(iv) Calculate the concentration of the ethanoic acid solution in g/dm^3.
(Relative atomic masses: H = 1; C = 12; O = 16)

concentration = _____ g/dm^3 [2]

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For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
Total Marks	

Examiner Number

SYMBOLS OF SELECTED IONS

Positive ions

Name	Symbol
Ammonium	NH_4^+
Chromium(III)	Cr^{3+}
Copper(II)	Cu^{2+}
Iron(II)	Fe^{2+}
Iron(III)	Fe^{3+}
Lead(II)	Pb^{2+}
Silver	Ag^+
Zinc	Zn^{2+}

Negative ions

Name	Symbol
Butanoate	$C_3H_7COO^-$
Carbonate	CO_3^{2-}
Dichromate	$Cr_2O_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	$HCOO^-$
Nitrate	NO_3^-
Propanoate	$C_2H_5COO^-$
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}

SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

Soluble
All sodium, potassium and ammonium salts
All nitrates
Most chlorides, bromides and iodides EXCEPT silver and lead chlorides, bromides and iodides
Most sulfates EXCEPT lead and barium sulfates Calcium sulfate is slightly soluble

Insoluble
Most carbonates EXCEPT sodium, potassium and ammonium carbonates
Most hydroxides EXCEPT sodium, potassium and ammonium hydroxides
Most oxides EXCEPT sodium, potassium and calcium oxides which react with water

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Data Leaflet

Including the Periodic Table of the Elements

For the use of candidates taking
Science: Chemistry,
Science: Double Award
or Science: Single Award

Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations

gcse examinations

chemistry

For first teaching from September 2017

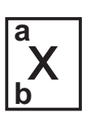
THE PERIODIC TABLE OF ELEMENTS

Group

1	2											3	4	5	6	7	0
1 **H** Hydrogen 1																	4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	98 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La*** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	210 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86
223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac†** Actinium 89	261 **Rf** Rutherfordium 104	262 **Db** Dubnium 105	266 **Sg** Seaborgium 106	264 **Bh** Bohrium 107	277 **Hs** Hassium 108	268 **Mt** Meitnerium 109	271 **Ds** Darmstadtium 110	272 **Rg** Roentgenium 111	285 **Cn** Copernicium 112						

* 58 – 71 Lanthanum series
† 90 – 103 Actinium series

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	145 **Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	231 **Pa** Protactinium 91	238 **U** Uranium 92	237 **Np** Neptunium 93	242 **Pu** Plutonium 94	243 **Am** Americium 95	247 **Cm** Curium 96	245 **Bk** Berkelium 97	251 **Cf** Californium 98	254 **Es** Einsteinium 99	253 **Fm** Fermium 100	256 **Md** Mendelevium 101	254 **No** Nobelium 102	257 **Lr** Lawrencium 103



a = relative atomic mass (approx)
x = atomic symbol
b = atomic number