Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2018

Double Award Science: Chemistry

Unit C2

Higher Tier

MV18

[GSD52]

WEDNESDAY 13 JUNE 2018, MORNING

Time

1 hour 15 minutes, plus your additional time allowance.

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 on blank pages.
Complete in black ink only. Answer **all eight** questions.

Information for Candidates

The total mark for this paper is 90.
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in Questions **2(a)** and **8(a)(i)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

1 This question is about the element sulfur and its compounds.

Sulfur is a poor conductor of heat.

(a) List three other physical properties of sulfur. [3 marks]

1. _____

2. _____

3. _____

(b) Heating a mixture of iron and sulfur in a boiling tube causes a chemical reaction to start.

(i) Describe two observations that can be made **after the heating has been stopped**. [2 marks]

1. _____

2. _____

(ii) Write a balanced symbol equation for the reaction of iron and sulfur. [2 marks]

_____

(c) Sulfur burns in oxygen to form sulfur dioxide.

(i) What colour is the flame when sulfur burns in oxygen? [1 mark]

_____

(ii) Which **one** of the following words best describes the smell of sulfur dioxide?

Circle the correct answer. [1 mark]

odourless

pungent

pleasant

sweet

(d) Acid rain is a major environmental issue worldwide.

(i) Coal burning power stations are one of the main sources of acid rain. Many of these power stations use chemical sprays in the chimneys to try to reduce or prevent acid rain pollution.

How do these chemical sprays reduce or prevent acid rain? [2 marks]

_____

_____

(ii) Describe two other methods of acid rain prevention. [2 marks]

1. _____

2. _____

2 **(a)** This question is about carbon dioxide and its role in global warming.

Describe:

- The physical properties of carbon dioxide
- The reaction of carbon dioxide with water and with limewater
- The role of carbon dioxide in global warming and the effects of global warming.

[6 marks]

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

The physical properties of carbon dioxide

The reaction of carbon dioxide with water and with limewater

The role of carbon dioxide in global warming and the effects of global warming

(b) A theory developed to explain the changing composition of the Earth's atmosphere suggests that the atmosphere was originally made up mainly of carbon dioxide. Give two reasons why the concentration of carbon dioxide in the atmosphere may have gradually decreased with time. [2 marks]

1.

2.

3 This question is about relative formula masses, moles and relative atomic masses.

(a) Calculate the relative formula mass of both of the following substances. [1 mark for each]

(relative atomic masses: H = 1, C = 12, N = 14, O = 16, Na = 23, S = 32)

(i) sodium sulfite Na_2SO_3

_____

(ii) ammonium carbonate $(NH_4)_2CO_3$

_____

(b) Complete the sentence below to show the relationship between relative formula mass and moles. [2 marks]

The relative formula mass of a substance _____

_____

_____

(c) Hydrated copper(II) sulfate, $CuSO_4.5H_2O$, has a relative formula mass of 250.

(i) How many moles would there be in 1 kg of hydrated copper(II) sulfate? [1 mark]

_____

(ii) If all of the water was removed from hydrated copper(II) sulfate, what would the relative formula mass be? Circle the correct answer. [1 mark]

245

240

232

160

64

(d) Phosphoric acid can be neutralised with sodium hydroxide.

$$H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$$

Relative formula masses:

phosphoric acid = 98 sodium phosphate = 164
sodium hydroxide = 40 water = 18

(i) If one mole of phosphoric acid was completely neutralised with sodium hydroxide, what mass of water would be produced? [1 mark]

_____ g

(ii) Calculate the maximum mass of sodium phosphate that could be produced when 40 g of sodium hydroxide is reacted with excess phosphoric acid. [2 marks]

_____ g

4 The rate of the reaction between calcium carbonate and hydrochloric acid can be studied by recording the volume of gas produced at different times.

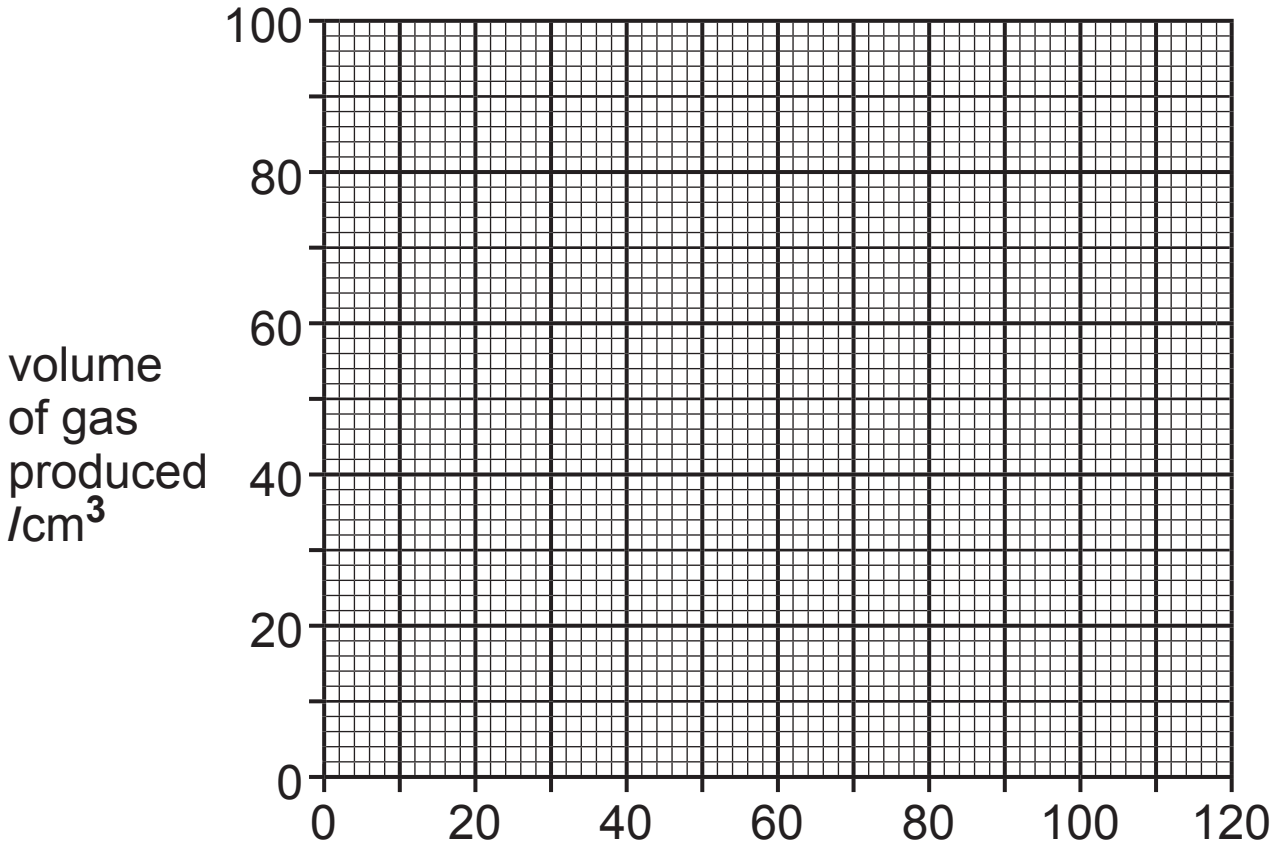
(a) Complete and balance the symbol equation below: [2 marks]

$CaCO_3$ + HCl → + +

(b) A group of students, investigating the rate at which gas was produced, obtained the following results:

Time *l*s	0	10	20	40	60	80	100	120
Volume of gas produced *l*cm^3	0	22	39	62	79	88	92	92

On the grid below, label the x-axis and plot a graph to show how the volume of gas produced changes with time. [4 marks]



(c) (i) Why was the volume of gas produced after 120 seconds the same as the volume produced after 100 seconds? [1 mark]

(ii) What volume of gas was produced between 40 seconds and 50 seconds? [1 mark]

(d) The students had used marble chips in their investigation. A different group used powdered calcium carbonate but found that the reaction happened too quickly to get many results.

Explain, using the collision theory, how using powdered calcium carbonate rather than marble chips increases the rate of this reaction. [3 marks]

5 This question is about the reactivity series of metals.

(a) When excess zinc metal is added to copper(II) sulfate solution the solution changes colour.

(i) What colour change is observed in the solution? [2 marks]

from _____ to _____

(ii) Why does the solution change colour? [1 mark]

_____

_____

(b) Zinc metal reacts with steam. Write a balanced symbol equation for this reaction. [2 marks]

_____

(c) Caesium is a Group 1 metal which reacts with water. Caesium is above potassium in the reactivity series of metals.

(i) Predict two observations, apart from bubbles of gas, which you would expect to make when caesium reacts with water. [2 marks]

1. _____

2. _____

(ii) Name and give the formula of the caesium compound formed when caesium reacts with water. [2 marks]

Name: _____

Formula: _____

(d) Caesium metal needs to be extracted from its ore.

(i) What method would need to be used to carry out this extraction? [1 mark]

_____

(ii) Why is this method needed to extract caesium? [1 mark]

_____

_____

6 This question is about crude oil and organic compounds.

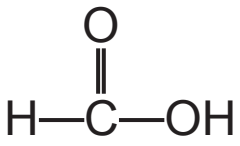
(a) Crude oil is a mixture of different hydrocarbons.

What is meant by the term hydrocarbon? [2 marks]

(b) During the process of fractional distillation, crude oil enters the bottom of a fractionating column as a hot gaseous mixture.

Explain **how** and **why** the hydrocarbons in crude oil separate into different fractions, such as petrol and diesel oil. [2 marks]

(c) Complete the missing information about two organic compounds. [4 marks]

Name	**Molecular formula**	**Structural formula**	**Physical state at room temperature**
propane	C_3H_8		
			liquid

(d) Polythene is one of the world's most important plastics. It is made by the addition polymerisation of the monomer ethene.

Write a balanced symbol equation, **using structural formulae**, for the addition polymerisation of ethene. [4 marks]

(e) Ethanoic acid is found in vinegar and it will react with some metals such as magnesium.

Describe two things that you would observe happening when some magnesium is added to a beaker containing ethanoic acid. [2 marks]

1. _____

2. _____

(f) Organic compounds which react similarly are grouped together in a homologous series.

(i) Which homologous series does ethanoic acid belong to? [1 mark]

_____

(ii) Ethanoic acid is described as a weak acid. Tick (✓) the box which best describes why ethanoic acid is a **weak acid**. [1 mark]

A it is not as concentrated as strong acids ☐

B it has a distinctive smell whereas strong acids have no smell ☐

C it reacts more slowly than strong acids because it has fewer H^+ ions ☐

D it is found in vinegar ☐

7 **(a)** This part of the question is about the combustion of propane. The reaction is described by the equation below:

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

Explain, in terms of the bonds that are broken and made **in this reaction**, why the burning of propane is exothermic. [5 marks]

(b) Hard water can be softened by a precipitation reaction. The equation below gives an example of a precipitation reaction that is used to soften water.

$$MgSO_4 + Na_2CO_3 \rightarrow MgCO_3 + Na_2SO_4$$

(i) Write an **ionic** equation, including state symbols, for the precipitation reaction when magnesium sulfate reacts with sodium carbonate. [3 marks]

(ii) What is meant by the term **precipitation reaction**? [2 marks]

8 **(a)** Iron is manufactured by the reduction of its ore, haematite, in a Blast Furnace. Haematite is mainly iron(III) oxide.

(i) Describe how iron is manufactured. [6 marks]

In your answer you should:

- Name the other raw materials which are needed
- Describe how the reducing agent is produced in the Blast Furnace
- Describe how the iron is removed from the Blast Furnace
- Describe what happens to the acidic impurities, including how they are removed

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

(ii) Write a balanced symbol equation to show how iron is produced by the reduction of iron(III) oxide.
[3 marks]

(b) Aluminium is produced by electrolysis of its oxide.

The key reactions which happen can be summarised by the half equations below:

$Al^{3+} + 3e^- \rightarrow Al$ $\qquad$ $2O^{2-} - 4e^- \rightarrow O_2$

Explain clearly, by referring to the equations above, why the production of aluminium from aluminium oxide can be described as a redox reaction. [3 marks]

THIS IS THE END OF THE QUESTION PAPER

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
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
Carbonate	CO_3^{2-}
Dichromate	$Cr_2O_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogen carbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	$HCOO^-$
Nitrate	NO_3^-
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

Rewarding Learning

DATA LEAFLET

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.

Contents **Page**

gcse
science
chemistry
double award
single award

Rewarding Learning

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	99 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	263 Sg Seaborgium 106	262 Bh Bohrium 107	265 Hs Hassium 108	266 Mt Meitnerium 109	269 Ds Darmstadtium 110	272 Rg Roentgenium 111	285 Cn Copernicium 112						

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

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

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 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