Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2024–2025

Single Award Science: Chemistry

Unit 2

Higher Tier

[GSA22]

GSA22

MONDAY 19 MAY 2025, MORNING

TIME

1 hour.

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 questions in black ink and use a dark HB pencil for drawings and graphs.
Do not write with a gel pen.
Answer **all nine** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 60.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
You may use a scientific calculator.
Quality of written communication will be assessed in Question **2**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

14886

20GSA2201

1 In recent years local councils have tried to reduce the amount of waste produced. In 2005, **1 064 090** tonnes of waste were produced and in 2020, **913 546** tonnes of waste were produced.

(a) Calculate the decrease in the amount of waste produced from 2005 to 2020.

_____ tonnes [1]

(b) Local councils also tried to increase the amount of waste that is recycled. The table below shows the recycling targets that were set by local councils and the percentages of waste actually recycled between 2005 and 2020.

Year	Waste recycling target /%	Waste actually recycled /%
2005	15.0	17.0
2010	35.0	35.5
2015	40.0	41.0
2020	45.0	52.0

(i) Give **one** trend shown by this information.

_____

_____ [1]

(ii) In which year did local councils **exceed** their target by the greatest percentage?

_____ [1]

(c) It is important to recycle plastics because most are non-biodegradable.

(i) What is meant by the term **non-biodegradable**?

_____

_____ [1]

(ii) Explain why it is important to reduce the amount of waste being sent to landfill.

_____

_____ [1]

2 Sodium and potassium are alkali metals that react with cold water.
Describe how a teacher could demonstrate these reactions to their students.

Your answer should include:

- how to carry out the demonstration safely;
- **two** similarities in the observations made during these reactions; and
- **two** differences in the observations made during these reactions.

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

[6]

BLANK PAGE

DO NOT WRITE ON THIS PAGE

(Questions continue overleaf)

3 **(a)** Complete the following sentences about crude oil.

Crude oil is a fossil fuel formed from the remains of animals that died

_____ of years ago. It is a mixture of hydrocarbons

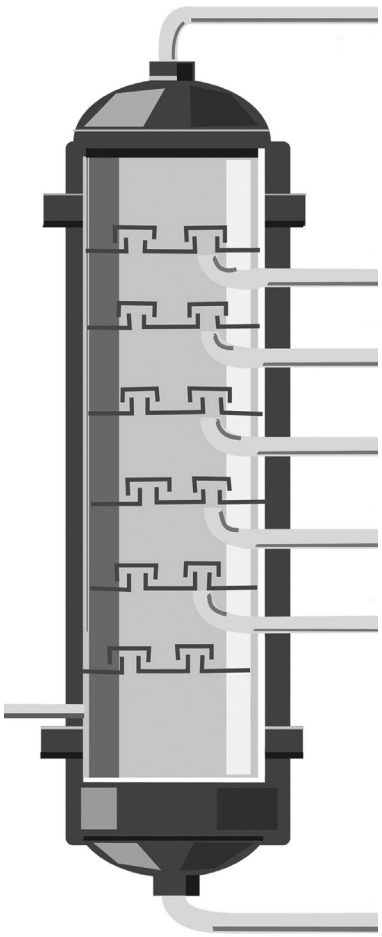
which are compounds that contain only the elements

_____ and _____ .

[2]

Different hydrocarbons are separated from crude oil by fractional distillation.

(b) Complete the diagram below to name the chemical used for fuel in jet engines and **one** use for bitumen. [2]



Refinery gas – used for fuels in gas ovens

Petrol – used as fuel in cars

Naphtha – used for making chemicals

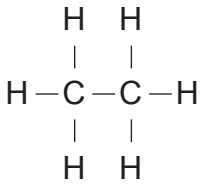
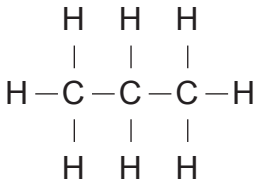
[ ] – used for fuel in jet engines

Diesel – used as fuel in cars and lorries

Fuel oil – used for fuel in ships

Bitumen – used for [ ]

(c) (i) Complete the table below about some hydrocarbons.

Name	Molecular formula	Structural formula
butane	C_4H_{10}	
	C_2H_6	
propane		

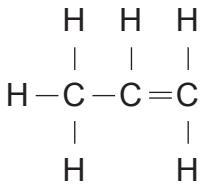
[3]

(ii) Pentane is a hydrocarbon that contains five carbon atoms.
How many hydrogen atoms will be in a molecule of pentane?

_____ [1]

[Turn over

(d) The diagram below shows the structural formula of propene (C_3H_6).



(i) Name the homologous series that propene belongs to.

_____ [1]

(ii) What is the general formula for this group of hydrocarbons?

_____ [1]

(iii) Polypropene can be formed when monomers of propene join together. What name is given to this **type** of reaction?

_____ [1]

4 In 1869 the Russian chemist Dmitri Mendeleev created the framework that would become the modern Periodic Table. Below is part of his table of elements.

I									
H	II	III	IV	V	VI	VII			
Li	Be	B	C	N	O	F			
Na	Mg	Al	Si	P	S	Cl			
K	Ca		Ti	V	Cr	Mn	Fe	Co	Ni
Cu	Zn			As	Se	Br			
Rb	Sr	Y	Zr	Nb	Mo		Ru	Rh	Pd

One feature of Mendeleev's periodic table was that the elements were placed in groups.

(a) Give **two** other features of Mendeleev's table.

1. _____

_____

2. _____

_____ [2]

One group of elements in the modern Periodic Table was **not** included in Mendeleev's table.

(b) Name this group of elements and explain why they had not been discovered by 1869.

_____

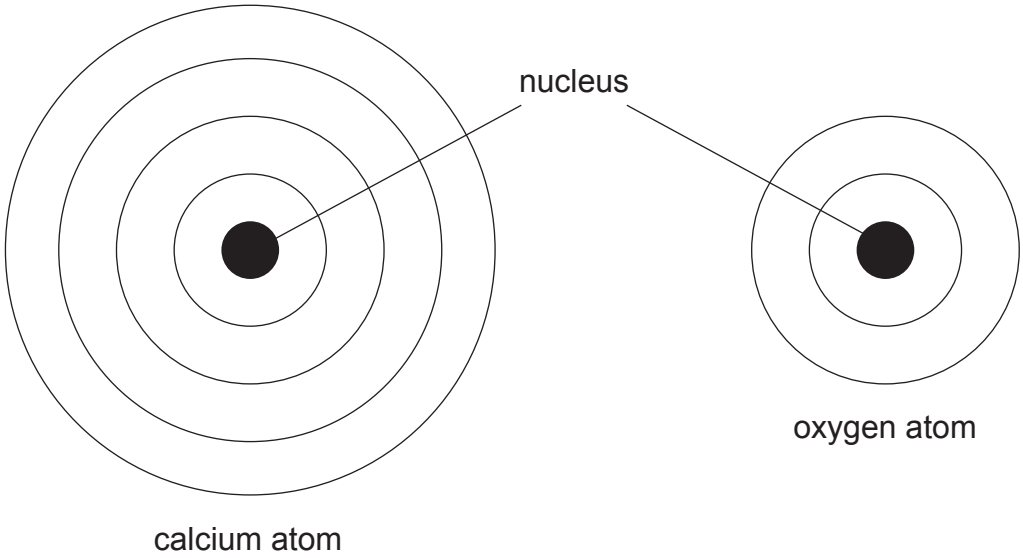
_____

_____ [2]

[Turn over

5 **(a)** An atom of calcium has 20 electrons and an atom of oxygen has 8 electrons.

(i) Complete the diagrams below to show how the electrons are arranged in a calcium atom and an oxygen atom.



[2]

(ii) Explain, in terms of electrons, how the atoms of calcium and oxygen react to form the compound calcium oxide.

_____

_____

_____ [2]

(b) Calcium and oxygen react together to form an ionic bond.

(i) Balance the symbol equation below for this reaction.

$$Ca + O_2 \longrightarrow CaO$$

[1]

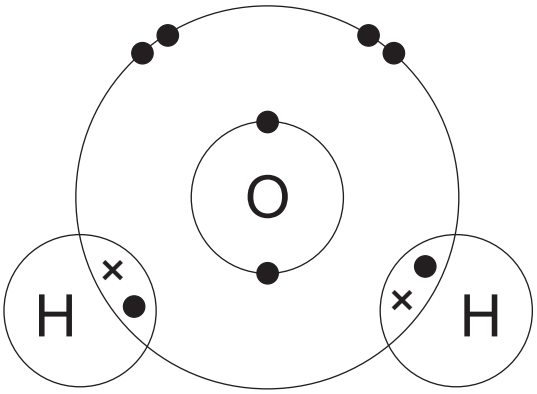
(ii) Explain why ionic bonds are strong.

_____

_____ [1]

14886

(c) The diagram below shows the bonding between hydrogen and oxygen in a molecule of water.



(i) Name the type of bonding in a molecule of water.

_____ [1]

(ii) How many lone pairs of electrons are shown in the diagram above?

_____ [1]

[Turn over

6 **(a)** Thermochromic and photochromic materials are two examples of smart materials.

(i) What is meant by the term **smart material**?

_____

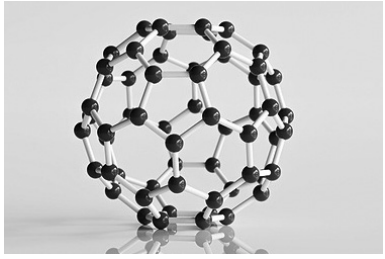
_____ [2]

(ii) One similarity between thermochromic and photochromic materials is that they can both change colour. Explain the **difference** between these materials.

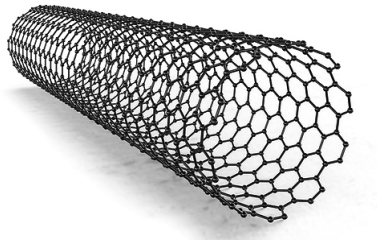
_____

_____ [1]

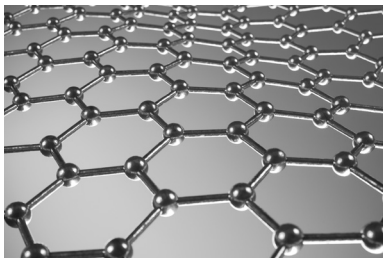
(b) Shown below are the structures of three nanomaterials.



A



B



C

(i) Which structure, **A**, **B** or **C**, is graphene?

_____ [1]

(ii) Name the element that graphene is made from.

_____ [1]

(iii) Nanomaterials contain nanoparticles which are 1–100 nanometres in size. What size is a nanometre?

_____ m [1]

7 Aluminium carbonate, $Al_2(CO_3)_3$, is a compound containing three elements.

(a) Complete the table below giving the number of atoms of each element represented by the formula, $Al_2(CO_3)_3$.

Element	Number of atoms
carbon	3
oxygen	
aluminium	

[2]

Sodium oxide, Na_2O, is another compound. It contains the elements sodium and oxygen.

(b) Complete the table below about the number of protons, electrons and neutrons in an atom of sodium (Na), in an atom of oxygen (O) and in sodium oxide (Na_2O).

	Sodium (Na)	Oxygen (O)	Sodium oxide (Na_2O)
protons	11	8	30
electrons			
neutrons	12	8	

[2]

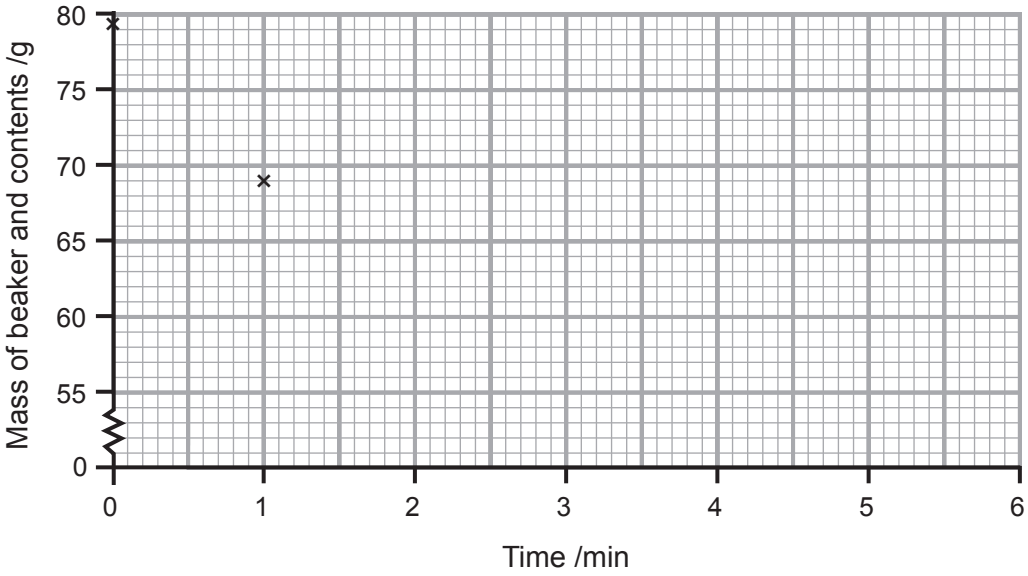
[Turn over

8 **(a)** A student investigated the reaction between sodium hydrogencarbonate and hydrochloric acid in a beaker. He measured the mass of the beaker and its contents at the start and then every minute for six minutes.

His results are shown below.

Time /min	0	1	2	3	4	5	6
Mass of beaker and contents /g	79.5	69.0	64.5	61.0	59.0	58.5	58.0

(i) On the grid below, plot and draw a line graph for these results.
The first two points are plotted for you.



[3]

(ii) Use the results to explain how the student knows the reaction is **not** finished.

_____

_____ [1]

(iii) Calculate the change in mass during this reaction.

_____ g [1]

14886

The reaction produces carbon dioxide.

(b) Describe the chemical test used to identify carbon dioxide.

_____

_____ [2]

The student repeated this investigation using sodium hydrogencarbonate and ethanoic acid.

(c) Give **one** similarity and **one** difference between the reaction of sodium hydrogencarbonate with ethanoic acid and with hydrochloric acid.

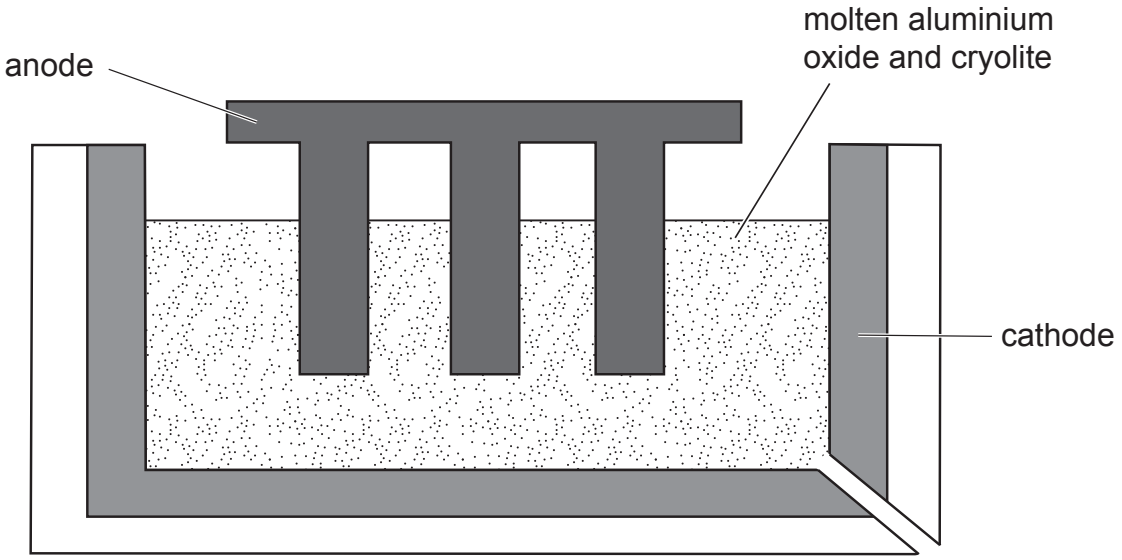
Similarity _____

_____

Difference _____

_____ [2]

9 Electricity can be used to extract aluminium from aluminium oxide. Some of the electricity provides energy to melt the aluminium oxide and keep it molten. The chemical cryolite is added to make the process more cost effective.



(a) What name is given to the process of using electricity to extract aluminium?

_____ [1]

(b) Explain, in terms of ions, why the aluminium oxide must be **molten**.

_____

_____ [1]

The table below gives the melting points of some chemicals involved in this process.

Chemical	Melting point /°C
aluminium	660
aluminium oxide	2072
cryolite	1012
aluminium oxide and cryolite mixture	960

(c) Use this information to explain why the addition of cryolite makes this process more cost effective.

_____

_____ [2]

(d) Aluminium is produced at the cathode and oxygen is produced at the anode.

(i) Name a suitable material from which the anode and cathode could be made.

_____ [1]

(ii) Complete the ionic equation for the production of aluminium at the cathode.

_____ + _____ $\longrightarrow$ Al

[2]

THIS IS THE END OF THE QUESTION PAPER

BLANK PAGE

DO NOT WRITE ON THIS PAGE

BLANK PAGE

DO NOT WRITE ON THIS PAGE

Sources:
Q3(b) . . . © Spencer Sutton / Science Source / Science Photo Library
Q4 . . . . Principal Examiner
Q5(a)(i) . . Principal Examiner
Q5(c) . . . Principal Examiner
Q6(b) . . . © Thom Leach / Science Source / Science Photo Library
. . . . © Kateryna Kon / Science Source / Science Photo Library
. . . . . .© Getty Images
Q9 . . . . Principal Examiner

DO NOT WRITE ON THIS PAGE

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total Marks	

Examiner Number

Permission to reproduce all copyright material has been applied for.
In some cases, efforts to contact copyright holders may have been unsuccessful and CCEA will be happy to rectify any omissions of acknowledgement in future if notified.

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

© CCEA 2017

COUNCIL FOR THE CURRICULUM, EXAMINATIONS AND ASSESSMENT
29 Clarendon Road, Clarendon Dock, Belfast BT1 3BG
Tel: +44 (0)28 9026 1200 Fax: +44 (0)28 9026 1234
Email: info@ccea.org.uk Web: www.ccea.org.uk

Rewarding Learning

Rewarding Learning

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

11984.02

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						

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

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

a X b

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

11984.02