



Rewarding Learning

General Certificate of Secondary Education
2022–2023

Centre Number

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Candidate Number

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Single Award Science: Chemistry

Unit 2

Higher Tier



[GSA22]

GSA22

MONDAY 22 MAY, 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 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 60.

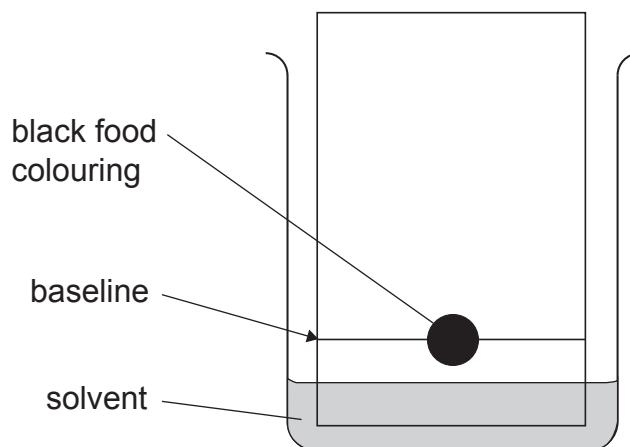
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in Question **1(a)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is included for your use.



- 1 (a) A student used the apparatus shown below to investigate the soluble dyes present in black food colouring.



Describe how the student would use this apparatus to carry out the experiment.

Your answer should include:

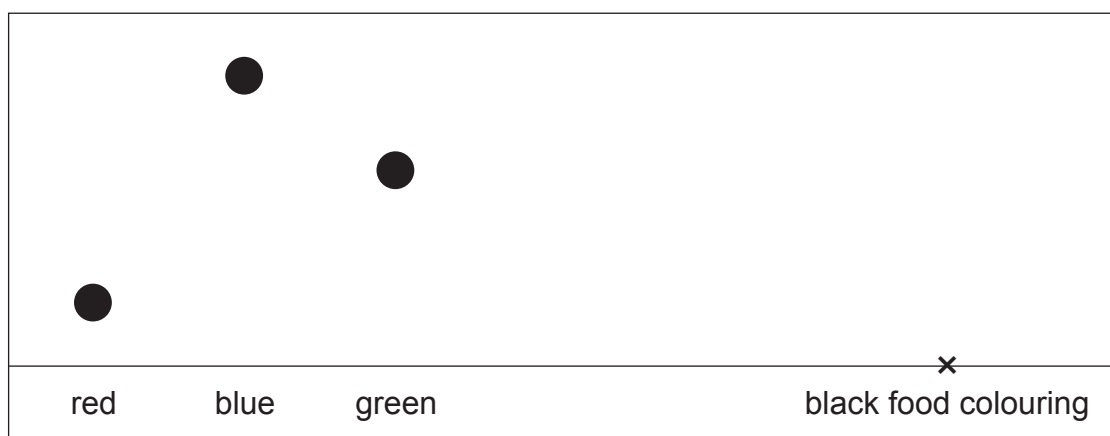
- the name of this separation technique;
- a description of the set-up and method; and
- an explanation of how this set-up prevents spoiling the results.

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



[6]

- (b) The student found that black food colouring contains the red and blue dyes shown below.



- (i) On the diagram above draw the results the student would expect to see at the end of his investigation. [1]

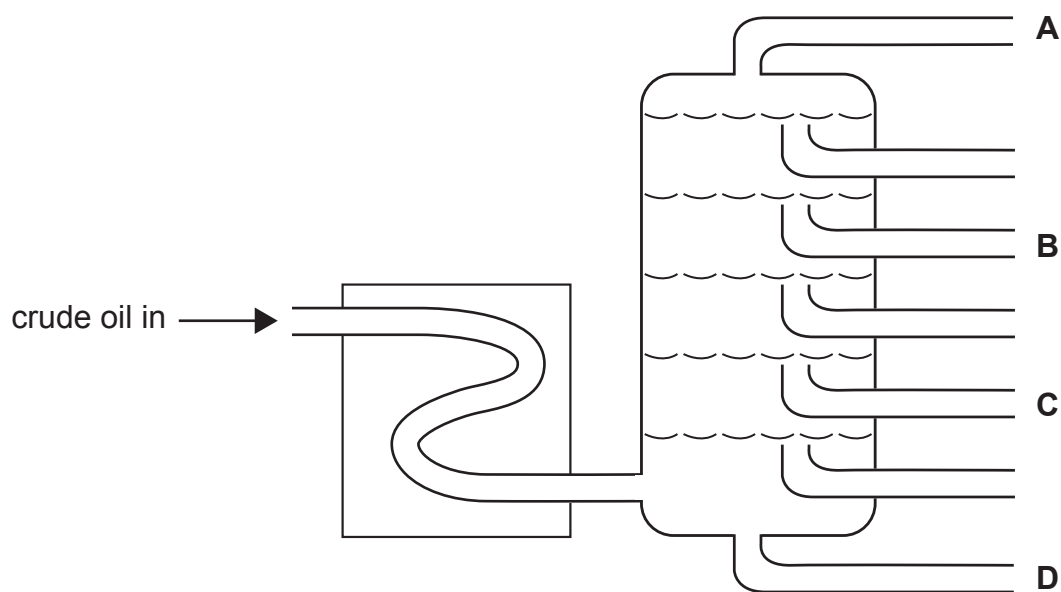
- (ii) Which of these coloured dyes (red, blue or green) is the most soluble?

_____ [1]

[Turn over



- 2 Crude oil can be separated into its different fractions using a fractionating column as shown below.



- (a) Which letter (**A**, **B**, **C** or **D**) shows where refinery gas is collected?

_____ [1]

- (b) What name is given to the process which separates crude oil into different fractions?

_____ [1]

- (c) Describe how this process separates crude oil into its different fractions.

_____ [3]



(d) Refinery gas contains methane and ethane.

(i) Name the homologous series (family) that methane and ethane belong to.

_____ [1]

(ii) In the space below, draw the structural formula for ethane (C_2H_6).



[1]

(iii) Complete the word equation below for the combustion of ethane.



[2]

[Turn over



- (e) The table below shows the percentages of some gases in the exhaust of a diesel car engine.

Gas	Percentage/%
nitrogen	77.00
oxygen	12.50
carbon dioxide	5.50
water vapour	3.00
carbon monoxide	0.50
nitrogen oxides	0.25
sulfur dioxide	0.05
other gases	

- (i) Calculate the percentage of **other gases** found in the exhaust of a diesel car engine.

(Show your working out.)

_____ % [2]

- (ii) Name the **compound**, shown in the table, that makes up the largest percentage of the exhaust gases.

_____ [1]



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(Questions continue overleaf)

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[Turn over



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- 3 The table below gives the melting point and boiling point of five substances.

Substance	Melting point /°C	Boiling point /°C
ethanol	−130	79
iron oxide	1460	1565
water	0	100
ammonia	−78	−33
sodium chloride	801	1465

- (a) What is meant by the term **boiling point**?

_____ [1]

- (b) Using information from the table and your knowledge answer the following questions.

- (i) Name the substance with the **lowest** melting point.

_____ [1]

- (ii) Name the substance which will be in a **liquid** state at −20 °C.

_____ [1]

- (iii) In what state will ammonia be at room temperature (20 °C)?

_____ [1]

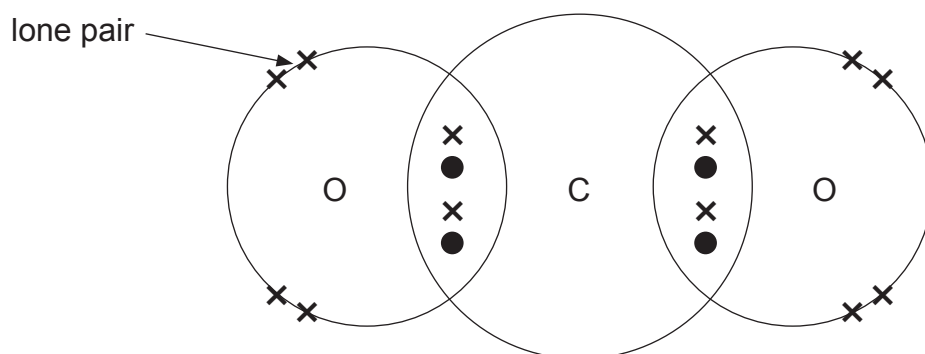
Another substance, carbon dioxide, sublimes at −78 °C.

- (c) What is meant by the term **sublime**?

_____ [1]



- (d) The diagram below shows the bonding in a molecule of carbon dioxide. Only the outer electron shells are drawn.



- (i) Name the type of bonding between carbon and oxygen as shown in the diagram.

_____ [1]

- (ii) A lone pair of electrons is labelled on the diagram above. What is meant by the term **lone pair**?

 _____ [1]

[Turn over]



- 4 (a) The image below shows Dmitri Mendeleev, the scientist who was responsible for developing the first periodic table in 1869.



Source: © Getty Images

- (i) Give **one** similarity in the arrangement of the elements in Mendeleev's table and the modern Periodic Table.

[1]

- (ii) Complete the sentence below.

Mendeleev arranged the elements in order of atomic _____.

[1]



(b) The table below gives the melting point of some Group 7 elements.

Element	Atomic number	Melting point /°C
fluorine	9	–220
chlorine	17	–101
bromine	35	–7
iodine	53	

(i) What name is given to Group 7 elements?

_____ [1]

(ii) State the trend shown by the information in the table.

_____ [1]

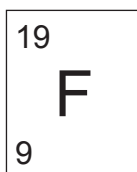
(iii) Predict the melting point of iodine.

_____ °C [1]

[Turn over



(c) Fluorine is represented on the Periodic Table as shown below.



(i) Complete the table below about an atom of fluorine.

Particle	Number	Relative charge
proton	9	+1
neutron		
electron		

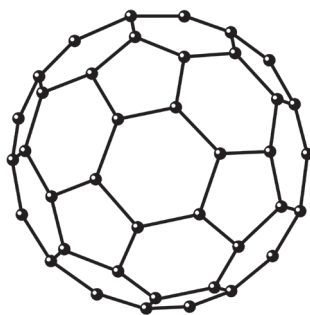
[2]

(ii) Explain how an **ion** of fluorine is formed from a fluorine atom.

[2]



- 5 Fullerene is a new nanomaterial made of carbon. The diagram below shows a fullerene molecule.



Source: © Getty Images

Fullerene has photochromic properties and can be used in protective eyewear such as sunglasses.

Nanotechnology involves the use of very small particles which are only a few nanometres across.

- (a) What size is a nanometre?

_____ m [1]

- (b) What is meant by the term **photochromic**?

_____ [2]

- (c) Name **one** other nanomaterial made of carbon.

_____ [1]

- (d) Give **two** reasons why some people may be concerned about the use of nanomaterials.

1. _____

2. _____
_____ [2]

[Turn over]

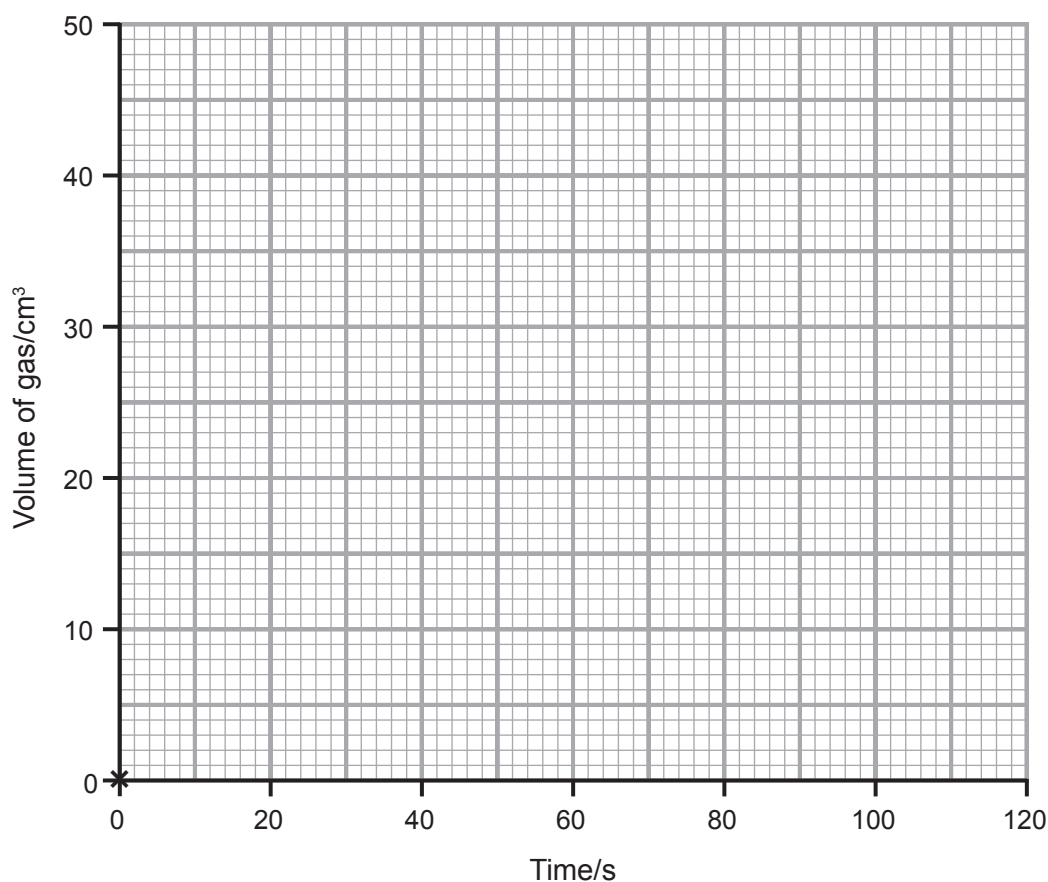


- 6 (a) A student investigated the rate of reaction between calcium carbonate powder and dilute hydrochloric acid by measuring the volume of gas produced over two minutes.

The results are shown below.

Time/s	0	20	40	60	80	100	120
Volume of gas/cm ³	0.0	18.5	36.0	43.5	45.0	45.0	45.0

- (i) On the grid below plot and draw a line graph for these results. The first point has been plotted for you.



[3]

- (ii) Describe fully the trend shown by these results.

[2]



(iii) Use the equation:

$$\text{rate of reaction} = \frac{\text{volume of gas}}{\text{time taken}}$$

to calculate the rate of this reaction during the first **20 seconds**.
Give your answer to 1 decimal place.

(Show your working out.)

_____ cm³/s [2]

(iv) The student repeated the investigation, but doubled the temperature.
Predict the volume of gas that would be collected during the first
20 seconds.

_____ cm³ [1]

(b) Explain, in terms of particles, why the rate of a reaction will **increase** if a more
concentrated acid is used.

_____ [3]

[Turn over



- 7 (a) Ethene is a colourless gas with the formula C_2H_4 . Polythene is a plastic made by heating ethene at high pressure in the presence of a catalyst.

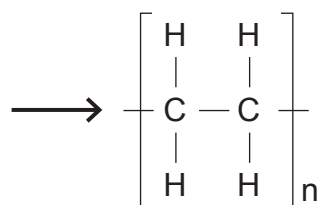
(i) What is meant by the term **catalyst**?

_____ [2]

(ii) Name the type of reaction that is used to make polythene.

_____ [1]

- (b) Complete the balanced symbol equation below to show the formation of polythene from ethene.



[2]

- (c) Give **one** way of disposing of plastics and describe **one** problem associated with this method of disposal.

_____ [2]

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Question Number	Marks
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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	$\text{C}_3\text{H}_7\text{COO}^-$
Carbonate	CO_3^{2-}
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	HCOO^-
Nitrate	NO_3^-
Propanoate	$\text{C}_2\text{H}_5\text{COO}^-$
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}

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

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

gcse examinations chemistry

THE PERIODIC TABLE OF ELEMENTS

Group

																0																			
1		2																		4															
7	Li Lithium 3	9	Be Beryllium 4																	2	He Helium 2														
23	Na Sodium 11	24	Mg Magnesium 12																	10	Ne Neon 10														
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



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

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