Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2023–2024

# Single Award Science: Chemistry

Unit 2

Higher Tier

**[GSA22]**

*GSA22*

**WEDNESDAY 22 MAY 2024, 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 eight** 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 **3**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included for your use.

14362

*20GSA2201*

**1** **(a)** Nanotechnology can be used to create clothing with enhanced features such as UV protection and anti-odour properties. It can also be used to create clothing that is more environmentally friendly.

Nano-titanium dioxide adds sun protection to clothing just as it does in sun creams. Nano-silver is woven into fabric to give it anti-bacterial properties, killing the bacteria that make clothes smell due to sweat.

While scientists studying nanomaterials think they have the potential to change the way we live, there are also some concerns about their use.

Use this information and your knowledge to answer the following questions.

**(i)** Give **one** advantage of using nano-silver in clothing. Explain your answer.

_____

_____

_____ [2]

**(ii)** Give **one** advantage of using nanoparticles in sun creams.

_____

_____ [1]

**(iii)** Why are some scientists concerned about the use of nanomaterials?

_____

_____ [1]

**(b)** Shown below is a baby bottle made from a smart material.

This smart material is a plastic that changes colour from blue to red when hot liquid is added.

**(i)** What name is given to this type of smart material?

_____ [1]

**(ii)** Suggest why using this type of smart material makes the bottle safer when feeding a baby.

_____

_____ [1]

**[Turn over**

**2** **(a)** The table below gives information about four hydrocarbons.

| Hydrocarbon | Number of carbon atoms | Melting point/°C | Boiling point/°C |
|---|---|---|---|
| methane | 1 | –182.0 | –161.0 |
| ethane | 2 | –183.0 | –88.0 |
| propane | 3 | –188.0 | –42.0 |
| butane | 4 | –138.0 | –0.5 |

**(i)** Name the hydrocarbon with the highest **melting** point.

_____ [1]

**(ii)** Describe the trend in **boiling** point as the number of carbon atoms changes.

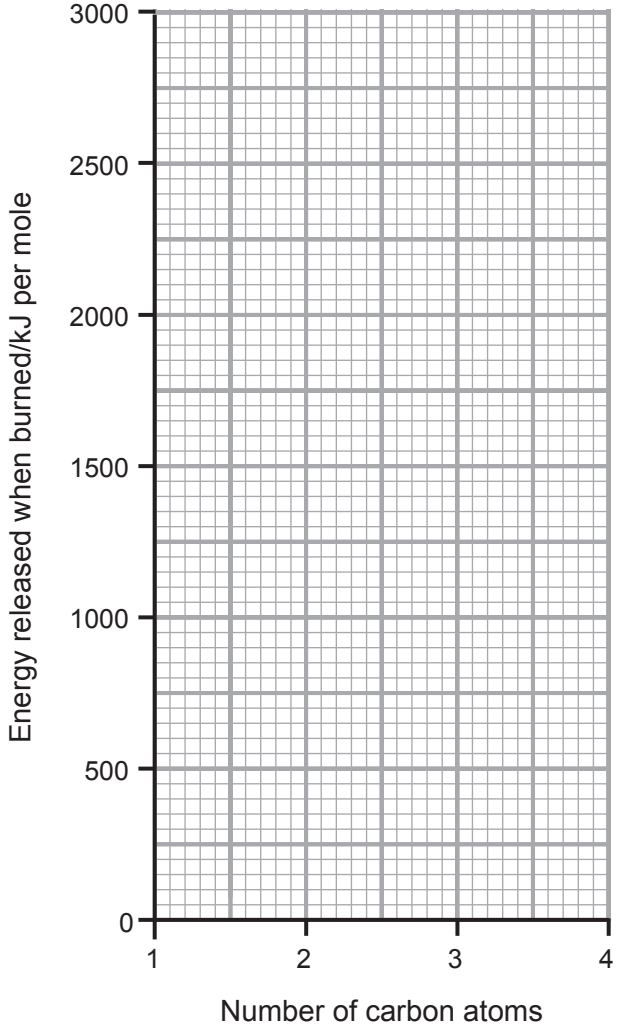
_____

_____ [1]

**(b)** The table below gives the energy released when the four hydrocarbons burn.

| Hydrocarbon | Number of carbon atoms | Energy released when burned/ kJ per mole |
|---|---|---|
| methane | 1 | 900 |
| ethane | 2 | 1550 |
| propane | 3 | 2200 |
| butane | 4 | 2850 |

**(i)** On the grid below plot and draw a **line graph** to show this information.




[3]

**(ii)** Pentane is a hydrocarbon with **five** carbon atoms. Predict the energy released when pentane is burned.

_____ kJ per mole [1]

**(c)** Complete the word equation for the combustion of methane.

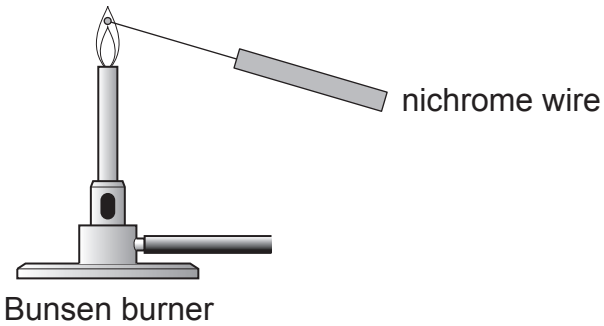
methane + oxygen ⟶ [ ] + [ ]

[2]

**[Turn over**

**3** Different metal ions produce different flame colours when they are heated strongly.

Describe how you would use the apparatus below to carry out a flame test to identify two samples, one containing potassium ions and one containing calcium ions.




Your answer should include:

- a description of the method;
- **one** safety precaution; and
- the results you would expect to see when each sample is tested.

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

[6]

[Turn over

**4** The table below gives some information about the reactions of five metals with water.

| Metal | Reaction with cold water | Reaction with hot water or steam |
|---|---|---|
| **A** | no reaction | reacts very slowly |
| **B** | very slow reaction | reacts readily |
| **C** | no reaction | no reaction |
| **D** | violent reaction | extremely violent reaction |
| **E** | no reaction | reacts slowly |

**(a)** Use information from the table to put the metals **A**, **B**, **C**, **D** and **E** in order of **decreasing** reactivity. The first one has been done for you.

**D**

_____

_____

_____

_____

_____

[2]

**(b)** Which metal **A**, **B**, **C**, **D** or **E** would be most suitable for making water pipes in a house?

_____ [1]

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**(Questions continue overleaf)**

**5** The table below gives some information about the different particles found in an atom.

**(a)** Complete the table.

| Particle | Relative charge | Relative mass | Location |
|---|---|---|---|
| electron | | $\frac{1}{1840}$ | |
| neutron | 0 | | nucleus |
| proton | +1 | 1 | |

[2]

Magnesium and fluorine are represented in the Periodic Table as shown below.

| | |
|---|---|
| 24<br>Mg<br>12 | 19<br>F<br>9 |

Magnesium reacts with fluorine to produce magnesium fluoride ($MgF_2$).

**(b)** Complete the table below to give the number of electrons and neutrons in magnesium, fluorine, and magnesium fluoride.

| Particle | Magnesium (Mg) | Fluorine (F) | Magnesium Fluoride ($MgF_2$) |
|---|---|---|---|
| proton | 12 | 9 | 30 |
| electron | | | |
| neutron | | | |

[3]

**(c)** Magnesium is found in Group 2 of the Periodic Table.

**(i)** What **name** is given to this group?

_____ [1]

Fluorine is a halogen.

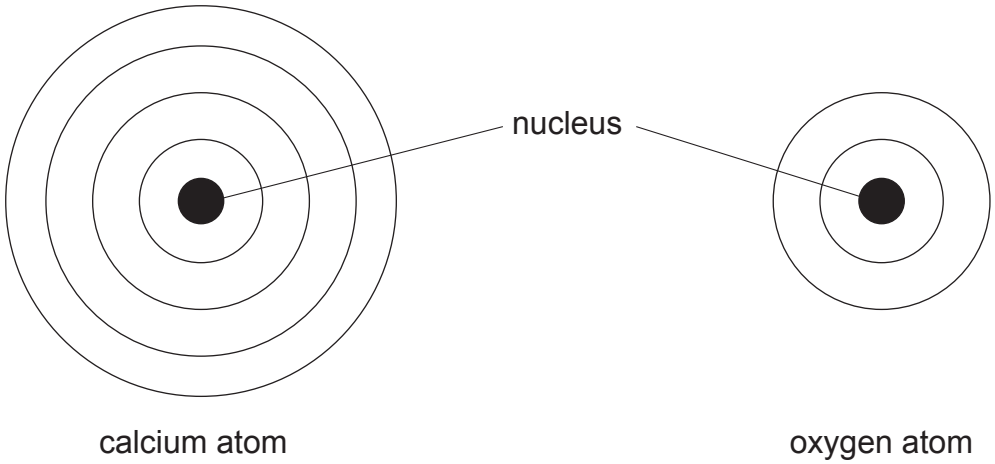
**(ii)** What group **number** is given to the halogens in the Periodic Table?

_____ [1]

**6** **(a)** Calcium and oxygen react together to form the compound calcium oxide.

**(i)** Complete the diagrams below to show the arrangements of all the electrons in a calcium atom and an oxygen atom.

(You may find your Data Leaflet useful.)




[2]

**(ii)** Describe, in terms of electrons, how calcium oxide is formed from calcium and oxygen atoms.

_____

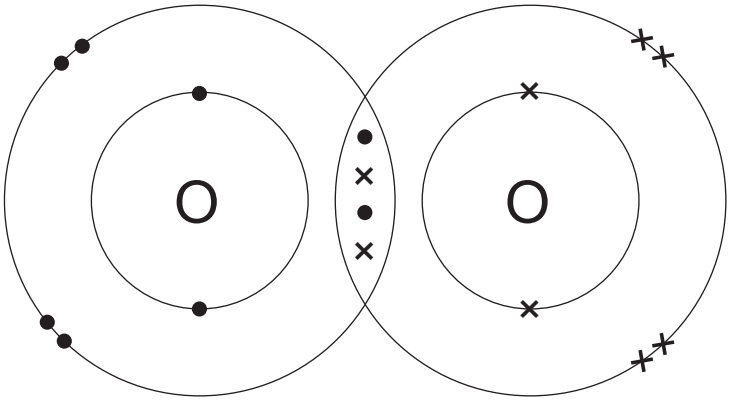
_____

_____ [2]

**(iii)** What is the formula for an oxide ion?

_____ [1]

**(b)** The dot and cross diagram below shows the electrons in a molecule of oxygen ($O_2$).




**(i)** Name the type of bonding present in a molecule of oxygen.

_____ [1]

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

_____ [1]

**(iii)** Name a **compound** that has the same type of bonding as oxygen.

_____ [1]

**[Turn over**

**7** **(a)** Magnesium reacts with dilute hydrochloric acid to produce a salt and hydrogen.

**(i)** What is the name of the salt produced in this reaction?

_____ [1]

**(ii)** Describe how a student could prove that the gas produced is hydrogen.

_____

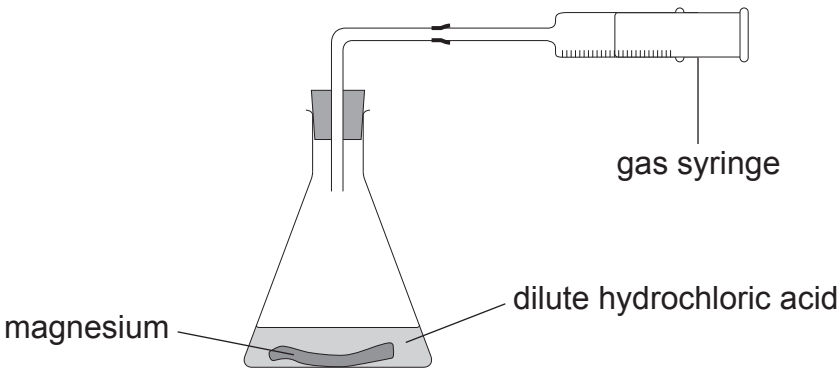
_____ [1]

**(iii)** Complete the balanced symbol equation below for the test for hydrogen.

$$H_2 \quad + \quad O_2 \longrightarrow$$

[2]

**(b)** The student investigated the rate of reaction between magnesium and dilute hydrochloric acid, using the apparatus shown below and a stopwatch.




**(i)** What **two** measurements should be recorded to allow the student to determine the rate of reaction?

_____

_____

_____ [2]

**(ii)** Another student carried out the same investigation at a **higher temperature** and found that this increased the rate of reaction. Explain, in terms of particles, why this reaction was faster.

_____

_____

_____

_____ [3]

**(iii)** Apart from increasing temperature, give **one** other way the student could increase the rate of this reaction.

_____ [1]

**(c)** Some reactions are described as exothermic. What is meant by the term **exothermic**?

_____ [1]

**8** **(a)** Alkanes and alkenes are hydrocarbons.

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

_____

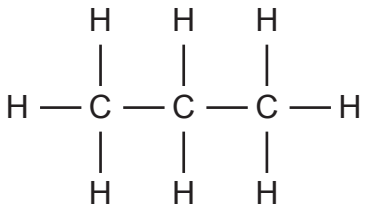
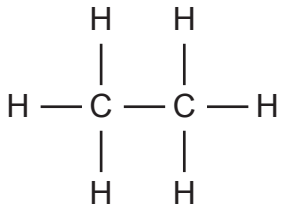
_____

_____ [2]

**(ii)** Alkanes and alkenes can be separated from crude oil. What name is given to this separation process?

_____ [1]

**(b)** **(i)** Complete the table below about different hydrocarbons.

| Hydrocarbon | Molecular formula | Structural formula |
|---|---|---|
| propane | |  |
| | $C_2H_6$ |  |
| ethene | $C_2H_4$ | |

[3]

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**(ii)** What state is ethene at room temperature?

_____ [1]

**(c)** Burning hydrocarbons causes an increase in the amount of greenhouse gases in the atmosphere.
Give **one** effect of increasing amounts of greenhouse gases.

_____

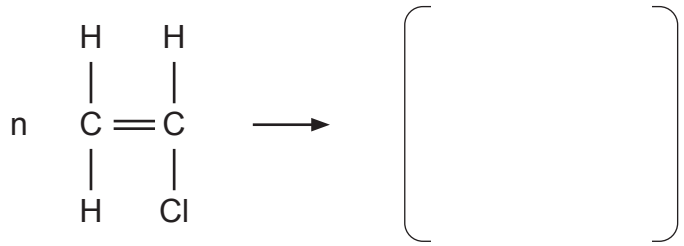
_____ [1]

**(d)** The monomer chloroethene can be used to make polyvinylchloride (PVC).

**(i)** What name is given to this process?

_____ [1]

**(ii)** Complete the balanced symbol equation below for the production of PVC.




[2]

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

**Examiner Number**

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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 | $C_3H_7COO^-$ |
| 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<br>EXCEPT silver and lead chlorides, bromides and iodides |
| Most sulfates EXCEPT lead and barium sulfates<br>Calcium sulfate is slightly soluble |

| Insoluble |
|---|
| Most carbonates<br>EXCEPT sodium, potassium and ammonium carbonates |
| Most hydroxides<br>EXCEPT sodium, potassium and ammonium hydroxides |
| Most oxides<br>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

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

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