



*Rewarding Learning*

General Certificate of Secondary Education  
2019

Centre Number

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Candidate Number

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## GCSE Chemistry

Unit 1

Higher Tier

<b>MV24</b>
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[GCM12]

TUESDAY 28 MAY, AFTERNOON

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### **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 five** questions.

## Information for Candidates

The total mark for this paper is 80.

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 Question **5(a)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

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**(Questions start overleaf)**

1 The element sulfur is found on the Earth's surface particularly in volcanic regions such as Sicily. The atomic number of sulfur is 16.

(a) (i) What is meant by the term element?  
[1 mark]

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(ii) What is meant by the term atomic number? [1 mark]

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(b) A sample of sulfur from a volcanic rock was analysed to give the following percentage abundance of its isotopes.

Isotope	Percentage abundance
$^{32}\text{S}$	95.02
$^{33}\text{S}$	0.76
$^{34}\text{S}$	4.22

- (i) Calculate the relative atomic mass for the sample of sulfur. Show your working out and give your answer to **one** decimal place. [3 marks]

Relative atomic mass = \_\_\_\_\_

- (ii) Explain what is meant by relative in the term relative atomic mass.  
[1 mark]

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(iii) Describe how an atom of  $^{33}\text{S}$  is different from an atom of  $^{34}\text{S}$ .  
[1 mark]

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(c) Complete the table below. [2 marks]

<b>Atom/ion</b>	<b>Number of protons</b>	<b>Number of neutrons</b>	<b>Number of electrons</b>
$^{32}\text{S}$			
$^{34}\text{S}^{2-}$			

**(d)** A volcanic rock found in Sicily contains a compound made up of magnesium, silicon and oxygen. A sample of this compound was found to contain 1.80 g of magnesium, 1.05 g of silicon and 2.40 g of oxygen.

Determine the empirical formula of this compound. [4 marks]

Show your working out.

Empirical formula: \_\_\_\_\_

**2** The elements of Period 2 are listed below.

lithium

beryllium

boron

carbon

nitrogen

oxygen

fluorine

neon

**(a)** Lithium burns in air to form lithium oxide.

**(i)** Write a balanced symbol equation for the reaction which occurs when lithium burns in air. [3 marks]

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**(b)** Lithium also reacts with fluorine. In this reaction fluorine molecules form fluoride ions.

Write a half equation for the formation of fluoride ions from a fluorine molecule.  
[3 marks]

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**(c)** Carbon reacts with oxygen to form carbon dioxide. Draw dot and cross diagrams to show the bonding in an oxygen molecule and the bonding in a carbon dioxide molecule. [2 marks]

oxygen

carbon dioxide

**(d)** Carbon has several allotropes including diamond, graphite and graphene.

**(i)** What is meant by the term allotropes?  
[2 marks]

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**(ii)** State one difference between the structure of graphite and the structure of graphene. [1 mark]

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**(e)** Fluorine forms a compound with oxygen called oxygen difluoride,  $\text{OF}_2$ .

**(i)** Name the type of bonding found in a molecule of oxygen difluoride.  
[1 mark]

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**(ii)** Oxygen difluoride reacts very slowly with water to form hydrofluoric acid and oxygen gas. Write a balanced symbol equation for this reaction.  
[3 marks]

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**(f)** Lithium, carbon (in the form of diamond) and fluorine have very different melting points. The differences in melting points are the result of different types of structure and different forces or bonding between the particles in the structures.

Complete the table opposite. [6 marks]

	<b>Lithium</b>	<b>Carbon (diamond)</b>	<b>Fluorine</b>
<b>Melting point (°C)</b>	181	3550	-220
<b>Structure</b>	metallic lattice		
<b>Forces or bonding broken on melting</b>		covalent bonding	
<b>Particles between which the forces or bonding are acting</b>			molecules

**3** Chlorine and hydrated aluminium sulfate,  $\text{Al}_2(\text{SO}_4)_3 \cdot x\text{H}_2\text{O}$ , are both used in water treatment to make fresh water potable.

**(a) (i)** What is potable water? [1 mark]

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**(ii)** Why is chlorine used in water treatment? [1 mark]

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**(iii)** Describe the test for chlorine gas. [3 marks]

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**(iv)** Why is aluminium sulfate used in water treatment? [1 mark]

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**(b)** The following method may be used to prepare hydrated aluminium sulfate.

- Measure out  $25\text{ cm}^3$  of dilute sulfuric acid into a beaker
- Warm the acid and add spatula measures of aluminium oxide until it is in excess
- Remove the excess aluminium oxide by filtration
- Slowly evaporate the aluminium sulfate solution

**(i)** What piece of apparatus is used to measure out  $25\text{ cm}^3$  of dilute sulfuric acid? [1 mark]

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**(ii)** How is the excess aluminium oxide removed? [1 mark]

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**(iii)** Write the balanced symbol equation for the reaction of aluminium oxide and sulfuric acid. Include state symbols. [4 marks]

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**(iv)** What does  $x\text{H}_2\text{O}$  represent in the formula  $\text{Al}_2(\text{SO}_4)_3 \cdot x\text{H}_2\text{O}$ ? [1 mark]

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**(v)** Explain why dilute sulfuric acid is a strong acid. [1 mark]

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**(vi)** What is the effect on pH of decreasing the concentration of a solution of sulfuric acid? [1 mark]

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(c) In an experiment, 12.60 g of hydrated aluminium sulfate crystals,  $\text{Al}_2(\text{SO}_4)_3 \cdot x\text{H}_2\text{O}$ , were heated to constant mass. The anhydrous aluminium sulfate formed had a mass of 6.84 g.

Calculate the value of  $x$  in  $\text{Al}_2(\text{SO}_4)_3 \cdot x\text{H}_2\text{O}$ .  
[4 marks]

Show your working out.

$x =$  \_\_\_\_\_

4 When experimenting with manganese(IV) oxide and compounds of the elements yttrium and indium, scientists accidentally discovered a new blue pigment. The new blue colour was named 'YInMn blue' after the elements it contained. It is being used as a new colour for crayons.

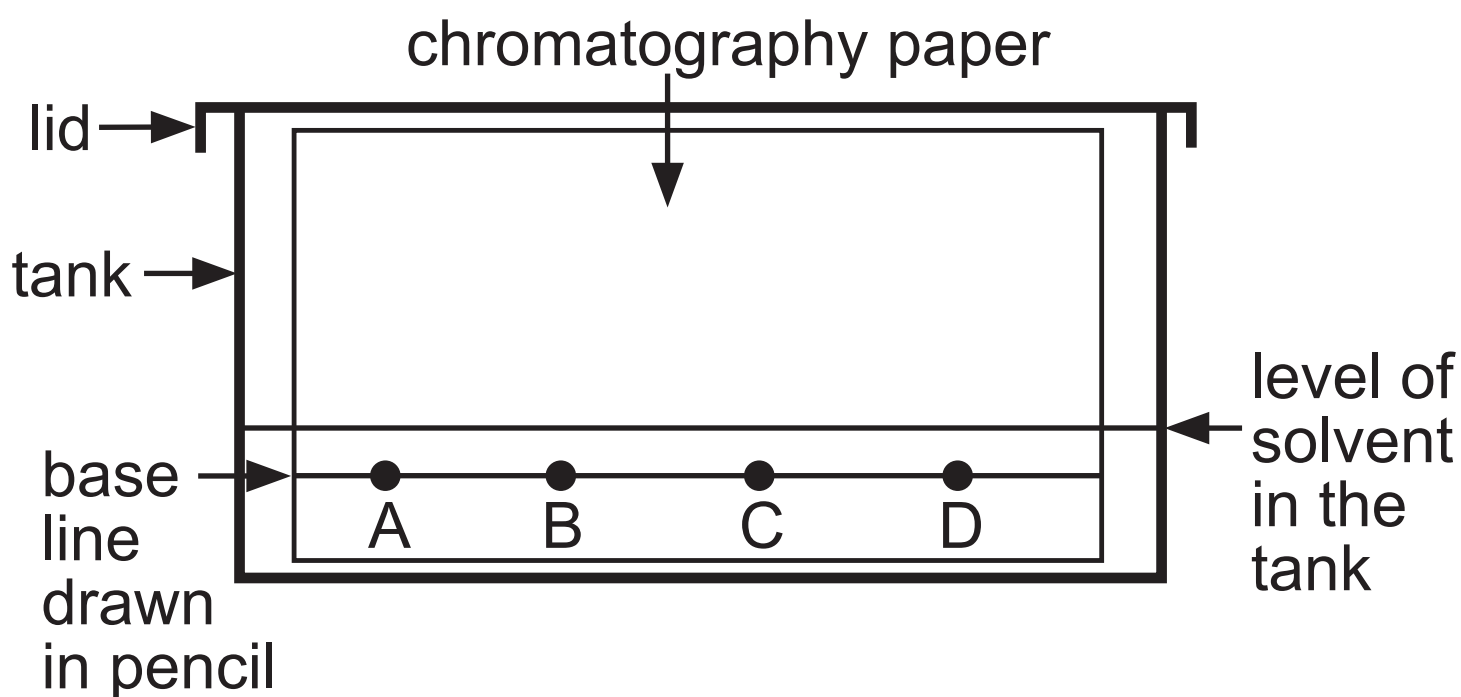
(a) Name the block of elements in the Periodic Table which form coloured compounds. [1 mark]

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(b) Complete the table below. [3 marks]

<b>Substance</b>	<b>Colour</b>
copper(II) oxide powder	
copper(II) nitrate solution	
calcium chloride solution	

(c) A student used chromatography to analyse a coloured pigment. The student set up the apparatus as shown in the diagram below. A is a coloured pigment and B, C and D are spots of pure dyes.



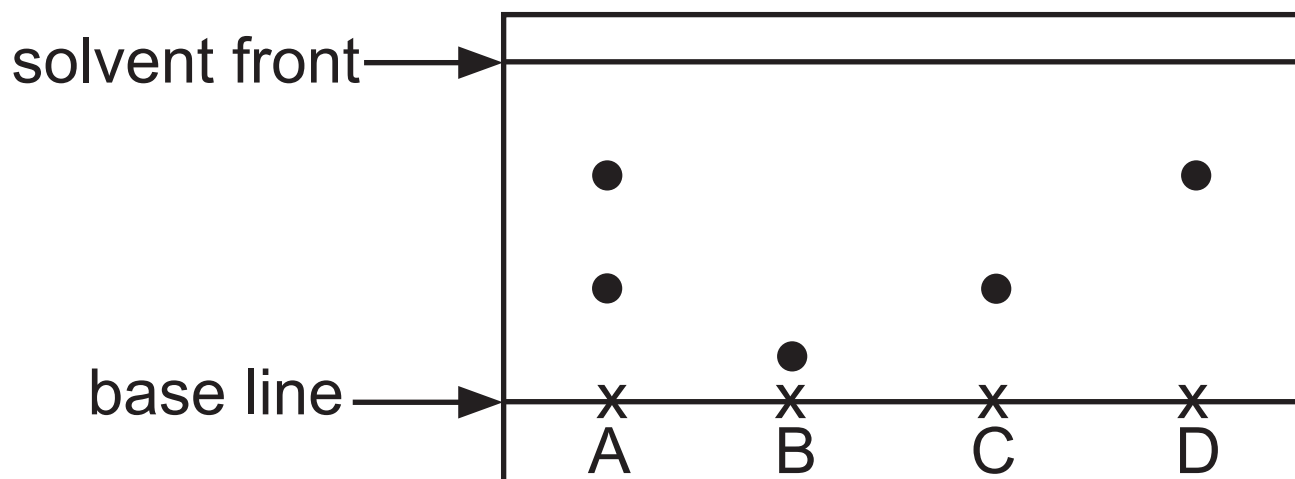
The student made an error in setting up the experiment. Identify the error and state the effect it would have.

[2 marks]

Error \_\_\_\_\_

Effect \_\_\_\_\_

(d) A different student set up the same experiment correctly and obtained the chromatogram below.



(i) Using a ruler, take measurements from the chromatogram and use them to calculate an  $R_f$  value for spot C. [3 marks]

$R_f$  value = \_\_\_\_\_

**(ii)** Explain which pure dye (B, C or D) is least soluble in the solvent.  
[1 mark]

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**5 (a)** An investigation was carried out into the displacement reactions of the halogens. Bromine was added to a test tube containing sodium iodide solution and in a separate test tube chlorine was added to sodium bromide solution. A reaction occurred in both test tubes.

State and explain what the student found out. In your answer you should include:  
[6 marks]

- word equations for the chemical reactions
- an order of reactivity, from most reactive to least reactive, of the halogens shown by these reactions
- an explanation of the order of reactivity of the halogens in terms of electronic configuration.



**(b)** Some analytical tests were carried out to identify the ions present in several compounds. Write the **formula** of the anion or cation present based on the results of the analytical tests given below.

**(i)** A white precipitate is produced on adding a few drops of barium chloride solution to a salt solution. [1 mark]

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**(ii)** A white precipitate is produced on adding a few drops of sodium hydroxide solution to a salt solution. The white precipitate remains when excess sodium hydroxide solution is added. [1 mark]

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**(iii)** On adding dilute nitric acid to a solid salt, a gas is produced which changes limewater from colourless to milky. [1 mark]

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**(iv)** A flame test was carried out on a solid salt and a crimson flame was observed. [1 mark]

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**This is the end of the question paper**

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For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
<b>Total Marks</b>	

Examiner Number

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## SYMBOLS OF SELECTED IONS

### Positive ions

Name	Symbol
Ammonium	$\text{NH}_4^+$
Chromium(III)	$\text{Cr}^{3+}$
Copper(II)	$\text{Cu}^{2+}$
Iron(II)	$\text{Fe}^{2+}$
Iron(III)	$\text{Fe}^{3+}$
Lead(II)	$\text{Pb}^{2+}$
Silver	$\text{Ag}^+$
Zinc	$\text{Zn}^{2+}$

### Negative ions

Name	Symbol
Butanoate	$\text{C}_3\text{H}_7\text{COO}^-$
Carbonate	$\text{CO}_3^{2-}$
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$
Ethanoate	$\text{CH}_3\text{COO}^-$
Hydrogencarbonate	$\text{HCO}_3^-$
Hydroxide	$\text{OH}^-$
Methanoate	$\text{HCOO}^-$
Nitrate	$\text{NO}_3^-$
Propanoate	$\text{C}_2\text{H}_5\text{COO}^-$
Sulfate	$\text{SO}_4^{2-}$
Sulfite	$\text{SO}_3^{2-}$



New  
Specification

## 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

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

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

$\begin{matrix} a \\ \boxed{X} \\ b \end{matrix}$  a = relative atomic mass (approx)  
 x = atomic symbol  
 b = atomic number

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