GCSE

WJEC GCSE
The Sciences (Double Award)

Approved by Qualifications Wales

Sample Assessment Materials

Unit 5: Chemistry - Chemical Bonding, Reactions and Resources
Higher Tier

Teaching from 2026
For award from 2028

This Qualifications Wales regulated qualification is not available to centres in England.

Made for Wales.
Ready for the world.

WJEC would like to thank the students and teachers of Fitzalan High School, Cardiff and Llanwern High School, Newport for their participation in the creation of these covers.

Contents

Surname	Centre number	Candidate number
First name(s)		0

GCSE

3455UE

The Sciences (Double Award) – Unit 5 Chemistry – Chemical Bonding, Reactions and Resources

HIGHER TIER
1 hour 15 minutes
SAMPLE ASSESSMENT MATERIALS

Additional materials

A calculator and ruler are permitted.

Instructions to candidates

Use black ink or black ball-point pen. Do **not** use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces provided at the top of this page.

Answer **all** questions.

For examiner's use only		
Question	**Maximum mark**	**Mark awarded**
1.	**8**	
2.	**8**	
3.	**7**	
4.	**14**	
5.	**14**	
6.	**13**	
Total	**64**	

Write your answers in the spaces in this booklet. If you need more space, use the additional page(s) at the back of this booklet. Number the question(s) correctly.

Information for candidates

The number of marks is given in brackets at the end of each question or part-question.

The total number of marks available is **64.**

You should think carefully about how you use your time.

Your responses must be clear, accurate and well presented.

Answer **all** questions.

Examiner only

1. (a) Crude oil can be separated into simpler mixtures called fractions. The table show information about the main fractions obtained from crude oil.

Fraction	Number of carbon atoms in fraction	Boiling point range (°C)	Colour of fraction	Flame when burning	Ease of burning
petroleum gases	1-4	<20	colourless	clean	very easy
petrol	5-8	30-70	pale yellow	clean	easy
naphtha	9-12	70-180	yellow	some smoke	quite easy
kerosene	13-16	180-250	dark yellow	smoky	quite difficult
diesel oil	17-20	250-340	orange brown	smoky	quite difficult
lubricating oil	20-24	340-500	brown	very smoky	difficult
fuel oil	25-28	500-580	brown black	very smoky	very difficult

(i) Name the process used to separate crude oil into fractions. [1]

…….....

(ii) Decane has a boiling point of 174°C. Give the name of the fraction which contains decane. [1]

…….....

(iii) One alkane is found in both diesel oil and lubricating oil. Give the number of carbon atoms in this alkane. [1]

…….....

Examiner only

(iv) Put a **tick** (✓) in the box next to the **two** statements that describe how the properties of the fractions change as the chain length increases. [2]

they are darker in colour and are easier to burn	☐
their boiling points increase, and they are more difficult to burn	☐
their flames are less smoky, and their boiling points increase	☐
their boiling points decrease, and they are lighter in colour	☐
they are darker in colour, and their flames are smokier	☐
their boiling points increase, and their flames are less smoky	☐

(b) Oil companies make good use of all fractions and use a process called cracking to split molecules with long chains into molecules with shorter chains.

The alkane $C_{20}H_{42}$ can be cracked forming propene, nonene and **one molecule** of hydrocarbon **A**.

(i) Complete the equation for the cracking of $C_{20}H_{42}$. [1]

$$C_{20}H_{42} \longrightarrow \underset{\text{propene}}{C_3H_6} + \underset{\text{nonene}}{C_9H_{18}} + \underset{\text{hydrocarbon A}}{\text{.....}}$$

(ii) State the **two** conditions needed for cracking. [1]

…….....

Examiner only

(c) Petrol is commonly used as a fuel for cars.

The photograph shows firefighters using foam to put out a car engine fire.

Explain how this method puts out the fire. [1]

.....

.....

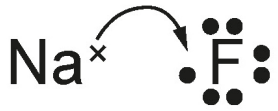
8

Examiner only

2. (a) The table shows the electronic structure of the elements present in sodium fluoride.

Element	Electronic structure
sodium	2,8,1
fluorine	2,7

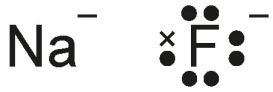
The diagram shows the electron transfer that occurs when sodium reacts with fluorine to form sodium fluoride. The **x** and ● symbols are outer shell electrons.



(2,8,1) (2,7)

A student was asked to draw a diagram showing the electronic structures and charges on the ions formed. There are **two** mistakes in the student's answer.

student's answer:



(2,8) (2,8,8)

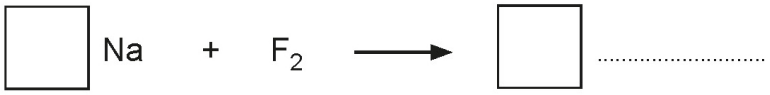
(i) Circle the **two** mistakes in the student's answer and write the corrections below. [2]

(ii) Name the type of bonding found in sodium fluoride. [1]

……

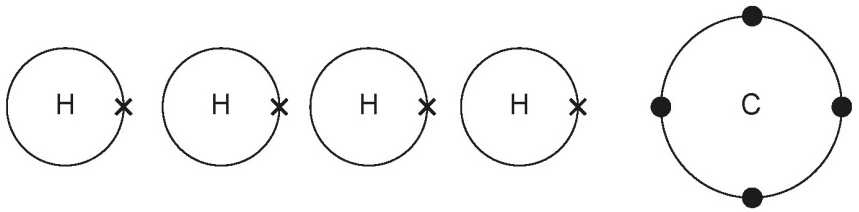
Examiner only

(iii) Complete the equation for the reaction between sodium and fluorine by:
- giving the formula for sodium fluoride
- inserting numbers into the boxes to balance the equation [2]



(b) Pembroke Power Station is the largest gas-fired power station in Europe. It uses natural gas to generate electricity. The chemical energy stored in natural gas, which is mainly methane, CH_4, is converted successively into thermal energy, mechanical energy and, finally, electrical energy.

The ● and **x** symbols in the diagram represent the outer shell electrons in atoms of hydrogen and carbon.



(i) Draw a dot and cross diagram to show the bonding in a molecule of methane, CH_4. [2]

(ii) Name the type of bonding found in methane. [1]

…….....

8

Examiner only

3. (a) A teacher wanted to find out the position of four metals, **A**, **B**, **C** and **D**, in the reactivity series.

She heated each metal in turn with oxides of the other three. The results were as follows.

A reduced the oxide of **C**

B reduced the oxide of **A**

B reduced the oxide of **C**

D reduced the oxide of **B**

Place the metals in order of reactivity. [2]

Most reactive .....

.....

.....

Least reactive .....

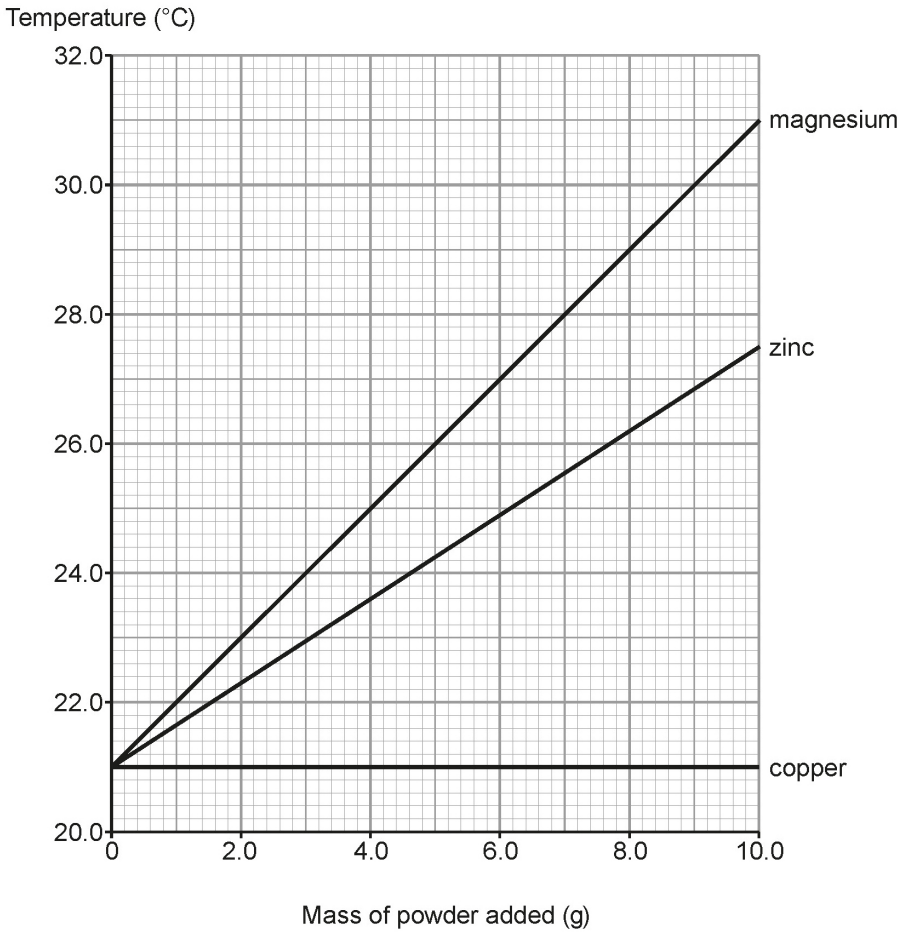
Examiner only

(b) The teacher decided to investigate metal reactivity using a different method.

She added 10.0 g of magnesium powder in 2.0 g portions to 50 cm^3 of iron(II) sulfate solution and recorded the temperature of the mixture after each addition.

She then repeated the experiment with zinc powder and again with copper powder.

The graphs of her results are shown below.



(i) State the conclusions that can be drawn about the reactivities of magnesium, zinc, copper and iron. Give your reasoning. [3]

……

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……

Examiner only

(ii) Aluminium is more reactive than copper and zinc, but less reactive than magnesium.

Circle the temperature you would expect to record after adding 5.0 g of aluminium to 50 cm^3 of the iron(II) sulfate solution. [1]

23.0°C **25.0°C** **27.0°C** **29.0°C**

(iii) Name the products formed in the reaction between zinc and iron(II) sulfate. [1]

…… and ……

7

Examiner only

4. (a) The molecular formulae of six carbon compounds, **A**-**F**, are shown below.

C_2H_6	C_2H_5OH	C_4H_8	C_3H_6	C_3H_8	CH_4
A	**B**	**C**	**D**	**E**	**F**

(i) Give the **letters** of the compounds with the general formula C_nH_{2n+2}. [1]

.....

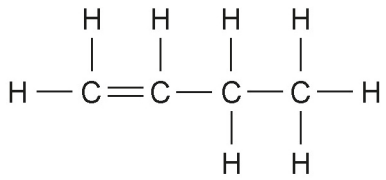
(ii) Give the **name** of compound **A**. [1]

.....

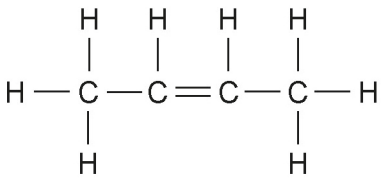
Examiner only

(b) Isomers are compounds that have the same molecular formula but different structural formulae.

C_4H_8 has three isomers. The diagrams below show two of the three isomers.



but-1-ene



but-2-ene

The third isomer is methylpropene. Draw its structure. [1]

(c) Ethene is the simplest alkene. It is an unsaturated hydrocarbon.

(i) Describe how bromine water can be used to distinguish between ethane and ethene.

Give the expected observations for **both** compounds. [2]

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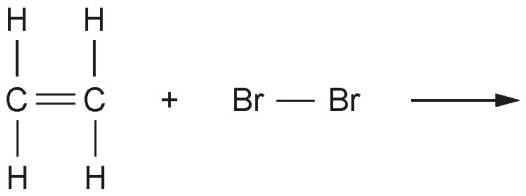
……

Examiner only

(ii) Complete the equation for the reaction between ethene and bromine. Give the name of the product formed. [2]



Name of product .....

(d) Recent research from Wrap Cymru estimates that 400 000 tonnes of plastic waste is generated in Wales each year, of which 67% is packaging waste.

Explain how plastic waste results in microplastic particles being found on beaches in the remotest parts of the world.

In your answer you should refer to the relevant property of plastics such as polyethene. [4]

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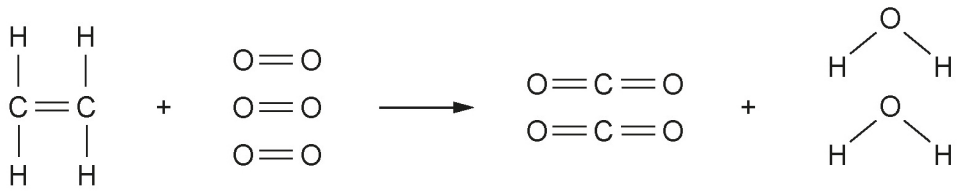
Examiner only

(e) The burning of ethene in air can be represented by the following equation.



Some of the bond energies are given in the table.

Bond	Bond energy (kJ)
O – H	464
C = O	805

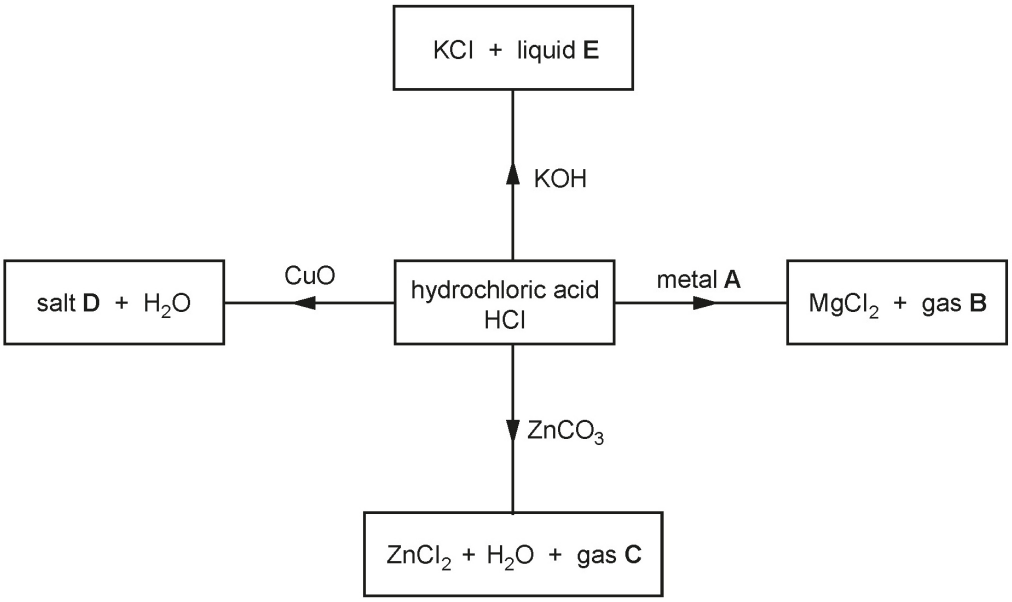
The total energy needed to break all the bonds in the reactants is 3758 kJ.

Use the bond energy values to show that the overall energy change for the reaction is –1318 kJ. [3]

14

Examiner only

5. (a) The diagram shows some reactions of hydrochloric acid, HCl.



Use the information in the diagram to answer parts (i) and (ii).

(i) Give the chemical **names** of substances **A**, **B** and **C**. [3]

metal **A** .....

gas **B** .....

gas **C** .....

(ii) Give the **formulae** of substances **D** and **E**. [2]

salt **D** .....

liquid **E** .....

(iii) Calculate the percentage by mass of zinc in zinc carbonate, $ZnCO_3$. [2]

Examiner only

$A_r(Zn) = 65$ $A_r(C) = 12$ $A_r(O) = 16$

Percentage = ……%

(b) The reaction between sodium carbonate and dilute nitric acid, HNO_3, can be represented by the following equation.

sodium carbonate	+	nitric acid	→	sodium nitrate	+	water	+	carbon dioxide

Use this information to write the balanced symbol equation for the reaction. [3]

……..

(c) A white salt is thought to be either potassium bromide or potassium sulfate.

A group of students are asked to find out which one it is.

(i) One suggested carrying out a flame test on the salt.

Explain why a flame test would not be helpful. [2]

…….

…….

…….

Examiner only

(ii) Another student suggested dissolving some of the salt in water and testing for sulfate ions.

Describe the test for sulfate ions and give the **two** possible observations. [2]

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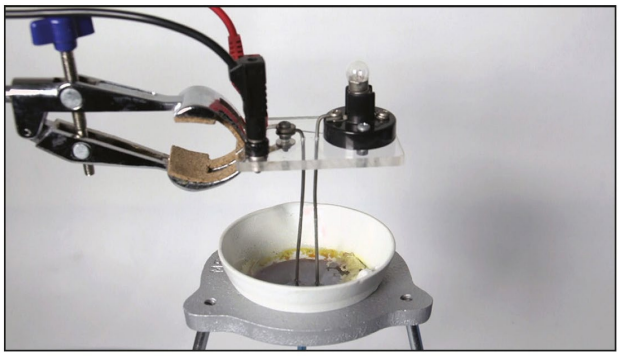
……..

14

Examiner only

6. (a) The photograph shows how the electrolysis of molten zinc chloride can be carried out in the laboratory.



(i) State why the zinc chloride must be molten to be electrolysed. [1]

……

(ii) Explain the formation of zinc at the negative electrode. [3]

……

……

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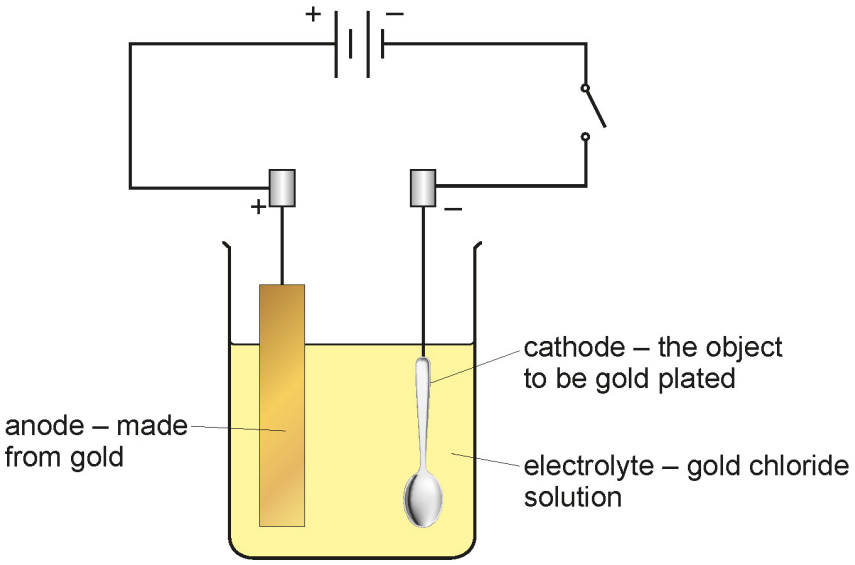
……

Examiner only

(b) Ashford Chroming has been providing high-quality gold plating services in the Cardiff area for over 20 years. They specialise in providing plating services to local car enthusiasts, motorcycle clubs and more.

The diagram shows how gold plating can be carried out in the laboratory.



The reactions taking place at each of the electrodes are given below.

at the anode: $Au \rightarrow Au^{3+} + 3e^-$

at the cathode: $Au^{3+} + 3e^- \rightarrow Au$

Explain how these reactions show both oxidation and reduction. [3]

……

……

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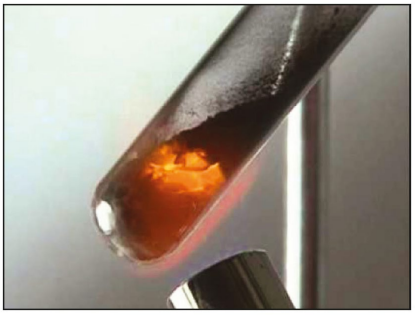
Examiner only

(c) The photograph shows how copper can be extracted from copper(II) oxide in the laboratory by heating it with carbon.



The equation for the reaction taking place is given below.

$$2CuO + C \rightarrow CO_2 + 2Cu$$

A group of students were asked to predict the mass of copper that can be produced from 3.18 g of copper(II) oxide.

The answers they each predicted were as follows:

Student	Answer (g)
Student **A**	2.4-2.5
Student **B**	2.5-2.6
Student **C**	2.6-2.7

Find which student made the correct prediction.

[3]

You must show your working.

A_r(Cu) = 63.5 A_r(O) = 16

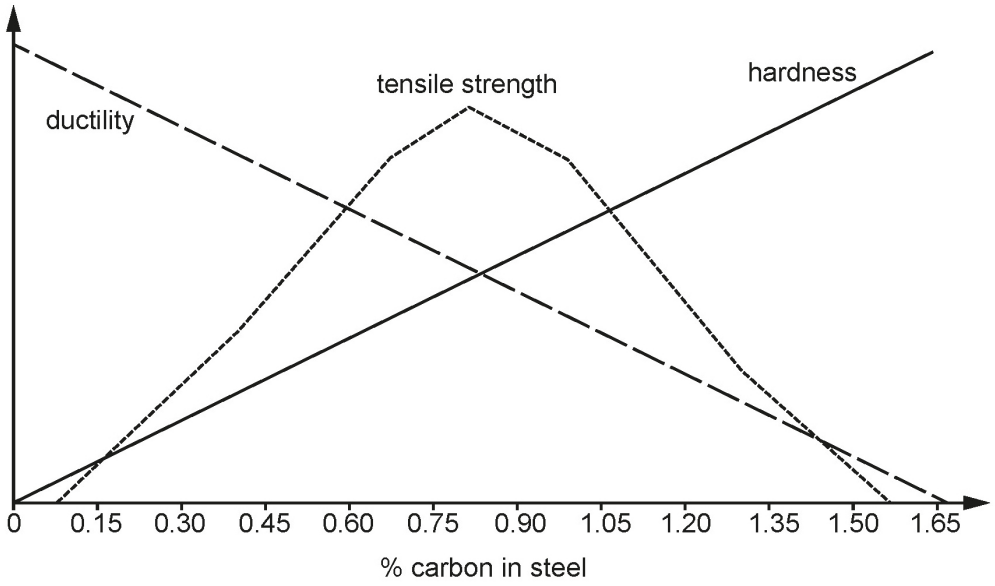
Put a tick (✓) in the box to show the student who made the correct prediction.

Student **A**		Student **B**		Student **C**	

Examiner only

(d) Steel is a metal alloy. It can be described in general terms as iron containing small amounts of carbon to make it tougher and more ductile. There are many types of steel, each with its own specific chemical composition and properties to meet the needs of the many different applications.

Figure 1 below shows the relationships between the carbon content of steel and its ductility, tensile strength and hardness.



Ductility is a material's ability to be pulled into a wire.

Tensile strength is a measure of the force required to pull something such as wire to the point where it breaks.

Hardness is a measure of how resistant a material is to permanent shape change when a compressive force is applied.

The table below shows the percentage of carbon in various alloys of iron.

Name of alloy	Percentage of carbon
low carbon steel	0.0 – 0.6 %
medium carbon steel	0.6 – 0.8 %
high carbon steel	0.8 – 1.3 %
very high carbon steel	1.3 – 1.6 %

Examiner only

(i) Put a tick (✓) in the box next to the statement which best describes the effect of increasing the percentage of carbon in steel from 0% to 0.45%. [1]

ductility increases, hardness increases ☐

tensile strength increases, ductility increases ☐

ductility decreases, tensile strength increases ☐

hardness increases, tensile strength decreases ☐

(ii) A steel manufacturer wants to design an alloy with a high tensile strength but low ductility.

Put a tick (✓) in the box next to the approximate value for the percentage of carbon that should be included. [1]

0.2 ☐ 0.6 ☐ 1.0 ☐ 1.5 ☐

(iii) Name the alloy which is the most easily pulled into a wire and withstands the least compressive force. [1]

.....

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.
	…… ……

Examiner only

FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
aluminium	Al^{3+}	bromide	Br^{-}
ammonium	NH_4^{+}	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^{-}
calcium	Ca^{2+}	fluoride	F^{-}
copper(II)	Cu^{2+}	hydroxide	OH^{-}
hydrogen	H^{+}	iodide	I^{-}
iron(II)	Fe^{2+}	nitrate	NO_3^{-}
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^{+}	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^{+}		
silver	Ag^{+}		
sodium	Na^{+}		
zinc	Zn^{2+}		

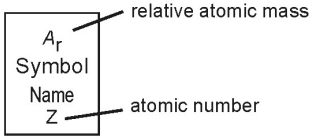
THE REACTIVITY SERIES

potassium
sodium
lithium
calcium
magnesium
aluminium
(carbon)
zinc
iron
(hydrogen)
copper
silver
gold

THE PERIODIC TABLE

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	63.5 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
86 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	179 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															

Key



THE SCIENCES (DOUBLE AWARD)
UNIT 5

Chemistry - Chemical Bonding, Reactions and Resources

HIGHER TIER

MARKING SCHEME

Guidance for examiners

Generic marking principles

- Marks awarded are always whole marks (not half marks, or other fractions).
- Answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.
- Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
- Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Positive marking

It should be remembered that candidates are writing under examination conditions and credit should be given for what the candidate writes, rather than adopting the approach of penalising candidates for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Marks should not be deducted for a less than perfect answer if it satisfies the criteria of the mark scheme.

For questions that are objective or points-based, the mark scheme should be applied precisely. Marks should be awarded as indicated and no further subdivision made.

Mark schemes often list points which may be included in candidates' answers. The list is not exhaustive. The inclusion of *'Credit any other valid response.*' (or similar instruction) within mark schemes allows for the possible variation in candidates' responses. Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme. Credit should be given according to the accuracy and relevance of candidates' answers.

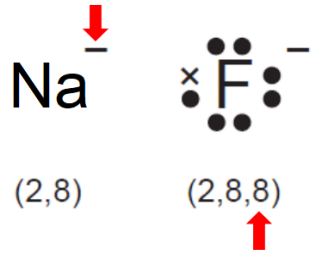
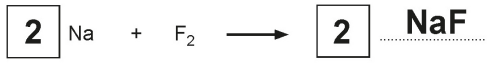
Appropriate terminology is reflected in exemplar responses in mark schemes. However, unless there is a specific requirement within a question, candidates may be awarded marks where the answer is accurate but expressed in their own words.

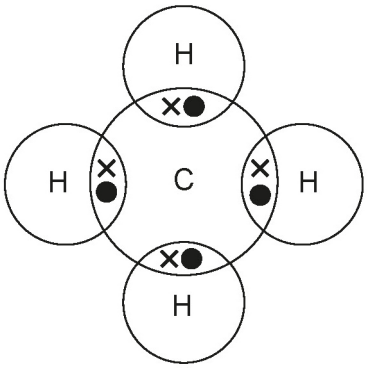
Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

ecf = error carried forward
bod = benefit of doubt

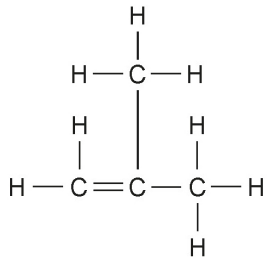
Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections relationships
1.	(a)	(i)	fractional distillation	1			1			
		(ii)	naphtha			1	1			
		(iii)	20 accept C_{20} / $C_{20}H_{42}$			1	1			
		(iv)	they are darker in colour and are easier to burn ☐ their boiling points increase, and they are more difficult to burn ✓ their flames are less smoky, and their boiling points increase ☐ their boiling points decrease, and they are lighter in colour ☐ they are darker in colour, and their flames are smokier ✓ their boiling points increase, and their flames are less smoky ☐ award (1) for each correct answer			2	2			
	(b)	(i)	C_8H_{18}		1		1			1
		(ii)	heat / high temperature **and** catalyst accept high pressure as an alternative for either condition	1			1			
	(c)		removes oxygen which is one part of the fire triangle neutral answer – reference to air		1		1			
			Question 1 total	**2**	**2**	**4**	**8**	**0**	**0**	**1**

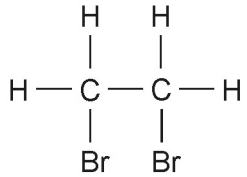
Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
2.	(a)	(i)	 award (1) for each mistake identified and corrected sodium ion ⇨ Na^+ electronic structure of fluoride ion ⇨ 2,8		2		2			
		(ii)	ionic	1			1			
		(iii)	 award (1) for correct formula award (1) for balancing only if correct formula given		1 1		2			1

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
	(b)	(i)	 award (2) for correct diagram award (1) for diagram including eight dots or eight crosses only if incorrect award (1) for clear indication that carbon bonds with four hydrogen atoms e.g. overlapping shells, lines for bonds		2		2			
		(ii)	covalent ignore any reference to simple or molecular	1			1			
			Question 2 total	**2**	**6**	**0**	**8**	**0**	**0**	**1**

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
3.	(a)		**D** **B** **A** **C** award (2) for correct order award (1) for any two in correct position			2	2		2	
	(b)	(i)	award (1) for either of following • order of reactivity is Mg > Zn > Fe > Cu • magnesium and zinc are more reactive than iron and copper is less reactive than iron – must refer to all four metals award (1) for any of following • copper does not react with iron(II) sulfate / does not displace iron • temperature doesn't change / increase with copper • magnesium and zinc react with iron(II) sulfate / displace iron award (1) for any of following • reaction between magnesium and iron(II) sulfate is more exothermic than that between zinc and iron(II) sulfate • magnesium reaction more exothermic than zinc • temperature increases more with magnesium than zinc • magnesium most exothermic			3	3		3	

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
		(ii)	29.0°C		1		1	1	1	
		(iii)	zinc sulfate and iron both needed accept $ZnSO_4$ and Fe		1		1			
Question 3 total				**0**	**2**	**5**	**7**	**1**	**6**	**0**

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
4.	(a)	(i)	**A**, **E** and **F** all three needed		1		1			1
		(ii)	ethane	1			1			
	(b)		 accept any correct structure		1		1			
	(c)	(i)	award (2) for complete answer e.g. bromine water changes from orange to colourless with ethene (1) but there is no change with ethane (1) award (1) for any of following bromine water changes from orange to colourless with ethene bromine water changes from orange to colourless with an alkene bromine water changes colour with ethene but not with ethane bromine water changes colour with an alkene but not with an alkane neutral answers bromine water changes colour with ethene / an alkene bromine water does not change colour with ethane / an alkane	2			2			

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
		(ii)	 (1) 1,2-dibromoethane (1)		2		2			
	(d)		award (1) each for any **two** descriptions of bonding or lack of reactivity e.g. • plastics are long chains of atoms / polymers • they have strong bonds between atoms • they do not react with natural substances in the environment / they are non-biodegradable award (1) for any reference to mechanical breakdown e.g. • they break down to smaller and smaller pieces (over time) award (1) for any reference to transport e.g. • they are washed into waterways / oceans and carried all over the world	4			4			

	(e)	award (1) for identifying all bonds formed in products e.g. (4 × O—H) + (4 × C=O) (4 × 805) + (4 × 464) 3220 + 1856 5076 (1) 3758 – 5076 = –1318 (1)		3		3	3		
		Question 4 total	**7**	**7**	**0**	**14**	**3**	**0**	**1**

Question				Marking details	Marks available						
					AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
5.	(a)	(i)	I	magnesium / Mg (1) hydrogen / H_2 (1) carbon dioxide / CO_2 (1)		3		3		3	
			II	$CuCl_2$ (1) neutral answer – copper(II) chloride H_2O (1) neutral answer – water		1 1		2			1
		(ii)		52% (2) if incorrect award (1) for M_r 125 ecf possible from incorrect M_r value		2		2	2		2
	(b)			$Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + H_2O + CO_2$ award (1) for formulae of reactants award (1) for formulae of products award (1) for balancing only if correct formulae throughout		3		3			
	(c)	(i)		not helpful because both will give a lilac flame (1) because they both contain potassium ions (1) neutral – both give the same result	1		1	2		2	1
		(ii)		add barium chloride (solution) / $BaCl_2$ (1) potassium sulfate gives a white precipitate whereas potassium bromide gives no precipitate (1)	1	1		2			
				Question 5 total	**2**	**11**	**1**	**14**	**2**	**5**	**4**

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
6.	(a)	(i)	so that the ions are free to move	1			1			
		(ii)	zinc / Zn^{2+} ions are positive (1) they move towards the electrode with opposite charge / are attracted by the negative charge (1) they gain 2 electrons to form zinc / Zn atoms (1)	1	2		3			
	(b)		oxidation is loss of electrons and reduction is gain of electrons (1) at the anode gold / Au atoms lose 3 electrons (1) at the cathode gold / Au^{3+} ions gain 3 electrons (1) clear differentiation between 'atoms' and 'ions' needed for full marks to be credited	1	2		3			
	(c)		working **must** be shown for any credit to be awarded *by reacting masses from the equation* 159 g of CuO gives 127 g of Cu (1) 3.18 g of CuO gives $\frac{127}{159}$ × 3.18 = 2.54 g of Cu (1) *using moles* moles of CuO = $\frac{3.18}{79.5}$ = 0.04 mol (1) 2 mol CuO gives mol Cu mass of Cu = 0.04 × 63.5 = 2.54 g (1) award (1) for identifying Student **B** as being correct ecf possible			3	3	3		1

Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
	(d)	(i)	ductility increases, hardness increases ☐ tensile strength increases, ductility increases ☐ ductility decreases, tensile strength increases ✓ hardness increases, tensile strength decreases ☐			1	1		1	
		(ii)	0.2 ☐ 0.6 ☐ 1.0 ✓ 1.5 ☐			1	1		1	
		(iii)	low carbon steel			1	1			
			Question 6 total	**3**	**4**	**6**	**13**	**3**	**2**	**1**

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	Enquiry Skills	Connections Relationships
1	2	2	4	8	0	0	1
2	2	6	0	8	0	0	1
3	0	2	5	7	1	6	0
4	7	7	0	14	3	0	1
5	2	11	1	14	2	5	4
6	3	4	6	13	3	2	1
TOTAL	**16**	**32**	**16**	**64**	**9**	**13**	**8**