GCSE

WJEC GCSE
The Sciences (Double Award)

Approved by Qualifications Wales

Sample Assessment Materials

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

Teaching from 2026
For award from 2028

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

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Contents

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Surname	Centre number	Candidate number
First name(s)		0

GCSE

3455U5

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

FOUNDATION 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.	**11**	
2.	**5**	
3.	**10**	
4.	**11**	
5.	**11**	
6.	**8**	
7.	**8**	
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.

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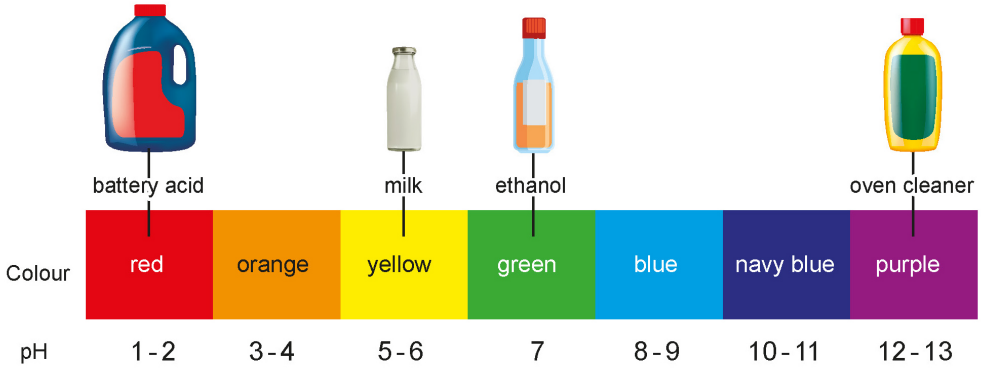
Answer **all** questions.

Examiner only

1. This question is about the pH scale and the reactions of acids.

(a) The diagram shows the colours of universal indicator at different pH values and the position of some substances on the pH scale.



(i) Battery acid turns universal indicator red. Give the pH range of this solution. [1]

.....

(ii) Put a tick (✓) in the box next to the statement that best describes oven cleaner. [1]

oven cleaner is a strong acid	☐
oven cleaner is a weak acid	☐
oven cleaner is a strong alkali	☐
oven cleaner is a weak alkali	☐

(iii) Give the name of the substance that is neutral. [1]

.....

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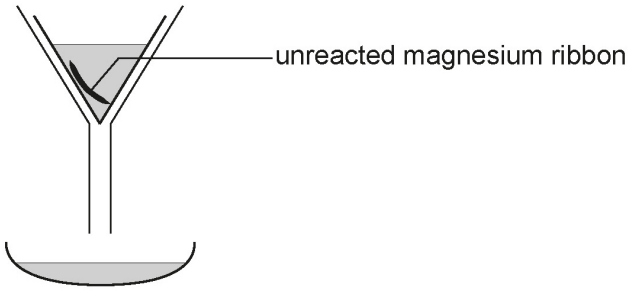
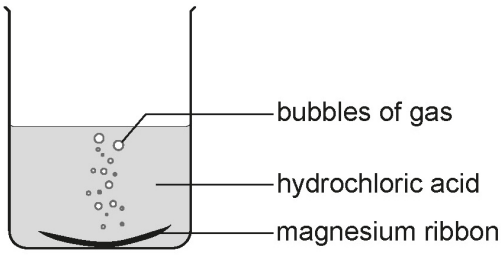
(b) Magnesium chloride tablets are often taken as supplements to improve digestion and for better sleep.

A student carried out an experiment to prepare magnesium chloride crystals from magnesium ribbon and dilute hydrochloric acid.

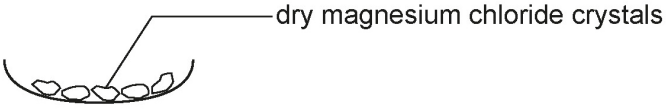
Diagrams **A**, **B** and **C** show the stages of the experiment they carried out. The stages are **not** in the correct order.



A



B



C

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(i) I. Give the **letter** that shows the **first** stage of the experiment. [1]

Letter .....

II. Give the **letter** of the stage that shows filtration. [1]

Letter .....

(ii) Put a tick (✓) in the box next to the test to show that the gas formed is hydrogen. [1]

the gas relights a glowing splint	☐
the gas turns limewater milky	☐
the gas pops with a lighted splint	☐

(iii) Magnesium chloride contains Mg^{2+} and Cl^- ions.

Underline the correct formula of magnesium chloride. [1]

$MgCl_2$ **Mg_2Cl** **MgCl** **Mg_2Cl_2**

(c) The word equations show some reactions of acids.

Underline one substance in each box that correctly completes the equation. [2]

magnesium + [hydrochloric acid / nitric acid / sulfuric acid] → magnesium nitrate + hydrogen

[lead(II) oxide / copper(II) oxide / magnesium oxide] + sulfuric acid → copper(II) sulfate + water

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(d) The chemical formula of sulfuric acid is H_2SO_4.

Complete the table and calculate the relative formula mass, M_r, of sulfuric acid. [2]

Element	Number of atoms	Relative atomic mass (A_r)	Total mass of each element in H_2SO_4
hydrogen	2	1	.....
sulfur	1	32	32
oxygen	.....	16	64
Relative formula mass (M_r)			.....

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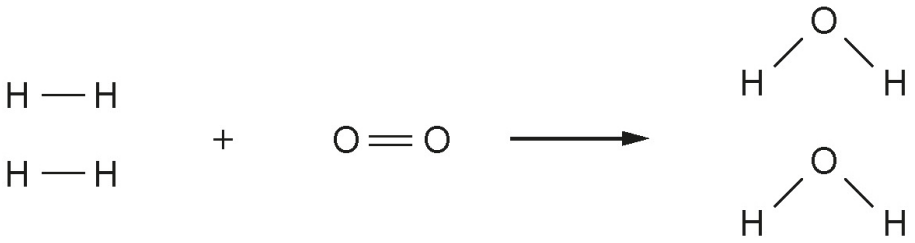
2. The Cymru H2 Wales project aims to ensure that Wales can play an active role in establishing new hydrogen technology products.

Although much research has been carried out into development of hydrogen fuel cell vehicles, they are currently working on the development of practical hydrogen combustion engines.

(a) The overall equation for the combustion of hydrogen can be represented as follows.



Some of the bond energies are given in the table.

Bond	Bond energy (kJ)
H – H	?
O = O	498
O – H	464

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(i) The total energy needed to break the bonds in the hydrogen and oxygen molecules is 1370 kJ.

Calculate the energy needed to break the bond in the **one** hydrogen molecule. [2]

Energy = ... kJ

(ii) The energy released when **two** molecules of water are formed is 1856 kJ. Show how this value is calculated. [1]

(iii) Put a tick (✓) in the box next to the calculation used to find the overall energy change for the reaction. [1]

1370 kJ ÷ 1856 kJ	☐
1370 kJ × 1856 kJ	☐
1370 kJ – 1856 kJ	☐
1370 kJ + 1856 kJ	☐

(b) Insert a number into the box to balance the equation to represent the combustion of hydrogen. [1]

$$2\,H_2 \quad + \quad O_2 \longrightarrow \square\, H_2O$$

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3. This question is about the materials and their properties.

(a) The table gives some information about five substances, **A**-**E**.

Substance	Melting point (°C)	Boiling point (°C)	Malleable?	Soluble in water?	Conducts electricity?
A	-219	-183	no	yes	no
B	1083	2595	yes	no	yes
C	801	1465	no	yes	when molten or dissolved
D	1536	2861	yes	no	yes
E	3550	4830	no	no	no

(i) Give the **letter** of the substance with the biggest difference between the melting point and boiling point. [1]

.....

(ii) Give the **letters** of the two substances that are metals. [1]

..... and .....

(iii) Give the **letter** of the substance that could be oxygen gas. [1]

.....

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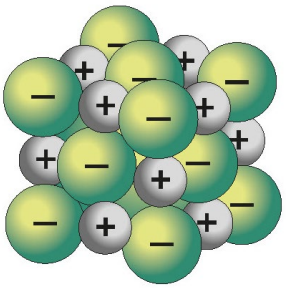
(b) (i) The following diagram shows a giant ionic structure.



Substances with giant ionic structures have high melting points and conduct electricity when dissolved or molten.

Use the diagram and your knowledge to draw **one** line from each property to its correct explanation. [2]

Property	Explanation
	ions are regularly arranged
high melting point	strong bonds between ions
	ions are free to move
conducts electricity when dissolved or molten	ions cannot move
	weak bonds between ions

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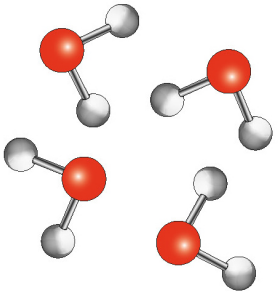
(ii) The following diagram shows a simple covalent structure.



Substances with simple covalent structures have low melting points and do not conduct electricity.

Use the diagram and your knowledge to draw **one** line from each property to its correct explanation. [2]

Property	**Explanation**
	strong forces between molecules
low melting point	molecules cannot move
	weak forces between molecules
does not conduct electricity	molecules are not charged
	molecules are tightly packed

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(c) The Royal Mint, in Llantrisant, is the official maker of coins in the UK.

Coins used to be made of sterling silver, an alloy made from 92.5% silver. They are now made of a cheaper silver-coloured alloy.

The table gives information about the composition of sterling silver, as well as other alloys containing silver and gold.

Name of alloy	Composition of alloy by mass (%)
amalgam	mercury 48%, silver 25%, tin 15%, copper 12%
green gold	gold 75%, silver 6-24%, copper ……..%
nordic gold	gold 89%, aluminium 5%, zinc 5%, tin 1%
sterling silver	silver 92.5%, platinum 4%, germanium 1.5-3%, zinc 0.5-2%
white gold	gold 75%, palladium 10%, nickel 10%, zinc 5%

(i) **Circle** the number of alloys that contain an element from group 4 of the periodic table. [1]

0 1 2 3 4 5

(ii) **Circle** the correct percentage range for the mass of copper that can be found in green gold. [1]

0-25% 1-19% 19-25% 6-24%

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(iii) Solder is an alloy that contains copper, silver and tin.

Give the letter of the diagram that best represents solder. [1]

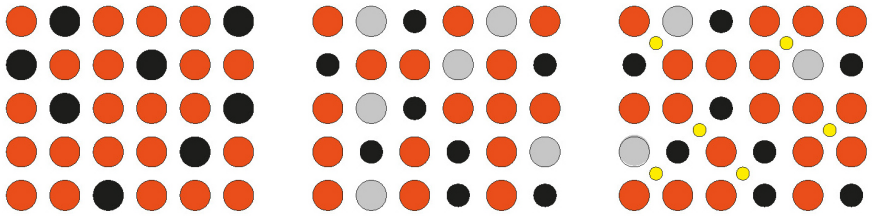

Diagram .....

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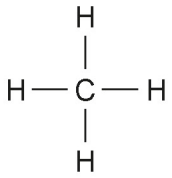
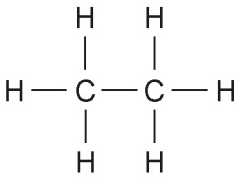
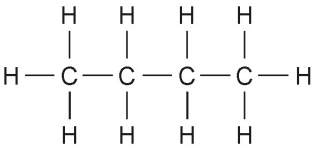
4. This question is about alkanes and alkenes.

(a) The table shows the names, molecular formulae and structural formulae of some alkanes.

Name	Molecular formula	Structural formula
methane	CH_4	
……..	C_2H_6	
propane	C_3H_8	
butane	……..	

Complete the table by filling in the missing name, molecular formula and structural formula. [3]

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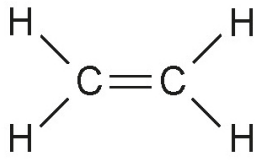
(b) The following diagram shows the structure of ethene.



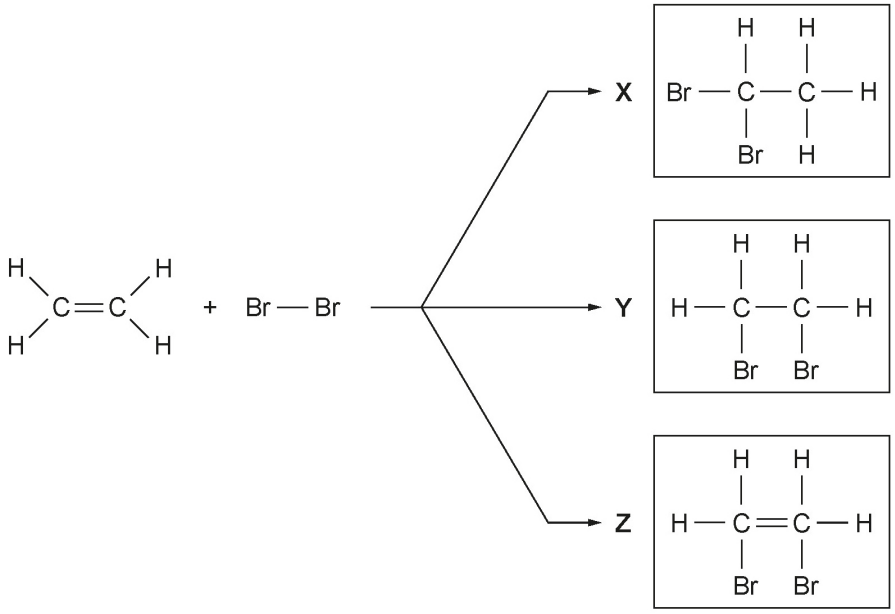
(i) Bromine water is used to identify the presence of the double bond in ethene.

I. Underline the correct word in the brackets to complete the sentence. [1]

When ethene is bubbled through orange bromine water, the solution

becomes **(darker / milky / colourless)**.

II. Give the letter, **X**, **Y** or **Z**, that shows the product formed when bromine reacts with ethene. [1]



Letter .....

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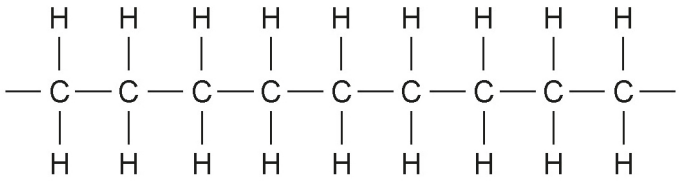
(ii) Ethene is used in the production of polyethene.

The following diagram shows part of a polyethene molecule.



double	**split**	**single**	
multiply	**triple**	**catalyst**	**cracking**
distillation	**electrolysis**	**polymer**	**join**

Describe how polyethene is produced from ethene. Use words from the box in your answer. [3]

……

……

……

……

……

……

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(c) Polyethene has widely been used in the production of supermarket carrier bags for many years.

Use the information in the following statements to answer the question below.

'supermarket carrier bags are a major source of microplastics.'

'most supermarket carrier bags are non-biodegradable.'

'paying for carrier bags was introduced in Wales in 2011, since then the number of bags used is significantly lower.'

Shoppers having to pay for carrier bags has led to a reduction in the volume of microplastics ending up in our environment but has not stopped the problem altogether.

Explain why. [3]

……

……

……

……

……

……

11

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5. This question is about the reactivity of metals.

(a) The list shows part of the reactivity series.

magnesium
zinc
iron
copper

(i) Use the reactivity series to predict whether each of the following pairs of chemicals will react when mixed together.

Put a tick (✓) in the correct column for each pair of chemicals. [2]

Pair of chemicals	A reaction will happen	No reaction will happen
magnesium + copper(II) sulfate solution		
iron + magnesium chloride solution		
zinc + iron(III) chloride solution		
copper + zinc nitrate solution		

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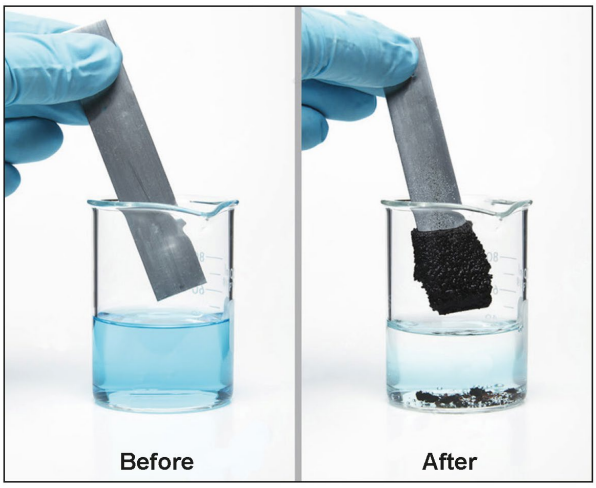
(ii) The photographs show what happens when a strip of zinc is added to copper(II) sulfate solution.



During the reaction the zinc strip becomes coated in a brown solid and the blue solution becomes colourless.

Explain the observations seen during the reaction. [2]

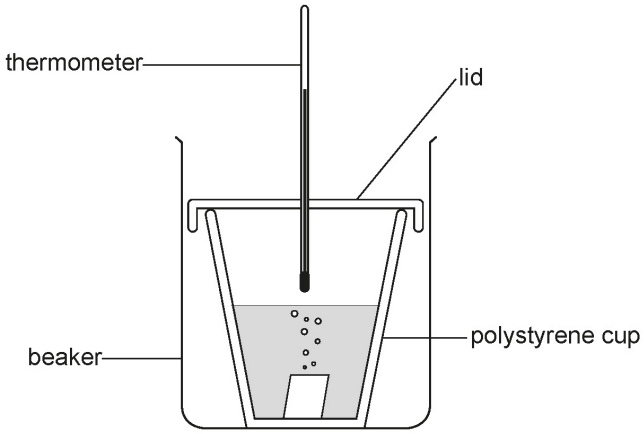
.....

.....

.....

.....

(b) A group of students were investigating the reactivity of four metals, **A**, **B**, **C** and **D**.
They used the following apparatus to investigate the temperature rise when each metal was added to 50 cm^3 of hydrochloric acid.



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(i) Identify the error in the way the apparatus was set up. State how this would affect the results collected. [2]

Error

……

Effect

……

……

(ii) Once they had set up their apparatus correctly, they obtained the following results.

Metal	Temperature rise (°C)
A	22
B	37
C	0
D	14

I. Use the results to list the metals in order of their reactivity. Give the reason for your choice. [2]

Most reactive ……..

……..

……..

Least reactive ……..

Reason

……

……..

II. The temperature rise recorded when zinc was added to 50 cm^3 of hydrochloric acid was 18°C.

State what this tells you about the reactivity of zinc compared to metals **A**, **B**, **C** and **D**. [1]

……

……

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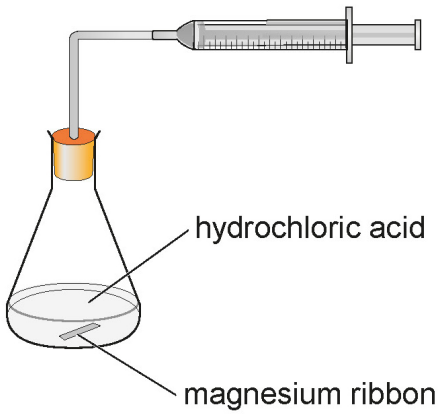
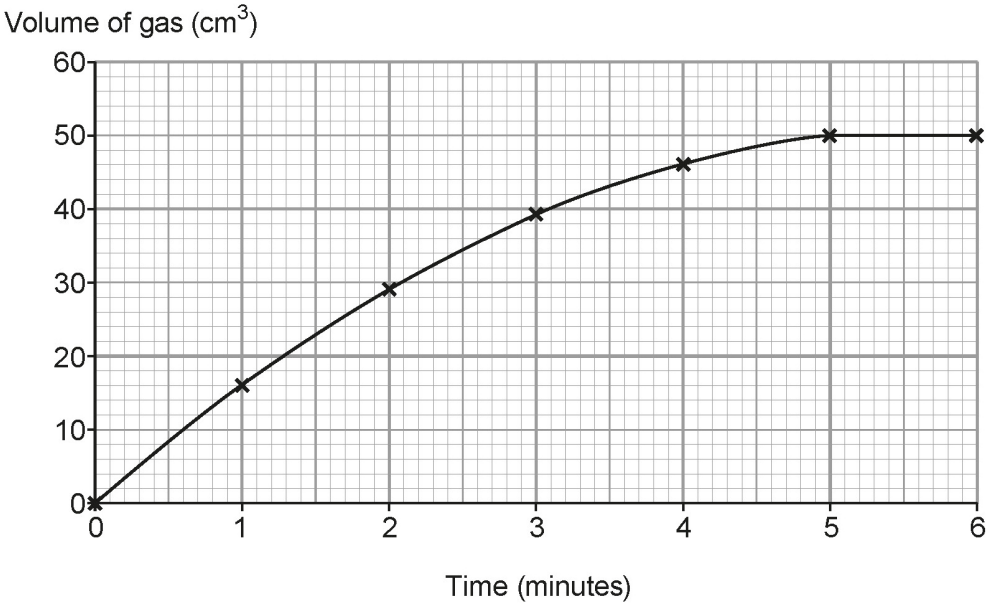
(c) In a second experiment, the students used the following apparatus to investigate the reaction between magnesium and excess hydrochloric acid.



They measured the volume of hydrogen gas collected every minute for 6 minutes. Their results are shown in the graph.



(i) Give the time taken for the magnesium to completely react with the hydrochloric acid. [1]

Time = …….... minutes

(ii) The reaction between hydrochloric acid and a different metal was investigated. The reaction was slower and only produced half the volume of hydrogen gas in 6 minutes.

Sketch a graph to show these results on the **same grid above**. [1]

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6. (a) Crude oil can be separated into simpler mixtures called fractions. The table shows 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]

.....

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(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]

.....

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(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]

.....

.....

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

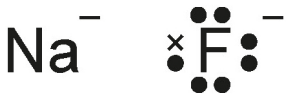
Element	Electronic structure
sodium	2,8,1
fluorine	2,7

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]

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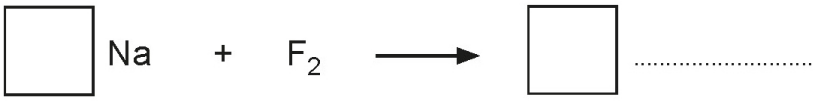
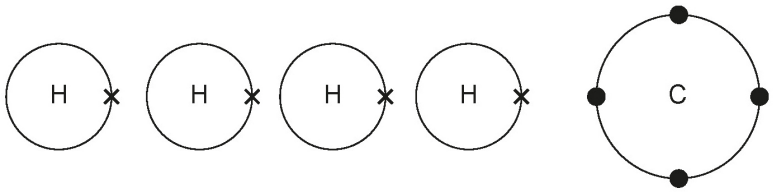
(iii) Complete the equation for the reaction between sodium and fluorine by:
- giving the formula for sodium fluoride
- inserting numbers into the boxes to balance the equation. [2]



(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]

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END OF PAPER

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

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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

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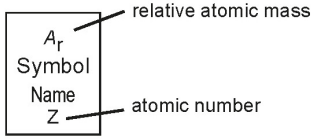
THE PERIODIC TABLE

1	2	Group										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

FOUNDATION TIER

MARK 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

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Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
1.	(a)	(i)	1-2	1			1			
		(ii)	oven cleaner is a strong acid ☐ oven cleaner is a weak acid ☐ oven cleaner is a strong alkali ✓ oven cleaner is a weak alkali ☐		1		1			
		(iii)	ethanol		1		1			
	(b)	(i)	I **B**	1			1		1	
			II **A**	1			1			
		(ii)	the gas relights a glowing splint ☐ the gas turns limewater milky ☐ the gas pops with a lighted splint ✓	1			1			1
		(iii)	$MgCl_2$		1		1			1

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Question	Marking details	Marks available						
		AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
(c)	magnesium + hydrochloric acid / <u>nitric acid</u> / sulfuric acid → magnesium nitrate + hydrogen lead(II) oxide / <u>copper(II) oxide</u> / magnesium oxide + sulfuric acid → copper(II) sulfate + water		2		2			
(d)	<table><tr><th>Element</th><th>Number of atoms</th><th>Relative atomic mass (A_r)</th><th>Total mass of each element in H_2SO_4</th></tr><tr><td>hydrogen</td><td>2</td><td>1</td><td>2</td></tr><tr><td>sulfur</td><td>1</td><td>32</td><td>32</td></tr><tr><td>oxygen</td><td>4</td><td>16</td><td>64</td></tr><tr><td colspan="4"></td></tr><tr><td colspan="3">Relative formula mass (M_r)</td><td>98</td></tr></table>award (2) for all correct award (1) for either of first two numbers correct		2		2	1		2
	Question 1 total	**4**	**7**	**0**	**11**	**1**	**1**	**5**

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Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
2.	(a)	(i)	436 (2) if incorrect award (1) for either of following 1370 – 498 872		2		2	2		
		(ii)	4 × 464		1		1			
		(iii)	1370 kJ ÷ 1856 kJ ☐ 1370 kJ × 1856 kJ ☐ 1370 kJ – 1856 kJ ✓ 1370 kJ + 1856 kJ ☐		1		1			
	(b)		$2\,H_2 + O_2 \longrightarrow$ **2** H_2O		1		1			1
			Question 2 total	**0**	**5**	**0**	**5**	**2**	**0**	**1**

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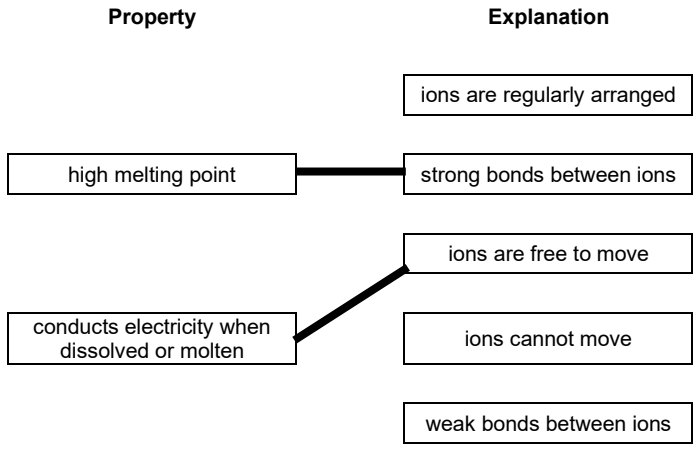
Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
3.	(a)	(i)	**B**			1	1	1		
		(ii)	**B** and **D** (both needed)			1	1			
		(iii)	**A**			1	1			
	(b)	(i)	 award (1) for each correct line do not award credit for a property with more than one line drawn from it	2			2			

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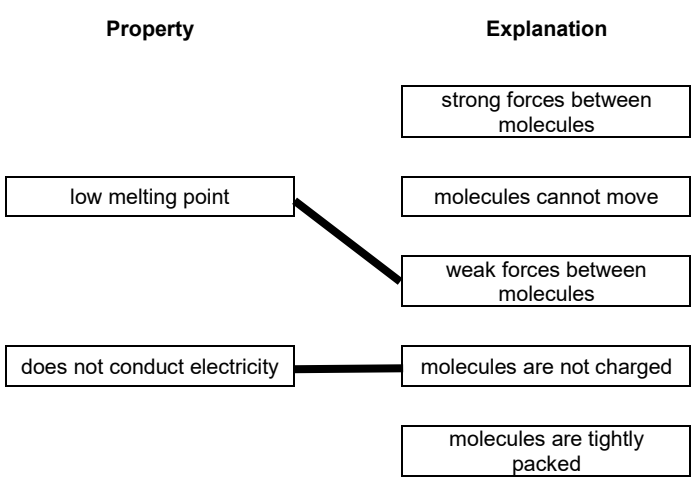
		(ii)	 award (1) for each correct line do not award credit for a property with more than one line drawn from it	2			2			
	(c)	(i)	3			1	1			
		(ii)	1-19%			1	1	1	**1**	
		(iii)	**B**			1	1			
			Question 3 total	**4**	**0**	**6**	**10**	**2**	**1**	**0**

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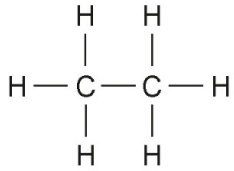
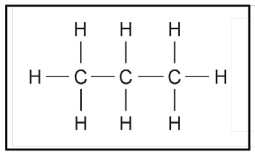
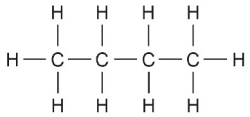
Question				Marking details	Marks available						
					AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
4.	(a)			<table><tr><td>**ethane**</td><td>C_2H_6</td><td>  </td></tr><tr><td>propane</td><td>C_3H_8</td><td>  </td></tr><tr><td>butane</td><td>**C_4H_{10}**</td><td>  </td></tr></table> award (1) for each correct answer		3		3			
	(b)	(i)	I	colourless	1			1			
			II	**Y**		1		1			

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		(ii)	credit the following points the double bonds within the ethene molecules split this allows the molecules to join together award (3) if all three words used correctly award (2) if any two words used correctly award (1) if any one word used correctly accept use of additional words from the box provided that there are no contradictions	3			3			
	(c)		fewer carrier bags disposed of each year (since the charge) (1) the bags that are used do not (fully) decompose (1) so they gradually break down into smaller and smaller pieces (1)		3		3			
			Question 4 total	**4**	**7**	**0**	**11**	**0**	**0**	**0**

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<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="7">Marks available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Enquiry Skills</th><th>Connections Relationships</th></tr>
<tr><td>5.</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th>Pair of chemicals</th><th>A reaction will happen</th><th>No reaction will happen</th></tr>
<tr><td>magnesium + copper(II) sulfate solution</td><td>✓</td><td></td></tr>
<tr><td>iron + magnesium chloride solution</td><td></td><td>✓</td></tr>
<tr><td>zinc + iron(III) chloride solution</td><td>✓</td><td></td></tr>
<tr><td>copper + zinc nitrate solution</td><td></td><td>✓</td></tr>
</table>
award (2) for all four correct
award (1) for any two correct</td><td></td><td>2</td><td></td><td>2</td><td></td><td>2</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>zinc displaces copper (1)

the <u>brown</u> solid is <u>copper</u> and the <u>colourless</u> <u>solution</u> is <u>zinc sulfate</u> (1)</td><td></td><td>2</td><td></td><td>2</td><td></td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>thermometer (bulb) is not in acid / is too high (1)

award (1) for any of the following

will not measure the <u>temperature</u> of the solution
will measure the <u>temperature</u> of the air
will not get a <u>temperature</u> rise / change</td><td></td><td></td><td>2</td><td>2</td><td></td><td>2</td><td></td></tr>
</table>

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Question				Marking details	Marks available						
					AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
		(ii)	I	award (1) for correct order Most reactive **B** **A** **D** Least reactive **C** the <u>more reactive</u> (the metal) the <u>more heat is given out</u> (1) neutral answer – reference to higher temperature			2	2		2	
			II	zinc is less reactive than metal **A** (and **B**) and more reactive than metal **D** (and **C**)			1	1	1	1	
	(c)	(i)	5				1	1	1	1	

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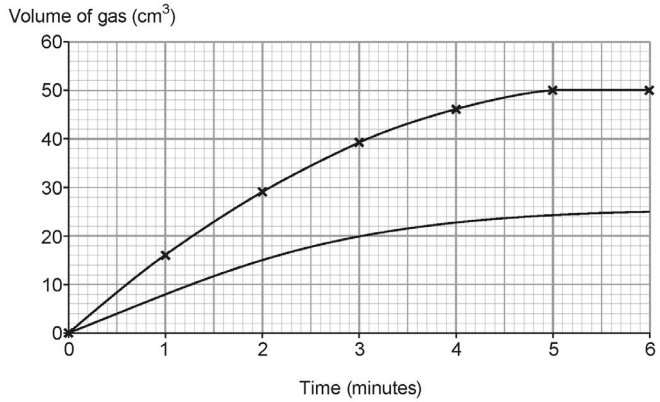
		(ii)	 accept any curve that reaches 25 cm^3 at 6 minutes		1		1	1	1	
			Question 5 total	**0**	**5**	**6**	**11**	**3**	**9**	**0**

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Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
6.	(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			

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	(c)	removes oxygen which is one part of the fire triangle neutral answer – reference to air		1		1			
		Question 6 total	**2**	**2**	**4**	**8**	**0**	**0**	**1**

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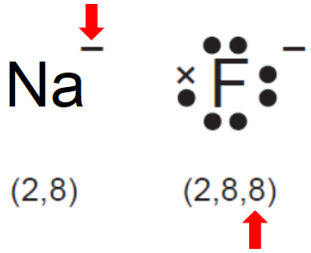
Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
7.	(a)	(i)	 award (1) for each mistake identified and corrected sodium ion ⇨ Na^+ electronic structure of fluoride ion ⇨ 2,8		2		2			
		(ii)	ionic	1			1			
		(iii)	**2** Na + F_2 ⟶ **2** **NaF** award (1) for correct formula award (1) for balancing only if correct formula given		1 1		2			1

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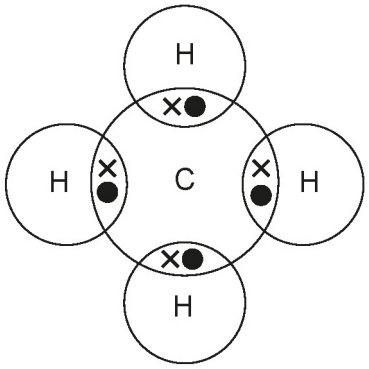
Question			Marking details	Marks available						
				AO1	AO2	AO3	Total	Maths	Enquiry Skills	Connections Relationships
	(b)	(i)	 award (2) for correct diagram award (1) for diagram including eight dots or eight crosses only if incorrect award (1) for clear indication that carbon bonds with four hydrogen atoms e.g. overlapping shells, lines for bonds		2		2			
		(ii)	covalent ignore any reference to simple or molecular	1			1			
			Question 7 total	**2**	**6**	**0**	**8**	**0**	**0**	**1**

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SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	Enquiry Skills	Connections Relationships
1	4	7	0	11	1	1	5
2	0	5	0	5	2	0	1
3	4	0	6	10	2	1	0
4	4	7	0	11	0	0	0
5	0	5	6	11	3	9	0
6	2	2	4	8	0	0	1
7	2	6	0	8	0	0	1
TOTAL	**16**	**32**	**16**	**64**	**8**	**11**	**8**

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