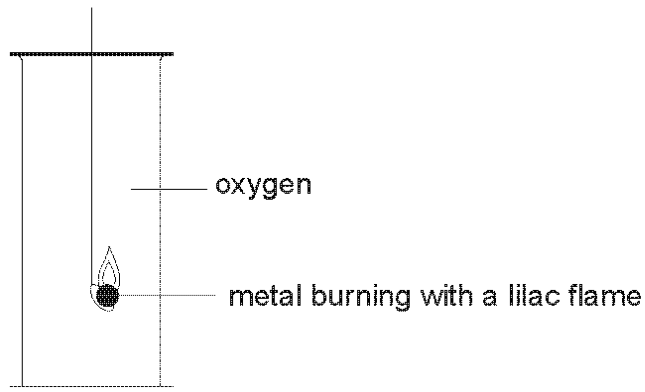
Chemical analysis C3

Question	Maximum Mark	Mark Awarded
1	6	
2	6	
3	12	
4	4	
5	6	
6	5	
7	10	
8	11	
9	5	
10	6	
11	4	
12	6	
13	6	
14	6	
15	6	
16	6	
17	6	
Total Mark		

1. A Group 1 metal is burned in a gas jar containing oxygen.



(a) Use the information in the diagram above to name the Group 1 metal. [1]

.....

(b) Write a **word** equation for the reaction taking place. [1]

..... + ... ⟶ .....

(c) Give the name of a Group 1 metal that would react **less** vigorously than the metal named in *(a)* above. [1]

.....

(d) A similar reaction can be carried out using chlorine instead of oxygen. The product obtained is a white solid.

(i) Choose from the box below a solution that could be used to show that the white solid contains chloride ions. [1]

limewater	**silver nitrate**	**sodium hydroxide**	**sulfuric acid**

Solution .....

(ii) State what must be done to the white solid in order to carry out the test. [1]

.....

(iii) Give the colour of the precipitate formed. [1]

.....

6

2.

(a) Draw a line from each gas below to the observation made in identifying it. [3]

Gas	Observation
	relights a glowing splint
carbon dioxide	turns flame red
ammonia	turns limewater milky
oxygen	pops with a burning splint
	turns damp red litmus blue

(b) The following box contains observations made when testing for some common metal ions.

lilac flame	**yellow flame**	**green flame**
blue precipitate	**brown precipitate**	**green precipitate**
	white precipitate	

Choose from the box the result you would expect for the following tests. [3]

A flame test is carried out on a sample of sodium chloride

.....

A flame test is carried out on a sample of copper(II) sulfate

.....

Sodium hydroxide solution is added to a solution of iron(III) chloride

.....

6

3. *(a)* The table below shows information about three substances. Complete the table. [3]

Common name	Chemical name	Chemical formula
.....	calcium carbonate	$CaCO_3$
quicklime	calcium oxide	.....
slaked lime	.....	$Ca(OH)_2$

(b) A group of pupils investigated the composition of egg shells. They suspected that egg shells contain calcium carbonate. They carried out the following tests.

(i) Flame test

Choose from the box below the colour you would expect to see if egg shells contain calcium ions. [1]

brick-red	**lilac**	**yellow**	**green**	**white**

Colour .....

(ii) Test for carbonate ions by adding dilute hydrochloric acid

Name the gas formed if egg shells contain carbonate ions. Describe the test you would carry out to identify this gas. Include the result for your test. [2]

Gas .....

Test and result .....

.....

(iii) The pupils were told that 2.0g of egg shells contain 1.9g of calcium carbonate. Calculate the percentage of calcium carbonate in these egg shells. [2]

Percentage = ... %

(c) The box below shows some of the concerns a local conservation group have about the opening of a new limestone quarry in their area.

Concerns
Noise pollution from blasting
Unsightly quarry pits
Dust pollution from rock blasting
Noise and dust pollution from lorries
Habitat destruction

The quarry owner suggests that planting trees around the quarry will reduce the impact of noise pollution. Suggest **two** other things the quarry owner could do to reduce the impact of the quarry on the local environment. [2]

.....

.....

.....

(d) Suggest **two** advantages of limestone quarrying. [2]

Advantage 1 .....

Advantage 2 .....

12

4. *(a)* A Year 11 class investigated tests used to identify positive and negative ions. The results recorded by one pupil are shown below.

Put a **circle** around the **three** *incorrect* observations. [3]

Flame tests

Metal ion	Flame colour
Na^+	yellow
K^+	lilac
Cu^{2+}	brick-red

Adding sodium hydroxide to metal ions in solution

Metal ion solution	Colour of precipitate
Cu^{2+}	blue
Fe^{2+}	green
Fe^{3+}	white

Testing negative ions

Ion	Test	Observation
Cl^-	add dilute nitric acid followed by silver nitrate solution	yellow precipitate
CO_3^{2-}	add dilute hydrochloric acid	bubbles formed
SO_4^{2-}	add dilute hydrochloric acid followed by barium chloride solution	white precipitate

(b) Compounds containing ammonium ions, NH_4^+, are identified by adding sodium hydroxide solution, warming and testing the gas formed with damp red litmus paper. The damp red litmus paper turns blue.

The symbol equation below shows the reaction between ammonium chloride and sodium hydroxide solution.

$$NH_4Cl + NaOH \longrightarrow NaCl + H_2O + NH_3$$

Name the **three** products of the reaction. [1]

.....

4

5. *(a)* Lithium, sodium and potassium are elements in Group 1 of the Periodic Table.

The following table shows what a student recorded when these elements reacted with water. Two of the observations are **incorrect**.

Element	Observations	pH of solution
lithium	bubbles slowly on the surface of the water	6
sodium	bubbles rapidly and melts into a ball	12
potassium	burns with an orange flame	13

Identify the errors and give the correct observations below. [2]

Error 1 .....

Correction .....

Error 2 .....

Correction .....

(b) A student carries out tests to prove that a powder contains sodium ions and chloride ions. The following box gives some tests for ions and some expected observations.

white precipitate	**yellow precipitate**	**no reaction**	**cream precipitate**
flame test	**add sodium hydroxide solution**		**add silver nitrate solution**
add universal indicator	**yellow flame**	**red flame**	**green flame**

Select the appropriate tests and results to complete the following table. [4]

Ion	Test used	Observation expected
sodium		
chloride		

6

6. *(a)* When bromine is passed over heated iron wool it glows and forms iron(III) bromide.

Write a balanced **symbol** equation for the reaction. [3]

..... + ... ⟶ .....

(b) Name the substance used to test for the presence of bromide ions in iron(III) bromide solution and give the expected result. [2]

.....

.....

.....

5

7. *(a)* The following box contains the names of six ionic compounds.

sodium chloride	**sodium carbonate**	**copper(II) sulfate**
ammonium chloride	**potassium sulfate**	**lithium carbonate**

State which of the compounds in the box you would expect to

(i) give a yellow flame in a flame test, [1]

.....

(ii) produce bubbles when reacting with hydrochloric acid. [1]

.....

(b) A student has two colourless solutions in unlabelled bottles. He knows that one is potassium chloride and that the other is potassium iodide. Describe a test that could be carried out to distinguish between the solutions, giving the observations expected in **both** cases. [3]

.....

.....

.....

(c) Compounds containing ammonium ions can be identified by heating gently with sodium hydroxide solution and testing the gas produced.

Name the gas produced and describe how you would positively identify this gas. [2]

.....

.....

(d) Iron(III) chloride solution produces a brown precipitate when it reacts with sodium hydroxide solution.

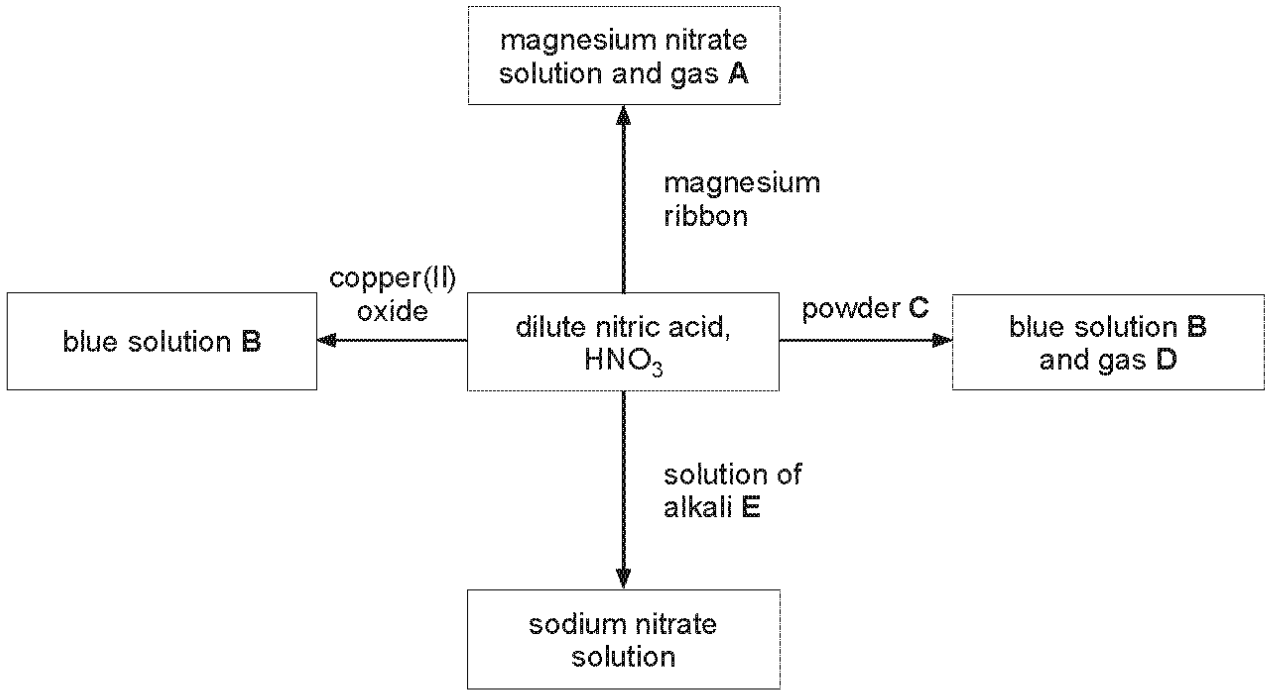
Write a balanced **ionic** equation for this reaction. You should include state symbols. [3]

..... + ... → .....

10

8.

(a) The following diagram shows some reactions of dilute nitric acid.



(i) Name the following substances. [3]

Powder **C** .....

Solution **B** .....

Alkali **E** .....

(ii) Name gases **A** and **D** and describe how they can be identified. [4]

Gas **A**

.....

.....

Gas **D**

.....

.....

(b) When sodium hydroxide reacts with sulfuric acid a solution of sodium sulfate is produced.

(i) Give the formula of sodium sulfate. ..... [1]

(ii) Describe how crystals of sodium sulfate can be obtained from a solution of sodium sulfate. [2]

.....

.....

.....

(c) Phosphoric acid can be used to remove rust, Fe_2O_3. Balance the equation for the reaction taking place. [1]

Fe_2O_3 + ☐ H_3PO_4 ⟶ ☐ $FePO_4$ + ☐ H_2O

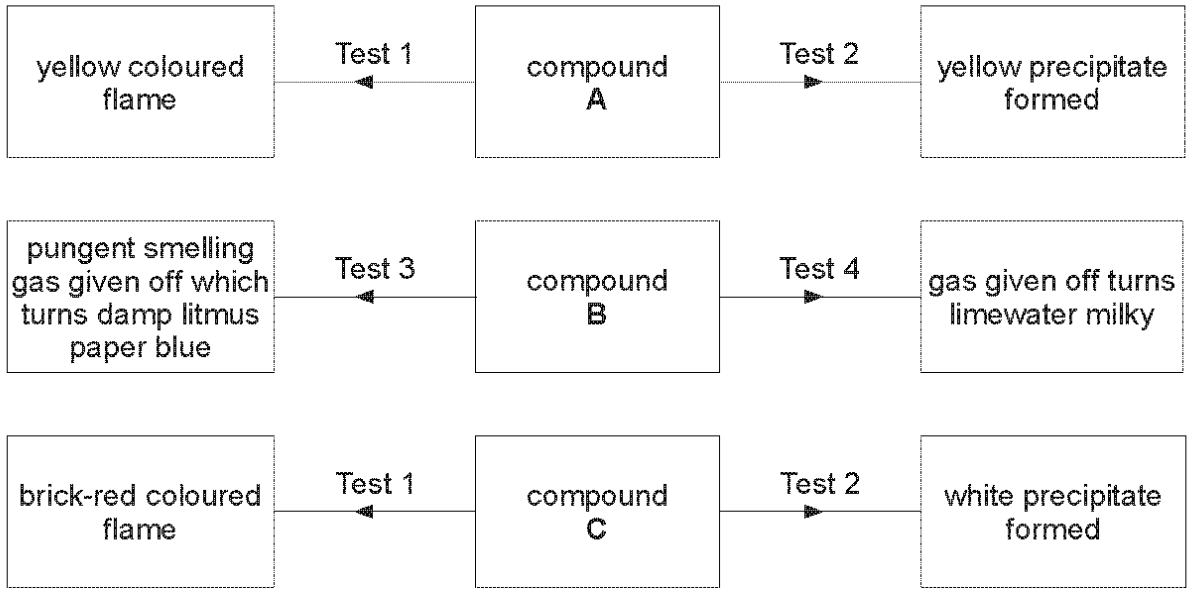
11

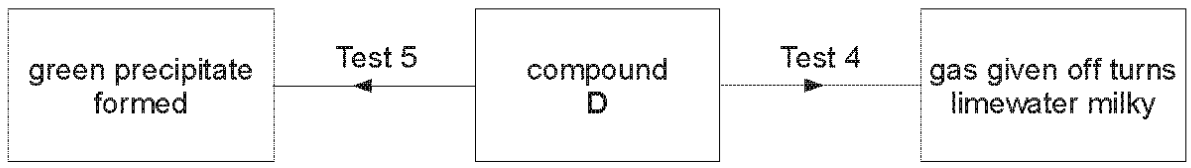
9. *(a)* A pupil used the following tests to identify unknown compounds **A**, **B**, **C** and **D**.

add sodium hydroxide solution and warm mixture, test gas given off with damp litmus paper	**add dilute hydrochloric acid, bubble gas given off into limewater**	
add silver nitrate solution	**add sodium hydroxide solution**	**flame test**

These are described as tests 1 to 5 but not necessarily in this order.

The flow charts show the results obtained for each compound.





Deduce which test is which and hence give the **names** of compounds **A**, **B**, **C** and **D**. [4]

A .....

B .....

C .....

D .....

(b) Describe the test for sulfate ions in solution. Include the result for your test. [1]

.....

5

10. Substance **S** is a white, solid metal bromide. It dissolves readily in water to give a colourless solution.

(a) On carrying out a flame test with substance **S** a red colour was seen. Name the metal ions present in substance **S**. [1]

.....

(b) Some silver nitrate solution was added to a solution of substance **S**.

(i) State what was seen. [1]

.....

(ii) Give the **ionic** equation for the reaction taking place. [2]

..... + ... ⟶ .....

(c) When a Group 7 gas, **G**, is passed through a solution of **S**, the solution turns orange.

(i) Name gas **G**. ..... [1]

(ii) Give the name of the **type** of reaction that takes place between gas **G** and substance **S**. [1]

.....

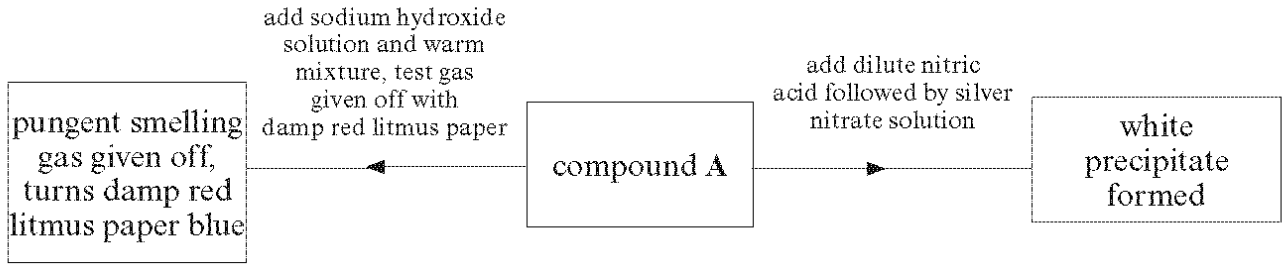
6

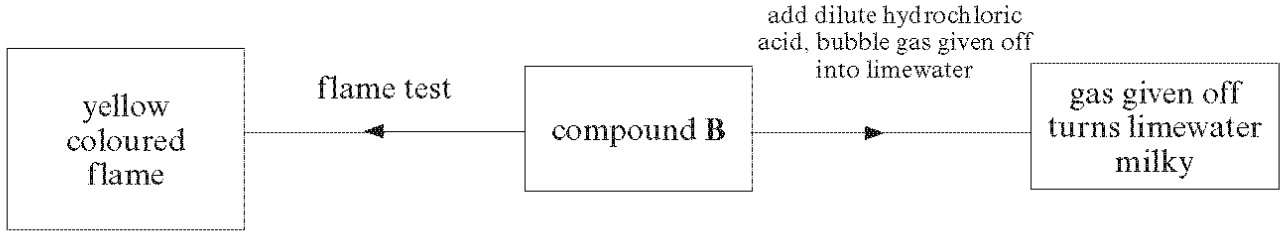
11.

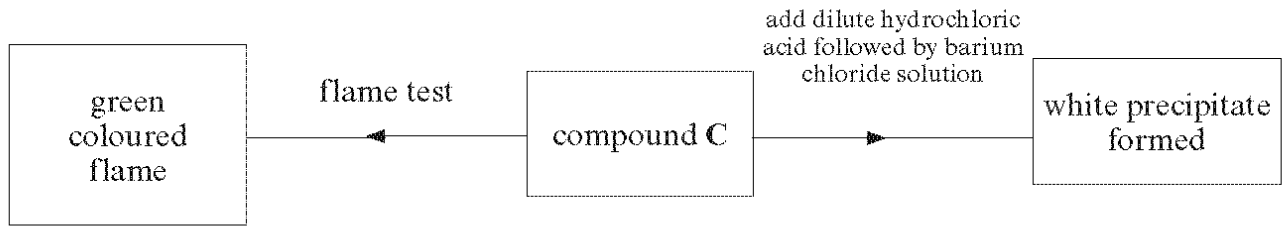
(a) The flow charts below show tests carried out on compounds **A**, **B** and **C** and the results of those tests.

The compounds were known to include some of the following ions.

NH_4^+	Ca^{2+}	Cu^{2+}	K^+	Na^+	Cl^-	Br^-	I^-	SO_4^{2-}	CO_3^{2-}







Use the information to give the **chemical formulae** of compounds **A**, **B** and **C**. [3]

A .....

B .....

C .....

(b) Aqueous iron(III) ions form an orange-brown precipitate when mixed with aqueous sodium hydroxide.

Give the letter **A**, **B**, **C**, **D** or **E** for the ionic equation which correctly represents this reaction. [1]

A $Fe^{3+} + OH^-_3 \longrightarrow FeOH_3$

B $Fe^{3+} + OH^- \longrightarrow Fe(OH)$

C $Fe^{3+} + 3OH^- \longrightarrow Fe_3OH$

D $Fe^{3+} + 3OH^- \longrightarrow Fe(OH)_3$

E $Fe^{3+}_3 + OH^- \longrightarrow Fe_3(OH)$

Letter [ ]

[ ]

4

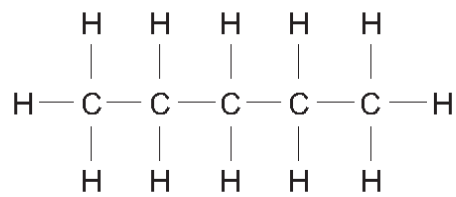
12. *(a)* The table below shows the first five members of the alkane family.

Alkane	Molecular formula
methane	CH_4
ethane	C_2H_6
propane	C_3H_8
butane	C_4H_{10}
pentane	C_5H_{12}

(i) Give the molecular formula for the alkane which contains 18 hydrogen atoms. [1]

.....

(ii) C_5H_{12} has three isomers. The diagram below shows one of these isomers.
Draw the other **two** isomers. [2]



Isomer 1

Isomer 2

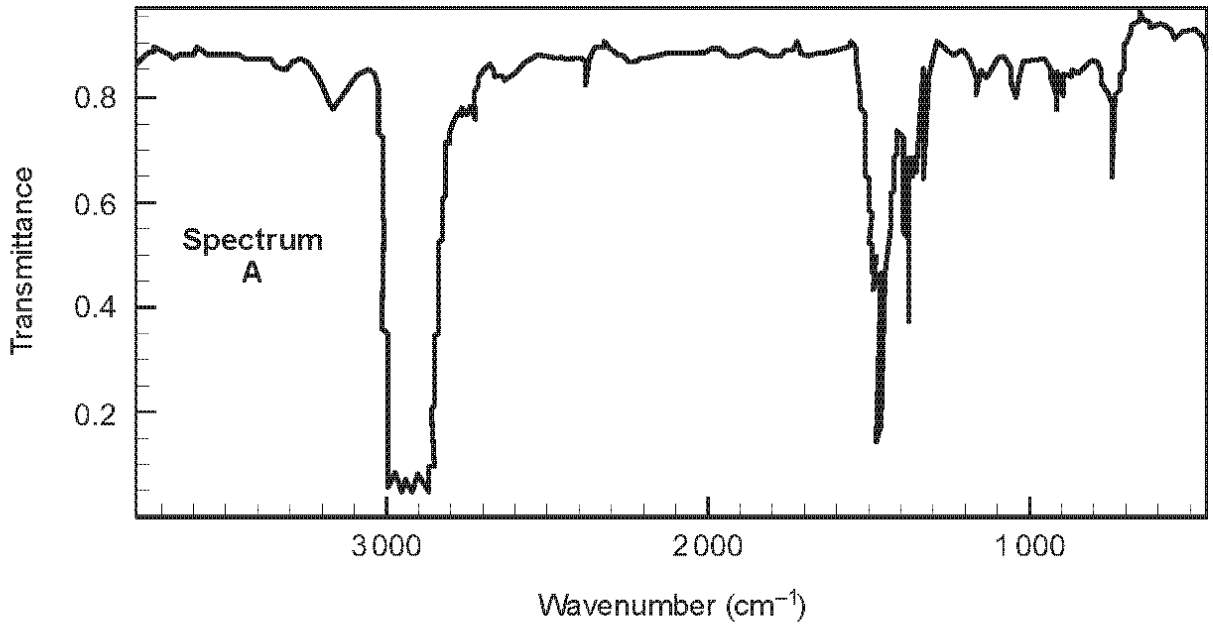
Isomer 3

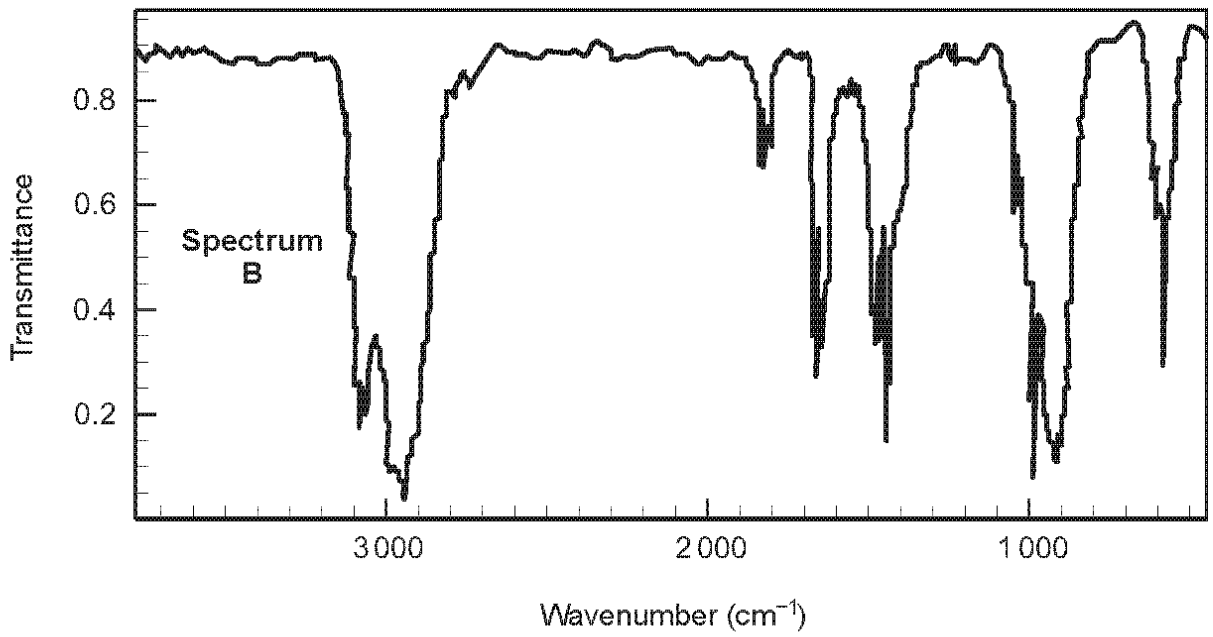
(b) (i) The first two members of the alkene family are ethene, C_2H_4, and propene, C_3H_6. Give the general formula for the alkene family. [1]

.....

(ii) Draw the structural formula for propene. [1]

(c) Study the infrared spectra of propane and propene below. Using the information in the table opposite, identify the spectrum of propene and give a reason for your answer. [1]





Bond	Wavenumber / cm^{-1}
C═C	1620 to 1670
C═O	1650 to 1750
C—H	2800 to 3100
O—H	2500 to 3550

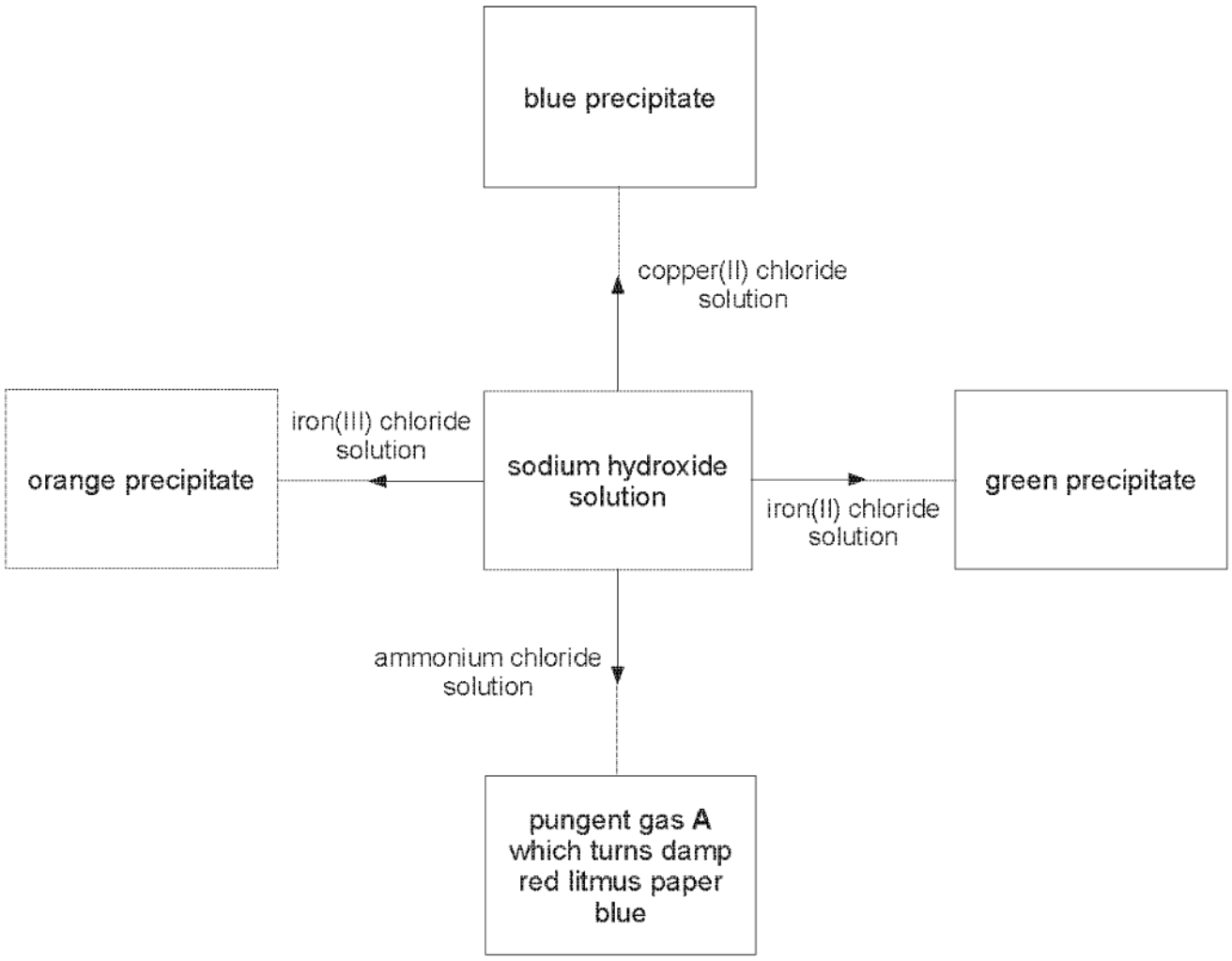
Spectrum .....

Reason .....

.....

6

13. *(a)* A Year 11 pupil added sodium hydroxide to solutions of four compounds. The observations made by the pupil are shown below.



(i) Name pungent gas **A**. [1]

.....

(ii) Give the chemical name of the blue precipitate formed. [1]

.....

(iii) The green precipitate formed is iron(II) hydroxide. Give the chemical formula for this compound. [1]

.....

(b) The following table shows the colours of universal indicator at different pH values.

Colour	red	orange	yellow	green	blue	navy blue	purple
pH	0-2	3-4	5-6	7	8-9	10-12	13-14

(i) Universal indicator turns red in sulfuric acid and orange in ethanoic acid.
State what these results tell you about the **relative** strength of these acids. [1]

.....

(ii) Both acids react with magnesium ribbon forming hydrogen gas.

I. State how the reactions would differ. [1]

.....

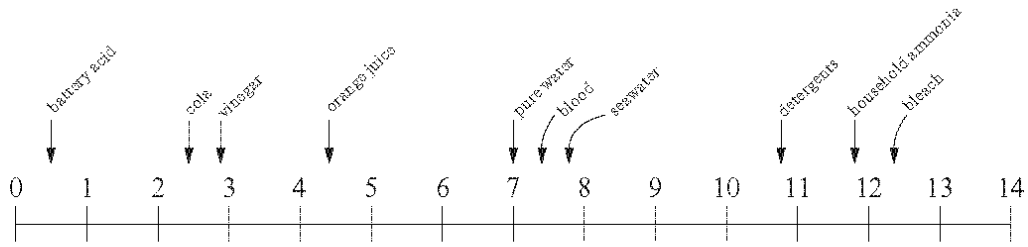
II. Give the test you would carry out to identify hydrogen. Include the result of your test. [1]

.....

.....

6

14. The following diagram shows the pH scale and the pH values of some common substances.



(a) From the substances above, name

(i) the strongest acid, ... [1]

(ii) the weakest alkali, ... [1]

(iii) a neutral substance. ..... [1]

(b) John was studying the reactions of acids with three different substances, **A**, **B** and **C**. He recorded his observations and temperature changes in the table shown below.

Substance added to acid	Observations	Temperature change (°C)
A	bubbles of gas produced, gas collected turns limewater milky, substance reacts to produce blue solution	+4
B	no gas produced, substance reacts to produce a blue solution	0
C	no visible change	+8

Identify **A**, **B** and **C** from the substances in the box below. [3]

copper carbonate **copper oxide** **magnesium** **sodium chloride** **sodium hydroxide**

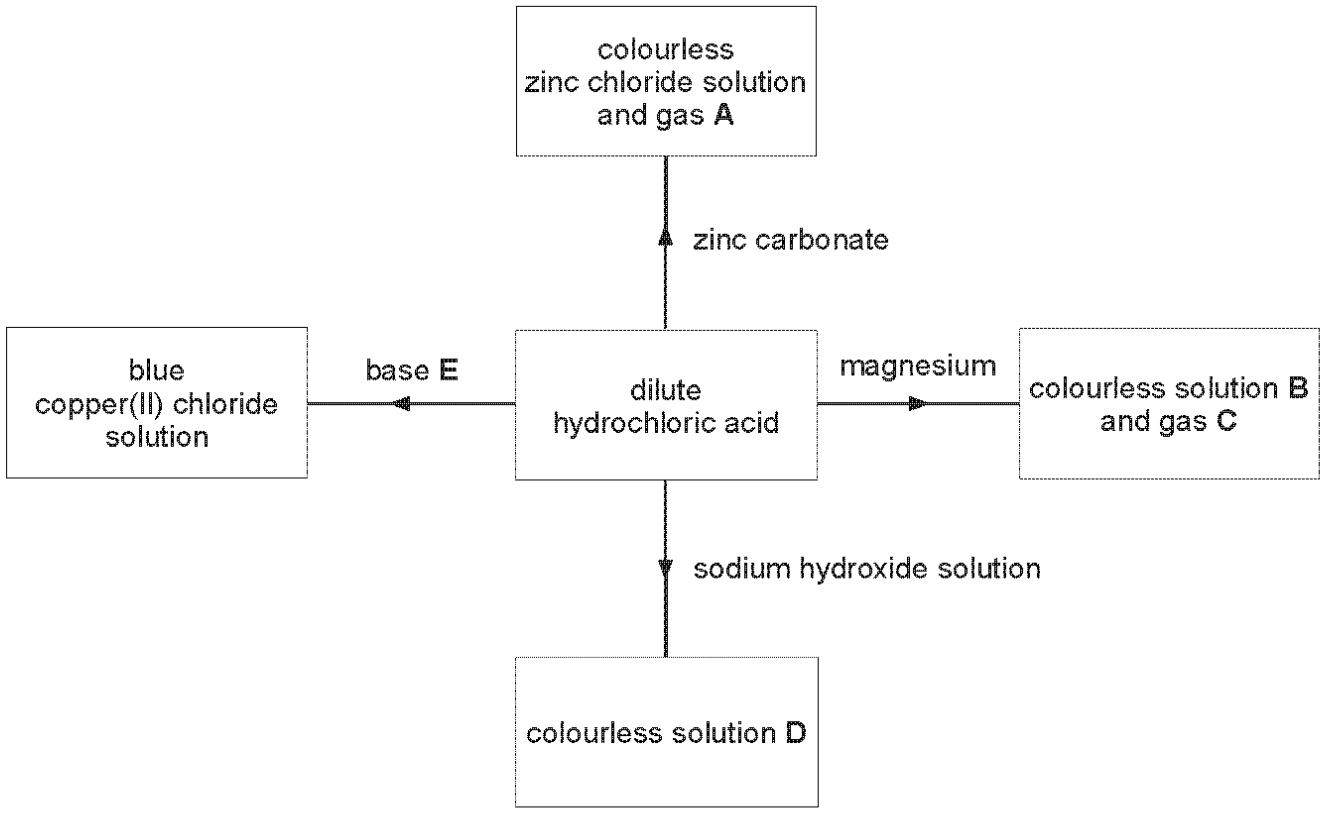
A .....

B .....

C .....

6

15. The diagram below shows some reactions of dilute hydrochloric acid.



(a) Give the names of each of the substances **A** to **E**. [5]

A .....

B .....

C .....

D .....

E .....

(b) Give the chemical formula of zinc chloride. [1]

.....

6

16. The following table shows the pH of some common substances.

Substance	pH
limewater	10.5
saliva	6.4
lemon juice	2.2
orange juice	2.6
milk of magnesia	10.0

(a) Use only information from the table to answer parts (i) and (ii).

(i) Name the strongest acid. [1]

.....

(ii) Name the substance closest to being neutral. [1]

.....

(b) Milk of magnesia is used to treat indigestion. It contains magnesium hydroxide which reacts with excess hydrochloric acid in the stomach.

(i) Complete the following word equation to show the products formed. [2]

magnesium hydroxide + hydrochloric acid ⟶ ..... + ...

(ii) Another indigestion remedy contains calcium carbonate. Name the gas produced when calcium carbonate reacts with hydrochloric acid and state how this gas can be identified. [2]

Gas produced .....

How this gas can be identified .....

.....

6

17. The percentage of carbon dioxide in air is 0.04%.

State, giving a reason in each case, how you would expect the percentage of carbon dioxide to change

(a) in a crowded classroom, [2]

.....

.....

.....

.....

(b) in a greenhouse full of plants on a sunny day, [2]

.....

.....

.....

.....

(c) in the furnace of a coal-fired power station. [2]

.....

.....

.....

.....

6

Marking Scheme

1.

Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
2		(a)			1	potassium	K		
		(b)			1	potassium + oxygen → potassium oxide follow through (ft) error from (a) only if Group 1 metal given	$K + O_2 \rightarrow K_2O$ (ignore balancing) consequential possible	gas	
		(c)			1	lithium / sodium ft only if Group 1 metal given is less reactive than that named in (a)	Li / Na		
		(d)	(i)		1	silver nitrate	$AgNO_3$		
			(ii)		1	dissolved (in water)	diluted / solution	liquid / molten	
			(iii)		1	white independent of (i)		milky	creamy

2.

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
3		*(a)*			3	carbon dioxide → turns limewater milky (1) ammonia → turns damp red litmus blue (1) oxygen → relights a glowing splint (1)			
		(b)			3	yellow flame (1) green flame (1) brown precipitate (1)			

3.

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
4		(a)			3	limestone / chalk / marble (1) CaO (1) calcium hydroxide (1)			
		(b)	(i)		1	brick-red	red		
			(ii)		2	carbon dioxide / CO_2 (1) must have correct gas to award test mark turns limewater milky (1)			
			(iii)		2	1.9/2.0 (1) 95 (1) award (2) for correct answer only (cao)			
		(c)			2	landscaping during /after quarry to remove visual pollution restrict quarry size to reduce visual pollution trains instead of lorries blast at agreed times spray lorry wheels with water to reduce dust remove endangered species to safe site any two for (1) each	other sensible	reference to economic benefits	
		(d)			2	local jobs money into local economy limestone for building / named buildings e.g. houses, walls, etc. local industries / named industry e.g. for making cement/iron building better local road system any two for (1) each	other sensible		

4.

Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
6		(a)			3	brick-red (for Cu^{2+} flame test) (1) yellow precipitate (for Cl^- ion test) (1) white (precipitate for Fe^{3+} test) (1)			
		(b)			1	sodium chloride, water and ammonia – all needed			

5.

Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
8	2	(a)			2	pH6 – should be pH 11-12 (or alkaline) (1) burns with an orange flame – should be lilac flame (1)	8-14 / above 7 lithium with implication that reaction should be more rapid (but less rapid than reaction of sodium)		7 or above
		(b)			4	flame test (1) yellow flame (1) (add) silver nitrate (solution) (1) white precipitate (1) must have correct test for observation mark to be awarded	orange flame		

6.

Question Number								
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	8	*(a)*			3	$Fe + Br_2$ (1) $FeBr_3$ (1) 2 3 2 (1) balancing mark only awarded if all formulae are correct			
		(b)			2	silver nitrate (solution) (1) cream / off-white precipitate (1)			

7.

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	6	*(a)*	(i)		1	sodium chloride / sodium carbonate			
			(ii)		1	sodium carbonate / lithium carbonate			
		(b)			3	add silver nitrate solution (1) white **precipitate** with potassium chloride (1) yellow **precipitate** with potassium iodide (1) allow (1) for **both** colours correct if precipitate not used in either case	answer based on displacement reaction – bromine water; description of colour changes	add HNO_3 flame test	
		(c)			2	ammonia (1) turns (damp) red litmus blue (1)			
		(d)			3	Fe^{3-} + $3OH^-$ (1) $Fe(OH)_3$ (1) correct state symbols (1)			

8.

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	5	*(a)*	(i)		3	copper(II) carbonate (1) copper(II) nitrate (1) sodium hydroxide (1)	formulae		
			(ii)		4	**A** – hydrogen (1) must be correct to award second mark pop with lighted splint (1) **D** – carbon dioxide (1) must be correct to award second mark limewater turns milky (1)	H_2 CO_2	H 'pop test'	
		(b)	(i)		1	Na_2SO_4			
			(ii)		2	heat until half volume / remove some water (1) leave to form crystals (1)	evaporate	 filtration	to dryness
		(c)			1	$Fe_2O_3 + 2H_3PO_4 \rightarrow 2FePO_4 + 3H_2O$			

9.

Question Number									
FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	7	(a)			4	**A** sodium iodide **B** ammonium carbonate **C** calcium chloride **D** iron**(II)** carbonate mark positive and negative ions independently 8 ions correct = 4 marks 6/7 ions correct = 3 marks 4/5 ions correct = 2 marks 2/3 ions correct = 1 mark	NaI $(NH_4)_2CO_3$ $CaCl_2$ $FeCO_3$ no credit for either ion if incorrect formula given **instead** of name – ignore formulae if names also given		
		(b)			1	barium chloride (solution forms a) white precipitate test **and** result needed	barium nitrate / $Ba^{2+}(aq)$		

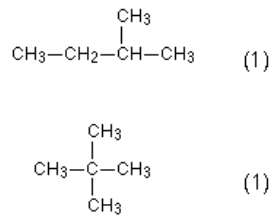
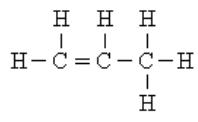
10.

Question Number FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	7	(a)			1	lithium / Li^+	Li Ca Sr		
		(b)	(i)		1	cream precipitate	off white ppt		pale yellow ppt
			(ii)		2	$Ag^+ + Br^-$ (1) AgBr (1)			
		(c)	(i)		1	chlorine / fluorine	Cl_2 / F_2	Cl / F	
			(ii)		1	displacement	redox		

11.

Question Number FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	8	(a)			3	A NH_4Cl B Na_2CO_3 C $CuSO_4$ all ions correctly identified (2) 3, 4 or 5 ions correctly identified (1) all formulae correct (1)	correct names only for all three compounds (2)		
		(b)			1	D			

12.

Question Number FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	5	(a)	(i)		1	C_8H_{18}			
			(ii)		2	 (1) (1)			
		(b)	(i)		1	C_nH_{2n}			
			(ii)		1				
		(c)			1	**B** contains C=C peak both needed for (1)			

13.

Question Number FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
5		(a)	(i)		1	ammonia	NH_3		
			(ii)		1	copper(II) hydroxide	copper hydroxide $Cu(OH)_2$		
			(iii)		1	$Fe(OH)_2$			
		(b)	(i)		1	sulfuric acid is stronger / more acidic (than ethanoic acid) ethanoic acid is weaker / less acidic (than sulfuric acid)	sulfuric acid is strong and ethanoic acid is weak	pH of sulfuric acid is 1 and pH of ethanoic acid is 3	
			(ii)	I	1	reaction with sulfuric acid would be faster more reactive / more bubbles / gets hotter with sulfuric acid	converse answers		
				II	1	(gas) pops with **lighted** splint			

14.

Question Number FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
8	2	(a)	(i)		1	battery acid			
			(ii)		1	blood			
			(iii)		1	**pure** water			
		(b)			3	**A** copper carbonate (1) **B** copper oxide (1) **C** sodium hydroxide (1)	$CuCO_3$ CuO NaOH		

15.

Question Number FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
	5	*(a)*			5	A carbon dioxide / CO_2 B magnesium chloride / $MgCl_2$ C hydrogen / H_2 D sodium chloride / NaCl E copper(II) oxide / CuO copper(II) hydroxide / $Cu(OH)_2$	 copper oxide copper hydroxide		 $CuCO_3$
		(b)			1	$ZnCl_2$	$Zn^{2+}Cl^-_2$ $Zn(Cl)_2$		

16.

Question Number FT	HT	Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
4		*(a)*	(i)		1	lemon juice			
			(ii)		1	saliva			
		(b)	(i)		2	magnesium chloride (1) water (1)	formulae		
			(ii)		2	carbon dioxide (1) gas must be correct to award test mark turns limewater milky (1)			

17.

Question Number		Sub-section			Mark	Answer	Accept	Neutral answer	Do not accept
FT	HT								
4		(a)			2	increase (1) carbon dioxide given out during breathing / respiration (1)		breathing	
		(b)			2	decrease (1) carbon dioxide removed during photosynthesis / plants take in carbon dioxide (1)			
		(c)			2	increase (1) carbon dioxide given out during combustion / burning (of fuels) (1)			