Chemical analysis – triple

Ion tests:

Ion	Test	Positive result	Negative result
Carbonate (CO_3^{2-})	Add hydrochloric acid and bubble gas produced through limewater	Limewater turns cloudy, CO_2 present	No change
Sulfates (SO_4^{2-})	Add hydrochloric acid and barium chloride	White precipitate	No change
Halides	Add nitric acid then silver nitrate	Chloride: white precipitate Bromide: cream precipitate Iodide: yellow precipitate	No change
Aluminium, calcium, magnesium ions	Add sodium hydroxide, then add sodium hydroxide to excess	All give white precipitate, aluminium hydroxide dissolves again in excess	No change/ turns a colour other than white
Copper (II)	Add sodium hydroxide	Blue precipitate	No change/ turns a colour other than blue
Iron (II)	Add sodium hydroxide	Green precipitate	No change/ turns a colour other than green
Iron (III)	Add sodium hydroxide	Brown precipitate	No change/ turns a colour other than brown
Lithium	Flame test	Crimson	Any other colour
Sodium	Flame test	Yellow	Any other colour
Potassium	Flame test	Lilac	Any other colour
Calcium	Flame test	Orange-red	Any other colour
Copper	Flame test	Green	Any other colour

Instrumental analysis

Instrumental analysis uses complicated scientific equipment to analyse substances. Advantages: Accurate, Sensitive, Rapid.

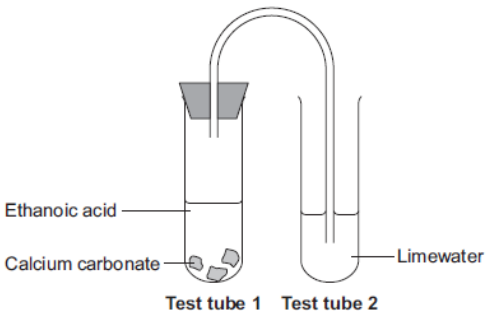
Flame emission spectroscopy

This is a way of doing a flame test but getting a much more accurate reading. Normally, we have to look at the colour and then match it to an ion. In flame emission spectroscopy we allow the coloured light from the flame to pass through special filters and machines and produce lines in a spectrum. This allows us to match those lines to a reference and identify the ion.

Q1. This question is about reactions of ethanoic acid and the analysis of salts.

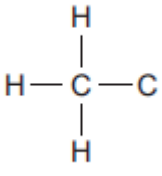
(a) **Figure 1** shows the apparatus used to investigate the reaction of ethanoic acid with calcium carbonate.

Figure 1



(i) Describe a change that would be seen in each test tube. Give a reason for each change. **(4)**

(ii) Complete the displayed structure of ethanoic acid.

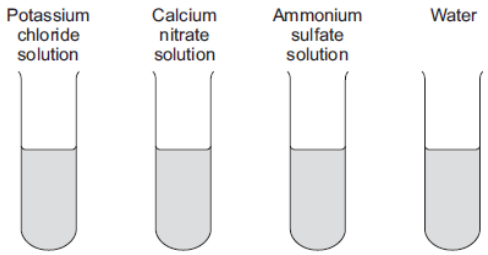


(1)

(iii) Ethanoic acid is a carboxylic acid. Complete the sentence. Carboxylic acids react with alcohols in the presence of an _____ catalyst to produce pleasant-smelling compounds called _____ . **(2)**

(b) **Figure 2** shows four test tubes containing three different salt solutions and water.

Figure 2



Each solution and the water was tested with:

- silver nitrate in the presence of dilute nitric acid
- barium chloride in the presence of dilute hydrochloric acid.

Complete the table of results.

	Potassium chloride solution	**Calcium nitrate solution**	**Ammonium sulfate solution**	**Water**
Test with silver nitrate in the presence of dilute nitric acid			no change	no change
Test with barium chloride in the presence of dilute hydrochloric acid		no change	white precipitate	

(2)

(c) Flame tests can be used to identify metal ions.

(i) Complete the following sentences.
The flame colour for potassium ions is _____ .
The flame colour for calcium ions is _____ . **(2)**

(ii) Give **one** reason why a flame test would **not** show the presence of both potassium ions and calcium ions in a mixture. **(1)**

Q2. Burgundy Mixture is a formulation used to kill fungi on grapevines. It is made by mixing two compounds, **A** and **B**. The ratio by mass of **A** : **B** in the mixture is 1 : 8

(a) Calculate the mass of A needed in a mixture containing 125 g of **B**. **(2)**

Scientists test a solution of compound **A**. The table shows their results.

Test	**Result**
Add sodium hydroxide solution	Blue precipitate
Add dilute hydrochloric acid and barium chloride solution	White precipitate

(b) Which **two** ions are in compound **A**? Choose the answers from the box.

bromide	**chloride**	**copper**
iron(II)	**iron(III)**	**sulfate**

_____ ions and _____ ions **(2)**

(c) The scientists think that compound **B** is sodium carbonate. Describe how the scientists can test a solution of **B** to see if sodium ions are present. Give the result of the test if sodium ions are present **(2)**

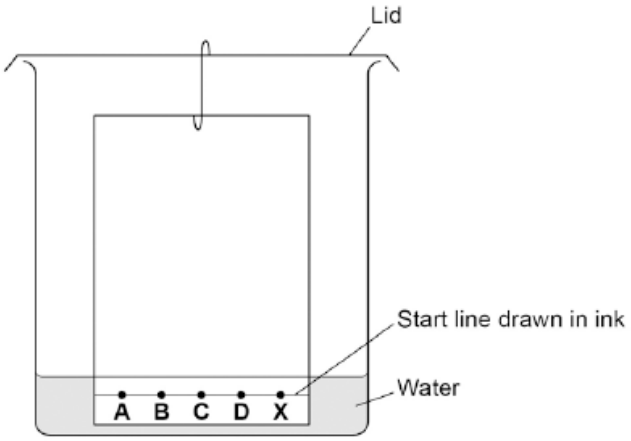
(d) Describe how the scientists can test a solution of **B** to see if carbonate ions are present. Give the result of the test if carbonate ions are present. **(3)**

Q3. A student investigated food dyes using paper chromatography. This is the method used.

1. Put a spot of food colouring **X** on the start line.
2. Put spots of four separate dyes, **A**, **B**, **C** and **D**, on the start line.
3. Place the bottom of the paper in water and leave it for several minutes.

Figure 1 shows the apparatus the student used.

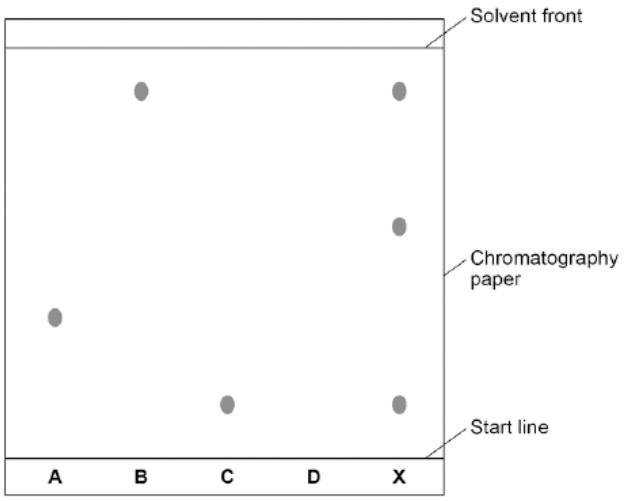
Figure 1



(a) Write down **two** mistakes the student made in setting up the experiment and explain what problems one of the mistakes would cause. **(2)**

(b) Another student set up the apparatus correctly. **Figure 2** shows the student's results. The result for dye **D** is not shown.

Figure 2



Calculate the R_f value of dye **A.** Give your answer to two significant figures. **(3)**

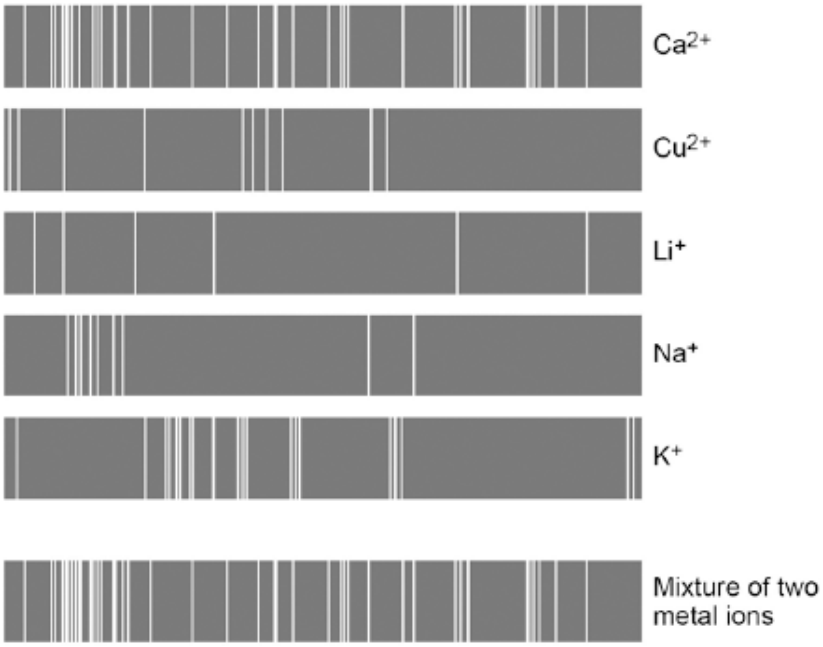
(c) Dye **D** has an R_f value of 0.80. Calculate the distance that dye **D** moved on the chromatography paper. **(1)**

(d) Explain how the different dyes in **X** are separated by paper chromatography. **(4)**

(e) Flame emission spectroscopy can be used to analyse metal ions in solution.

Figure 3 gives the flame emission spectra of five metal ions, and of a mixture of two metal ions.

Figure 3



Use the spectra to identify the **two** metal ions in the mixture. **(2)**

(g) Two students tested a green compound **X**. The students added water to compound **X**. Compound **X** did not dissolve. The students then added a solution of ethanoic acid to compound **X**. A gas was produced which turned limewater milky.

Student **A** concluded that compound **X** was sodium carbonate.
Student **B** concluded that compound **X** was copper chloride.

Which student, if any, was correct? Explain your reasoning. **(4)**

Q4. A student was investigating a magnesium salt, **X**. The student found that **X**:

- has a high melting point
- does not conduct electricity
- dissolves in water and the solution conducts electricity.

(a) (i) What is the type of bonding in magnesium salt **X**? **(1)**

(ii) Explain why solid **X** does **not** conduct electricity but a solution of **X** does conduct electricity. **(2)**

(b) The student dissolved **X** in water. The student added dilute nitric acid and silver nitrate solution to the solution of **X**. A white precipitate was formed. Salt **X** contains chloride ions. Explain why a white precipitate was formed. **(2)**

(c) The student dissolved **X** in water. The student added a few drops of sodium hydroxide solution to the solution of **X**. A white precipitate was formed.

(i) Salt **X** contains magnesium ions. Name **two** other metal ions that would give a white precipitate when a few drops of sodium hydroxide solution are added. **(2)**

(ii) Describe the **two** further tests the student would have to do to show that salt **X** contains magnesium ions, and **not** the two metal ions you identified in part **(c) (i)**. Give the expected results of each test.

(4)

(Total 11 marks)

Q1.

(a) (i) fizz / effervescence / bubbles

allow calcium carbonate decreases in size or dissolves

1

because carbon dioxide produced / released

allow because gas produced / released

1

limewater turns cloudy / milky / white

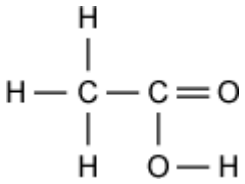
1

because (a precipitate of or solid) calcium carbonate forms

allow because of carbon dioxide if not already credited

1

(ii)



allow -OH

do not allow lower case 'h'

1

(iii) acid

must be in this order

ignore any name of an acid

1

ester(s)

1

(b) white (precipitate) no change

no change no change

all four correct 2 marks

any two correct 1 mark

2

(c) (i) lilac

allow purple

1

red

1

must be in this order

(ii) colours are masked / changed by each flame colour

1

[12]

Q2.

(a) $\frac{125}{8}$

1

= 15.6(25) (g)

1

*an answer of 15.6(25) (g) scores **2** marks*

(b) copper (ions)

allow in either order

1

sulfate (ions)

1

(c) flame test

1

yellow (flame)

1

(d) add dilute acid

allow named acid

1

(bubble gas produced through) limewater

1

(turns) cloudy / milky

allow forms white precipitate

1

[9]

Q3.

(a) water level above the start line
and
start line drawn in ink

allow water level too high

1

water level
food colours would dissolve into water
or
start line
the ink would 'run' on the paper

1

(b) (distance moved by **A**) 2.8cm **and** 8.2 cm (distance moved by solvent)

allow values in range 2.7 – 2.9 cm and 8.1 – 8.3 cm

1

$\frac{2.8}{8.2}$

1

0.34

allow 0.33 or 0.35

*allow ecf from incorrect measurement to final answer for **2** marks if given to 2 significant figures*

*accept 0.34 without working shown for **3** marks*

1

(c) 6.6 cm

allow values between 6.48 and 6.64 cm

1

(d) solvent moves through paper

1

different dyes have different solubilities in solvent

1

and different attractions for the paper

1

and so are carried different distances

1

(e) calcium ions

allow Ca^{2+}

1

sodium ions

allow Na^{+}

1

(f) two different colours

or

Ca^{2+} / one is orange-red and Na^{+} / the other is yellow

allow brick red for Ca^{2+} *and / or orange for* Na^{+}

allow incorrect colours if consistent with answer to ***7.5***

1

(so) colours mix

or

(so) one colour masks the other

1

(g) (Student **A** was incorrect)

because sodium compounds are white not green

or

because sodium carbonate is soluble

1

so can't contain sodium ions

1

(Student **B** was incorrect)

because adding acid to carbonate produces carbon dioxide

1

so must contain carbonate not chloride ions

1

[18]

Q4.

(a) (i) ionic (bonding)

1

(ii) <u>ions</u> cannot move in solid **or** are in fixed positions

do ***not*** *accept electrons / atoms / molecules*

ignore particles

must *mention ions*

1

but can move in solution

1

(b) silver chloride formed

1

which is insoluble

1

(c) (i) aluminium

1

calcium

accept other metal ions that also give white precipitates (such as lead and zinc)

1

(ii) add excess sodium hydroxide solution

the second mark of each pair is dependent on the first mark being awarded.

1

precipitate remains

1

carry out a flame test

1

not red / orange

accept any colour that is not orange / red

*give full credit for answers that correctly eliminate other cations in **(c)(i)** that would give white precipitates with a few drops of NaOH*

1

[11]