Chemical Analysis 3

Name: _____

Class: _____

Date: _____

Time: **58 minutes**

Marks: **58 marks**

Comments:

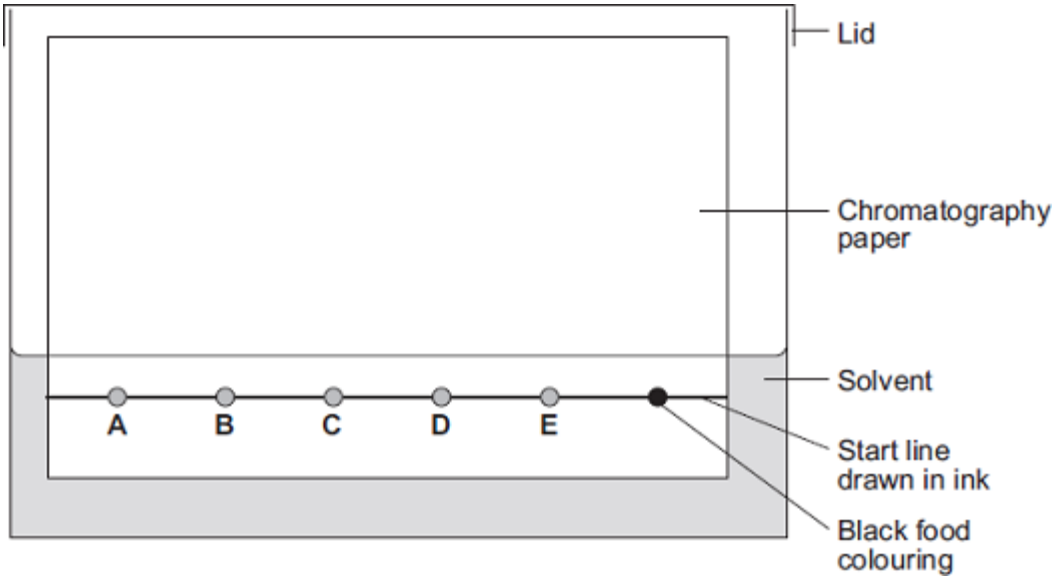
1. Chromatography can be used to separate components of a mixture.

(a) A student used paper chromatography to analyse a black food colouring.

The student placed spots of known food colours, **A**, **B**, **C**, **D** and **E**, and the black food colouring on a sheet of chromatography paper.

The student set up the apparatus as shown in **Diagram 1**.

Diagram 1



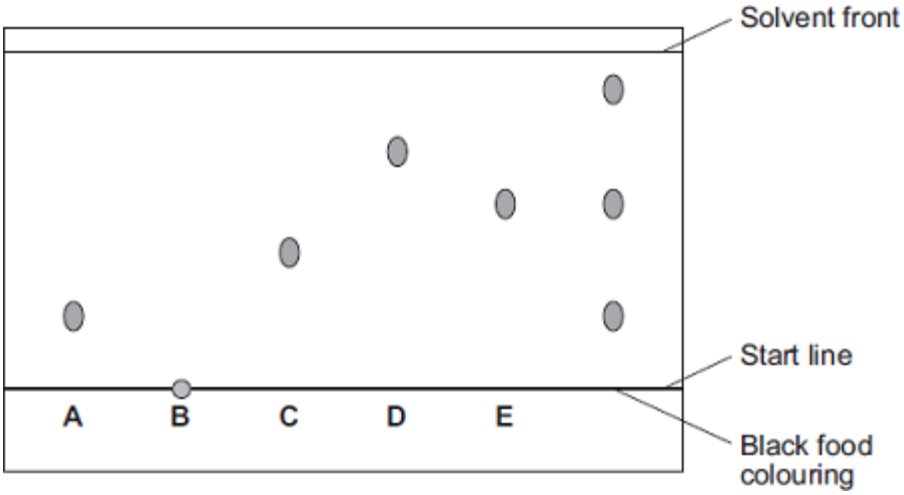
The student made **two** errors in setting up the apparatus.
Identify the **two** errors and describe the problem each error would cause.

(4)

(b) A different student set up the apparatus without making any errors.

The chromatogram in **Diagram 2** shows the student's results.

Diagram 2



(i) What do the results tell you about the composition of the black food colouring?

_____

_____

_____

(2)

(ii) Use **Diagram 2** to complete **Table 1**.

Table 1

	Distance in mm
Distance from start line to solvent front	_____
Distance moved by food colour **C**	_____

(2)

(iii) Use your answers in part **(b) (ii)** to calculate the R_f value for food colour **C**.

_____

_____

R_f value = _____

(1)

(c) **Table 2** gives the results of chromatography experiments that were carried out on some known food colours, using the same solvent as the students.

Table 2

Name of food colour	Distance from start line to solvent front in mm	Distance moved by food colour in mm	R_f value
Ponceau 4R	62	59	0.95
Carmoisine	74	45	0.61
Fast red	67	27	0.40
Erythrosine	58	17	0.29

Which of the food colours in **Table 2** could be food colour **C** from the chromatogram?

Give the reason for your answer.

_____

_____

_____

(2)

(d) Two types of chromatography are gas chromatography and paper chromatography.

Give **one** advantage of gas chromatography compared with paper chromatography.

_____

_____

(1)

(Total 12 marks)

2. The label shows the ingredients in a drink called Cola.

Cola

Ingredients:

Carbonated water
Sugar
Colouring
Phosphoric acid
Flavouring
Caffeine

(a) (i) The pH of carbonated water is 4.5.

The pH of Cola is 2.9.

Name the ingredient on the label that lowers the pH of Cola to 2.9.

_____

(1)

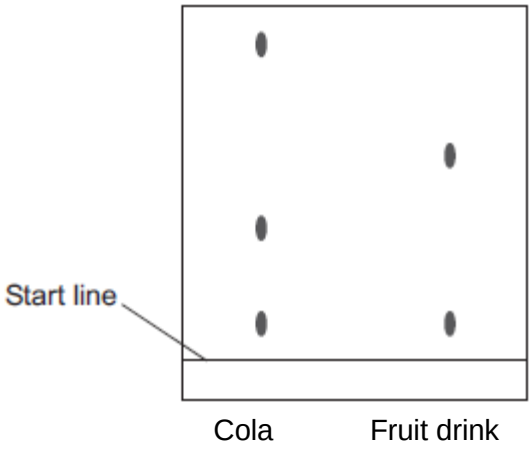
(ii) Which ion causes the pH to be 2.9?

_____

(1)

(b) A student investigated the food colouring in Cola and in a fruit drink using paper chromatography.

The chromatogram in the figure below shows the student's results.



(i) Complete the sentence.

The start line should be drawn with a ruler and _____ .

Give a reason for your answer.

_____

_____

(2)

(ii) Suggest **three** conclusions you can make from the student's results.

_____

_____

_____

_____

_____

_____

(3)

(c) Caffeine can be separated from the other compounds in the drink by gas chromatography.

Why do different compounds separate in a gas chromatography column?

_____

_____

(1)

(d) Caffeine is a stimulant.

Large amounts of caffeine can be harmful.

(i) Only **one** of the questions in the table **can** be answered by science alone.

Tick (✓) **one** question.

Question	Tick (✓)
Should caffeine be an ingredient in drinks?	
Is there caffeine in a certain brand of drink?	
How much caffeine should people drink?	

(1)

(ii) Give **two** reasons why the other questions **cannot** be answered by science alone.

Reason 1 _____

_____

Reason 2 _____

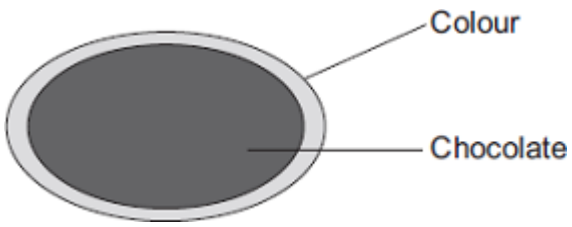
_____

(2)

(Total 11 marks)

3. Colours are used to coat some chocolate sweets.

Some of these colours are given E-numbers.



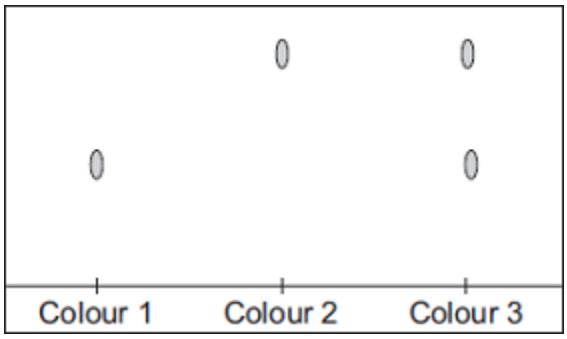
(a) Use the correct word from the box to complete the sentence.

additive	element	fuel

An E-number is used to identify a permitted food _____

(1)

(b) Chromatography was used to compare three of the colours used to coat the chocolate sweets.



What do these results tell you about these three colours?

_____

_____

_____

_____

_____

_____

(3)

(Total 4 marks)

4. This is part of an article about food additives.

THE PERIL OF FOOD ADDITIVES

Some orange drinks contain the additives E102 (Tartrazine), E104 (Quinoline Yellow) and E110 (Sunset Yellow).These three coloured additives are thought to cause hyperactivity in children.

(a) State **two** reasons that a manufacturer might give to justify the use of these additives.

1. _____

_____

2. _____

_____

(2)

(b) Some scientists asked 4000 twelve-year-old children to help them investigate if there is a link between these three coloured additives and hyperactivity.

How would the scientists use these 4000 children to investigate if there is a link between these three coloured additives and hyperactivity in children?

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) A manufacturer used an independent scientist to show that their orange drink did not contain these three coloured additives.

(i) Suggest why the manufacturer would use a scientist who was independent instead of using their own scientist.

_____

_____

(1)

(ii) The scientist had samples of E102, E104 and E110 and the orange drink. The scientist used paper chromatography for the test.

Describe how the scientist could use the results to show if the orange drink contained any of these three coloured additives.

You may include a diagram of the paper chromatography results.

(2)

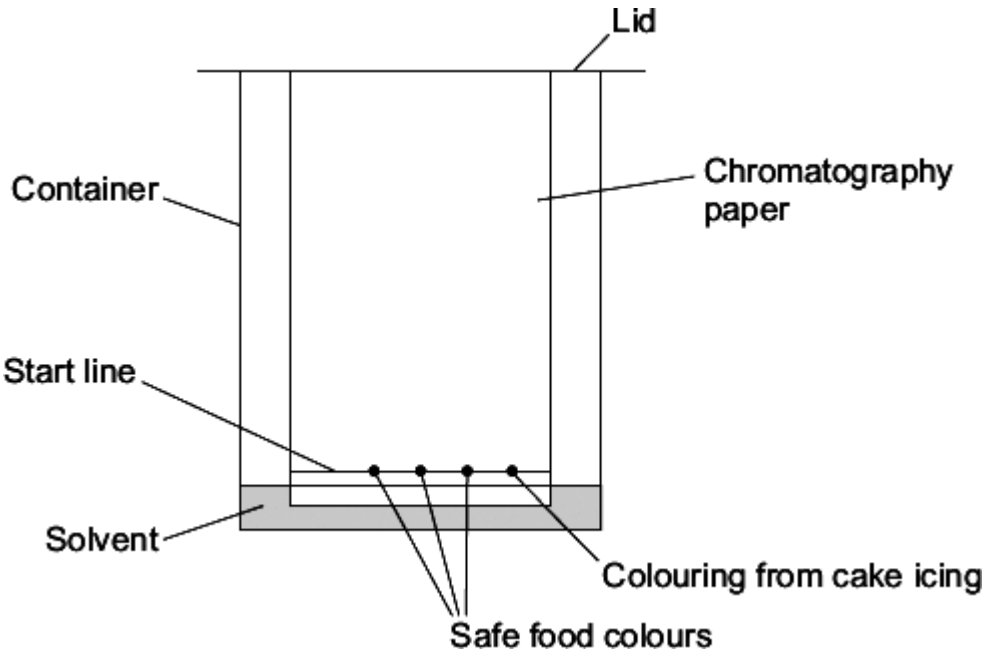
(Total 9 marks)

5. Icing on cakes is tested to check that safe colours were used when they were made.

By Megan Chromik [CC-BY-SA-2.0], via Wikimedia Commons

Paper chromatography is one method of testing which colours are in cake icing.

(a) The diagram shows an experiment a student did.



(i) Suggest why there is a lid on the container.

_____

_____

(1)

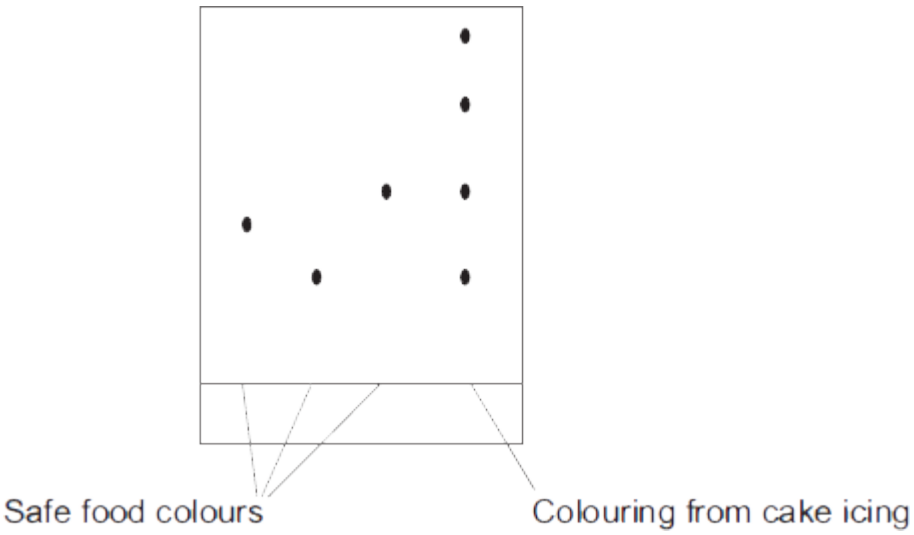
(ii) The start line should be drawn in pencil **not** in ink.
Suggest why.

_____

_____

(1)

(b) The diagram shows the results of the paper chromatography experiment.



(i) How many different food colours were used in the colouring from the cake icing?

_____

(1)

(ii) Is the cake icing safe to eat?

Give a reason for your answer.

_____

_____

(1)

(c) Gas chromatography linked to mass spectroscopy is an example of an instrumental method. This method was used on a mixture of solvents.

(i) Give **two** advantages of gas chromatography compared with paper chromatography.

_____

_____

_____

_____

(2)

(ii) What does gas chromatography do to the mixture of solvents?

_____

_____

(1)

(iii) What information does mass spectroscopy give?

_____

_____

(1)

(Total 8 marks)

6. Read the article.

Problem food colourings

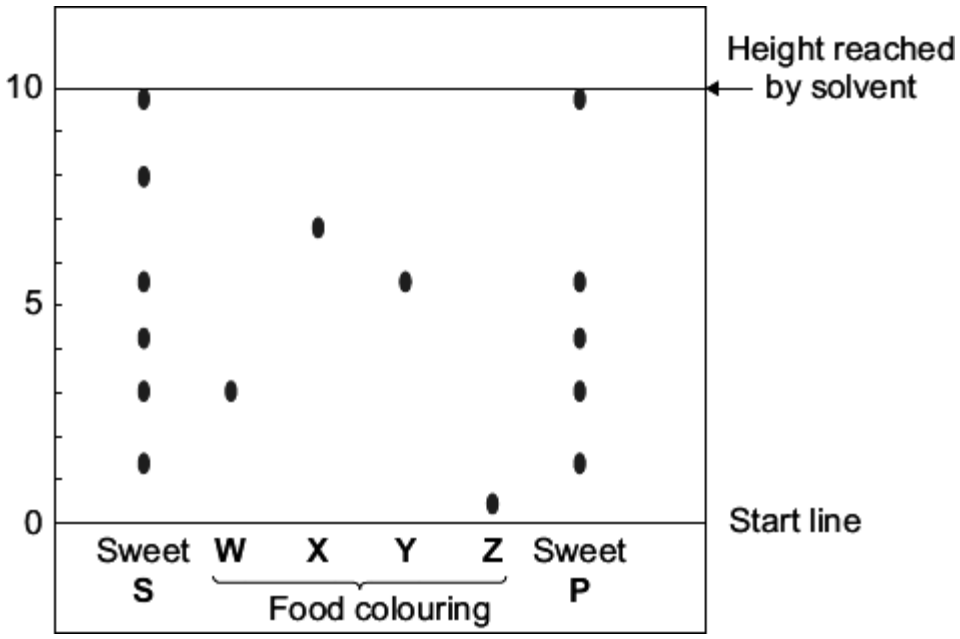
Scientists say they have evidence that some food colourings cause hyperactive behaviour in young children.

These food colourings are added to some sweets.

W, **X**, **Y** and **Z** are food colourings that may cause hyperactive behaviour in young children.

A scientist used chromatography to see if these food colourings were used in two sweets, **S** and **P**.

The results are shown on the chromatogram.



(a) Food colourings, such as **W**, **X**, **Y** and **Z**, are added to some sweets.

Suggest **one** reason why.

_____

_____

(1)

(b) In chromatography, the R_f value = $\frac{\text{distance moved by the colouring}}{\text{distance moved by the solvent}}$

Use the scale on the chromatogram to help you to answer this question.

Which food colouring, **W**, **X**, **Y** or **Z**, has an R_f value of 0.7?

(1)

(c) From the chromatogram, what conclusions can the scientist make about the colourings in sweets **S** and **P**?

(3)

(Total 5 marks)

7. This is part of an article about food additives.

THE PERIL OF FOOD ADDITIVES

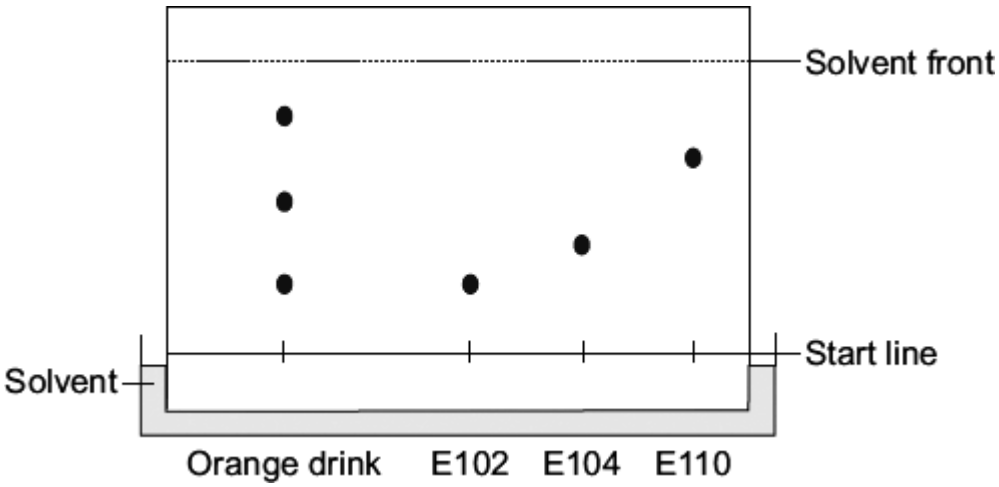
Some orange drinks contain the additives E102 (Tartrazine), E104 (Quinoline Yellow) and E110 (Sunset Yellow).
These three additives are thought to cause hyperactivity in children.

(a) Tick (✓) **two** reasons why a manufacturer of orange drinks uses these additives.

Reason	Tick (✓)
to make the drink healthier	
to improve the appearance of the drink	
because they are permitted colours	
because they are expensive	

(2)

(b) A scientist tested an orange drink to find out if it contained these additives.
The result of the test is shown.



(i) Draw a ring around the correct answer to complete the sentence.

The test that the scientist did is called

chromatography.

cracking.

distillation.

(1)

(ii) How many coloured additives are there in the orange drink? _____

(1)

(iii) The scientist concluded that the orange drink contained only **one** of the additives E102, E104 and E110.

Explain why.

_____

_____

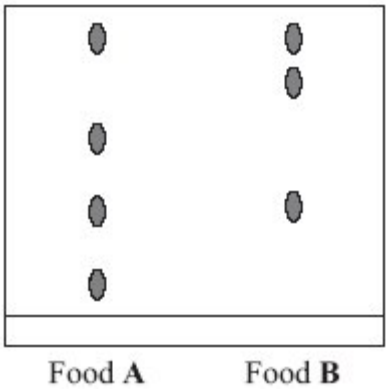
_____

_____

(2)

(Total 6 marks)

8. The result of a process used to detect and identify the colours in two foods, **A** and **B**, is shown.



(i) Describe the differences between the colours used in food **A** and food **B**.

_____

_____

_____

_____

(2)

(ii) Tick (✓) the name of the process used to detect and identify colours in food.

Process	(✓)
chromatography	
extraction	
hardening	

(1)

(Total 3 marks)

1. (a) start line drawn in ink

1

so it will run / dissolve in the solvent / split up

allow mixes with the spots

1

spots under solvent **or** solvent above spots / start line

1

so they will mix with solvent **or** wash off paper **or** colour the solvent **or** dissolve in the solvent

1

(b) (i) contains **A** and **E**

1

and one other (unknown substance)

*if no other marks awarded, an answer saying it is made up of three colours gains **1** mark*

1

(ii) 45 or 46

allow any value from 45 to 46

1

18

allow any value from 16 to 20

*award **1** mark if numbers correct but in cm*

1

(iii) 0.40

*allow ecf from **(b)(ii)***

ignore units

1

(c) fast red

*allow ecf from **(b)(iii)***

1

has same R_f value

*allow none of them, as none has the same R_f value for **2** marks*

1

(d) any **one** from:

- more accurate
- more sensitive
- uses small quantities of samples
- quicker / faster / more rapid
- can link to mass spectrometer (MS)

1

[12]

2. (a) (i) (phosphoric) acid

allow phosphoric

1

(ii) H^+ / hydrogen (ion)

if ion symbol given, charge must be correct

1

(b) (i) pencil

1

so it will not run / smudge / *dissolve*

ignore pencil will not interfere with / affect the results

or

because ink would run / smudge / *dissolve*

ignore ink will interfere with / affect the results

1

(ii) any **three** from:

*reference to spots / dots = max **2***

allow colouring for colour

- *3* colours in Cola

*allow more colours in cola **or** fewer colours in fruit drink*

- *2* colours in Fruit drink
- one of the colours is the same
- two of the colours in Cola are different
- one of the colours in Fruit drink is different

allow some of the colours in the drinks are different

- *one of the colours in Cola is the most soluble*

accept one of the colours in Cola has the highest R_f value

3

(c) different substances travel at different speeds **or** have different retention times

accept different attraction to solid

ignore properties of compounds

1

(d) (i) Is there caffeine in a certain brand of drink?

1

(ii) any **two** from:

- cannot be done by experiment
- based on opinion / *lifestyle choice*
- ethical, *social* or economic issue

accept caffeine has different effects on different people

2

[11]

3. (a) additive

1

(b) colour 3 is a mixture of colours 1 and 2

any **two** from:

accept E-number or additive instead of colour

ignore comments about height / level

1

- colour 1 is made up of only one colour / dye
- colour 2 is made up of only one colour / dye
- colour 3 is made up of two colours / dyes
  or
  more colours (than colours 1 and 2)

2

[4]

4.

(a) any **two** from:

ignore reference to taste / shelf-life / sales etc

- improve the colour / appearance
- additives are permitted / not banned / listed on the label
- link between additives and hyperactivity not proved
- maintain the low cost of the drink **or** natural colours would make the drink cost more

  allow cheaper if qualified

2

(b) have a control group / placebo **or** test children before any drink given

1

give a drink to at least 3 groups **or** give a drink at least 3 times

1

give each additive to different group / children / at different times

1

observe / monitor / compare behaviour of group / children

1

(c) (i) so that there would be trust / respect / no bias

1

(ii) compare the colours / spots from the orange drink with those of the (three) additives

accept diagram of chromatogram(s) with spots for E102, 104, 110 and sample from the orange drink

1

there should be no matching colours / spots

1

[9]

5.

(a) (i) prevent evaporation of solvent

allow prevent loss of solvent

allow to support the (chromatography) paper

1

(ii) ink dissolves in the solvent

allow ink 'runs' / spreads ***or*** *pencil does not 'run' / spread*

allow ink would affect the result / mixes with colours

or

carbon / graphite does not dissolve in the solvent

accept pencil for carbon / graphite

1

(b) (i) 4

1

(ii) *no mark for 'no / don't know'* ,

ignore numbers

any **one** from:

- because not all colours match
- not all colours are safe
- some colours could be unsafe
- some colours travelled higher (than safe colours)

1

(c) (i) any **two** from:

ignore reliable / precise

- rapid / quick
- accurate
- sensitive **or** detects very small quantities

accept small sample

2

(ii) separates

1

(iii) identifies solvents / compounds / substances

accept (relative) molecular mass

accept formula mass

accept M_r

accept relative mass

accept molecular ion peak

1

[8]

6. (a) (improve) appearance

allow add colour

allow these food colourings have not been proven to cause hyperactive behaviour in young children

*do **not** accept taste / flavour / preservatives*

ignore reference to E-numbers

1

(b) X

1

(c) any **three** from:

- S contains six / 6 colourings
- P contains five / 5 colourings

  *if neither of first 2 bullet points given allow **1** mark for S contains more colours than P **or** converse*
- both S and P contain the same

  five / 5 colourings
- both contain W **and** Y
- both sweets (may) cause hyperactivity

  ignore unsafe
- neither contain X **and** Z

3

[5]

7. (a) to improve the appearance of the drink

1

because they are permitted colours

1

(b) (i) chromatography

1

(ii) three / 3

1

(iii) because one colour / spot / E102 matched

1

because the other / two colours / spots / E104 and E110 did not match

if no other mark awarded allow because the drink did not contain E104 and E110 ***or*** *because the drink contained E102 for* ***1*** *mark*

accept only E102 matched for ***2*** *marks*

1

[6]

8. (i) any **two** from:

- **A** has four colours(*)
- **B** has three colours(*)

(*) if first two bullets not stated
accept ***A*** *has more colours (than* ***B****)* ***or B*** *has less colours (than* ***A****) for* ***1*** *mark only*

- **A / B** have two colours the same
- **B** has one different colour

2

(ii) chromatography

1

[3]