Q1.
Rainwater is collected from the roofs of houses as shown in Figure 1.

![Figure 1](image)

(a) The water in the storage tank is **not** potable.

What does potable mean?

Tick one box.

- Contains dissolved substances
- Pure
- Safe to drink
- Tastes nice

(b) Why should the water in the tank be filtered to make it potable?

Tick one box.

- To kill microbes
- To remove dissolved gases
- To remove dissolved solids
- To remove undissolved solids

(1)
(c) A gas which bleaches litmus paper can be added to the water to make it potable. Name this gas and explain why it is added.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(d) The storage tank is made from concrete reinforced with steel wire, as shown in Figure 2.

![Figure 2](image)

**Figure 2.**

Steal wires

Concrete

**Figure 3** shows how the distance between the steel wires affects the relative strength of the concrete.

![Figure 3](image)

Use values from **Figure 3** to describe the relationship shown by the graph.

___________________________________________________________________
Q2.

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.
(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?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

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

**Table 1**

<table>
<thead>
<tr>
<th>Distance in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from start line to solvent front</td>
</tr>
<tr>
<td>Distance moved by food colour C</td>
</tr>
</tbody>
</table>

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

________________________________________________________________________

________________________________________________________________________

$R_i$ 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**
<table>
<thead>
<tr>
<th>Name of food colour</th>
<th>Distance from start line to solvent front in mm</th>
<th>Distance moved by food colour in mm</th>
<th>R&lt;sub&gt;f&lt;/sub&gt; value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponceau 4R</td>
<td>62</td>
<td>59</td>
<td>0.95</td>
</tr>
<tr>
<td>Carmoisine</td>
<td>74</td>
<td>45</td>
<td>0.61</td>
</tr>
<tr>
<td>Fast red</td>
<td>67</td>
<td>27</td>
<td>0.40</td>
</tr>
<tr>
<td>Erythrosine</td>
<td>58</td>
<td>17</td>
<td>0.29</td>
</tr>
</tbody>
</table>

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

Give the reason for your answer.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

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

Give the reason for your answer.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

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

Give the reason for your answer.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

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

Give the reason for your answer.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(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)

Q3.
The label shows the ingredients in a drink called Cola.

![Cola](image)

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.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(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.
Which ion causes the pH to be 2.9?

(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.

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

(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?
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.

<table>
<thead>
<tr>
<th>Question</th>
<th>Tick (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should caffeine be an ingredient in drinks?</td>
<td></td>
</tr>
<tr>
<td>Is there caffeine in a certain brand of drink?</td>
<td></td>
</tr>
<tr>
<td>How much caffeine should people drink?</td>
<td></td>
</tr>
</tbody>
</table>

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

Reason 1

Reason 2

Q4.

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. 

(Total 11 marks)
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?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

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.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(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.
Mark schemes

Q1.
(a) Safe to drink  
(b) To remove undissolved solids  
(c) the gas is chlorine / \( \text{Cl}_2 \)  
which sterilises water  
(d) as distance between steel increases strength of concrete decreases  
change above and change below 1.0 cm separation is compared and described  
must refer to graph values for this mark

Q2.
(a) start line drawn in ink  
so it will run / dissolve in the solvent / split up  
allow mixes with the spots  
spots under solvent or solvent above spots / start line  
so they will mix with solvent or wash off paper or colour the solvent or dissolve in the solvent

(b) (i) contains A and E  
and one other (unknown substance)  
if no other marks awarded, an answer saying it is made up of three colours gains 1 mark

(ii) 45 or 46  
allow any value from 45 to 46  
18  
allow any value from 16 to 20  
award 1 mark if numbers correct but in cm

(iii) 0.40  
allow ecf from (b)(ii)
ignore units

(c) fast red

  allow ecf from (b)(iii)

has same R\(f\) value

  allow none of them, as none has the same R\(f\) value for 2 marks

(d) any one from:

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

Q3.

(a) (i) (phosphoric) acid

  allow phosphoric

(ii) H\(^+\) / hydrogen (ion)

  if ion symbol given, charge must be correct

(b) (i) pencil

  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

(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

(c) different substances travel at different speeds or have different retention times
accept different attraction to solid
ignore properties of compounds

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

(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

Q4.

(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

(b) have a control group / placebo or test children before any drink given
give a drink to at least 3 groups or give a drink at least 3 times
give each additive to different group / children / at different times
observe / monitor / compare behaviour of group / children

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

(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

there should be no matching colours / spots