Chemical Analysis 2

Name: _____

Class: _____

Date: _____

Time: **64 minutes**

Marks: **59 marks**

Comments:

1. Chromatography is used to separate mixtures.

Chromatography involves a mobile phase and one other phase.

(a) What is the other phase in chromatography?

Tick (✓) **one** box.

Moving phase ☐

Recycled phase ☐

Stationary phase ☐

Viscous phase ☐

(1)

(b) Why do the substances in the mixture separate in the mobile phase?

_____

_____

(1)

(c) How many spots will be produced on the chromatogram of a pure compound?

Number of spots = _____

(1)

(d) In a chromatography experiment, a blue colour moved 4.77 cm.

The solvent moved 5.30 cm.

Calculate the R_f value for the blue colour.

_____

_____

_____

R_f value = _____

(2)

(e) Black ink is a mixture of several colours.

Plan an experiment using paper chromatography to:

- separate the colours in black ink
- identify the colours from their R_f values.

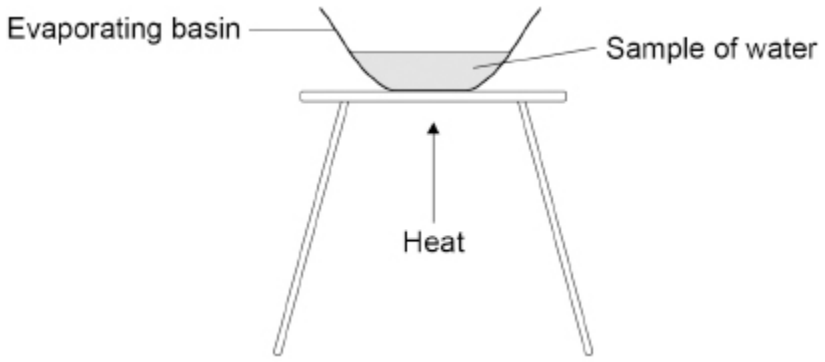
(6)

(Total 11 marks)

2. Some types of water contain dissolved substances.

A student investigated the mass of dissolved solids in distilled water and in sea water.

The figure below shows the apparatus.



This is the method used.

1. Weigh an evaporating basin.

2. Add 20 cm^3 of distilled water to the evaporating basin.

3. Weigh the evaporating basin and the water sample.

4. Heat the water sample for 2 minutes.

5. Weigh the evaporating basin and contents.

6. Repeat steps 1 to 5 two more times.

7. Repeat steps 1 to 6 with sea water.

(a) The method used by the student did **not** give valid results.

Describe **one** improvement the student could make to obtain valid results.

_____

_____

(1)

A different student used a method which gave valid results.

(b) The table below shows the results.

	Mass of dissolved solids in grams			
Type of water	**Test 1**	**Test 2**	**Test 3**	**Mean**
Distilled water	0.00	0.00	0.00	0.00
Sea water	0.30	**X**	0.26	0.29

Calculate the value **X** for the mass of dissolved solids in sea water in **Test 2**.

_____

_____

_____

Mass **X** = _____ g

(2)

(c) The student concludes that distilled water is pure.

Describe a test to confirm that distilled water is pure.

Test _____

_____

Result _____

_____

(2)

Tap water is potable.

A stage in the production of potable water is sterilising.

A gas is used to sterilise water.

The equation for the reaction is:

$$Cl_2(g) + H_2O(l) \rightleftharpoons HOCl(aq) + HCl(aq)$$

(d) What is meant by the symbol ⇌?

_____

_____

(1)

(e) The reaction is at equilibrium.

The reaction is exothermic.

What happens to the equilibrium position when the temperature is increased?

Tick (✓) **one** box.

Shifts towards the left-hand side ☐

Stays in the same place ☐

Shifts towards the right-hand side ☐

(1)

(f) Describe a test to identify the gas used to sterilise water.

Test _____

_____

Result _____

_____

(2)

(g) Another stage in the production of potable water is filtering.

Explain why potable water contains dissolved solids after filtering.

_____

_____

_____

_____

(2)

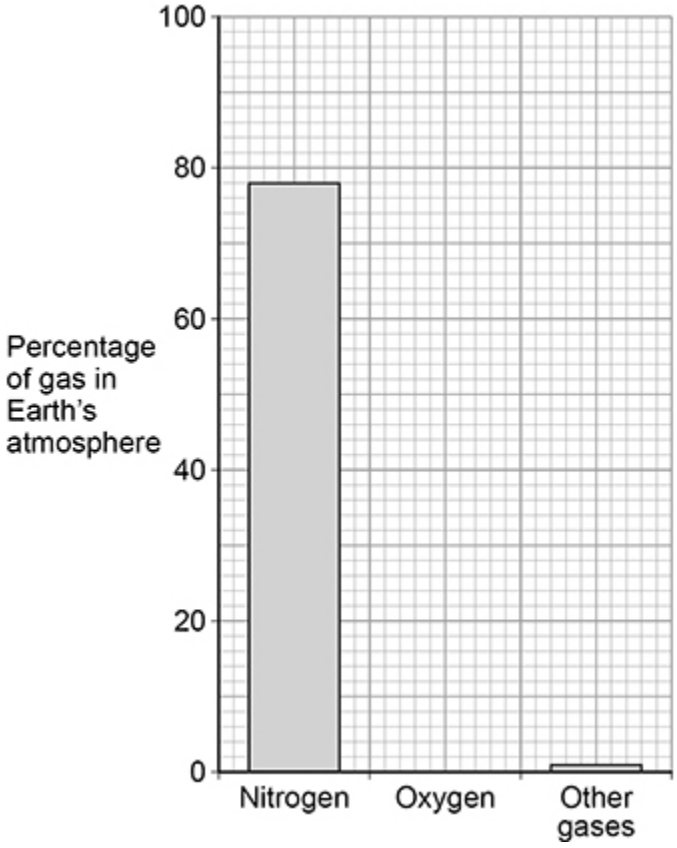
(Total 11 marks)

3. This question is about the Earth's atmosphere.

(a) The Earth's atmosphere contains 21% oxygen.

Draw the bar for oxygen on **Figure 1**.

Figure 1



(1)

(b) What is used to test for oxygen gas?

Tick (✓) **one** box.

A burning splint ☐

A glowing splint ☐

Damp litmus paper ☐

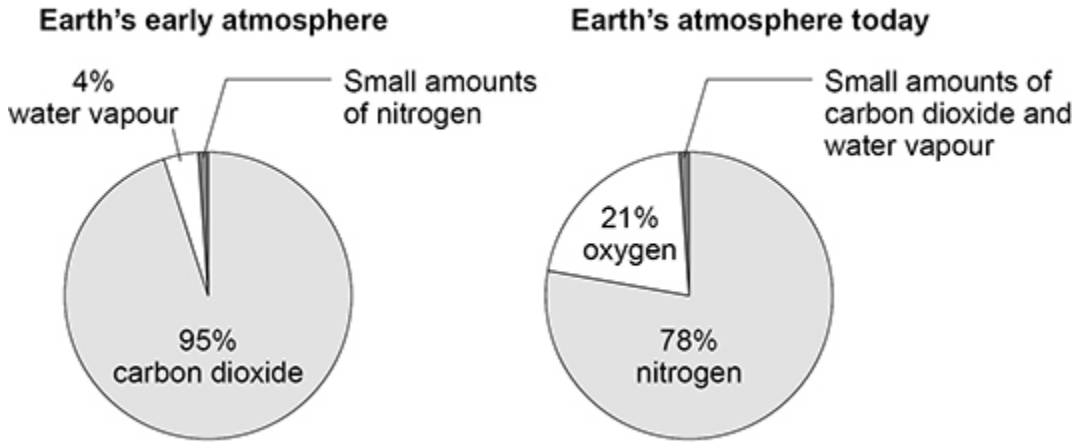
Limewater ☐

(1)

The Earth's early atmosphere was very different from the Earth's atmosphere today.

Figure 2 shows the composition of the Earth's early atmosphere and of the Earth's atmosphere today.

Figure 2



(c) The percentages of nitrogen and oxygen in the Earth's atmosphere today are different from the Earth's early atmosphere.

Complete the sentences.

Choose answers from the box.

Use **Figure 2**.

Each answer can be used once, more than once or not at all.

decreased	**increased**	**stayed the same**

Since the Earth's early atmosphere, the percentage of nitrogen in the Earth's atmosphere has _____.

Since the Earth's early atmosphere, the percentage of oxygen in the Earth's atmosphere has _____.

(2)

(d) The Earth's atmosphere today contains a small amount of carbon dioxide.

Why has the percentage of carbon dioxide decreased since the Earth's early atmosphere?

Tick (✓) **two** boxes.

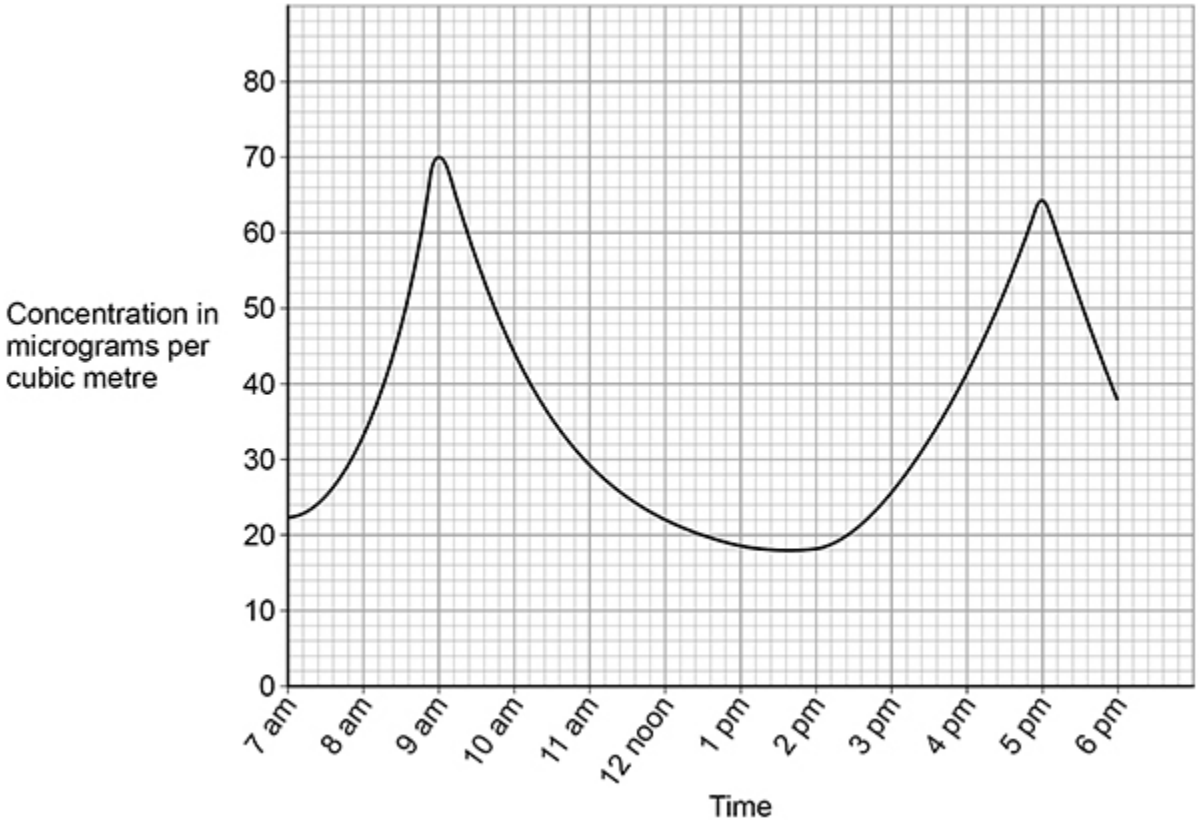
- Dissolved in oceans ☐
- Formation of sedimentary rocks ☐
- Industrialisation ☐
- Respiration ☐
- Volcanic activity ☐

(2)

Oxides of nitrogen are produced when nitrogen reacts with oxygen in car engines.

Figure 3 shows the concentration of oxides of nitrogen in the atmosphere during one day in a city.

Figure 3



(e) Which **two times** have the highest concentrations of oxides of nitrogen in the atmosphere?

1. _____

2. _____

(2)

(f) Suggest why there are the highest concentrations of oxides of nitrogen at these times.

_____

_____

(1)

(Total 9 marks)

4. (a) This question is about gases.

Draw **one** line from each substance to the description of the substance.

Substance	Description of substance
	Compound
Air	Element
Carbon dioxide	Hydrocarbon
Oxygen	Metal
	Mixture

(3)

(b) What is used to test for each of the gases?

Draw **one** line from each substance to the description of the substance.

Gas	Test
	A glowing splint
Carbon dioxide	A lighted splint
	Limewater
Oxygen	Litmus paper

(2)

(c) Give **two** reasons why the percentage of carbon dioxide in the air has decreased in the last 2.7 billion years.

Tick (✓) **two** boxes.

- Combustion ☐
- Dissolved in oceans ☐
- Intense volcanic activity ☐
- Photosynthesis ☐
- Respiration ☐

(2)

Oxygen reacts with sulfur dioxide.

The reaction is reversible.

(d) What is the symbol for a reversible reaction?

_____

(1)

(e) Complete the sentence.

In a reversible reaction the forward reaction is exothermic, so the

reverse reaction is _____ .

(1)

(f) A reversible reaction happens in apparatus which stops the escape of reactants and products.

Complete the sentence.

Equilibrium is reached when the forward and reverse reactions happen at

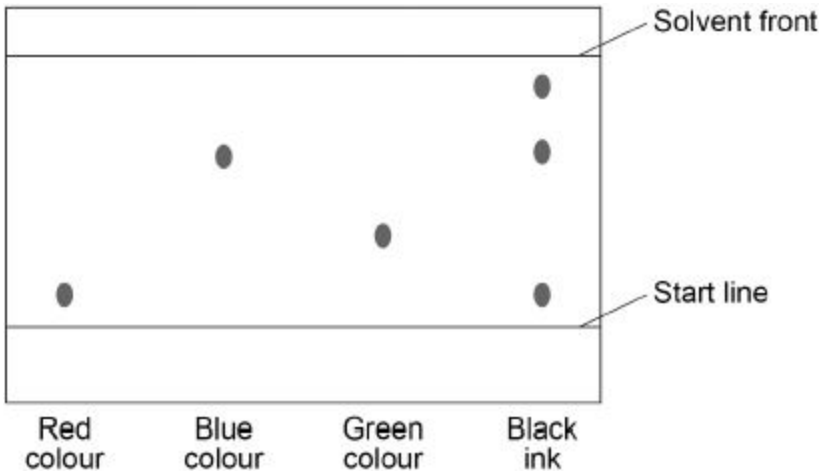
exactly the same _____ .

(1)

(Total 10 marks)

5. A student used paper chromatography to identify the colours in a black ink.

The diagram below shows the student's results.



(a) What colours are in the black ink?

_____

_____

(2)

(b) Suggest which colour is least soluble in the solvent.

Give a reason for your answer.

Colour _____

Reason _____

_____

(2)

(c) Use the diagram above to complete the table below.

	Distance in mm
Distance moved by green colour	
Distance moved by solvent	

Calculate the R_f value for the green colour.

Use the equation:

$$R_f = \frac{\text{distance moved by green colour}}{\text{distance moved by solvent}}$$

_____

_____

_____

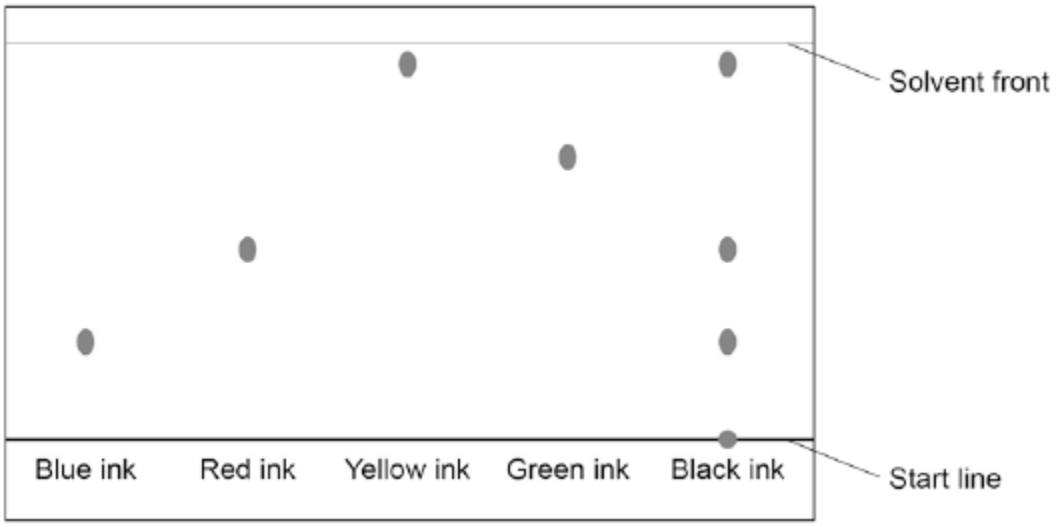
_____

R_f value = _____

(4)

(Total 8 marks)

6. The figure below shows a paper chromatogram of five different inks.



(a) Explain how paper chromatography separates substances.

(3)

(b) Analyse the chromatogram. Describe and explain the result for black ink.

(4)

(c) Use the figure above to calculate the R_f value of the blue ink.

_____

_____

_____

_____

R_f value = _____

(3)

(Total 10 marks)

1.

(a) stationary phase

1

(b) any **one** from:
(the substances)
- move at different speeds
- have different solubilities
- have different attractions for the (chromatography) paper

1

(c) 1

1

(d) (R_f =)

$$\frac{4.77}{5.30}$$

1

= 0.9

1

(e) **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

5-6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3-4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1-2

No relevant content

0

Indicative content

- **draw a pencil line**
- near the bottom edge of the (chromatography) paper

- **put a small dot of black ink on the pencil line**
- put a small volume of water / solvent in a beaker

- **place the (chromatography) paper in the solvent**
- the dots of ink should be above the level of the water / solvent
- support the paper in this position
- put a lid on the beaker

- **leave to run**
- mark position of solvent front
- remove from beaker and leave to dry

- **determine R_f values**
- measure distance of all dots from start line
- measure distance of solvent front from start line
- calculate R_f values for all dots
- compare with known R_f values

[11]

2. (a) heat the evaporating basin and contents to constant mass

allow heat until all of the water has evaporated

1

(b) (mass **X** =)
[0.29 × 3] - [0.30 + 0.26]

allow 0.87 - 0.56

allow $\frac{0.3 + \mathbf{X} + 0.26}{3} = 0.29$

1

= 0.31 (g)

1

(c) (test)
determine the boiling point

1

(result)
(pure water) boils at 100 °C

OR

(test)
determine the freezing point (1)

(result)
(pure water) freezes at 0 °C (1)

1

(d) reversible reaction

allow a reaction that can go both ways

1

(e) shifts towards the left hand side

1

(f) (test)
damp litmus paper

1

(result)
litmus paper bleached

allow litmus paper turns white ignore litmus paper turns red

1

(g) the dissolved solids pass through filter paper

1

(because) the dissolved solid (particles) are very small

1

[11]

3. (a) bar drawn to 21%

1

(b) a glowing splint

1

(c) (nitrogen) increased

1

(oxygen) increased

1

(d) dissolved in oceans

1

formation of sedimentary rocks

1

(e) 9 (am)

allow 0900

1

5 (pm)

allow 1700

1

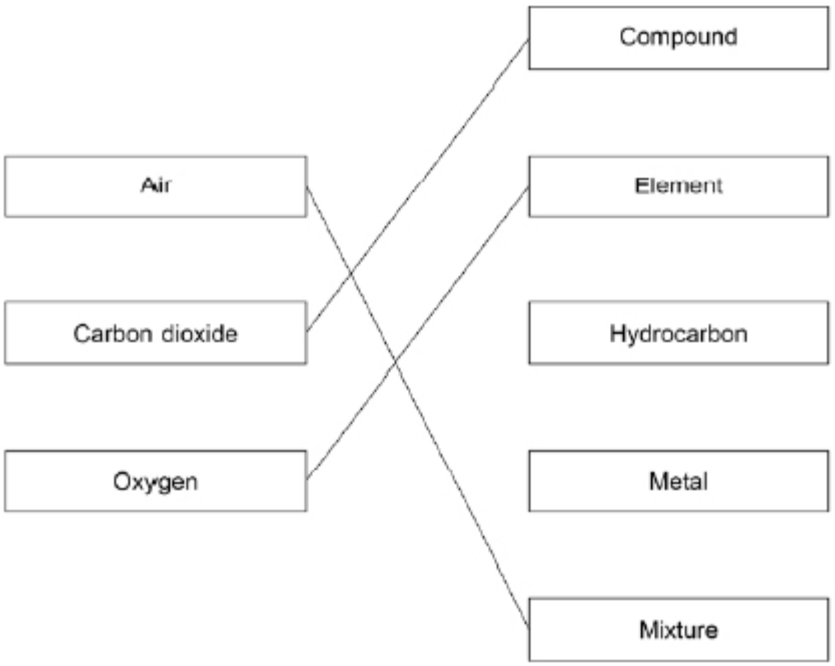
(f) more cars / buses / lorries on the roads

1

[9]

4.

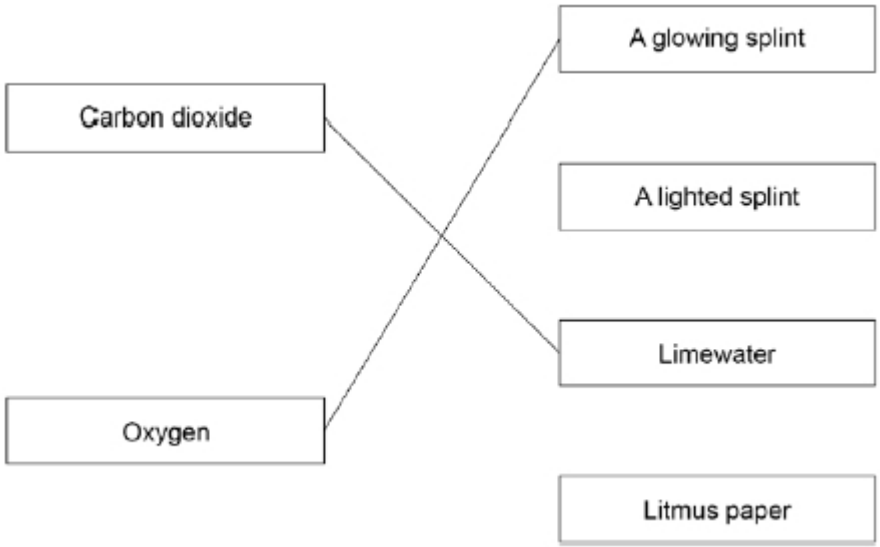
(a)



If more than one line is drawn from any one substance and not crossed out, no mark is given for that substance. The other marks can be awarded.

1
1
1

(b)



If more than one line is drawn from any one gas and not crossed out, no mark is awarded for that gas.

The other mark can be awarded.

1
1

(c) dissolved in oceans

1

photosynthesis

1

(d) ⇌

ignore any other words, formulae or symbols

1

(e) endothermic (reaction)

spelling must be correct

*do **not** accept exothermic*

1

(f) rate (of reaction)

allow speed or velocity

*do **not** accept any other response*

1

[10]

5. (a) red **and** blue

1

unknown

1

both needed for the mark

(b) red

ignore black

1

travels least far

dependent on correct colour allow closest to the start line

1

(c) distance moved by green colour = 12 mm

allow 10 to 14 mm

1

distance moved by solvent = 36 mm

allow 35 to 36 mm

1

$\frac{12}{36}$

allow correct substitution of student's measurements

1

R_f value = 0.33

*allow correct answer from student's measurements for **2** marks*

1

[8]

6. (a) mobile phase / solvent moves through paper

1

and carries substances different distances

1

which depend on their attraction for paper and solvent

allow which depend on solubility in solvent and attraction to paper

1

(b) **Level 2 (3–4 marks):**
A relevant and coherent description which provides a clear analysis of the chromatogram. The response makes logical links between the points raised and uses sufficient examples to support these links.

Level 1 (1–2 marks):
Simple statements are made which demonstrate a basic attempt to analyse the chromatogram. The response may fail to make logical links between the points raised.

0 marks:
No relevant content

Indicative content

- black ink is a mixture
- because more than one spot
- contains blue, red and yellow
- because Rf values / positions match
- does not contain green
- contains an unknown
- which is insoluble
- yellow is most soluble or has highest Rf value, blue is least

4

(c) both measurements from artwork for **1** mark (1.3 ± 0.1 cm and 5.3 ± 0.1 cm)

1

correct equation used for **1** mark

1

0.25 ± 0.02

1

*accept 0.25 ± 0.02 without working shown for **3** marks*

*allow ecf from incorrect measurement to final answer for **2** marks*

[10]