

# Chemical Analysis 1

Name: \_\_\_\_\_

Class: \_\_\_\_\_

Date: \_\_\_\_\_

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Time: **55 minutes**

Marks: **50 marks**

Comments:

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1.

Screenwash is a mixture designed to keep car windscreens clean.

The components in screenwash include glycerol, methanol and water.

- (a) Screenwash is made by mixing the components in carefully measured quantities so that the product has the required properties.

What name is given to this type of mixture?

Tick (✓) **one** box.

Catalyst

Formulation

Polymer

(1)

- (b) Glycerol has the formula  $C_3H_8O_3$

How many atoms are there in one molecule of glycerol?

Tick (✓) **one** box.

3

8

11

14

(1)

(c) Incomplete combustion happens when glycerol burns in limited oxygen.

Incomplete combustion produces carbon monoxide gas.

Why can the production of carbon monoxide gas be a problem?

Tick (✓) **one** box.

Carbon monoxide is a greenhouse gas.

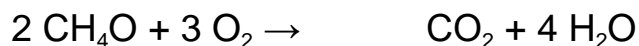
Carbon monoxide is a toxic gas.

Carbon monoxide is an acidic gas.

(1)

(d) Complete combustion happens when methanol (CH<sub>4</sub>O) burns in excess oxygen.

Balance the equation for the reaction.



(1)

Methanol can be produced by the reaction of carbon dioxide with hydrogen.

(e) Describe the test for hydrogen gas.

Give the result of the test.

Test \_\_\_\_\_

\_\_\_\_\_

Result \_\_\_\_\_

\_\_\_\_\_

(2)

(f) Carbon dioxide is a greenhouse gas.

An increase in greenhouse gases in the atmosphere has led to an increase in average global temperature.

The increase in average global temperature has caused global climate change.

Give **two** effects of global climate change.

1 \_\_\_\_\_

\_\_\_\_\_

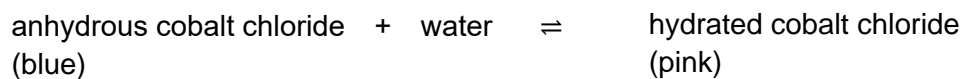
2 \_\_\_\_\_

\_\_\_\_\_

**(2)**

Anhydrous cobalt chloride can be used to test for water.

The word equation for the reaction is:



(g) Suggest **one** observation that could be made when water is added to anhydrous cobalt chloride.

\_\_\_\_\_

\_\_\_\_\_

**(1)**

(h) The reaction between anhydrous cobalt chloride and water is exothermic.

What type of reaction is the reverse reaction?

\_\_\_\_\_

**(1)**

**(Total 10 marks)**

2.

This question is about methanol.

(a) Methanol is used in screenwash.

Screenwash is used to keep car windscreens clean.

Screenwash is a formulation.

Define the term 'formulation'.

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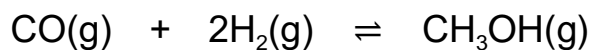
(1)

Carbon monoxide and hydrogen are used to produce methanol.

The conditions used in the production of methanol are:

- high temperature
- high pressure
- a catalyst.

The equation for the reaction is:



91 kJ/mol of energy is transferred during the exothermic forward reaction.

(b) How much energy is transferred when methanol is decomposed into carbon monoxide and hydrogen?

Tick (✓) **one** box.

< 91 kJ/mol

91 kJ/mol

> 91 kJ/mol

(1)

- (c) A scientist developed a principle to predict the effect of changing conditions on a system at equilibrium.

What was the name of the scientist?

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(1)

- (d) What is the effect of increasing the temperature on the proportion of methanol in the equilibrium mixture?

Tick (✓) **one** box.

The proportion of methanol decreases.

The proportion of methanol stays the same.

The proportion of methanol increases.

(1)

- (e) What is the effect of using a catalyst on the proportion of methanol in the equilibrium mixture?

Tick (✓) **one** box.

The proportion of methanol decreases.

The proportion of methanol stays the same.

The proportion of methanol increases.

(1)

(f) Explain the effect of increasing the pressure on the proportion of methanol in the equilibrium mixture.

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(3)

(g) Explain the effect of using a catalyst on the **rate** of production of methanol.

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(3)

(h) The catalyst allows the reaction to take place at a lower temperature.

Explain **one** advantage of using a lower temperature in the production of methanol.

Do **not** refer to the position of equilibrium in your answer.

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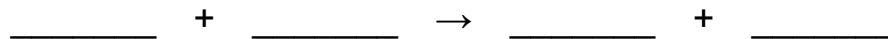
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(2)

(i) Methanol (CH<sub>3</sub>OH) can also be produced by reacting carbon dioxide with hydrogen.

Water is the other product of the reaction.

Write a balanced equation for the reaction.



(2)

(Total 15 marks)

3.

Different tests can be used to identify chemicals.

(a) A student measured the melting points of four substances.

The table below shows the results.

Substance	Melting point in °C
A	52 to 54
B	61
C	-2 to 0
D	80 to 82

Which substance was pure?

Give **one** reason for your answer.

Substance \_\_\_\_\_

Reason \_\_\_\_\_

(2)

Anhydrous copper sulfate can be used to test for water.

The word equation for the reaction is:



(b) Complete the sentence.

Choose answers from the box.

<b>blue</b>	<b>green</b>	<b>red</b>	<b>white</b>	<b>yellow</b>
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When water is added to anhydrous copper sulfate, the colour changes

from \_\_\_\_\_ to \_\_\_\_\_ .

(2)

(c) The reaction between anhydrous copper sulfate and water is reversible.

How does the word equation show that the reaction is reversible?

\_\_\_\_\_

(1)

(d) The formula of anhydrous copper sulfate is  $\text{CuSO}_4$

What is the total number of atoms in the formula  $\text{CuSO}_4$ ?

Tick (✓) **one** box.

3

4

6

7

(1)

(e) Chlorine is a gas.

Describe the test for chlorine.

Give the result.

Test \_\_\_\_\_

\_\_\_\_\_

Result \_\_\_\_\_

\_\_\_\_\_

(2)

(Total 8 marks)

4.

Printer ink is a mixture of chemicals.

(a) What is the name given to a mixture that has been designed as a useful product?

Tick (✓) **one** box.

Formula

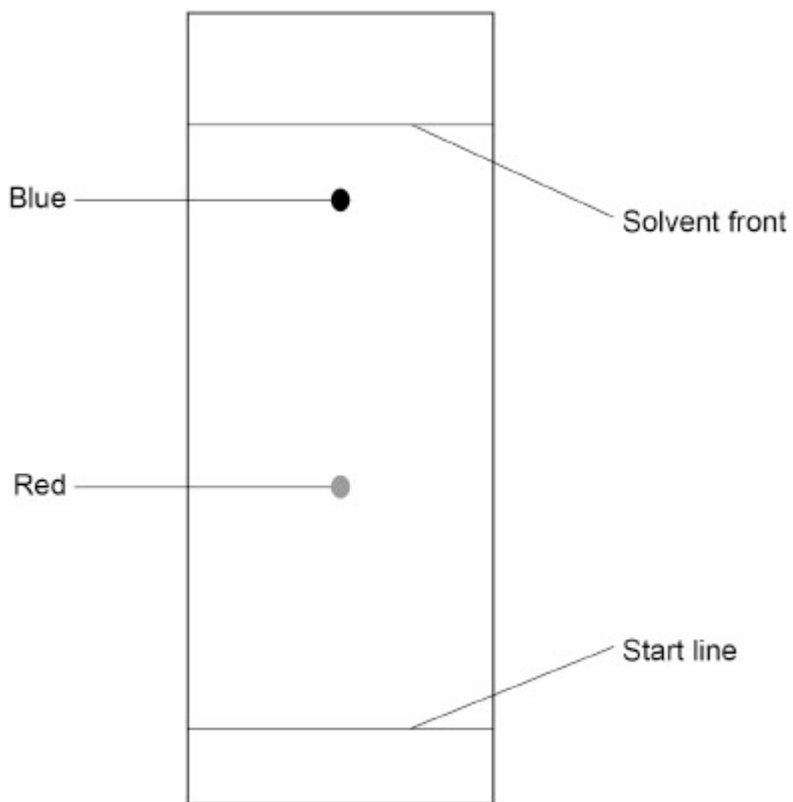
Formulation

Fraction

(1)

A student used chromatography to investigate the colours in a printer ink.

**Figure 2** shows the chromatogram.



(b) The student used a ruler for the start line.

What would the student have used to draw the start line?

Give **one** reason for your answer.

\_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

(2)

(c) Determine the  $R_f$  value of the **red** colour.

Use the equation:

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

Distance moved by red colour \_\_\_\_\_

Distance moved by solvent \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

$R_f =$  \_\_\_\_\_

(4)

(d) The table below shows the  $R_f$  values of four blue colours.

Blue colour	$R_f$
Cerulean	0.40
Cobalt	0.15
Prussian	0.88
Ultramarine	0.68

The student determined that the  $R_f$  value of the blue colour in the printer ink was 0.86

Suggest which blue colour was used in the printer ink.

Give **one** reason for your answer.

Blue colour \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

(2)

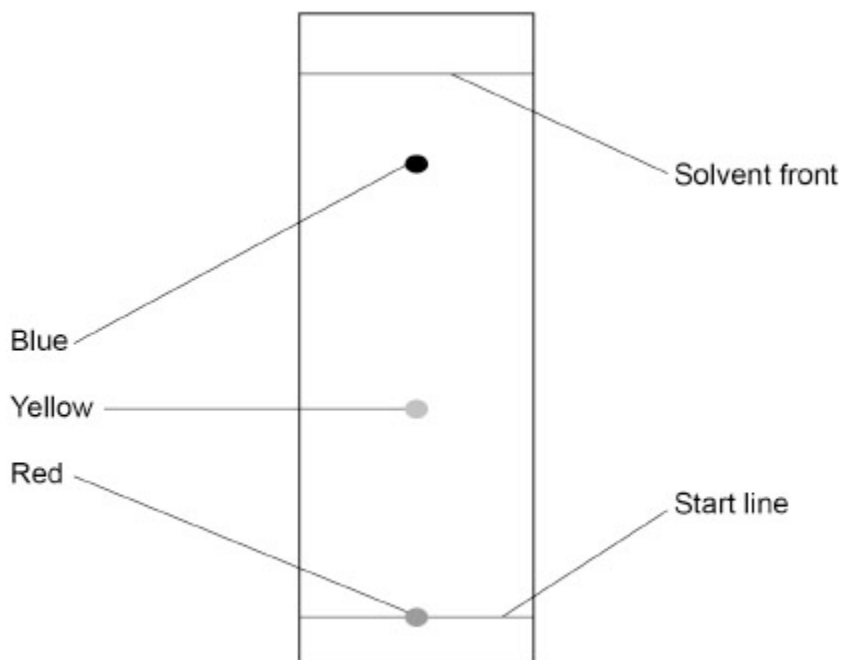
(Total 9 marks)

**5.** Printer ink is a mixture of chemicals.

A student used chromatography to investigate the colours in a printer ink.

The student put a spot of the printer ink on the start line.

The figure below shows the results.



**Not to scale**

(a) Explain why the red colour did **not** move from the start line.

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**(2)**

(b) The blue colour moved 6.4 cm up the chromatogram.

The  $R_f$  value of the blue colour is 0.87

Calculate the distance moved by the solvent.

Give your answer to 2 significant figures.

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Distance moved by the solvent (2 significant figures) = \_\_\_\_\_ cm

(4)

There were four colours in the printer ink.

(c) Suggest **one** reason why only three colours were visible on the chromatogram.

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(1)

(d) Suggest how the student could use chromatography to show there were four colours in the printer ink.

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(1)

(Total 8 marks)

## Mark schemes

- 1.** (a) formulation 1
- (b) 14 1
- (c) carbon monoxide is a toxic gas 1
- (d)  $2 \text{CH}_4\text{O} + 3 \text{O}_2 \rightarrow 2\text{CO}_2 + 4 \text{H}_2\text{O}$   
*allow multiples* 1
- (e) (test)  
add a burning splint  
*do not accept glowing splint* 1
- (result)  
(hydrogen burns with) a pop sound  
*MP2 is dependent on MP1 being awarded* 1
- (f) any **two** from:  
  - melting ice caps
  - rising sea levels
  - more flooding
  - extremes of weather  
*allow increase in frequency of storms*
  - increase in droughts  
*allow desertification*
  - increase in wildfires
  - loss of habitats
  - reduction in biodiversity
  - change in migration patterns  
*ignore global warming do not accept acid rain*  
*do not accept global dimming*  
*do not accept deforestation*  
*do not accept natural disasters*  
*do not accept references to ozone*2
- (g) colour change (from blue to pink) 1
- (h) endothermic  
*allow (thermal) decomposition* 1
- [10]**

2. (a) a mixture that has been designed as a useful product 1
- (b) 91 kJ/mol 1
- (c) Le Chatelier 1
- (d) the proportion of methanol decreases 1
- (e) the proportion of methanol stays the same 1
- (f) (increasing the pressure) increases the proportion of methanol 1
- (because) there are more molecules / moles of reactant (than product) 1
- (so) the equilibrium (position) shifts to the side with fewer molecules / moles 1
- (g) (the catalyst) increases the rate of the reaction 1
- (by) providing an alternative pathway (for the reaction) 1
- (with) a lower activation energy 1
- (h) reduces the costs 1
- (because) less energy is used
- OR**
- less fuels burned (1)
- (so) less contribution to global warming (1)
- allow (so) less carbon dioxide produced* 1
- (i)  $\text{CO}_2 + 3 \text{H}_2 \rightarrow \text{CH}_3\text{OH} + \text{H}_2\text{O}$
- allow multiples*
- allow 1 mark for*
- $\text{CO}_2 + \text{H}_2 \rightarrow \text{CH}_3\text{OH} + \text{H}_2\text{O}$  *with no / incorrect balancing numbers* 2

[15]

<b>3.</b>	(a) (substance) <b>B</b> <i>allow 61 (°C)</i>	1
	( <b>B</b> ) has a specific melting point <i>allow all the other substances melted over a range of temperatures</i> <i>MP2 is dependent on MP1 being awarded</i>	1
	(b) (from) white	1
	(to) blue	1
	(c) (the symbol / sign) = <i>allow the symbol with arrows both ways</i>	1
	(d) 6	1
	(e) (test) damp (blue / red) litmus paper	1
	(result) (litmus paper) is bleached <b>or</b> (litmus paper) turns white <i>ignore paper turns red</i>	1
		<b>[8]</b>
<b>4.</b>	(a) formulation	1
	(b) pencil	1
	(reason) (so) the start line does not dissolve in the solvent	1

- (c) (distance moved by red colour)  
*allow a value in the range 3.1 to 3.3 (cm) 3.2 (cm)*  
*allow a value in the range 3.1 to 3.3 (cm)*

**or**  
 32 (mm)  
*allow a value in the range 31 to 33 (mm)*

(distance moved by solvent) 8.0 (cm)

**or**  
 80 (mm)

$$(R_f =) \frac{3.2}{8.0} \text{ or } \frac{32}{80}$$

*allow correct use of incorrectly determined distance(s)*

$$= 0.4$$

- (d) prussian  
*allow 0.88*

(prussian) has the closest  $R_f$  value (to the colour in the printer ink)

[9]

5.

- (a) red colour is insoluble (in the solvent)

(so) does not move with the solvent

- (b)

$$0.87 = \frac{6.4}{\text{distance moved by solvent}}$$

$$(\text{distance moved by solvent} =) \frac{6.4}{0.87}$$

$$= 7.356$$

$$= 7.4 \text{ (cm)}$$

*allow a correctly calculated answer to 2 significant figures using the values in the question*

(c) any **one** from:

- (the two dyes) may have the same  $R_f$  value (as the blue / yellow colour)
- (the two dyes) may have spots in the same place
- two of the colours may be insoluble
- the other colour may be white  
*ignore colourless*

1

(d) use a different solvent

1

**[8]**