Neap:

Trial Examination 2008

VCE Chemistry Unit 3

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Marks	Suggested time (minutes)
A Multiple-choice	20	20	20	25
B Short-answer	6	6	50	65
			Total 70	Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, one scientific calculator.
Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

Question and answer booklet of 14 pages.
Data booklet of 11 pages.
Answer sheet for multiple-choice questions.

Instructions

Please ensure that you write **your name** and your **teacher's name** in the space provided on this booklet and in the space provided on the answer sheet for multiple-choice questions.
All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet and hand them in.

Students are NOT permitted to bring mobile phones and/or any other electronic communication devices into the examination room.

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2008 VCE Chemistry Unit 3 Written Examination.

SECTION A: MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

Answer all questions in pencil on the answer sheet provided for multiple-choice questions. Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0. Marks will **not** be deducted for incorrect answers. No mark will be given if more than one answer is completed for any question.

Questions 1 and 2 refer to the following information.

The lead-based pigments used in traditional artists' paints can react with pollutants from the air to produce the black compound lead(II) sulfide, PbS. To restore the paintings to their original colour, the PbS is converted to colourless lead(II) sulfate, $PbSO_4$, by treating it with a solution of hydrogen peroxide. The reaction can be represented by the following equation.

$$PbS(s) + 4H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$$

Question 1

In this reaction, the oxidation number of

A. lead changes from +1 to +2, and hydrogen peroxide acts as an oxidant.

B. sulfur changes from –2 to +6, and hydrogen peroxide acts as an oxidant.

C. lead changes from +2 to +4, and hydrogen peroxide acts as a reductant.

D. sulfur changes from –2 to +2, and hydrogen peroxide acts as a reductant.

Question 2

If 4.91 g of PbS is converted to $PbSO_4$ by 100.0 mL of a H_2O_2 solution, the concentration of the hydrogen peroxide solution is

A. 0.205 M

B. 0.821 M

C. 0.698 g L^{-1}

D. 6.98% m/v

Question 3

In an experiment, 4-hydroxybutanoic acid ($HOOC(CH_2)_3OH$) forms a polymer containing 500 monomer units.

The approximate molar mass (in g mol^{-1}) of this polymer is

A. 1.0×10^2

B. 6.8×10^3

C. 4.3×10^4

D. 5.2×10^4

Question 4

How many hydrogen atoms are there in one molecule of 3,3-dimethylhex-1-ene?

A. 14

B. 16

C. 18

D. 20

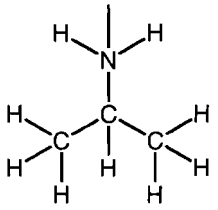
Question 5

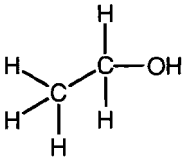
If separate samples of pent-l-ene and pent-2-ene are reacted with bromine, the products will be

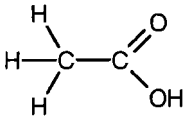
A. the same.
B. unsaturated compounds.
C. of lower mass than the organic reactant.
D. structural isomers of each other.

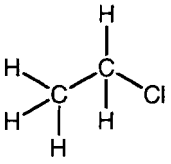
Question 6

Which of the following compounds would have a major peak in its mass spectrum at a mass/charge (*m/e*) ratio of 44?

A.


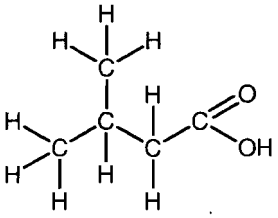
B.


C.


D.


Question 7

The systematic name for the compound shown below is



A. 3-methylbutanoic acid.
B. 2-methylbutanoic acid.
C. pentanoic acid.
D. 3,3-dimethylpropanoic acid.

Question 8

The mass (in g) of potassium hydrogen phthalate, $KH(C_8H_4O_4)$, required to make up 250.0 mL of a 0.0500 M standard solution is

A. $\dfrac{250.0 \times 204.1}{0.0500 \times 1000}$

B. $\dfrac{0.500 \times 204.1}{250.0}$

C. $\dfrac{250.0}{0.0500 \times 204.1 \times 1000}$

D. $\dfrac{0.0500 \times 250.0 \times 204.1}{1000}$

Question 9

Which of the following statements regarding the preparation of glassware for a titration procedure is correct?

A. The pipette, burette and conical flasks should be rinsed with water only.

B. The pipette should be rinsed with water only, while the burette should be rinsed with water and then with the solution with which it will be filled.

C. After rinsing with water, the conical flasks must be thoroughly dried to remove all water.

D. Both the pipette and burette should be rinsed with water and then with the solution with which they will be filled.

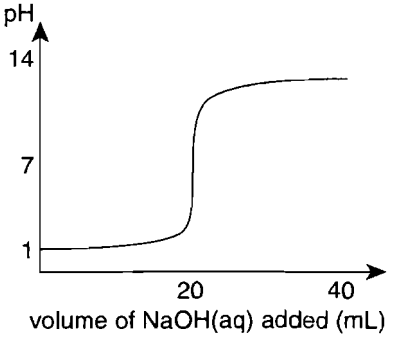
Questions 10 and 11 refer to the following information.

A titration is performed in which a 20.00 mL aliquot of 0.10 M hydrochloric acid solution is titrated with a 0.10 M solution of sodium hydroxide. The pH of the solution in the conical flask is monitored and recorded throughout the titration.

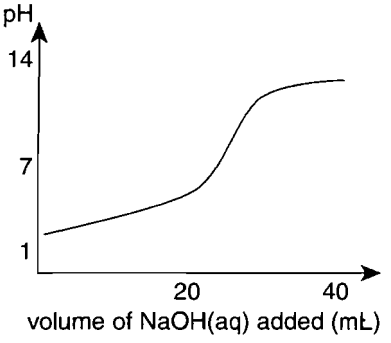
Question 10

Which of the following graphs shows the expected change in pH during the titration?

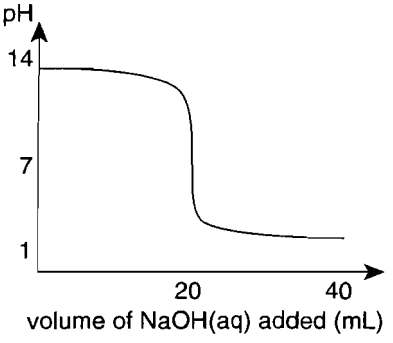
A.



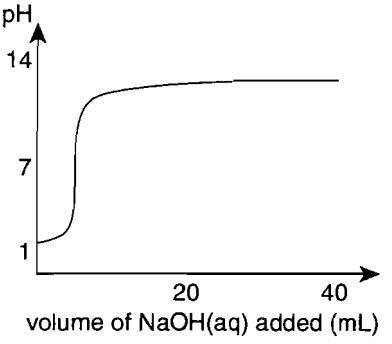
B.



C.



D.



Question 11

The experiment is repeated with 0.10 M ethanoic acid solution (CH_3COOH) instead of HCl.

In this case, the

A. equivalence point occurs when $n(CH_3COOH) = n(NaOH)$. The pH of the resulting solution is 7.

B. equivalence point occurs while $n(CH_3COOH)$ is less than $n(NaOH)$. The pH of the resulting solution is greater than 7.

C. equivalence point occurs while $n(CH_3COOH)$ is greater than $n(NaOH)$. The pH of the resulting solution is less than 7.

D. equivalence point occurs when $n(CH_3COOH) = n(NaOH)$. The pH of the resulting solution is greater than 7.

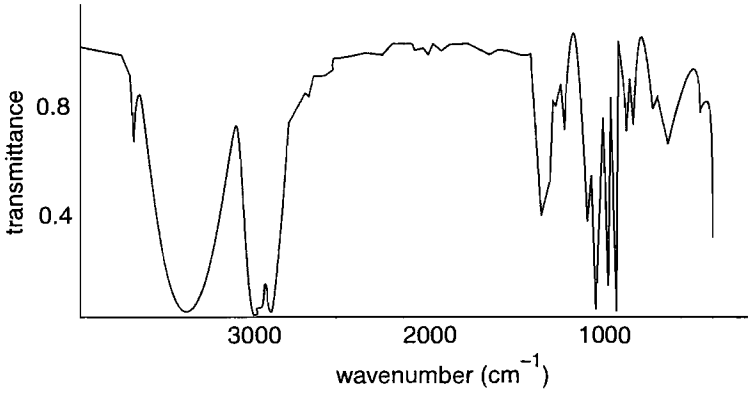
Question 12

What type of reaction is represented by the conversion of butan-1-ol to butanoic acid?

A. addition
B. hydrolysis
C. oxidation
D. substitution

Question 13

The infrared spectrum of an organic compound is shown below.



The compound could be

A. propene.
B. 2-propanol.
C. propanoic acid.
D. propanone (CH_3COCH_3).

Question 14

What type of bonding links the amino acid monomers together to form a protein chain?

A. dispersion forces
B. hydrogen bonds
C. covalent bonds
D. ionic bonds

Question 15

Capric acid ($C_9H_{19}COOH$) is found in goat fat.

The systematic name for capric acid could be

A. decanoic acid.
B. 3-decanoic acid.
C. nonanoic acid.
D. 3-nonanoic acid.

Question 16

Which of the following pairs of compounds are **not** isomers?

A. pentan-2-ol and 2,2-dimethylpropan-1-ol

B. butanoic acid and methyl propanoate

C. butane and cyclobutane

D. leucine and isoleucine

Question 17

A high-precision instrument maker suspects that the steel alloy that has been supplied contains less chromium and molybdenum than it should.

To determine the exact elemental composition of the alloy, the instrument maker should use

A. gravimetric analysis.

B. atomic absorption spectroscopy.

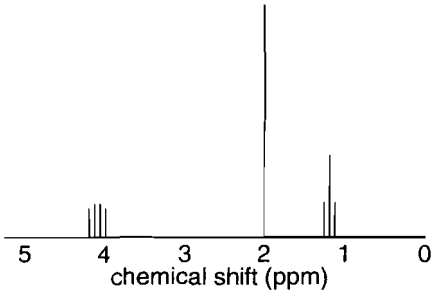
C. ^{1}H nuclear magnetic resonance spectroscopy.

D. high performance liquid chromatography.

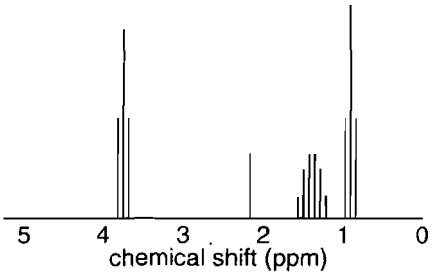
Question 18

Which of the following high resolution ^{1}H NMR spectra is that of 2-propanol?

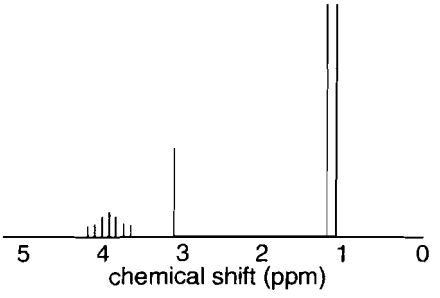
A.



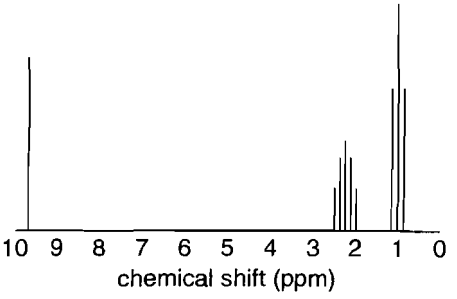
B.



C.

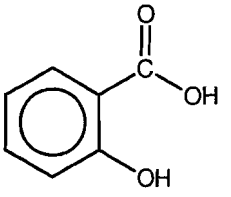


D.

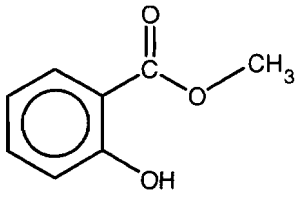


Question 19

The diagram below shows the structures of salicylic acid and methyl salicylate (oil of wintergreen).



salicylic acid



methyl salicylate

Which of the following statements regarding salicylic acid and methyl salicylate is **incorrect**?

A. The infrared spectra of both salicylic acid and methyl salicylate would include a strong band at approximately 1700 cm^{-1}.

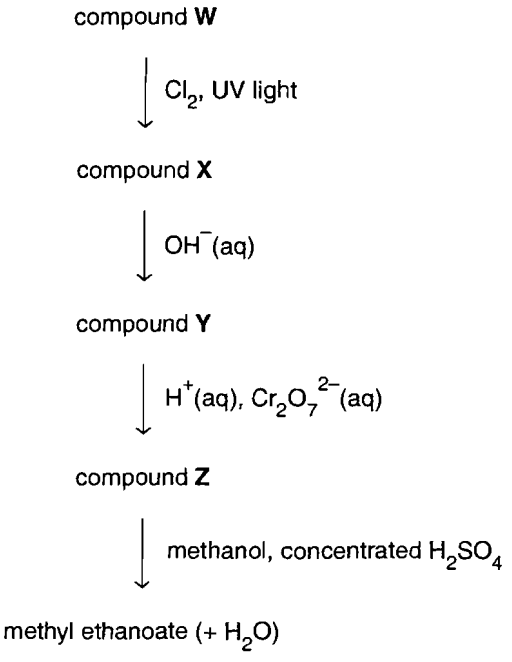
B. The hydrolysis of methyl salicylate would produce salicylic acid and methanol.

C. The ^{1}H NMR spectra of both salicylic acid and methyl salicylate would include four peaks at chemical shift values in the region 7 to 8 ppm.

D. Salicylic acid and methyl salicylate both contain the same percentage by mass of oxygen.

Question 20

The flowchart below represents a sequence of reactions that results in the formation of methyl ethanoate.



Which of the following correctly identifies the compounds labelled W to Z?

	W	X	Y	Z
A.	ethane	chloroethane	ethanol	ethanoic acid
B.	methane	chloromethane	methanol	methanoic acid
C.	ethene	chloroethane	ethanol	ethanoic acid
D.	ethene	chloroethene	ethanol	ethanoic acid

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

Answer **all** questions in the spaces provided.

To obtain full marks for your responses you should

- give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state, for example $H_2(g)$; NaCl(s).

Question 1

Ethane reacts with chlorine gas at high temperatures and in the presence of UV radiation to produce $C_2H_4Cl_2$ along with other products.

a. State the type of reaction that has occurred to form this product.

_____

1 mark

b. What is the function of the UV radiation in this reaction?

_____

_____

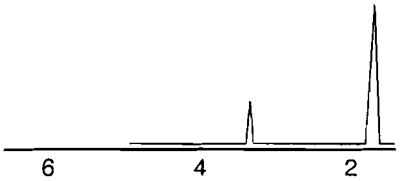
1 mark

c. $C_2H_4Cl_2$ can exist in two isomeric forms.

i. Complete the following table by drawing the structural formula and naming each isomer.

	Isomer I	**Isomer II**
structural formula		
systematic name		

ii. The low resolution ^1H NMR spectrum of one of the isomers of $C_2H_4Cl_2$ is shown below.



On the basis of this spectrum, which isomer (I or II as drawn in part **c.i.**) is present? Explain your answer.

_____

_____

_____

4 + 2 = 6 marks

d. The mass spectra of the two isomers would share a number of peaks at particular mass/charge (*m/e*) ratios, but would also include at least one peak from a fragment that would be only found in one of the isomers.

Draw the structural formula of a fragment that would be found in isomer I but not in isomer II.

1 mark
Total 9 marks

Question 2

A yeast extract is manufactured for use as a spread on sandwiches and as flavouring in stews. This extract has traditionally contained substantial quantities of salt. A student decides to determine the salt content of a yeast extract by performing a gravimetric analysis to calculate the chloride content. The following steps (**not** in correct order) are undertaken.

A *Collect the precipitate formed by passing it through filter paper in a Buchner funnel.*
B *Allow the precipitate to dry in an oven at 110°C.*
C *Filter the solution to remove any insoluble impurities.*
D *Wash the precipitate to remove any adsorbed ions.*
E *Accurately weigh a sample of approximately 5 g of yeast extract and dissolve it in 50 mL of deionised water.*
F *Add excess silver nitrate solution to the filtrate to precipitate the chloride ions as AgCl(s).*
G *Weigh the precipitate to constant mass and record the results.*

a. Complete the following flowchart by placing the letters A to G in the boxes to indicate the order in which the steps should be undertaken.

2 marks

b. The mass of yeast extract used by the student was 5.112 g. The silver chloride precipitate formed was weighed a number of times. The last five weighings shown below.

Weighing number	Mass (g)
1	1.183
2	1.137
3	1.109
4	1.110
5	1.108

i. Why were multiple weighings of the precipitate performed?

_____

ii. Calculate the average mass of silver chloride precipitate formed.

_____

iii. Calculate the mass of sodium chloride in the sample of yeast extract.

_____

_____

_____

iv. Determine the percentage mass (% m/m) of sodium chloride in yeast extract.

_____

_____

1 + 1 + 2 + 1 = 5 marks

c. Experimental error is associated with any gravimetric analysis.

State a source of error that could result in the calculated percentage mass of sodium chloride in yeast extract being

i. higher than the true value.

_____

_____

ii. lower than the true value.

_____

_____

1 + 1 = 2 marks

Total 9 marks

Question 3

Coconut oil is being investigated as a viable raw material in the production of biodiesel fuel. This has important economic implications for many small island nations of the Pacific Ocean, as petroleum-sourced fuels are prohibitively expensive. Approximately 50% of coconut oil is made up of lauric acid.

a. A sample of lauric acid is analysed and found to contain 72.0% carbon, 12.0% hydrogen and 16.0% oxygen by mass. A mass spectrum of the compound establishes that its relative molecular mass is 200.

i. Determine the empirical formula of lauric acid.

ii. Determine the molecular formula of lauric acid.

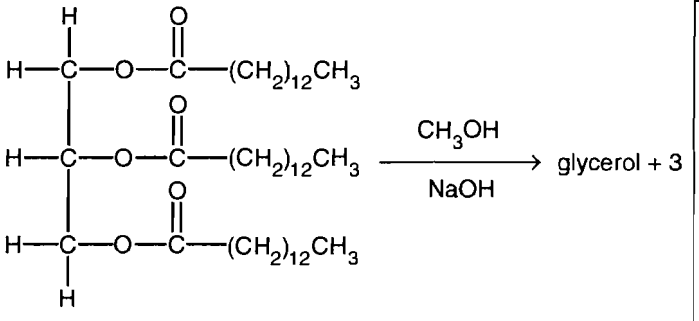
2 + 1 = 3 marks

b. Is lauric acid saturated, monounsaturated or polyunsaturated?

1 mark

c. Another important component of coconut oil is myristic acid, $CH_3(CH_2)_{12}COOH$, which forms a triglyceride named trimyristate. Trimyristate reacts with methanol in the presence of excess sodium hydroxide to form glycerol and large organic molecules that are the main components of biodiesel.

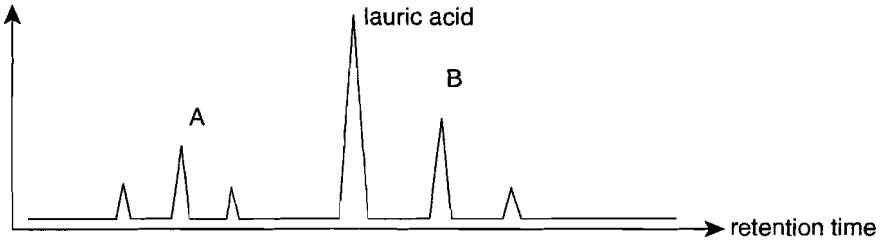
i. Complete the structural equation of the reaction below by drawing a formula for the organic molecule in the box provided.



ii. Circle and name the functional group present in the organic molecule formed in the reaction above.

1 + 1 = 2 marks

d. A small quantity of coconut oil is passed through a HPLC. A simplified chromatogram of the results is shown below.

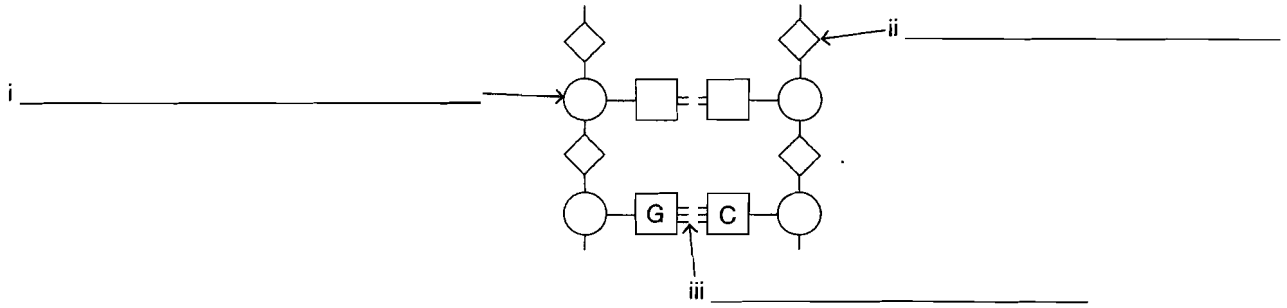


Which peak (A or B) could be due to the myristic acid component of the coconut oil? Explain your answer.

2 marks
Total 8 marks

Question 4

a. The diagram below shows a representation of a section of a DNA molecule.



Write appropriate labels for i, ii and iii.

1 + 1 + 1 = 3 marks

b. Name a functional group present in all four nitrogenous bases found in DNA.

1 mark

c. Explain why

i. nucleic acids are acidic.

ii. the number of adenine molecules in a segment of double-stranded DNA can be used to determine the number of thymine molecules in the same segment.

1 + 1 = 2 marks
Total 6 marks

Question 5

An organic compound with empirical formula $C_2H_3O_2$ was investigated in a series of experiments.

In **experiment 1**, 5.60 g of the compound was vaporised and found to occupy a volume of 1.64 L at a temperature of 150°C and a pressure of 765 mmHg.

In **experiment 2**, the infrared spectrum of the compound was obtained. The spectrum included a band at a wavenumber of approximately 1700 cm^{-1}.

In **experiment 3**, a 0.134 g sample of the compound was dissolved in water and titrated with a recently standardised 0.106 M NaOH solution. A titre of 21.43 mL was required to reach the endpoint of the titration.

a. Using the results from experiment 1,

i. determine the molar mass of the compound.

ii. determine the molecular formula of the compound.

2 + 1 = 3 marks

b. Does the information provided about experiment 2 allow you to state the functional group present in the compound? Explain.

2 marks

c. **i.** Using the results from experiment 3, calculate the mole ratio in which the compound and NaOH react.

ii. What does this ratio allow you to conclude about the structure of the compound?

3 + 1 = 4 marks

d. Draw a possible structural formula for the compound.

1 mark

Total 10 marks

Question 6

a. State the name of a technique that could be used to

i. separate a mixture of DNA fragments.

_____

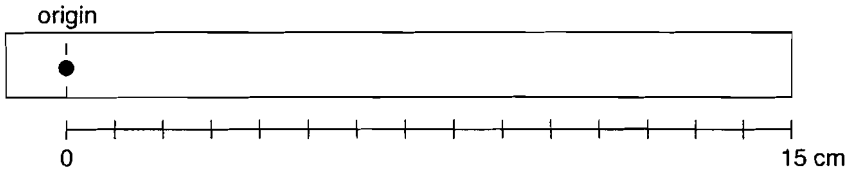
ii. separate a mixture containing alkanes with chain lengths varying from 5 to 25.

_____

1 + 1 = 2 marks

b. During a paper chromatography experiment, a dye sample was separated into two components. The R_f values of these components were 0.60 (green component) and 0.35 (yellow component).

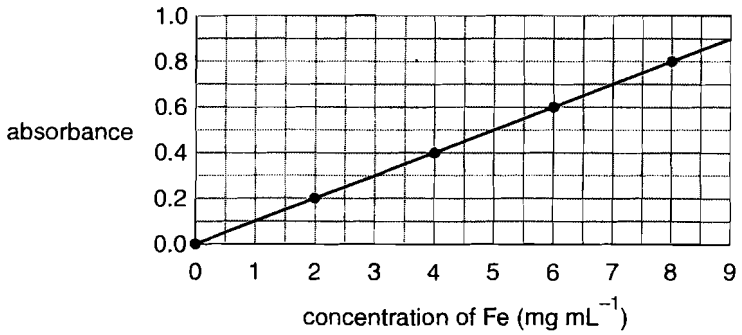
Sketch and label clearly the expected appearance of the chromatogram (to scale) when the solvent front had moved 12 cm from the origin.



2 marks

c. A student conducted an experiment using spectroscopy to determine the amount of iron in a sample of bore water. The iron was first combined with an organic compound, ferrozine, to form a purple complex.

Four standard solutions of iron were similarly treated with ferrozine, and their absorbances were determined in a spectrometer using an *appropriate wavelength* of light. The results are shown in the graph below.



A 6.0 mL sample of bore water was analysed using this method and its absorbance measured as 0.55.

i. Determine the concentration of iron in the bore water in mol L^{-1}.

_____

_____

_____

ii. How would an *appropriate wavelength* be determined for this analysis?

_____

_____

_____

2 + 2 = 4 marks
Total 8 marks

END OF QUESTION AND ANSWER BOOKLET