# VCE CHEMISTRY 2011

# YEAR 12 TRIAL EXAM UNIT 3



## Time allowed: 90 minutes
## Total marks: 86

20 Multiple Choice Questions
6 Short Answer Questions

**An Answer Sheet is provided for Section A.**
**Answer all questions in Section B in the space provided.**

**To download the Chemistry Data Book please visit the VCAA website:**
http://www.vcaa.vic.edu.au/vce/studies/chemistry/chem1_sample_2008.pdf *Page 20*

**Learning Materials *by Lisachem***
PO Box 2018, Hampton East, Victoria, 3188
Ph: (03) 9598 4564 Fax: (03) 8677 1725
Email: orders@learningmaterials.com.au or orders@lisachem.com.au
Website: www.learningmaterials.com.au

**Student Name....…….....**

# VCE Chemistry 2011 Year 12 Trial Exam Unit 3

**Student Answer Sheet**

There are 20 Multiple Choice questions to be answered by circling the correct letter in the table below. Use only a 2B pencil. If you make a mistake, erase and enter the correct answer. Marks will not be deducted for incorrect answers.

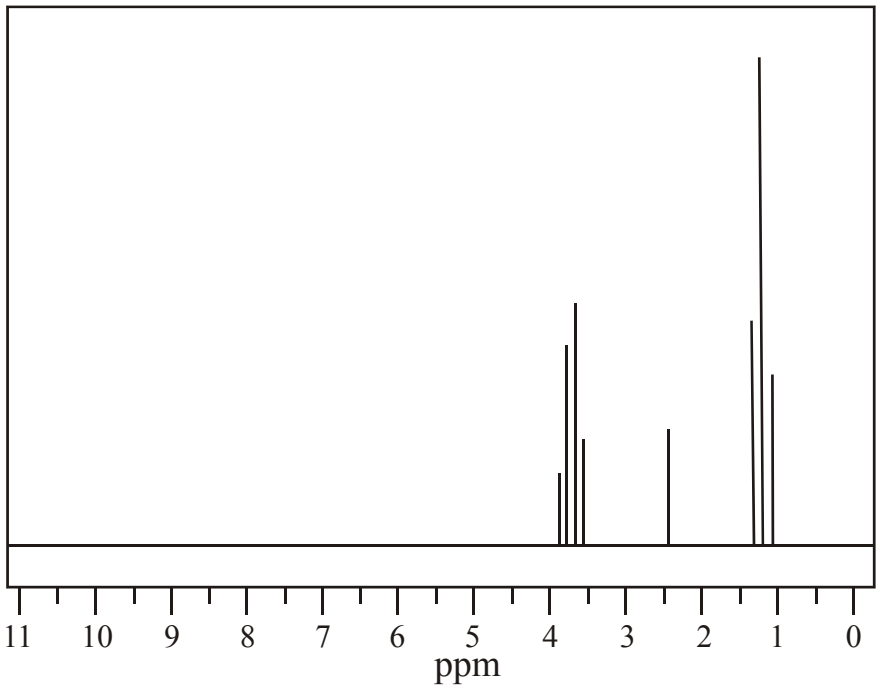
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Question 1* | A | B | C | D | *Question 2* | A | B | C | D |
| *Question 3* | A | B | C | D | *Question 4* | A | B | C | D |
| *Question 5* | A | B | C | D | *Question 6* | A | B | C | D |
| *Question 7* | A | B | C | D | *Question 8* | A | B | C | D |
| *Question 9* | A | B | C | D | *Question 10* | A | B | C | D |
| *Question 11* | A | B | C | D | *Question 12* | A | B | C | D |
| *Question 13* | A | B | C | D | *Question 14* | A | B | C | D |
| *Question 15* | A | B | C | D | *Question 16* | A | B | C | D |
| *Question 17* | A | B | C | D | *Question 18* | A | B | C | D |
| *Question 19* | A | B | C | D | *Question 20* | A | B | C | D |

# VCE Chemistry 2011 Year 12 Trial Exam Unit 3

## SECTION A – Multiple Choice Questions

*Section A consists of 20 multiple-choice questions.*
*Section A is worth approximately 24 per cent of the marks available.*
*Choose the response that is **correct** or **best answers** the question.*
*Indicate your choice on the answer sheet provided.*

**Question 1**
The diagram shown below is a representation of a spectrum obtained during the analysis of a chemical compound.




The spectrum is a
A. $^{13}C$ NMR spectrum of propane.
B. $^{1}H$ NMR spectrum of ethanol
C. $^{1}H$ NMR spectrum of ethyl ethanoate
D. $^{13}C$ NMR spectrum of propanoic acid

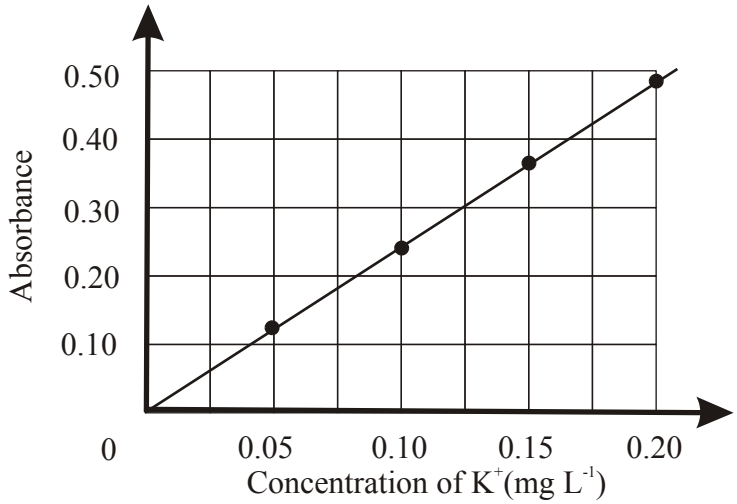
**Question 2**
Three key processes occurring in a mass spectrometer are acceleration in an electric field, deflection in a magnetic field, and ionisation in a beam of electrons. Which one of the alternatives below gives the correct order of these processes in a mass spectrometer?

| | | | |
|---|---|---|---|
| A. | ionisation | deflection | acceleration |
| B. | ionisation | acceleration | deflection |
| C. | acceleration | ionisation | deflection |
| D. | deflection | acceleration | ionisation |

**Question 3**
How many **structural** isomers exist with the molecular formula $C_3H_5Br_3$?
A. 3
B. 4
C. 5
D. 6

**Question 4**
Propene is converted to 2-propanol in a two stage process.
Propene → X → 2-propanol.
What is the formula of compound X?
A. $CH_3CHClCH_3$
B. $CH_3CH_2CH_3$
C. $CH_3CHOHCH_3$
D. $CH_3CH_2CH_2Cl$

**Question 5**
The potassium content of a banana was determined using Atomic Absorption Spectroscopy. Firstly a set of standard solutions of potassium were prepared and used to establish a calibration curve.




0.20 g of banana was treated with nitric acid and the resulting solution made up to 200 mL. Then 5.00 mL of this solution was diluted to 250 mL. The absorbance of the final solution was then determined to be 0.18
The concentration of potassium in the banana, in mg per 100 g was closest to
A. 0.08
B. 38
C. 75
D. 380

**Question 6**
Which of the alternatives below shows the semi-structural formula of the product of the reaction between but-2-ene and iodine?
A. $CH_3CH_2CH_2CH_2I$
B. $CH_3CHICHICH_3$
C. $CH_3CH_2CHICH_3$
D. $CH_2ICH_2CH_2CH_2I$

**Question 7**
Spectroscopic analysis of an organic compound which has the empirical formula, $C_2H_4O$, has a major peak centred at 1715 $cm^{-1}$ and a short narrow peak centred at 3100$cm^{-1}$ in its infrared spectrum. Its mass spectrum shows a fragment peak at $m/e^- = 29$. On its $^1H$ NMR spectrum there is a peak at $\delta = 4.1$ ppm.
The semi-structural formula of the compound is most likely to be
A. $CH_3CHO$
B. $CH_3COOH$
C. $CH_3COOCH_2CH_3$
D. $CH_3CH_2CH_2COOH$

**Question 8**
The boiling temperatures of methanol and propanoic acid are 65°C and 141°C respectively. When reacted together two products are formed, one of which has a boiling temperature of 80°C.
Simple distillation of a mixture containing both reactants and both products produces four pure liquids which are collected in separate beakers, labelled 1, 2, 3 and 4 in order of collection.
The products of the reaction would be in
A. Beakers 1 and 2.
B. Beakers 2 and 3.
C. Beakers 2 and 4.
D. Beakers 3 and 4.

**Question 9**
A sample of impure limestone contains 30 per cent, by mass, calcium. All the calcium in the sample is present as calcium carbonate.
The percentage, by mass, of calcium carbonate in the sample would be closest to
A. 30
B. 40
C. 70
D. 75

**Question 10**
Citric acid, $C_6H_8O_7$, the main acid in lemon juice, is a triprotic acid.
When 20.0 mL aliquots of lemon juice were fully titrated with 0.350 M NaOH, the volume of the average titre was 37.09 mL.
What was the concentration, in g $L^{-1}$, of citric acid in the lemon juice?
A. 0.831
B. 2.50
C. 41.5
D. 374

**Question 11**
When the iron ore, haematite, $Fe_2O_3(s)$, is heated with coke, a form of carbon, it is reduced to iron according to the equation

$$Fe_2O_3(s) + 3C(s) \rightarrow 3CO(g) + 2Fe(s)$$

The maximum mass of Fe(s) that can be obtained when 640 g of haematite (s) is heated with 130 g of coke is closest to
A. 224 g
B. 404 g
C. 448 g
D. 679 g

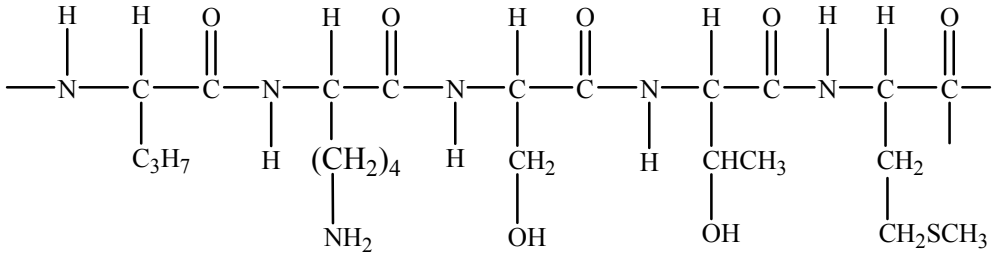
**Question 12**
What is the concentration, in mol $L^{-1}$, of $I^-(aq)$ in a solution that is 5.00% KI, by mass, if the solution has a density of 1.038 g $mL^{-1}$?
A. 0.0301
B. 0.0313
C. 0.313
D. 0.625

**Question 13**
An unbalanced equation for a redox reaction is shown below

$$\_\_Cr_2O_7^{2-}(aq) + \_\_HNO_2(aq) + \_\_H^+(aq) \rightarrow \_\_Cr^{3+}(aq) + \_\_NO_3^-(aq) + \_\_H_2O(l)$$

When this equation is balanced, with all species coefficients in the lowest whole number ratio, the coefficient for $H_2O$ is
A. 1
B. 4
C. 5
D. 7

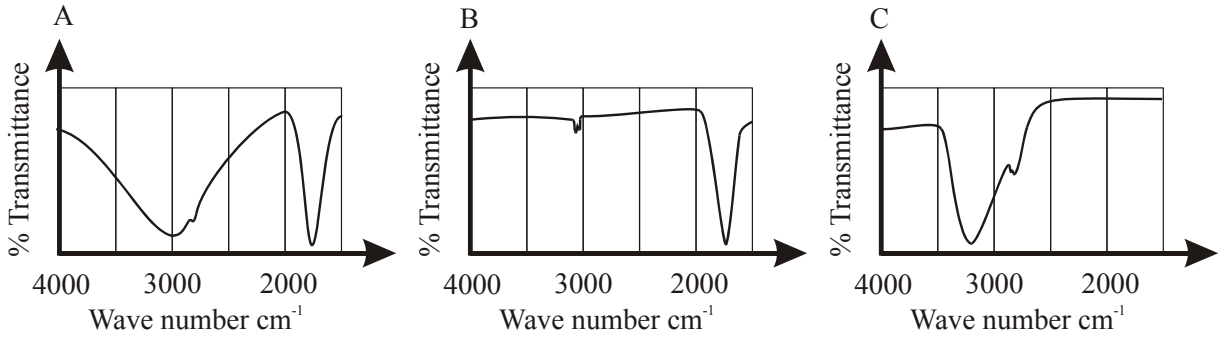
**Question 14**
Part of the primary structure of a section of a protein chain is represented below.




Which of the amino acids listed below would not be produced when this section of protein undergoes hydrolysis?

A. Leucine.
B. Threonine.
C. Methionine.
D. Serine.

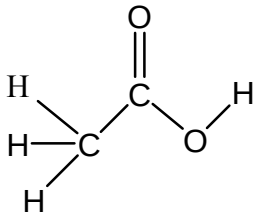
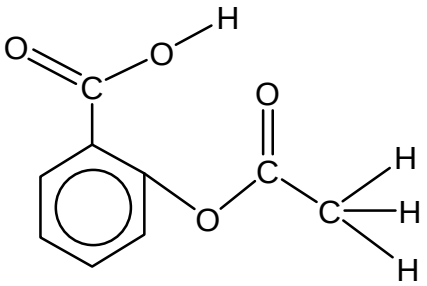
**Question 15**
For a practical investigation of an organic reaction pathway starting from ethene, A, B and C show sections of three IR spectra associated with compounds produced during the investigation

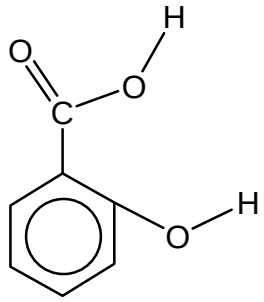
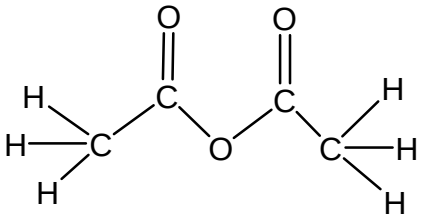


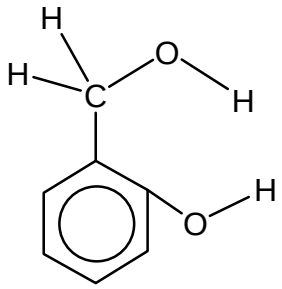
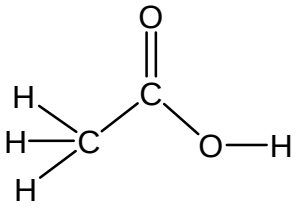

Which of the alternatives below best represents the order in which these compounds would be produced in the pathway?

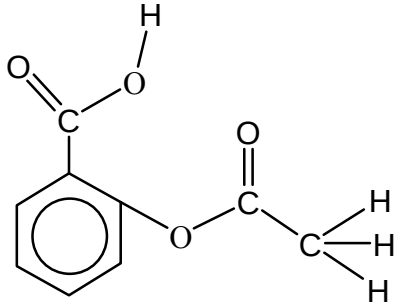
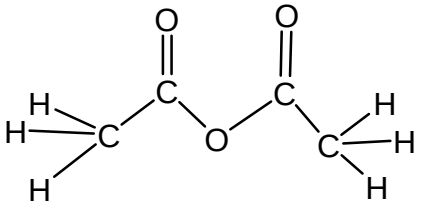
A. A then B then C
B. C then A then B
C. B then C then A
D. A then C then B

**Question 16**
Aspirin is produced by reaction between salicylic acid and ethanoic (acetic) anhydride. The structures of these of these reactants are

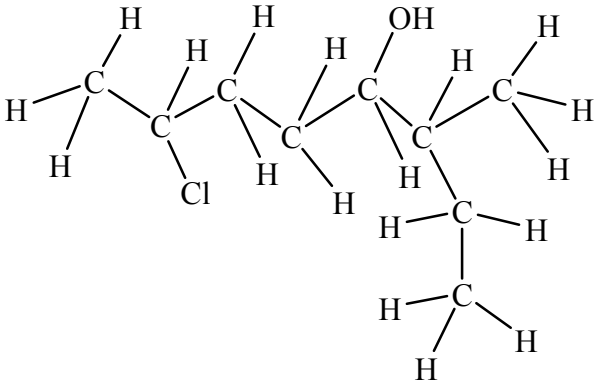
A.  and 

B.  and 

C.  and 

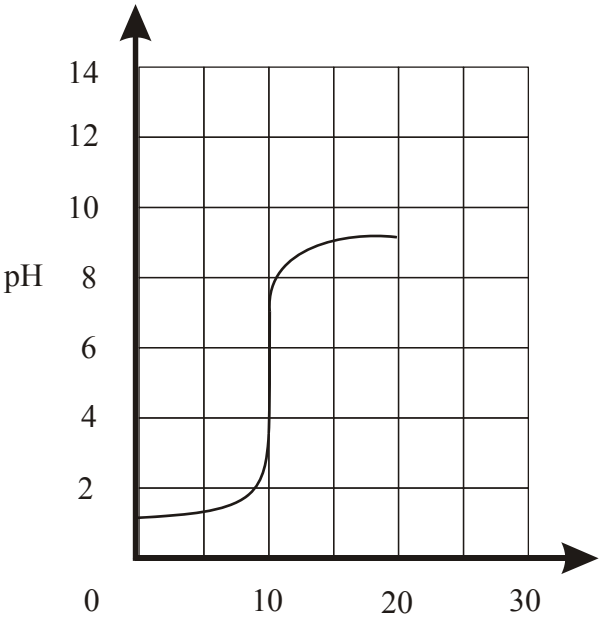
D.  and 

**Question 17**
What is the correct systematic name of the compound which has the molecular structure represented below?



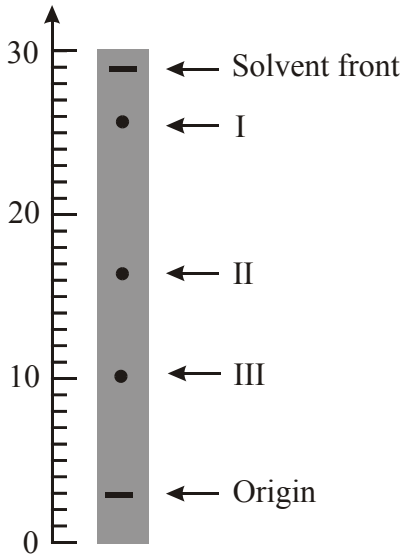
A. 2-chloro-6-methyl-5-octanol.
B. 6-chloro-2-ethyl-3-heptanol.
C. 2-chloro-6-ethyl-5-heptanol.
D. 7-chloro-3-methyl-4-octanol.

**Question 18**
The following titration curve was obtained by measuring the pH during an acid-base titration.




This titration curve best represents the titration of
A. 10 mL of 0.1 M $CH_3COOH(aq)$ with 0.1 M KOH(aq) using phenol red indicator.
B. 10 mL of 0.1 M HCl(aq) with 0.1 M NaOH(aq) using bromophenol blue indicator.
C. 10 mL of 0.1 M $HNO_3(aq)$ with 0.1 M $NH_3(aq)$ using methyl red indicator.
D. 10 mL of 0.1 M $H_2SO_4(aq)$ with 0.1 M $NH_3(aq)$ using phenolphthalein indicator.

**Question 19**
During a Thin Layer Chromatography investigation of a substance, using a non-polar stationary phase, it separated into three different components, I, II and III, and the following chromatogram was produced.




Which of the following alternatives is consistent with this information?
A. The $R_F$ value of component **II** is 0.54
B. The molecules of component **I** are larger than the molecules of component **II**.
C. The $R_F$ value of component **I** is 0.87
D. The molecules of component **III** are more strongly attracted to the mobile phase than those of component **I**.

**Question 20**
A confectionary producer uses 100 tonnes of sucrose, $C_{12}H_{22}O_{11}$, each year in the production of one of its chocolates. If 50 million of these chocolates are produced each year how many sucrose molecules, on average, are present in each chocolate?
A. $2.9 \times 10^{6}$
B. $3.5 \times 10^{15}$
C. $3.5 \times 10^{18}$
D. $3.5 \times 10^{21}$

## End of Section A

# VCE Chemistry 2011 Year 12 Trial Exam Unit 3

## SECTION B – Short Answer Section

*Section B consists of 6 short answer questions.*
*You should answer all of these questions in the spaces provided.*
*This section is worth approximately 76 per cent of the total marks available.*
*The marks allotted are shown at the end of each part of each question.*
*Questions should be answered in the spaces provided.*

**Question 1**

Potassium permanganate, $KMnO_4$, is a versatile chemical which, because of its mild antibacterial disinfectant properties, is used, often under the name Condy's crystals, in the treatment of some skin diseases and fungal infections such as athlete's foot. Dilute solutions of Condy's crystals are also used to wash fruit and vegetables to help remove pesticide residues and harmful bacteria.

The concentration of a dilute aqueous solution of potassium permanganate was determined by using it to titrate an aqueous solution of the primary standard sodium oxalate, $Na_2C_2O_4$.

0.2734 g $Na_2C_2O_4$ was dissolved in water in a 500.0 mL volumetric flask, the solution was acidified with sulfuric acid and made up to the calibration mark.

20.00 mL aliquots were then titrated with the potassium permanganate solution. The equation for the reaction occurring during the titration was

$$5C_2O_4^{2-}(aq) + 2MnO_4^{-}(aq) + 16H^{+}(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$$

Four titrations were carried out and the volumes of potassium permanganate used were recorded in the table below.

| Titration Number | Volume of $KMnO_4(aq)$ - mL |
|---|---|
| 1 | 17.98 |
| 2 | 18.32 |
| 3 | 18.07 |
| 4 | 18.16 |

a. Explain why the reaction occurring during the titration is a redox reaction, and identify the oxidant and the reductant.

**(3 marks)**

b. Write the oxidation half-equation for the reaction.

**(1 mark)**

c. Calculate the average volume, in mL, of the concordant titres of potassium permanganate solution.

**(1 mark)**

d. Calculate the amount, in mol, of $MnO_4^-(aq)$ ions in the average titre of potassium permanganate solution.

**(3 marks)**

e. Calculate the concentration of the potassium permanganate solution as a % (m/V).

**(2 marks)**

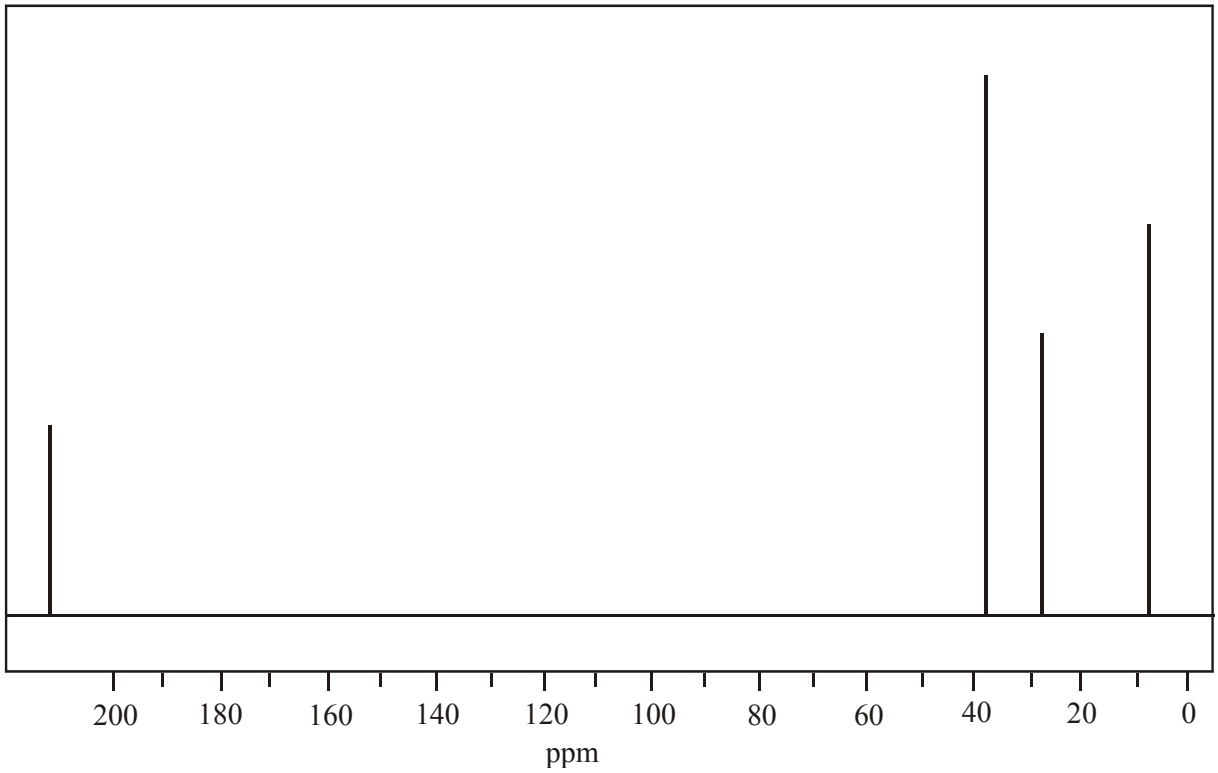
f. A key property of a primary standard is that it must have a 'known chemical formula'. Some compounds are not used as primary standards because their chemical composition becomes uncertain when they are exposed to the atmosphere.
Give the name of one such substance and two reasons why its chemical composition changes on exposure to the atmosphere.

**(2 marks)**

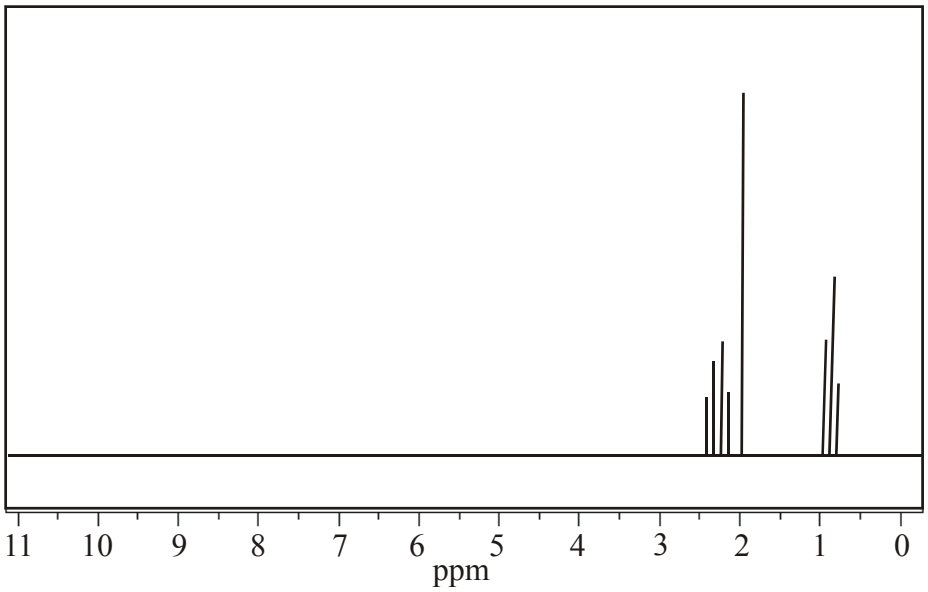
***Total 12 marks***

**Question 2**
The structure of a compound containing carbon, hydrogen and oxygen was identified using information gleaned from a number of spectra. These spectra, numbered 1, 2, 3 and 4, are represented below

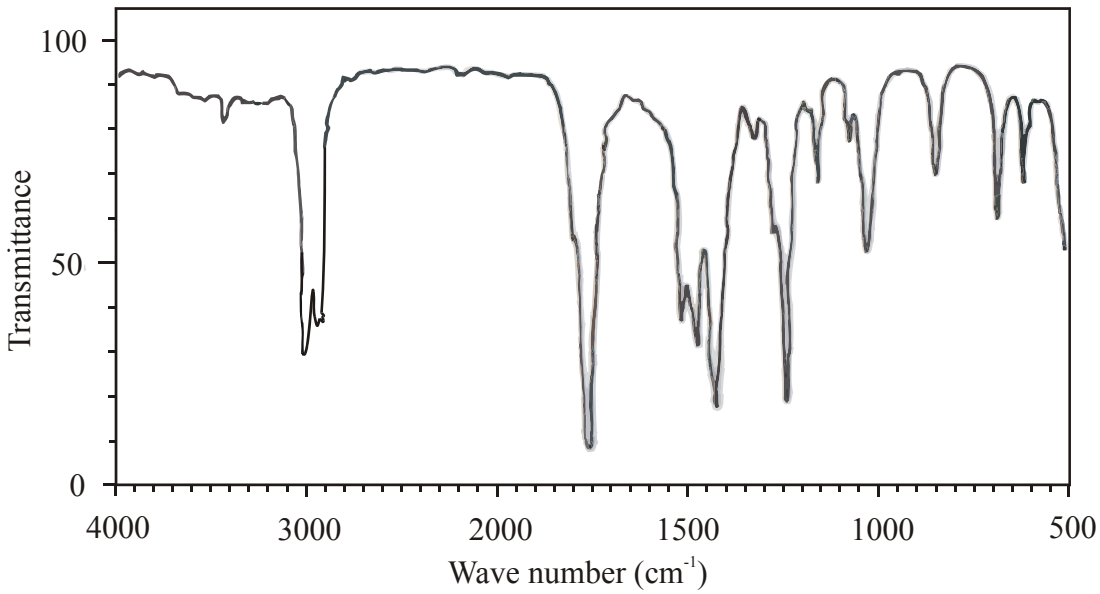
Spectrum **1**



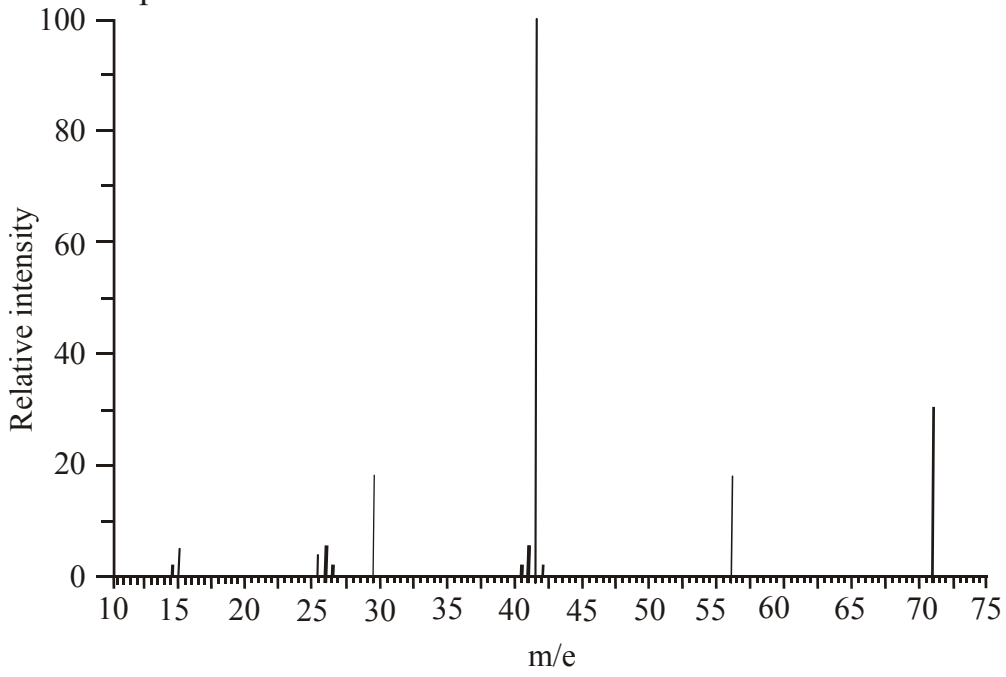

Spectrum **2**



Spectrum **3**




Spectrum **4**




a. Give the name of the 'type' of each spectrum.

Spectrum **1**

Spectrum **2**

Spectrum **3**

Spectrum **4**

**(4 x ½ = 2 marks)**

b. What can be deduced about the structure of the compound from Spectrum **1?**

**(1 mark)**

c. From Spectrum **2** it can be deduced that a specific alkyl group is present in molecules of the compound.
Give the name of this alkyl group and explain how the information on the spectrum allows for it to be identified.

**(2 marks)**

d. Spectrum **3** provides information about the bonding of oxygen in molecules of the compound. What does it indicate about how oxygen is bonded and what is it about the spectrum that enables you to deduce that?

**(2 marks)**

e. What is the relative molecular mass of the compound?

**(1 mark)**

f. i. Give the full structural formula of the compound showing all bonds.

**(2 marks)**

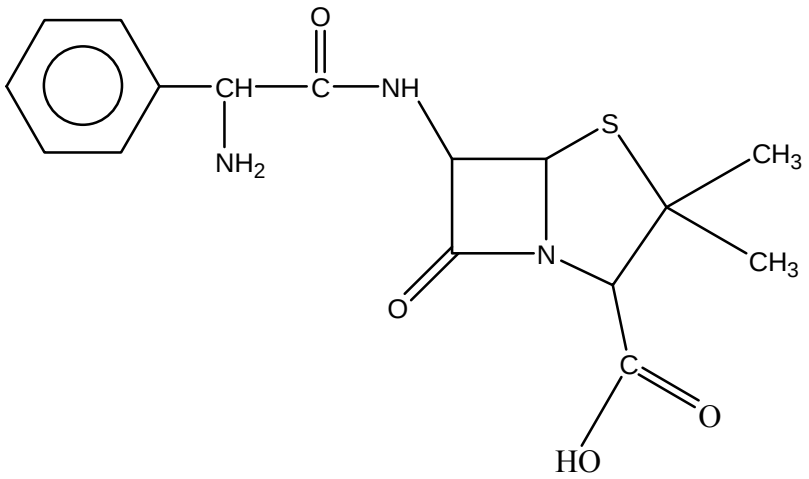
ii. Give the chemical formula of the species causing the peak at $m/e = 43$ on Spectrum **4**.

**(1 mark)**

***Total 11 marks***

**Question 3**

Penicillins are antibiotics that kill bacteria by destroying the cell wall of the microorganism. It does this by inactivating an enzyme, transpeptidase, necessary for the cross linking of bacterial cell walls. The chemical structure of ampicillin, a type of penicillin antibiotic, is shown below




a. Identify three functional groups present in molecules of ampicillin by (i) highlighting each one on the structure, and (ii) writing the name of each highlighted group.

**(3 x 1 = 3 marks)**

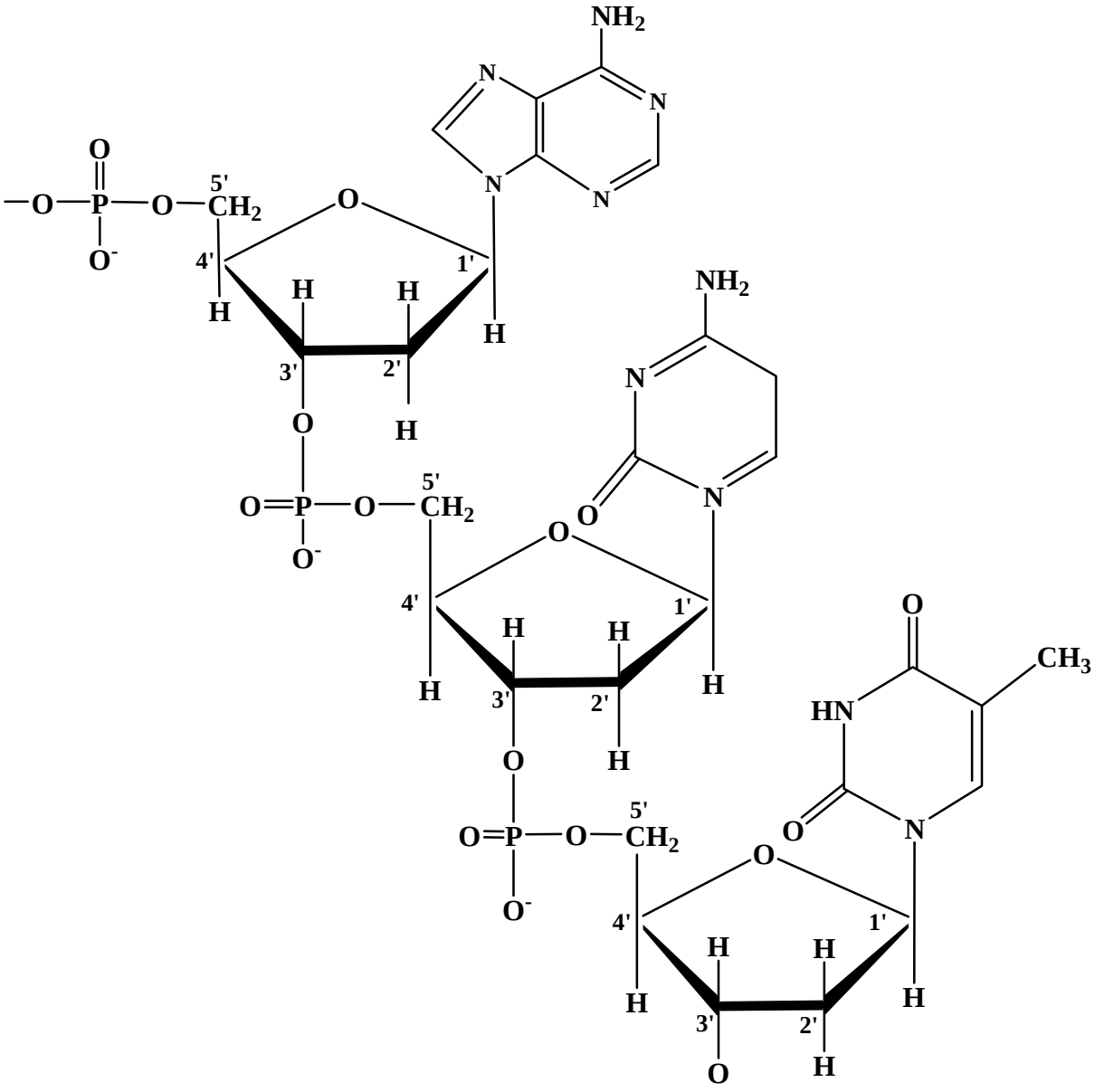
b. i. Draw the structure of the dipeptide **gly**cyl**cys**teine at pH 3.

**(2 marks)**

ii. What does this structure have in common with the structures of enzymes?

**(1 mark)**

c. A significant increase in antibiotic resistant bacteria has lead to research into new compounds that can attack bacteria by targeting their DNA. Consider the section of a strand of a nucleic acid molecule below



i. Identify a part of the nucleic acid that represents one nucleotide by circling that nucleotide.

**(1 mark)**

ii. Name the nitrogen bases in the sequence that identifies the primary structure of the nucleic acid.

**(1 mark)**

iii. Name the type of bonding that holds the secondary structure of DNA together and explain why the strength of this bonding depends on the relative numbers of the different nitrogen base pairs in the molecule.

**(2 marks)**

d. C-reactive protein (*CRP*) is a protein released into the bloodstream any time there is active inflammation in the body. As such it can be used to decide when antibiotic treatment can safely be discontinued in some medical treatments. What is the general name used to describe proteins such as CRP?

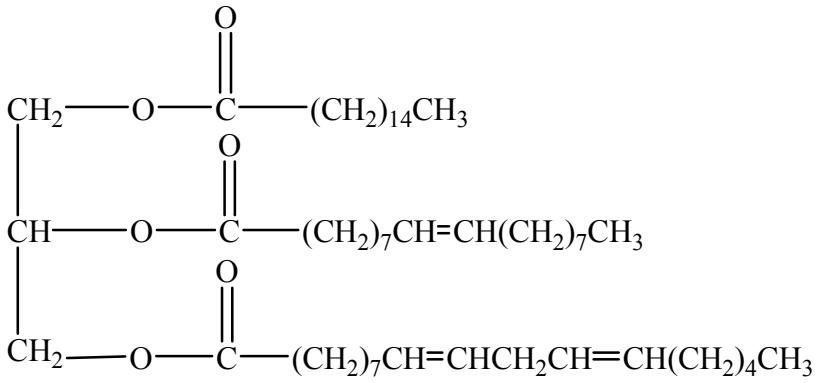
**(1 mark)**

***Total 11 marks***

**Question 4**

On November 22, 2010, Brazil's TAM Airlines conducted a Jatropha based biofuel test flight using one of the airline's CFM56 powered Airbus A320s. The 45 minute flight used a 50:50 Jatropha based biofuel and regular jet fuel blend. The biofuel was produced from oil extracted from the seeds of Jatropha plants.

a. Analysis of an oil sample extracted from Jatropha seeds identified the presence of molecules with the semi-structural formula given below.




i. Name the three fatty acids that would be released during the hydrolysis of these molecules.

**(3 marks)**

ii. Biodiesel produced from this Jatropha oil contains the methyl ester of the saturated fatty acid. Write a balanced equation for the production of this ester.

**(2 marks)**

b. 'Regular jet fuel' contains a mixture of hydrocarbons containing between 6 and 16 carbon atoms per molecule. One of those is the 12 C saturated hydrocarbon dodecane. Jet fuel can be collected during fractional distillation of crude oil.

i. Write a balanced equation for the combustion of dodecane.

**(2 marks)**

ii. During fractional distillation of crude oil, the fraction associated with jet fuel is collection at around 180°C whereas the fraction associated with petrol is collected at around 80°C.
What does that suggest about the composition of petrol compared to jet fuel and why can these different fractions be collected at different temperatures in the fractionating column?

**(3 marks)**

c. E20 motor vehicle fuel is a blend of bioethanol and petrol containing 20 % ethanol. Alcoholic beverages are aqueous solutions containing various percentages of ethanol.

i. Bioethanol and ethanol in alcoholic beverages are both produced in the chemical reaction represented by the equation below

$$C_6H_{12}O_6(aq) \rightarrow 2\ C_2H_6O(aq) + 2CO_2(g)$$

What is the name of this reaction?

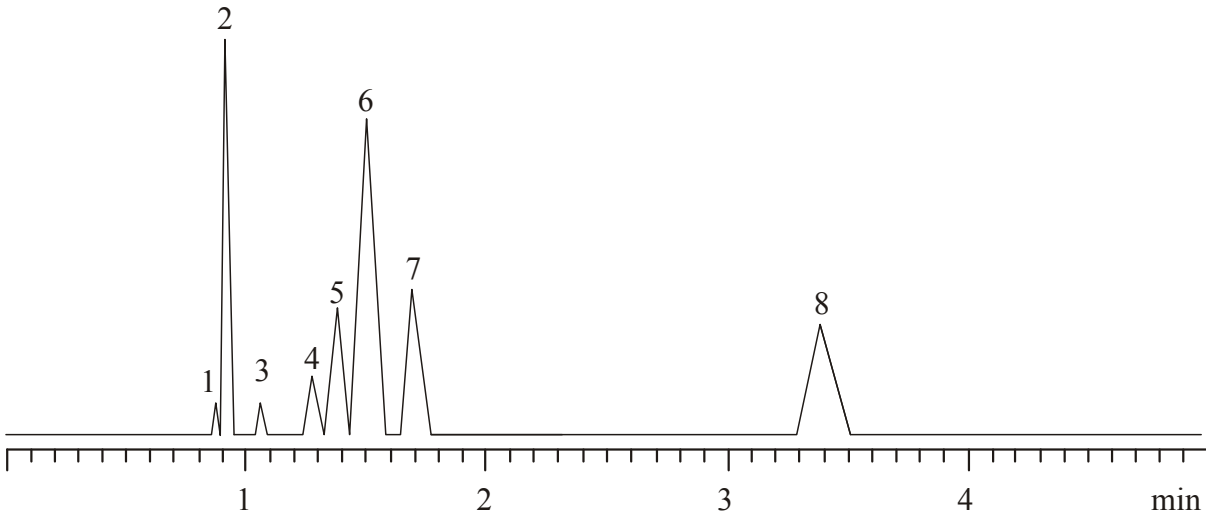
**(1 mark)**

ii. Explain why ethanol dissolves in both petrol and water.

**(3 marks)**

***Total 14 marks***

**Question 5**
The chromatogram represented below was produced during a Gas Chromatography blood alcohol analysis.




The most commonly measured blood alcohol compound is **ethanol – peak 3**.
However, there are other compounds that could be present in the bloodstream that may interfere with the identification or quantification of ethanol.
A small amount of **methanol – peak 1** may be present in alcohol beverages.
Ethanol in the body is oxidised to **ethanal**, **$CH_3CHO$ – peak 2.**
**2-propanol – peak 4** is present in soft drinks
**Propanone ($CH_3COCH_3$) – peak 5** is present in cosmetics and foodstuffs and is produced when the body uses fat rather than glucose (glycogen) as an energy source
**2-methyl-2-propanol – peak 6**, **1-propanol – peak 7**, and **2-butanol – peak 8** are also ingredients in some consumer products.

a. How can you tell from the chromatogram which alcohol was most strongly attracted to the stationary phase as the sample was run through the chromatograph?

**(1 mark)**

b. On the basis of the information given in the chromatogram, what is the advantage in using gas chromatography to determine the amount of ethanol in a blood sample?

**(1 mark)**

c. Other than the information obtained from the chromatograph shown, what other information is needed to calculate the actual amount of ethanol in the blood sample?

**(1 mark)**

d. Propanone is the product of the oxidation of 2-propanol. Write a half-equation for this reaction.

**(1 mark)**

e. Two of the molecules causing peaks in the chromatogram are structural isomers and they also have two other additional isomers with the same functional group. Draw the structures, showing all bonds, of the other two isomers and name each one.

**(3 marks)**

f. Two of the compounds causing peaks on the chromatogram can be used to produce, via at least one intermediate reaction, an ester with four carbon atoms in each molecule and which produces 3 peaks on its $^{13}C$ NMR spectrum.

i. Identify the two compounds.

**(2 marks)**

ii. Give the name and semi-structural formula of the ester produced.

**(1 mark)**

***Total 10 marks***

**Question 6**

Glyceryl trinitrate, more commonly known as nitroglycerin, is a compound of carbon, hydrogen, nitrogen and oxygen.

Its molar mass is 227 g $mol^{-1}$.

In an analysis of nitroglycerin, it was recorded that a 1.7321 g sample contains 0.2747 g of carbon, 0.3205 g of nitrogen and 1.0988 g of oxygen.

a. Use the data recorded in the analysis to determine

i. the mass of hydrogen in the analysed sample

**(1 mark)**

ii. the empirical formula of glyceryl trinitrate

**(3 marks)**

iii. the molecular formula of glyceryl trinitrate

**(1 mark)**

b. Glyceryl trinitrate is an unstable compound which, when exposed to a shock, undergoes explosive decomposition to produce carbon dioxide, nitrogen, water vapour and oxygen according to the equation

$$\mathbf{4}\text{Glyceryl trinitrate} \rightarrow \mathbf{12}CO_2(g) + \mathbf{10}H_2O(g) + \mathbf{6}N_2(g) + O_2(g)$$

A 50.1 g sample of glyceryl trinitrate decomposes explosively in a confined space of 800 mL.
If a temperature of 227 °C is generated, calculate the pressure in MPa, that results from the explosion.

**(3 marks)**

***Total 8 marks***

## End of Section B

## End of Trial Exam