VCE CHEMISTRY 2008

YEAR 12 TRIAL EXAM UNIT 3

Time allowed: 90 Minutes
Total marks: 83

SECTION A
Contains 20 Multiple Choice Questions
22 minutes, 20 marks

SECTION B
Contains 6 Extended Response Questions
68 minutes, 63 marks

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*

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Student Name....……..…….....

VCE Chemistry 2008 Year 12 Trial Exam Unit 3

Student Answer Sheet

Instructions for completing test. Use only an HB pencil. If you make a mistake erase and enter the correct answer. Marks will not be deducted for incorrect answers.
Write your answers to the Short Answer Section in the space provided directly below the question. There are 20 Multiple Choice questions to be answered by circling the correct letter in the table below.

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 2008 Year 12 Trial Exam Unit 3

Multiple Choice Section

Section A

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 provide.

Question 1
During an acid-base titration, a burette reading had to be made according to the liquid level shown in the diagram on the right.
The recorded burette reading should have been:
A. 18.4;
B. 17.6;
C. 17.65;
D. 18.35.

Question 2
Ethylamine may be prepared by reaction between chloroethane and ammonia. The maximum mass, in grams, of ethylamine that could be prepared from 3.225 g of chloroethane is:
A. 2.04;
B. 2.25;
C. 3.23;
D. 4.08.

Question 3
Sodium hydride dissolves water to produce the hydride ion, $H^-(aq)$, according to

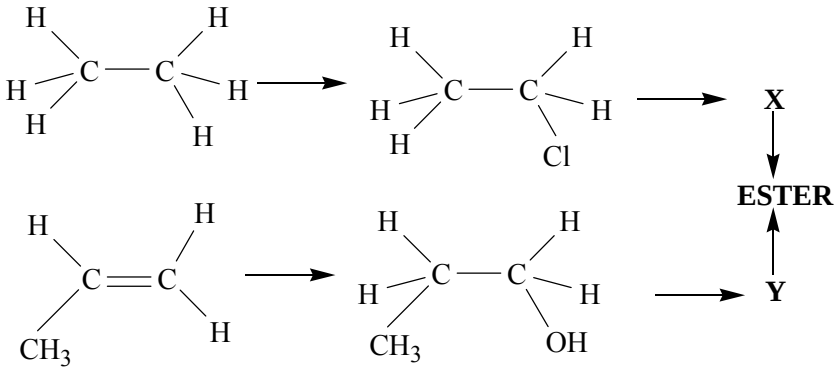
$$NaH(s) + aq \rightarrow Na^+(aq) + H^-(aq).$$

The hydride ion then immediately reacts with water according to

$$H^-(aq) + H_2O(aq) \rightarrow H_2(g) + OH^-(aq).$$

The reaction between $H^-(aq)$ and water is most accurately described as:
A. an hydrolysis reaction;
B. an acid-base reaction;
C. a redox reaction;
D. both an acid-base reaction and a redox reaction.

Questions 4, 5, 6 and 7 refer to the following information
The diagram below shows a possible reaction pathway for producing an ester which has a distinctly pineapple odour.



Question 4
Which of the following statements with respect to this pathway is **not** correct?
A. X and Y react together in a condensation reaction in the presence of an acid catalyst.
B. Chloroethane is converted to X in a substitution reaction
C. 1-propanol is converted to Y in a redox reaction using Cu as the oxidant.
D. The conversion of propene to 1-propanol is an addition reaction

Question 5
Comparison of the ^{13}C NMR spectra and low resolution ^{1}H NMR of compound Y would show?
A. More peaks on the ^{13}C NMR spectrum.
B. Fewer peaks on the ^{13}C NMR spectrum.
C. The same number of peaks on both spectra.
D. TMS at a lower chemical shift on the ^{1}H spectrum.

Question 6
How many of the organic compounds in this reaction pathway would be expected to show a strong absorption band between 3200 and 3550 cm^{-1} in their IR spectra?
A. 1.
B. 2.
C. 3.
D. 4.

Question 7
At what *m* / *e* ratio would the molecular ion be expected to appear in the mass spectrum of the ester produced via this reaction pathway?
A. 88.
B. 102.
C. 106.
D. 120.

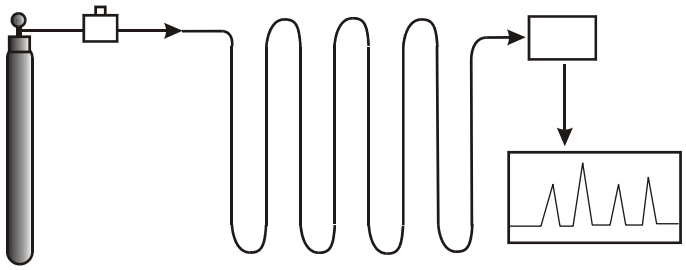
Question 8
Concentrated nitric acid, HNO_3, is a strong oxidising agent. Which of the following substances is least likely to be produced when nitric acid is the oxidant in a chemical reaction.
A. NO_3^-.
B. N_2.
C. NO_2.
D. NO.

Question 9
Aluminium will react with dilute sulfuric acid according to the equation
$2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$.
When 6.75 g of Al is added to excess dilute sulfuric acid and allowed to react to completion, 6.3 L of H_2, at STP is collected.
What percentage of the H_2 produced in the reaction was **not** collected?
A. 25.
B. 37.
C. 63.
D. 75.

Question 10
When aqueous solutions of silver nitrate, $AgNO_3$, and potassium chromate, K_2CrO_4, are mixed, silver chromate, Ag_2CrO_4, precipitates according to the ionic equation
$2Ag^+(aq) + CrO_4^{2-}(aq) \rightarrow Ag_2CrO_4(s)$.
10 mL of 0.1 M $AgNO_3(aq)$ is added to 20 mL of 0.05 M $K_2CrO_4(aq)$ and reaction allowed to proceed to completion. Remaining unprecipitated at the end of the reaction would be:
A. 0.05 mol Ag^+;
B. 0.05 mol CrO_4^{2-};
C. 0.0005 mol Ag^+;
D. 0.0005 mol CrO_4^{2-};

Question 11
A 20.0 mL sample of a saturated aqueous solution of calcium hydroxide, $Ca(OH)_2(aq)$, was titrated with 0.0300 M hydrochloric acid. 17.5 mL of the acid was required to reach the endpoint of the titration. The mass of calcium hydroxide, in grams, in one litre of the saturated solution was closest to:
A. 1;
B. 2;
C. 0.02;
D. 0.04.

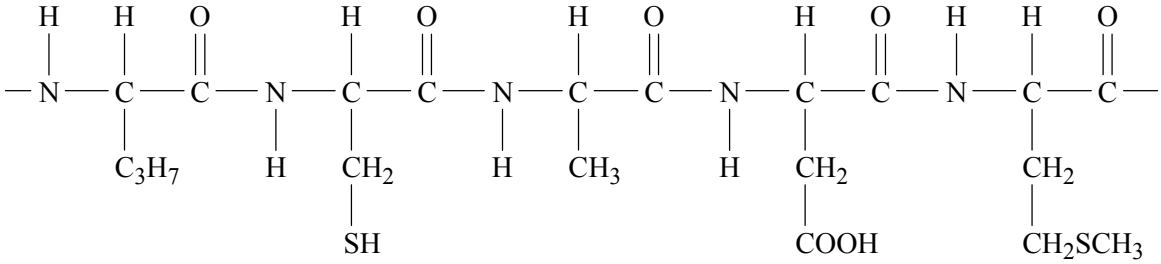
Question 12
Shown below is a schematic diagram of an instrument used in modern chemical analysis



This instrument is commonly used in partnership with:
A. a mass spectrometer;
B. a nuclear magnetic resonance spectrometer ;
C. an atomic absorption spectrometer;
D. a high performance liquid chromatograph.

Question 13
Amino acids and nucleic acids are both important to the functioning of living organisms. Which one of the elements listed below may be present in some amino acids but **not** in nucleic acids?
A. Hydrogen.
B. Oxygen
C. Phosphorus.
D. Sulfur.

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



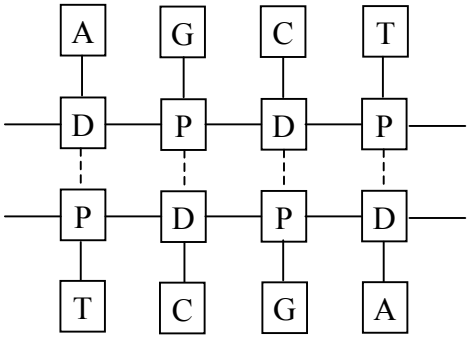
Which of the amino acids listed was not used to produce this section of the protein?
A. Cysteine.
B. Glycine.
C. Methionine.
D. Valine.

Question 15
Symbols for the chemical groups and bond types associated with DNA are shown below:

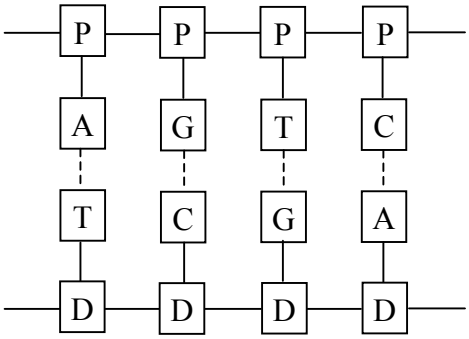
P	phosphate group	D	deoxyribose
A	adenine	C	cytosine
G	guanine	T	thymine
——	covalent bonds	----	hydrogen bonding

Which of the diagrams below best represents the arrangement of the components of DNA?

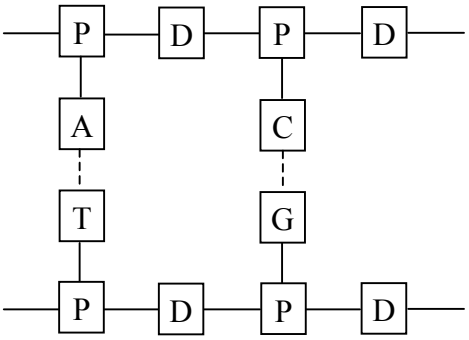
A.



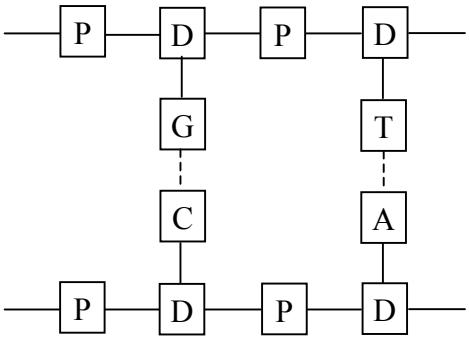
B.



C.

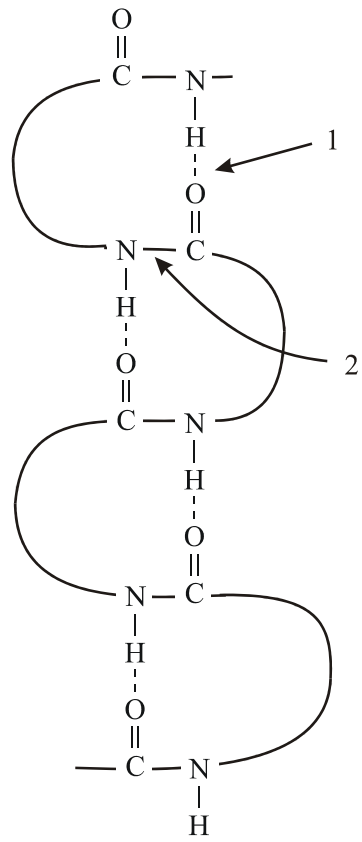


D.



Question 16
Catalase is an enzyme produced in the liver. Catalase is **best** described as:
A. a catalyst;
B. a substance that changes the rate of a chemical reaction;
C. a compound that is unaffected by changes in pH;
D. a protein that increases the rate of a chemical reaction.

Question 17
The diagram below emphasises particular aspects of the structure of proteins.



On this diagram the types of bond referred by labels **1.** and **2.** are:
A. 1. covalent, 2. ionic;
B. 1. hydrogen, 2. covalent;
C. 1. covalent, 2. disulfide;
D. 1. ionic, 2. covalent.

Question 18
Compared to a molecule of glucose, a molecule of deoxyribose has:
A. one less carbon atom;
B. one less oxygen atom;
C. one less hydrogen atom;
D. one less nitrogen atom.

Question 19
The following statement describes as aspect of the operation of a type of modern analytical instrument.

e.g. the electron in the third shell of a sodium atom will absorb energy of 589.0 nm wavelength. Only ground state atoms can absorb energy at this wavelength, and a hollow cathode lamp supplies the energy…

Which of the following analyses could be performed using this instrument?
A. Determining the amount of gold in seawater.
B. Determining the functional groups present in a new medicine.
C. Determining the number of 'different' carbon atoms in a molecule.
D. Determining the alcohol content of wine.

Question 20
The ratio of the peak areas in the ^{1}H NMR spectrum of 2- methylpropane is:
A. 1 : 9.
B. 1 : 3 : 3 : 3.
C. 1 : 3 : 6.
D. 2 : 5.

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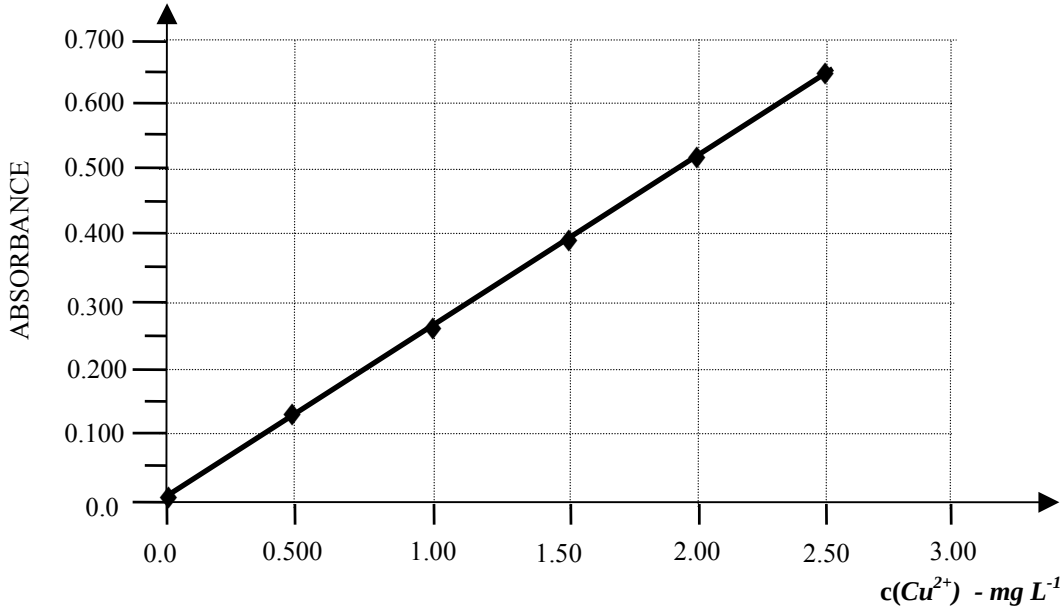
Section B

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
The concentration of copper ions in a solution was determined by converting the pale blue $Cu^{2+}(aq)$ ions to dark blue $Cu(NH_3)_4^{2+}(aq)$ ions and measuring the absorbance of the $Cu(NH_3)_4^{+}(aq)$ solution in a UV-Visible spectrometer at 600 nm.
Experimental data needed to construct a calibration curve was also collected and plotted as shown below.



a. What experimental data was needed to construct the calibration curve?

(1 mark)

b. After the spectrometer had been calibrated, a 10.0 mL sample of the solution to be analysed was diluted to 100 mL with deionised water. Then 5.00 mL of this diluted solution was further diluted to 100 mL with deionised water prior to analysis
The absorbance of the final diluted solution was 0.520
Determine the concentration, in mol L^{-1}, of the original solution with respect to $Cu^{2+}(aq)$.

(3 marks)

c. A wavelength around 600 nm is in the yellow region of spectrum of visible light. Why is this wavelength used in the analysis?

(2 marks)

d. The concentration of $Cu^{2+}(aq)$ can also be determined by another spectroscopic technique. Give the name of this technique and describe the light source that would be used.

(2 marks)

Total marks = 8 marks

Question 2

A sample of bath salts contains a mixture of sodium carbonate, Na_2CO_3 and sodium hydrogen carbonate, $NaHCO_3$.

In a volumetric analysis to determine the amounts of both Na_2CO_3 and $NaHCO_3$ present in a sample of bath salts, a 50.00 mL aliquot of an aqueous solution of the bath salts was titrated with 0.1020 M hydrochloric acid solution using phenolphthalein to indicate the end point. Methyl orange indictor was then added to the resulting solution and this was then titrated with the same acid to a second end point.

The reactions occurring during the titration are:

$HCl(aq) + Na_2CO_3(aq) \rightarrow NaHCO_3(aq) + NaCl(aq)$ – phenolphthalein end point and then

$HCl(aq) + NaHCO_3(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$ – methyl orange end point

10.25 mL of the HCl(aq) was used to reach the phenolphthalein end point and a further 25.35 mL was used to reach the methyl orange end point.

a. Describe the colour change that should occur at the end point of the first reaction?

(1 mark)

b. Calculate the $n(Na_2CO_3)$ present in the original 50.00 mL aliquot of bath salts solution.

(2 marks)

c. Determine the $n(HCl)$ used between the phenolphthalein and methyl orange end points.

(1 mark)

d. Describe the colour change that should occur at the end point of the second reaction.

(1 mark)

e. Calculate the $n(NaHCO_3)$ reacting between the phenolphthalein and methyl orange end points.

(1 mark)

f. Determine the molar concentration of the original 50.00 mL aliquot of bath salts solution with respect to $NaHCO_3$.

(2 marks)

g. In one analysis of the bath salts, the burette is rinsed with bath salts solution immediately before the hydrochloric acid is added to the burette. What effect would this error have on the calculated amounts of $NaHCO_3$ in the bath salts solution? Explain your answer

(2 marks)

Total 10 marks

Question 3

In an article entitled ***'Chemistry and agriculture join to make a new generation of renewable fuels'*** which *appeared in Chemical & Engineering News – November 20, 2006 – Marc Reisch wrote* *'Experts say biofuels won't replace all petroleum-derived gasoline or diesel. Instead, biofuels such as biodiesel, ethanol, and biobutanol will extend fossil fuel supplies.'*

a. Ethanol can be produced by fermentation of glucose or by an addition reaction from ethene.

i. Write a balanced equation for the production of ethanol by fermentation of glucose.

(2 marks)

ii. Explain why ethanol produced from glucose is classified as a biofuel.

(1 mark)

iii. Ethanol can also be produced from ethene. Write a balanced equation for this reaction.

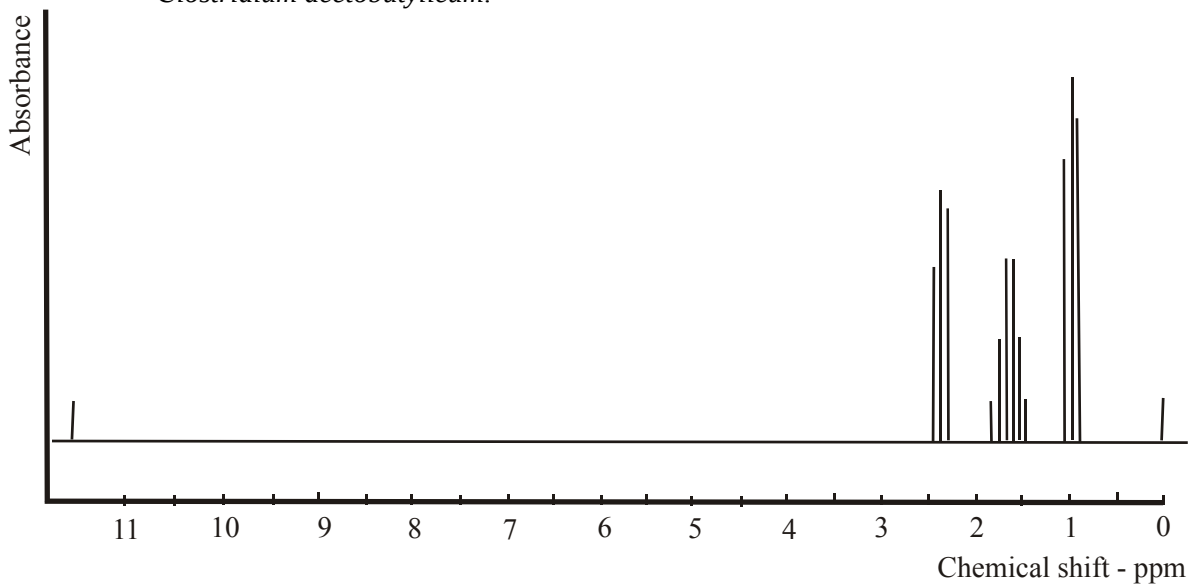
(1 mark)

b. Biobutanol is also produced by the fermentation of sugars in the presence of the specific bacterium, C*lostridium acetobutylicum.* The products of this fermentation include hydrogen, butanoic acid and carbon dioxide as well as 1-butanol.

i. Draw structural formulae, showing all bonds, for 1-butanol and butanoic acid.

(2 marks)

ii. The simulated high resolution proton NMR spectrum below is characteristic of one of the organic products of the fermentation of sugars in the presence of C*lostridium acetobutylicum*.



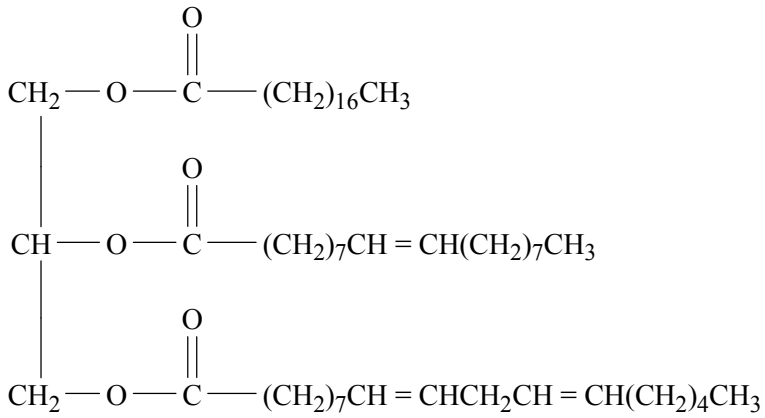
Identify this compound and explain how the information on the spectrum can be used to establish why it is the spectrum of one of the compounds but not the other.

(3 marks)

iii. A distinct advantage of biobutanol over ethanol as a fuel biocomponent is that it can be can be blended into petrol at larger concentrations. It is also less likely than ethanol to separate out of a biofuel-petrol blend in the presence of any water. Why does 1-butanol dissolve more easily in petrol but less easily in water than ethanol?

(2 marks)

c. Bio-diesel refers to fuels containing fatty acid methyl or ethyl esters made from any tri-glyceride oil molecule. The main reaction for converting oil to biodiesel is called transesterification. The Jatropha tree, a wild tree that grows readily in tropical areas carries a fruit with kernels that can be crushed to give an oil suitable for making biodiesel. The semi-structural formula for the triglyceride in this oil is shown below.



i. The first stage in the transesterification process is the hydrolysis of the oil. Each molecule produces three fatty acids molecules and one other compound. Give the name of the other compound and draw its structural formula, showing all bonds.

(2 marks)

ii. The second stage of the transesterification is the production of esters from the fatty acids released during hydrolysis. Write a balanced equation, using semi-structural formulae, for the production of the methyl ester of the monounsaturated fatty acid.

(2 marks)

d. In support of biofuels it is sometimes claimed that the energy obtained from biomass does not add to global warming. How is this possible when all fuel combustion, including fuels produced from biomass, releases carbon dioxide into the atmosphere?

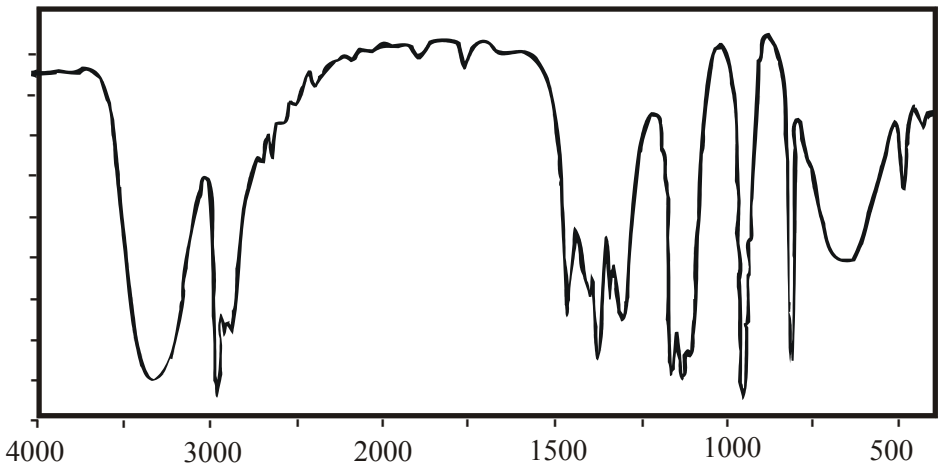
(1 mark)

Total 16 marks

Question 4

All three spectra shown below are of the same organic compound

a. IR spectrum



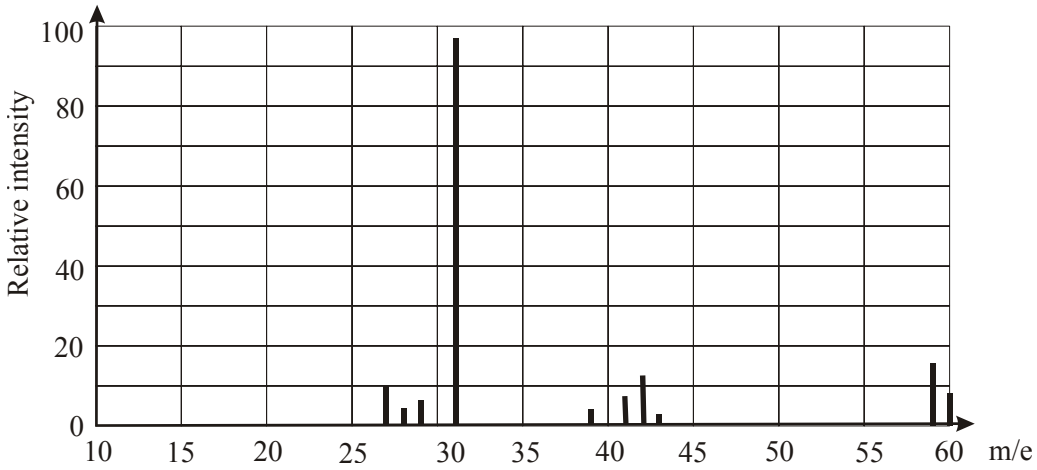
i. What functional group is indicated by the absorption band between 3200 and 3500 cm^{-1}?

(1 mark)

ii. What is region of the spectrum to the right of 1500 cm^{-1} called?

(1 mark)

b. Mass spectrum



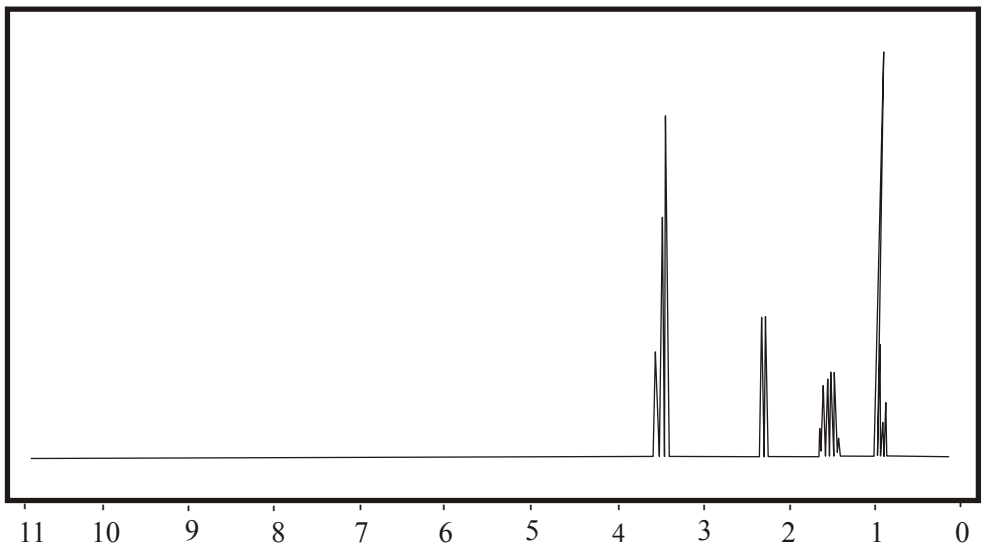
i. What is the relative molecular mass of the compound?

(1 mark)

ii. On the basis of the functional group identified from the IR spectrum and the relative molecular mass of the compound, how many carbon atoms should be present in each molecule? Explain your reasoning.

(2 marks)

c. ^{1}H NMR spectrum



i. How many different hydrogen environments are present in the molecules of the compound?

(1 mark)

ii. Give the semi-structural formula for the compound.

(1 mark)

iii. The peaks at chemical shifts 0.9 and 3.7 are both triplets. What causes the peaks for those hydrogen atoms to be split into triplets?

(1 mark)

iv. The peak at chemical shift 1.6 is split into 6 finer peaks, i.e. a sextet. Referring to the semi-structural formula of the compound briefly explain why this occurs.

(1 mark)

d. How many peaks would you expect to see on the ^{13}C NMR spectra of this compound?

(1 mark)

e. This compound has one other isomer, containing the same functional group.

i. Draw the structural formula of this isomer.

(1 mark)

ii. State the number of peaks this isomer would show and its:

– low resolution ^{1}H NMR spectrum.

– ^{13}C NMR spectrum.

(2 marks)

Total marks = 13 marks

Question 5
Consider the information provided below.

Improving Liver Cancer Diagnosis

ScienceDaily (Oct. 7, 2007) — Researchers have identified proteins that could be used to improve the diagnosis of hepatocellular carcinoma, the most common type of liver cancer. They have used a state-of-the-art technique called two-dimensional difference gel electrophoresis to look for proteins whose copies are either increased or decreased in patients with hepatocellular carcinoma. Among the many proteins they found, two proteins were validated as novel potential markers of hepatocellular carcinoma.

a. How do proteins act as markers for diseases such as cancers?

(1 mark)

b. Proteins are produced by a reaction between amino acids. What type of reaction occurs and what functional group changes occur during this reaction?

(3 marks)

c. Electrophoresis involves separation of molecules as they pass through a conducting gel under the influence of an applied electric field. Proteins and/or amino acids can be separated with the extent of movement depending on the charge on the molecules – determined by gel pH – and the mass of the molecules.

   i. Explain how the pH of the gel would affect the charge on an amino acid or protein.

(2 marks)

ii. Towards which electrode (positive or negative) would the amino cysteine move during electrophoresis in a gel of pH 2.

(1 mark)

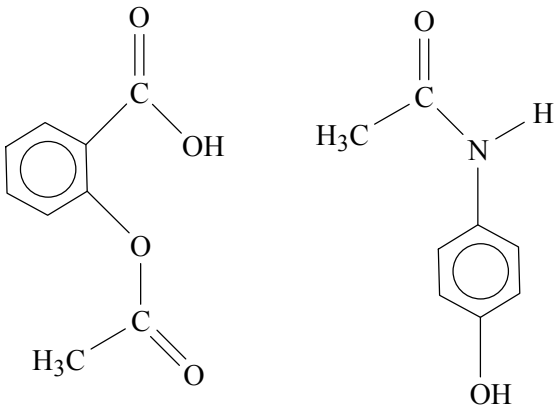
d. Since proteins can be separated according to mass and charge in electrophoresis what analytical tool is then a vital part of protein identification.

(1 mark)

Total marks = 8 marks

Question 6

The molecules structures of two common analgesics are shown below.



a. One of the analgesics represented is paracetamol and the other one is aspirin Highlight and give the names of the two functional groups present in a paracetamol molecule.

(2 marks)

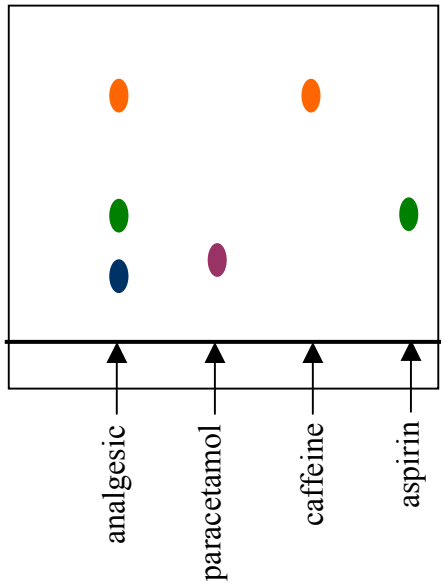
b. Highlight and give the names of the two functional groups present in an aspirin molecule.

(2 marks)

c. During hydrolysis, under alkaline conditions, aspirin is converted into a mixture of salicylic and ethanoic acids. Draw the molecular structure of salicylic acid.

(1 mark)

d. A particular brand of analgesic states that each tablet contains 250 mg of aspirin, 250 mg of paracetamol and 65 mg of caffeine. In order to check this claim a thin-layer chromatography analysis was performed, using pure aspirin, pure paracetamol and pure caffeine for reference. The following chromatogram was developed.



i. What can be concluded, from this data, about the composition of the analgesic?

(2 marks)

ii. In order to determine the relative amounts of the three substances present in the analgesic which chromatographic technique should be used?

(1 mark)

Total marks = 8 marks

End of Trial Exam