STUDENT NUMBER

									Letter
Figures									
Words									

CHEMISTRY

Written examination 1

Wednesday 9 June 2010

Reading time: 11.45 am to 12.00 noon (15 minutes)
Writing time: 12.00 noon to 1.30 pm (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	6	6	58
			Total 78

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and 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 book of 25 pages.
- A data book.
- Answer sheet for multiple-choice questions.

Instructions
- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- 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 book.
- You may keep the data book.

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

SECTION A – Multiple-choice questions

Question 1

The Lowry-Brønsted acid-base conjugates for the following species were isolated and dissolved in pure water. Which of these would **produce** the conjugate base with the greatest electrical conductivity when **it** ionises in water?

A. HCl

B. HNO_3

C. CH_3COOH

D. NaOH

Questions 2 to 4 refer to the following information.

To determine the amount of ammonium sulphate in a sample of fertilizer, a 2.105g sample of the fertilizer was dissolved in distilled water in a 100ml volumetric flask. The solution was made up to the mark with more distilled water. A pipette delivered a 25ml aliquot into a conical flask, and 20ml of 0.246M NaOH solution was added and the solution was boiled and then returned to 25°C. A titre of 19.36ml of 0.097M HCl solution was required to neutralise the resultant solution.

Question 2

What was the pH in the conical flask after the NaOH was added?

A. 1.38

B. 12.6

C. 12.9

D. 13.0

Question 3

If the burette had been rinsed with distilled water before use, how would this have affected the calculated percentage of ammonium sulphate in the fertilizer sample?

A. The calculated percentage would be unaffected.

B. The calculated percentage would be lower than the true value.

C. The calculated percentage would be higher than the true value.

D. It is not possible to determine how the calculated percentage would be affected.

Question 4

The endpoint of the neutralisation reaction between NaOH and HCl typically occurs around a neutral pH. An indicator that changes colour across that range is therefore required. If phenolphthalein indicator was **incorrectly** chosen for this titration

A. the observed end point would occur too soon, and the calculated concentration of ammonium sulphate would be lower than the true value.

B. the observed end point would occur too late, and the calculated concentration of ammonium sulphate would be lower than the true value.

C. the observed end point would occur too soon, and the calculated concentration of ammonium sulphate would be higher than the true value.

D. the observed end point would occur too late, and the calculated concentration of ammonium sulphate would be higher than the true value.

Question 5

A sample of hydrated barium chloride is found to have a composition by mass of 52.34% of barium and 27.07% chloride. The empirical formula for this compound is

A. $Ba_2Cl_4.2H_2O$

B. $BaCl_2.H_2O$

C. $BaCl_2.2H_2O$

D. $BaCl_2.3H_2O$

Question 6

In an experiment, hydrogen peroxide reacts with an unknown chemical species. The half equation for hydrogen peroxide in this equation is

$H_2O_2(aq) \rightarrow O_2(g) + 2H^+(aq) + 2e^-$

The unknown species is

A. a reductant, because it loses electrons.

B. an oxidant, because it gains electrons.

C. another H_2o_2 molecule, because of the negative gradient on the electrochemical series.

D. a base, because it accepts two protons.

Question 7

In a redox titration, 20.00ml of 1.0133M of an unknown alcohol is completely oxidised by acidified potassium permanganate to form 1.520g of an unknown carboxylic acid. The original species **before** oxidation could have been

A. ethanol

B. ethanoic acid

C. propanoic acid

D. propanol

Question 8

In which of these examples would high performance liquid chromatography be preferred to gas chromatography?

A. a sample containing high levels of decanoic and nonanoic acid

B. a sample containing high levels of valine, aspartic acid and glutamic acid

C. a sample containing mainly monosaccharides

D. a sample containing high levels of lauric and myristic acid

Question 9

In the case of a thin layer chromatograph made using a silica plate, which of these chemical properties would have the **least** adsorbent effect?

A. the ability to form hydrogen-bonds

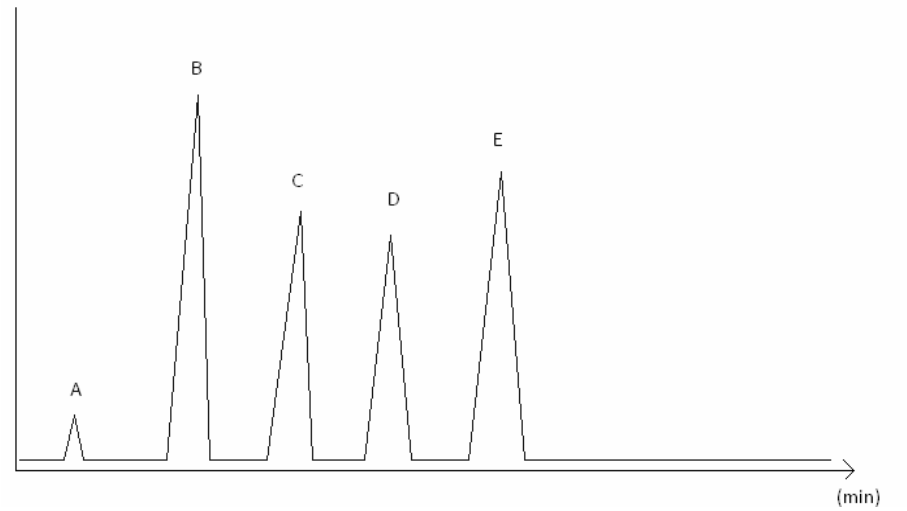
B. negative charge due to the presence of COO^- groups

C. large size

D. positive charge due to the presence of NH_4^+ groups

Questions 3 to 5 refer to the following information

A gas chromatograph (GC) of an alkene mixture had results as displayed below.



Question 10

Which choice correctly describes the most concentrated volatile compound in the mixture and the largest volatile compound in the mixture respectively?

A. B, E

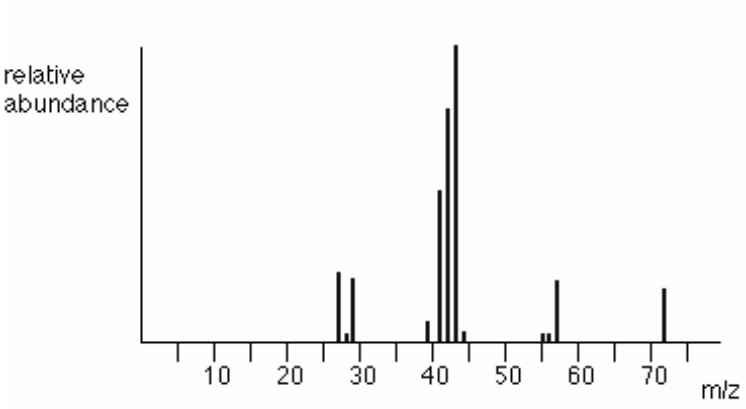
B. E, A

C. E, E

D. B, A

Question 11

Compound D was extracted, reacted with hydrogen in the presence of a nickel catalyst, and the result was sent directly into a mass spectrometer, producing the results shown below.



What is the correct name of the **most abundant** compound?

A. propene

B. butene

C. ethene

D. pentene

Question 12

The most concentrated compound in the mixture was then used as the basis of a number of tests. This involved the addition of hydrogen under a nickel catalyst or addition of chloride gas or addition of water vapour in the presence of a solid H_3PO_4 catalyst. Following this, compounds were again separated and this time individually run through an IR spectrometer. Assuming all compounds reacted with **at least one** of the reagents being added. Which of these features would be found in the IR spectrum?

A. a trough between wave number's 2500-3300 cm^{-1}

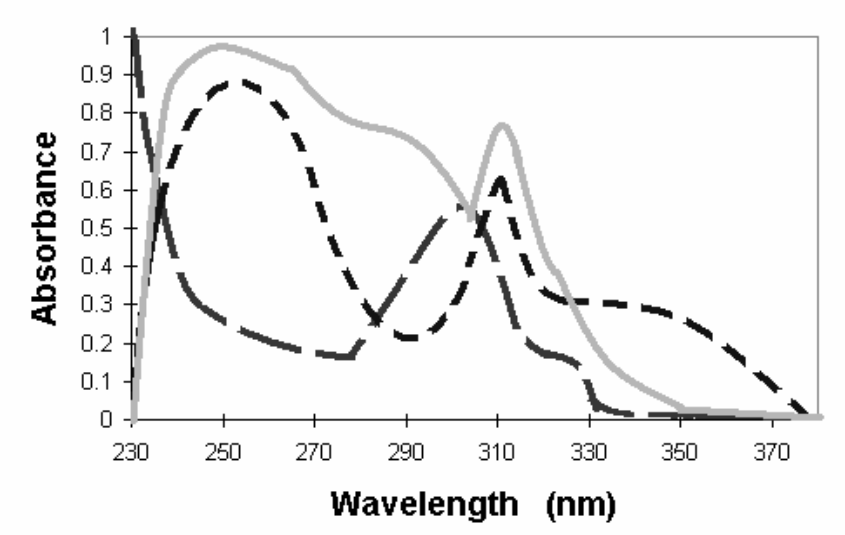
B. a trough between wave number's 1610-1680 cm^{-1}

C. a trough between wave number's 1670-1750 cm^{-1}

D. a trough between wave number's 3200-3550 cm^{-1}

Question 13

The absorbance spectra of three compounds in a sample are given below. What wavelength should be chosen for the UV-visible spectrophotometer to find the concentration of the compound represented by the solid line?



A. 250 nm

B. 280 nm

C. 300 nm

D. 310 nm

Question 14

A biologically important molecule was found to contain 76% carbon, 13% hydrogen and 11% oxygen by mass. The molecule is most likely a type of

A. carbohydrate.

B. protein.

C. nucleic acid.

D. fatty acid.

Questions 15 to 17 refer to the following information.

W, X, Y and Z are simple organic species each with only one functional group. Y can be oxidised to Z, while X can undergo a substitution reaction to form Y. Under appropriate conditions, Y and Z can condense to form an ester. Passing an acidic gas over W can produce X.

Question 15

Which of the following reagents could be used to turn Y into Z?

A. steam with solid H_3PO_4 catalyst

B. sodium hydroxide solution

C. hydrochloric acid

D. acidified dichromate

Question 16

Y and Z are, respectively,

A. an amide and a carboxylic acid.

B. a carboxylic acid and an amide.

C. an alcohol and a carboxylic acid.

D. a carboxylic acid and an alcohol.

Question 17

W and X could be, respectively,

A. propane and 2-chloropropane.

B. pent-1-ene and 1-chloropentane.

C. but-2-ene and 2-chlorobutane.

D. either pent-1-ene and 1-chloropentane or but-2-ene and 2-chlorobutane.

Question 18

Which of the following features would the ^{1}H NMR spectrum of butane be expected to contain?

A. a triplet and a quartet

B. two triplets and two quartets

C. a doublet and a triplet

D. two doublets and two triplets

Question 19

In ^{13}C NMR spectroscopy, the chemical shift of a group of equivalent carbon nuclei is most accurately described as a measure of

A. the average amount of radiation absorbed by one of those nuclei.

B. the energy required to excite one of those nuclei from a low energy state to a high energy state.

C. the density of electron clouds shielding each one of those nuclei from radio waves.

D. the resonating frequency of those nuclei compared to that of a reference standard.

Question 20

Which of the following types of bonding does not contribute to the tertiary structure of proteins?

A. ionic bonding

B. dispersion forces

C. covalent bonding

D. All of the above types of bonding directly contribute to the tertiary structure.

SECTION B – Short answer questions

Question 1

An ionic substance is found to contain only oxygen and an unknown metal, M, such that its empirical formula is MO_Z. A 0.0756M solution of this unknown substance is placed into a reaction flask and $CrSO_4$ solution is titrated against it. The two species react. The details of the experiment are shown in the table below:

Volume of MO_Z solution	15.75ml
Concentration of the $CrSO_4$ solution	0.21824M
Initial burette reading	50.0ml
Final burette reading	17.25ml

After the end point was reached it was determined that Cr^{3+} ions were produced, and the oxidation state of the unknown metal was now zero, M^0.

a. Explain why ionic substances can have an empirical formula but not a molecular formula.

_____

_____

_____

_____

_____

_____

_____

2 marks

b. Why do many redox titrations NOT require an indicator, even though acid-base reactions do?

_____

_____

_____

_____

_____

_____

_____

_____

2 marks

c.

i. Was the reaction that produced the Cr^{3+} a reduction reaction or an oxidation reaction?

_____

1 mark

ii. Determine the amount (in mol) of electrons that were involved in the reaction that formed the Cr^{3+}.

3 marks

iii. Determine the number of mol of MO_Z that reacted.

1 mark

iv. Consider the half-equation for the unknown species below:

$$M^{X+} + xe^- \longrightarrow M^0$$

What was the original oxidation state (x) of the unknown metal before the reaction with $CrSO_4$?

3 marks

d. State the empirical formula of the ionic substance.

1 mark

Total 13 marks

Question 2

Many insects attract a mate by releasing a volatile organic compound known as a sex pheromone. Muscalure is the female sex pheromone of the common housefly, Musca domestica. Musculare is an unbranched, non-cyclic hydrocarbon of considerable length.

To determine the molecular formula of Muscalure, 1.03 grams of the pure pheromone was isolated and then burnt in combustion analysis, yielding 3.24 grams of carbon dioxide and 1.32 grams of water.

a. Is Muscalure an alkane, alkene or alkyne? Explain how you reached your conclusion, showing all working.

3 marks

b. Given that Muscalure has a molecular weight of 322.0 amu, what is its molecular formula?

2 marks

Muscalure is commercially synthesised because the pheromone can be used to lure flies into traps. In the early 1970s, some American chemists proposed a synthesis of Muscalure using erucic acid extracted from rapeseed oil as a starting reagent. Erucic acid is a fatty acid with a similar chemical structure to Muscalure.

c. If a triglyceride made from three erucic acid molecules has a molecular formula of $C_{69}H_{128}O_6$, what is the molecular formula of erucic acid?

3 marks

d. Does erucic acid have any carbon-carbon double bonds? If so, how many?

2 marks

Total 10 marks

Question 3

While completing routine inspections on the bank of a river, the Federal River Protection Agency (FRPA) extracted a mysterious liquid (henceforth referred to as liquid X). It was decided that the unidentifiable liquid posed a possible hazard to the ecosystem, but before investigating its origins, it was important to find out what exactly it was.

The first step taken was to run the liquid through a Thin Layer Chromatography column. The plate was covered with powdered cellulose, the liquid was spotted onto the plate and then the plate was placed into a small amount of non-polar solvent such that the initial solvent level was **below** the spot. A compound called ninhydrin was also added to the mixture. The column was allowed to run for a short amount of time and results were produced.

a. In the case of the thin layer chromatography column, describe the role and likely influence of the following components **in this experiment**

i. Stationary phase

_____

_____

_____

_____

_____

2 marks

ii. Mobile phase

_____

_____

_____

_____

_____

2 marks

iii. Ninhydrin

_____

_____

_____

1 mark

b. What would be the likely effect if the solvent level was higher than the spotted amount of liquid X to begin with?

_____

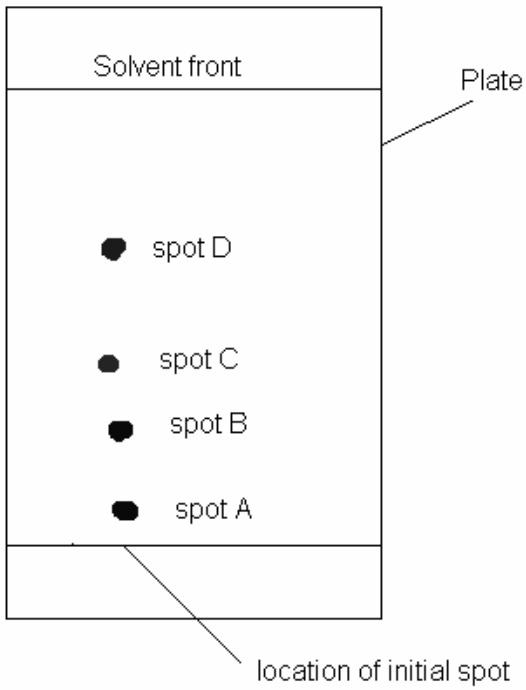
_____

_____

_____

1 mark

c. 1-pentamine has an R_f of 0.40. Comment on the possibility that this compound forms part of liquid X given the observed results below:



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2 marks

Unconvinced that this was all there was to see, The FRPA ordered the production of a high performance liquid chromatograph. This was intended to assist with identification of the components of the liquid.

d. Identify two advantages of HPLC over TLC **specific** to the purpose of identifying the possible danger presented by liquid X.

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2 marks

e. Suggest why specific chemicals (called chemical markers) might be added to some fuels to help in identification.

_____

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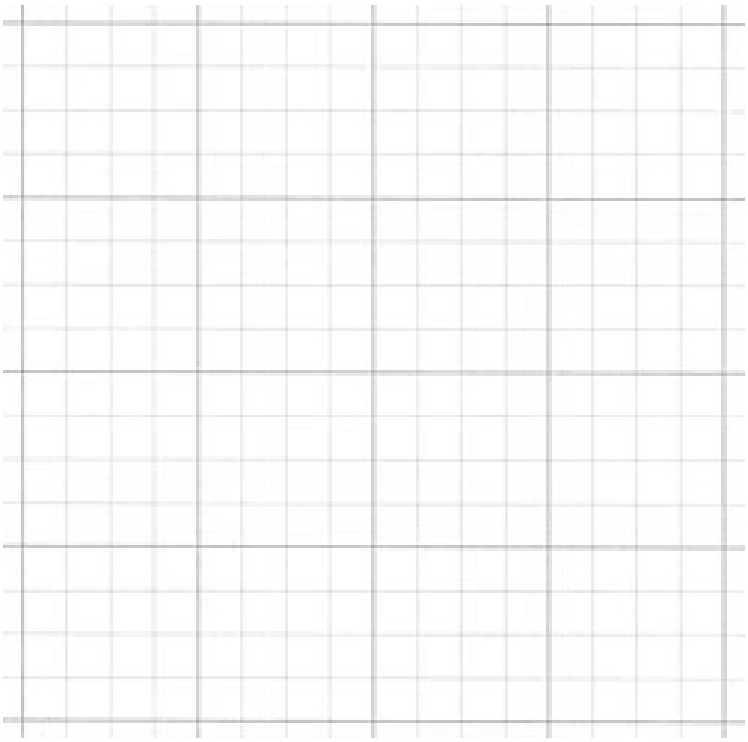
_____

1 mark

The researchers are now strongly convinced that this liquid contains a potentially toxic chemical. This chemical's absorbance of UV light was detected as it passed through the HPLC detector. Then a series of standard solutions were passed under UV light. If the concentration of this chemical exceeds 18 g/L it is considered to be dangerous. The table below shows results:

Concentration	**Absorbance**
Sample	0.67
5 g/L	0.17
10 g/L	0.34
25 g/L	0.84
30 g/L	0.98
35 g/L	0.99
40 g/L	0.99



f. Use the graph grid provided to recommend whether the FRPA should classify liquid X as a health hazard.

_____

2 marks

g. Suggest what could be done to find the exact concentration of this compound, still using UV-visible spectroscopy, if its concentration was above 60 g/L. Include why the current procedure would not suffice.

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_____

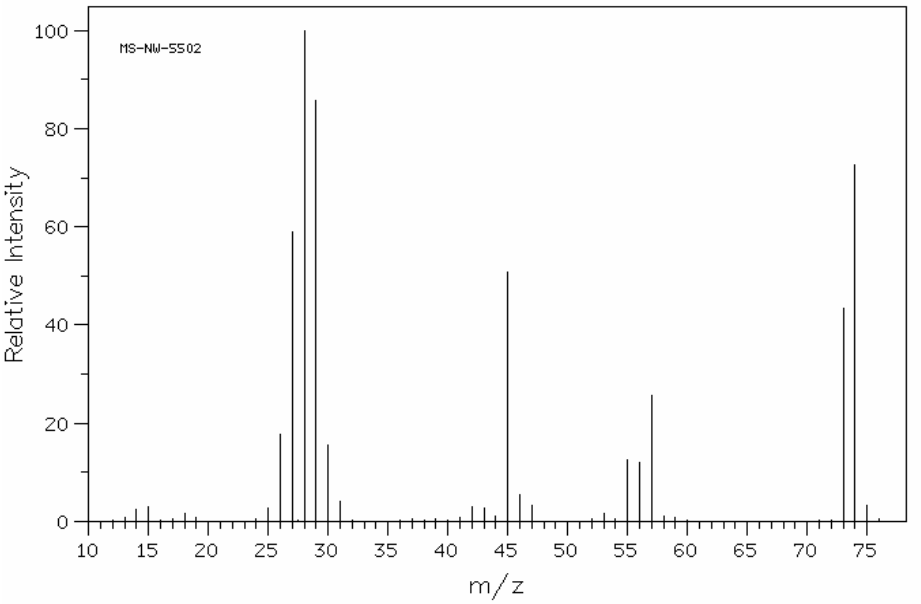
2 marks

Total 15 marks

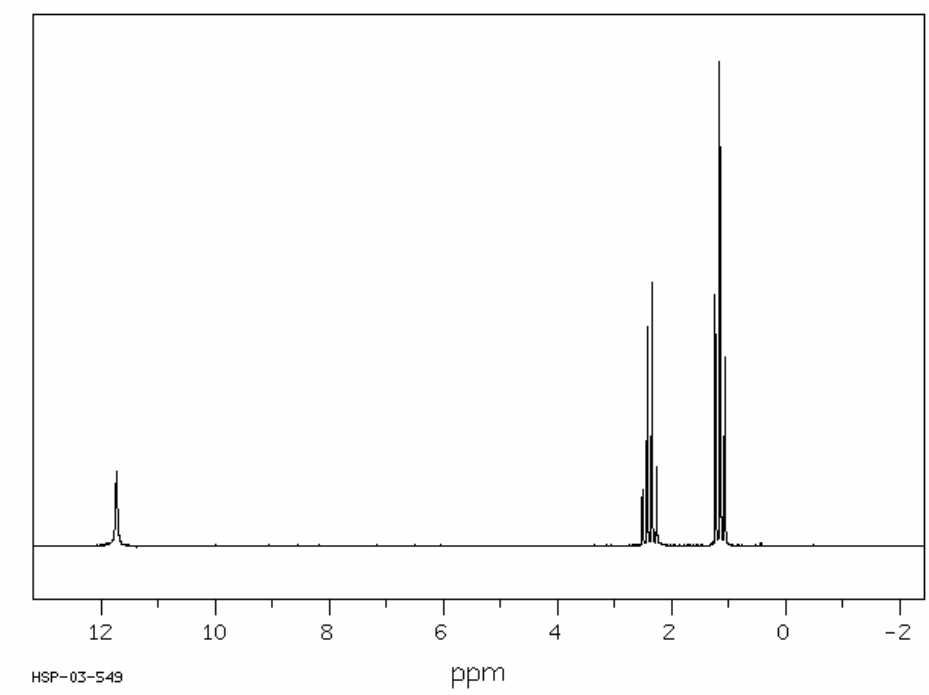
Question 4

IR spectroscopy, ^{1}H NMR and mass spectrometry were used to analyse two unknown compounds, A and B. The relevant spectra are shown below. Both A and B consist only of hydrogen, carbon and oxygen atoms. Additionally, the ^{13}C NMR spectrum of A showed 3 peaks.

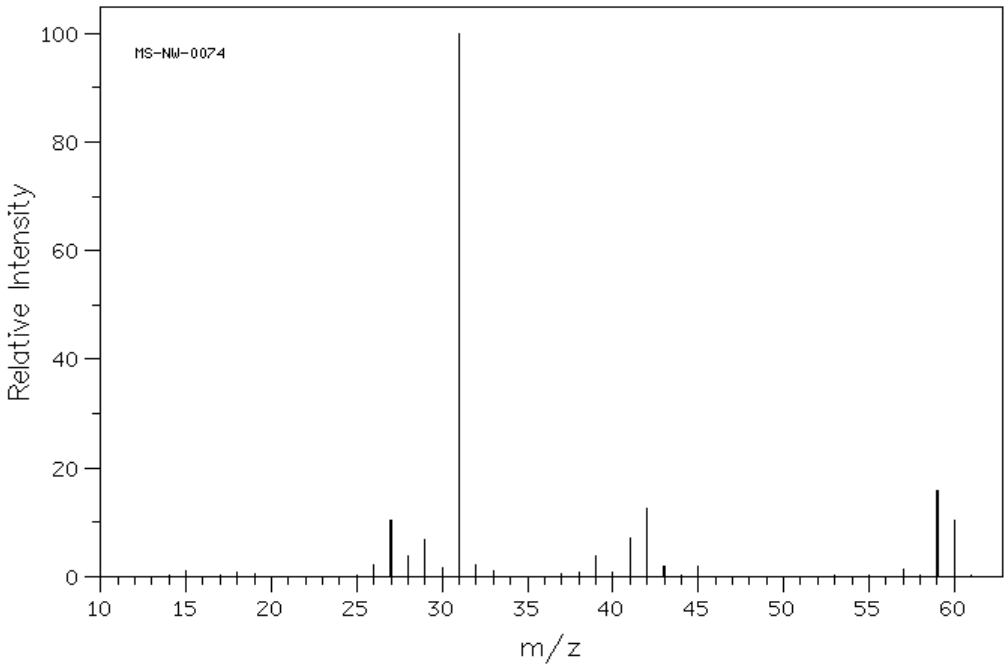
Mass spectrum of A:



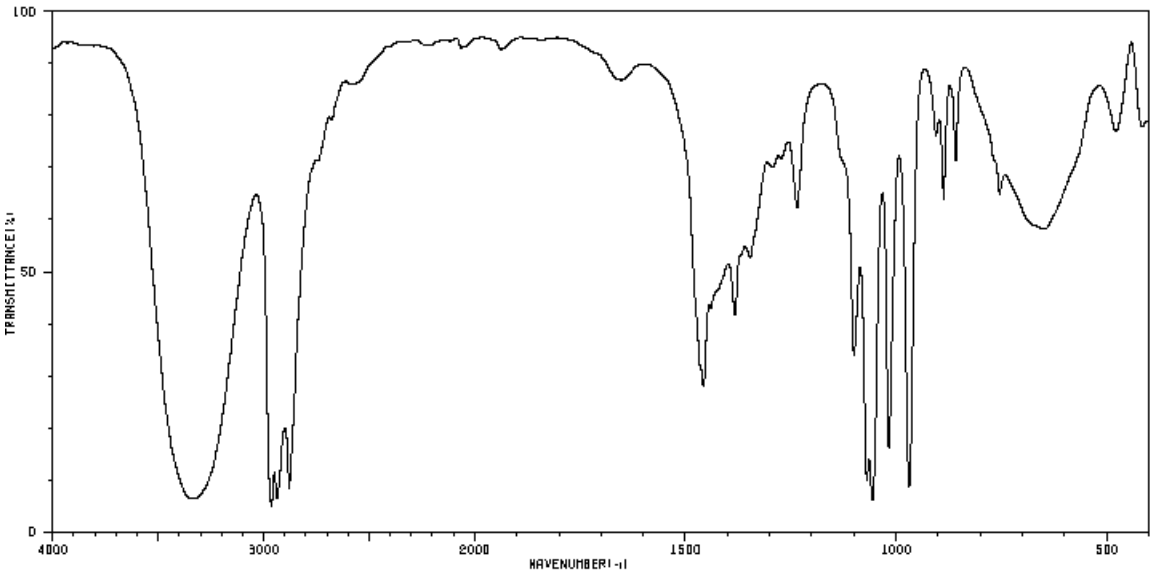
Proton NMR spectrum of A:



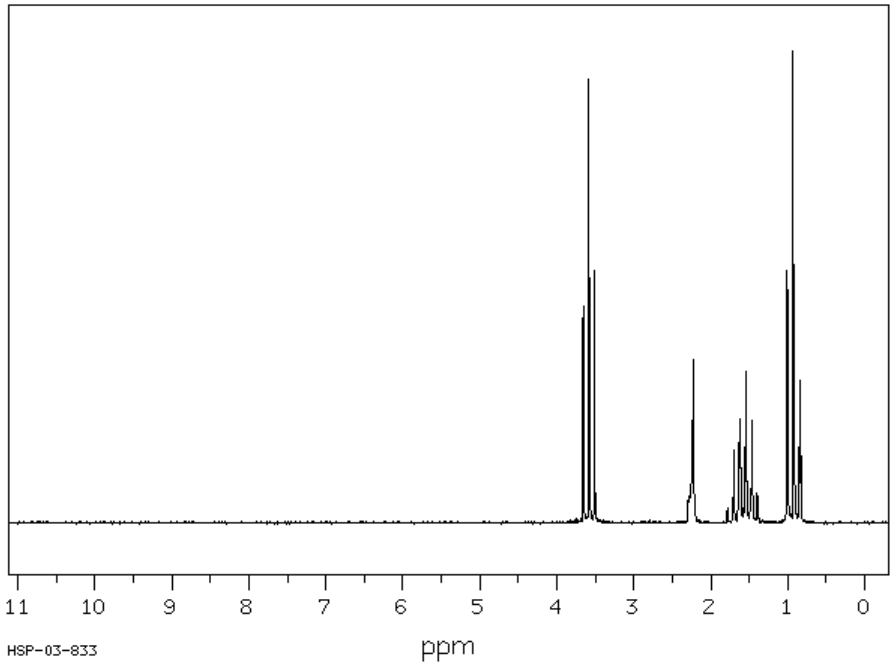
Mass spectrum of B:



IR spectrum of B:



NMR spectrum of B:



a. Draw the structure of A and name the molecule.

3 marks

b. Draw the structure of B and name the molecule.

3 marks

c. Write a balanced equation showing a possible reaction between A and B.

1 mark

Total 7 marks

Question 5

DNA is a polymer of nucleotide monomers joined together by phosphodiester bonds. A nucleotide consists of a nitrogenous base, a sugar residue and a phosphate group.

a. In the space below, draw the deoxyribotrinucleotide with a base sequence of CAT from the 5' end to the 3' end.

3 marks

The total length of all the DNA in a human body is approximately 2×10^{11} km. That this incredible length of DNA is able to fit in our cells is largely due to charged proteins called histones, around which DNA strands wrap.

b. Are histones positively charged or negatively charged? How does their charge relate to its function?

_____

_____

_____

_____

2 marks

Total 5 marks

Question 6

a. Write a balanced chemical equation showing the hydrolysis of the glycosidic bond of sucrose. Indicate in your equation the names of the products.

_____

_____

_____

3 marks

b. Name three polymers of glucose and describe their differences.

_____

_____

_____

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_____

3 marks

c. Write a balanced equation showing the formation of a biodiesel. You may use the symbol R to represent a long hydrocarbon chain.

_____

_____

_____

2 marks

Total 8 marks

END OF QUESTION AND ANSWER BOOKLET