TSSM™
Creating VCE Success

2011 Trial Examination

STUDENT NUMBER

Letter

Figures									
Words									

CHEMISTRY

Unit 3 – Written examination 1

Reading time: 15 minutes
Writing time: 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	8	8	65
			Total 85

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, VCAA approved data book and a 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 16 pages.

Instructions
- Print your name in the space provided on the top of this page.
- All written responses must be in English.

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

SECTION A- Multiple-choice questions

```
                        Instructions for Section A

Answer all questions.
Choose the response that is correct or best answers the question.
A correct answer scores 1, an incorrect answer scores 0.
No mark will be given if more than one answer is completed for any question.
Marks will not be deducted for incorrect answers.
```

Question 1
In a gravimetric analysis of a laundry detergent containing Na_3PO_4, the phosphate ions are precipitated as $Mg_2P_2O_7$. If 0.250 mole of $Mg_2P_2O_7$ precipitate is formed, the detergent contained;

|	no. of mole of Na^+	no. of mole of P atoms	no. of mole of PO_4^{3-} ions
A.	0.125	0.125	0.250
B.	0.250	0.250	0.250
C.	0.500	0.500	0.250
D.	1.50	0.500	0.500

Question 2
20 mL of 0.1 M hydrochloric acid is added to three separate beakers. 5 drops of phenol red is added to the first beaker, 5 drops of methyl orange is added to the second and 5 drops of methyl red is added to the third. Sodium hydroxide is added at the same rate to all three beakers.
A. All three beakers will change colour at the same time
B. The beaker with phenol red will change colour first
C. The beaker with methyl orange will change colour first
D. The beaker with methyl red will change colour first

Question 3
The pH curve for a titration is shown below.
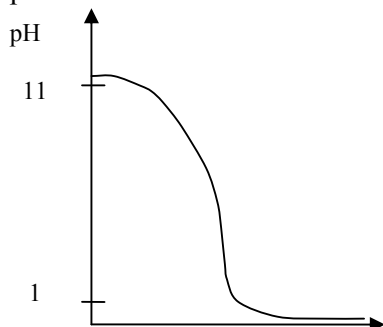
This is most likely to represent a titration between
A. a strong acid and a strong base
B. a strong acid and a weak base
C. a weak acid and a weak base
D. a weak acid and a strong base
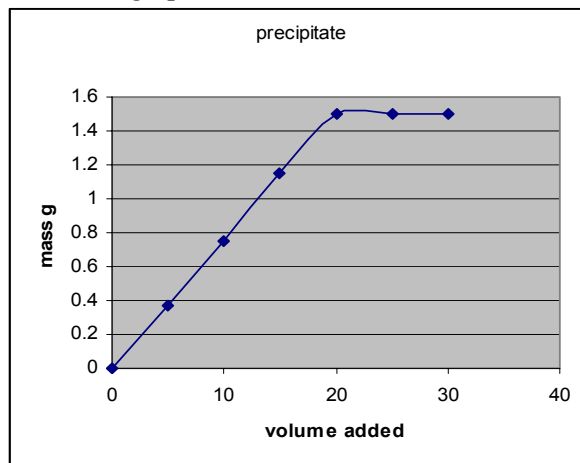
SECTION A - continued

Question 4

A sample of chloromethane is passed through a mass spectrometer. The peak with the highest mass visible on the mass spectrum is likely to have a mass of

A. 15
B. 47
C. 50.5
D. 52

Question 5

Magnesium sulfate solution is added slowly to a solution of barium nitrate. The mass of precipitate formed is shown on the graph below.
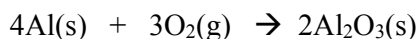

The number of mole of barium nitrate in the original solution is likely to be closest to

A. 0.0064
B. 0.0081
C. 0.090
D. 0.011

Question 6

The equation for the reaction between aluminium and oxygen is

$$4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$$

When 0.520 mole of aluminium reacts with 0.360 mole of the oxygen, the expected number of mole of product is

A. 0.24
B. 0.26
C. 0.38
D. 0.52

Question 7

Sulfuric acid, H_2SO_4 is considered a strong oxidant. Which substance is most likely to be formed in a reaction where sulfuric acid is acting as an oxidant.

A. SO_2
B. SO_3
C. $CuSO_4$
D. $H_2S_2O_7$

SECTION A – continued
TURN OVER

Question 8

A sample of helium gas at 27 °C has a volume of 80 L and a pressure of 4.0 atm. The temperature is increased to 47 °C, and the pressure is held at 4.0 atm. The volume will now be

A. 75 L
B. 85.3 L
C. 110 L
D. 139 L

Question 9

A 2.16 g sample of an oxide of nitrogen is broken down to release nitrogen and oxygen gases. After the oxygen gas is removed, 0.56 g of nitrogen remains. The oxide is likely to be
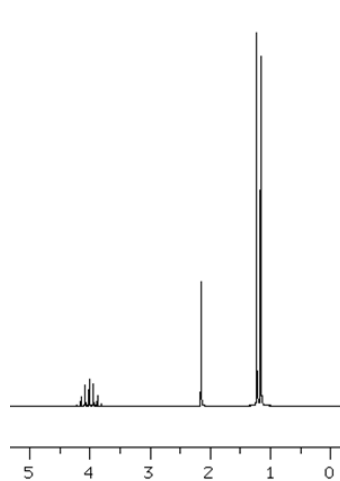
A. NO
B. N_4O
C. NO_2
D. N_2O_5

Question 10

2 mole of ethene is reacted to form ethanol. The mass, in grams, of ethanol formed will be

A. 46
B. 56
C. 92
D. 128

Question 11

The high resolution ^1H NMR spectrum drawn
could belong to

A. 1-propanol
B. 2-propanol
C. propanoic acid
D. propane

Question 12

Fractional distillation is conducted on a mixture of propanol, hexanol and octanol. A small sample of the mixture is also separated using laboratory distillation. Octanol will be the

A. first alcohol emerging from laboratory distillation and the lowest on the fractionating column
B. first alcohol emerging from laboratory distillation and the highest on the fractionating column
C. last alcohol emerging from laboratory distillation and the highest on the fractionating column
D. last alcohol emerging from laboratory distillation and the lowest on the fractionating column

Question 13
Both GC print-outs below refer to the same mixture of three different alcohol molecules.
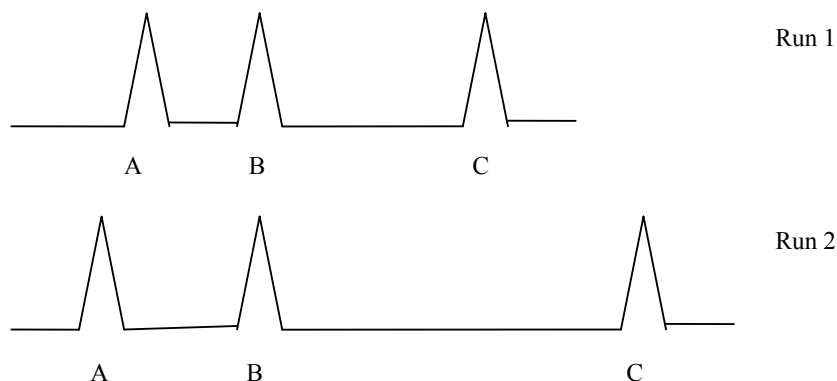
Run 1

Run 2

Compared to Run 1, Run 2 is probably
A. the same column at a higher temperature
B. the same column at a lower temperature
C. the same column with the carrier gas set to a higher flow rate
D. a different column

Question 14
An electron dot diagram of an organic molecule is drawn below.
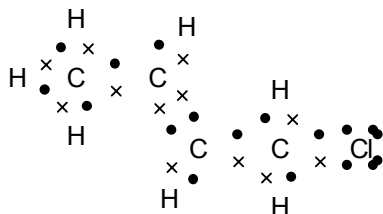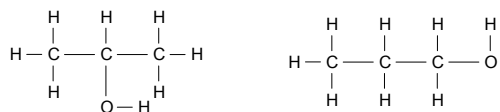

This molecule is
A. 1-chlorobutane
B. 4-chlorobutane
C. 1-chloro-2-butene
D. 4-chloro-2-butene

Question 15
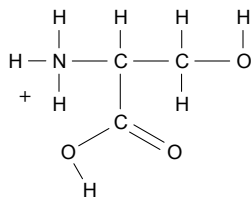Which test would NOT distinguish samples of the two molecules shown?

A. Proton NMR
B. Solubility in water
C. Reaction with $Cr_2O_7{}^{2-}$ in acid conditions
D. The finger print region of an infrared spectrum

SECTION A – continued
TURN OVER

Question 16
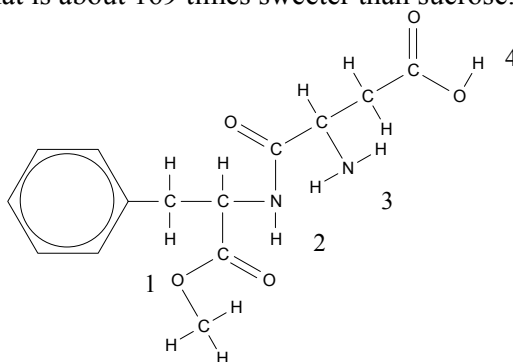The molecule drawn below is

A. serine in acid solution
B. the zwitterion of valine
C. the zwitterion of serine
D. the product of the reaction between ethanoic acid and ammonia

Question 17
The structure of aspartame is shown below. Aspartame, commercially known as Nutrasweet or Equal, is an artificial sweetener that is about 169 times sweeter than sucrose.

The functional groups numbered 1 to 4 in aspartame are
A. ester, amide, amine and carboxyl
B. ester, amine, amine and carboxyl
C. carboxyl, amine, amine and carboxyl
D. ester, amide, amide and ester

Question 18
The correct chemical name of the molecule drawn below is 9,12-octadecadienoic acid.

$CH_3CH_2CH_2CH_2CH_2CH=CHCH_2CH=CHCH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$
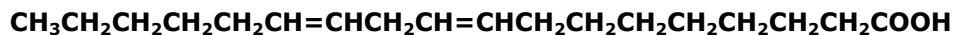
This molecule is better known as
A. linoleic acid
B. linolenic acid
C. palmitic acid
D. biodiesel

SECTION A – continued

Question 19
The base sequence along a strand of DNA is AATTCGG. The number of hydrogen bonds between this strand and its complementary strand will be
A. 7
B. 14
C. 17
D. 21

Question 20
The combined mass of deoxyribose, phosphoric acid and a base molecule is 536. Once the three molecules combine, the mass of the nucleotide will be
A. 268
B. 500
C. 536
D. 572

END OF SECTION A
TURN OVER

SECTION B – Short-answer questions

| **Instructions for Section B** |
| --- |
| Questions must be answered in the spaces provided in this book. |
| 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 workings 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

The concentration of a solution of sodium carbonate, Na_2CO_3 is determined by titration. A 20.0 mL sample is added to a flask and placed under a burette. 35.0 mL of 0.100 M hydrochloric acid is added from the burette and the pH curve for the titration is shown below
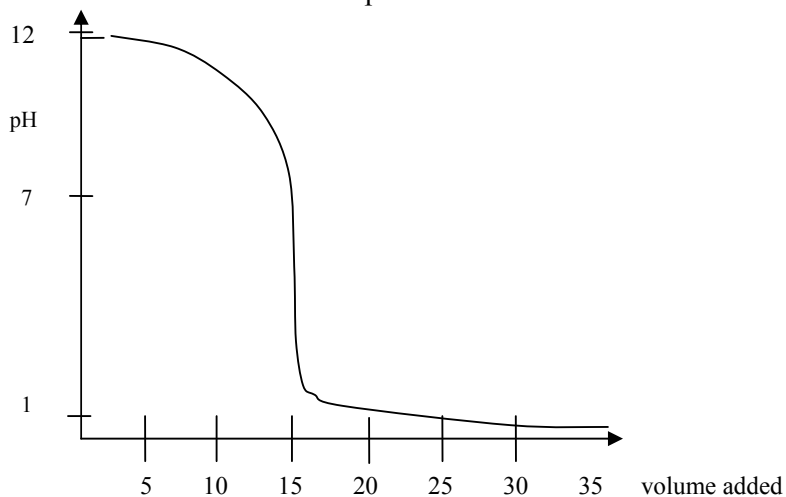
a. Write a balanced equation for the reaction.

_____

2 marks

b. **i.** Read the titre for this titration from the graph _____

   ii. Use the titre value to calculate the concentration of the Na_2CO_3

_____

_____

1 + 2 = 3 marks

SECTION B – **Question 1** - continued

c. **i**. If phenolphthalein had been used as an indicator for this titration, give an estimate of the titre that might have been obtained.

_____

   ii. What concentration of $NaCO_3$ would this titre have led to?

_____

_____

   iii. Comment on the suitability of phenolphthalein for this titration.

_____

_____

$1 + 2 + 1 = 4$ marks

Total 9 marks

Question 2

Students in Unit 3 Chemistry are expected to know limitations of particular analytical techniques and instruments. The table below contains a series of typical analytical tasks. For each task a method of analysis has been chosen that is unlikely to be very suitable. Use the second column of the table to give one important reason why the technique mentioned is not particularly suitable.

Analytical task and technique chosen	Reason the chosen method is unlikely to be suitable
Gravimetric analysis to determine the mass of sodium nitrate in a 100 mL solution of sodium nitrate	
Separation of a mixture of monosaccharides using GC	
Determination of the concentration of an ethanoic acid solution using a titration against sodium carbonate	
Determination of the concentration of ethanol solutions using infrared spectroscopy	

4 marks

Total 4 marks

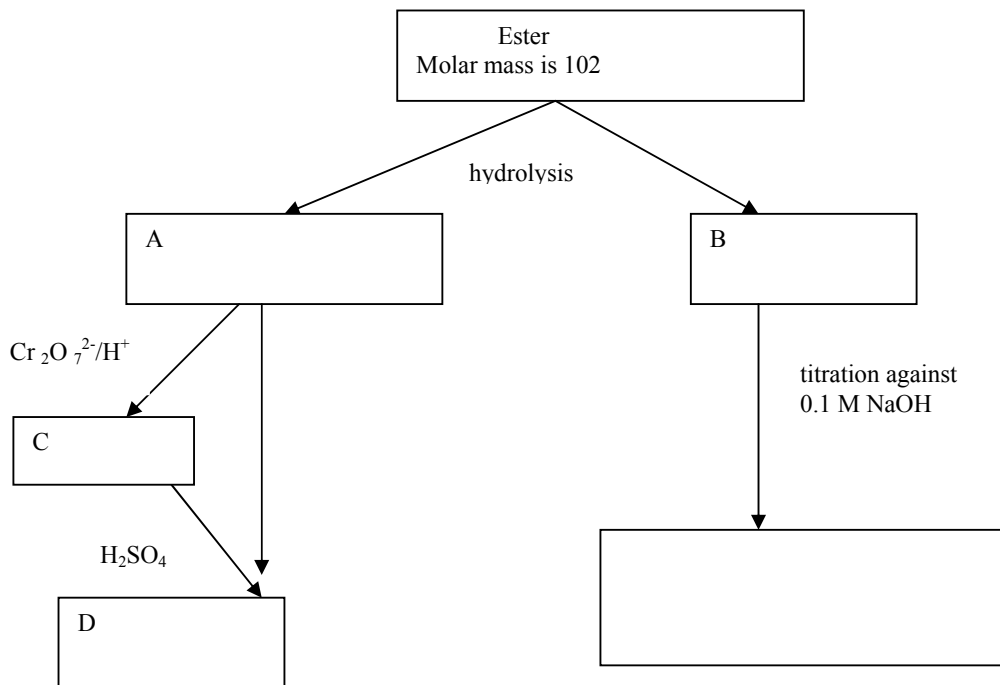**SECTION B** – continued
TURN OVER

Question 3

The flowchart below starts with the hydrolysis of an ester molecule to form two molecules labelled A and B. The molar mass of the ester is 102 g. Substances A and B are separated.

Some of product A is reacted further to form product C.
The remainder of product A is reacted with product C, using sulfuric acid as a catalyst, to form product D
Product B is titrated against 0.100 M sodium hydroxide using phenolphthalein as an indicator.

```
                    ┌─────────────────────┐
                    │       Ester         │
                    │  Molar mass is 102  │
                    └─────────────────────┘
                          hydrolysis
          ┌───────────────┐           ┌───────────────┐
          │  A            │           │  B            │
          └───────────────┘           └───────────────┘
   Cr₂O₇²⁻/H⁺                            titration against
                                        0.1 M NaOH
       ┌───────────────┐
       │  C            │
       └───────────────┘
         H₂SO₄                        ┌───────────────────┐
                                      │                   │
       ┌───────────────┐              │                   │
       │  D            │              └───────────────────┘
       └───────────────┘
```

$Cr_2O_7^{2-}/H^+$

H_2SO_4

a. i. The reaction of compound A to form compound C is an example of _____

ii. Compound D is an example of what type of molecule? _____

1 + 1 = 2 marks

b. i. Compound D contains 6 carbon atoms. Draw a structural diagram of compound D and name it.

Structure   Name _____

ii. Draw a structural diagram of molecule A

2 + 1 = 3 marks

c. Draw a structural diagram of the original ester molecule (shown at the top of the flowchart)

1 mark

SECTION B – Question 3 - continued

d. Draw a structural diagram of molecule B

1 mark

e. **i**. Write a balanced equation for the titration occurring between B and sodium hydroxide.

_____

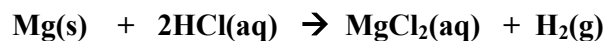**ii**. 20.0 mL of an aqueous solution of molecule B is neutralised by 8.6 mL of the NaOH. Calculate the concentration of the aqueous solution.

_____

_____

1 + 2 = 3 marks

Total 10 marks

Question 4

Magnesium reacts readily in hydrochloric acid. The equation is

$$Mg(s) \; + \; 2HCl(aq) \; \rightarrow \; MgCl_2(aq) \; + \; H_2(g)$$

a. Which of the following reactors could be used to produce the greatest mass of hydrogen gas?

Reactor	Contents
1	20 g of magnesium metal
2	2 L of 0.9 M HCl
3	2 L of HCl of pH 1

_____

2 marks

b. In a separate experiment, 2.0 g of magnesium is added to a beaker containing 200 mL of 1.0 M HCl.

Calculate the final pH of the beaker.

_____

_____

3 marks

c. A sample of magnesium completely reacts in a solution of HCl. The solution formed is placed in an evaporating basin and the water is carefully evaporated away. The contents of the evaporating basin are found to have a mass of 0.44 g.
Calculate the volume of hydrogen gas that was produced during the reaction if the temperature was 40 °C and the pressure 200 kPa.

_____

_____

3 marks

Total 8 marks

Question 5
The empirical formulas of several biomolecules are shown below

A	B	C
CH_2O	$C_3H_7NO_3$	$C_8H_{16}O$
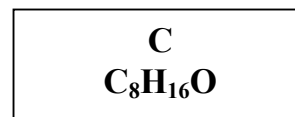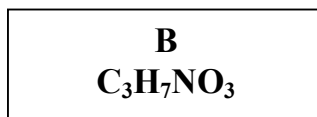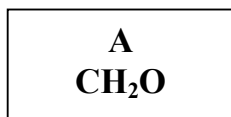
a. Molecule A has a molar mass of 180 g.
  i. What is its molecular formula? _____

  ii. Suggest a possible name for this molecule? _____

  iii. Are there any other biomolecules with this molecular formula? Explain your answer.

  _____

  1 + 1 + 1 = 3 marks

b. Molecule B is an amino acid
  i. Do you think the molecular formula will be the same as the empirical formula? Explain your answer.

  _____

  ii. Draw a structural diagram of Molecule B

  iii. Name Molecule B _____

  1 + 1 + 1 = 3 marks

c. Molecule C is a saturated fatty acid.
   i. Do you think the molecular formula will be the same as the empirical formula? Explain
     your answer.

_____

   ii. Suggest a possible name for Molecule C   _____
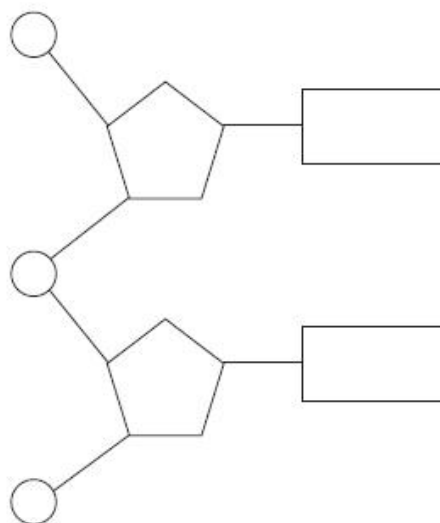
1 + 1 = 2 marks

Total 8 marks

Question 6

The diagram shown is an outline of a
segment of a DNA strand.

a. i. Label each base molecule on
      the sketch with the letter B.

   ii. Label each sugar molecule with the
      letter S.

   iii. Label each phosphate group with
      the letter P.

   iv. Circle one complete nucleotide

1 + 1 + 1 + 1 = 4 marks

b. Another segment of a DNA strand contains two base molecules. The two molecules are
different but both can form triple hydrogen bonds. Name the two base molecules.

_____

2 marks

c. A nucleotide is formed from a sugar with a mass S, a base with a mass B and a phosphate
group with mass P. After the nucleotide forms, what will its mass be, in terms of S, B and P?

_____

1 mark

d. A segment of a DNA molecule is subjected to gel electrophoresis.

    i.   What is the polarity of the plate that the segment moves toward?

_____

    ii.   What factor determines the rate the segment moves at?

_____

<div align="right">

1 + 1 = 2 marks

Total 9 marks

</div>

Question 7

Chemical instruments play an important role in chemical analysis. In the case of organic molecules, instruments can help scientists deduce the structure of an unknown molecule. The instruments are often used in tandem.
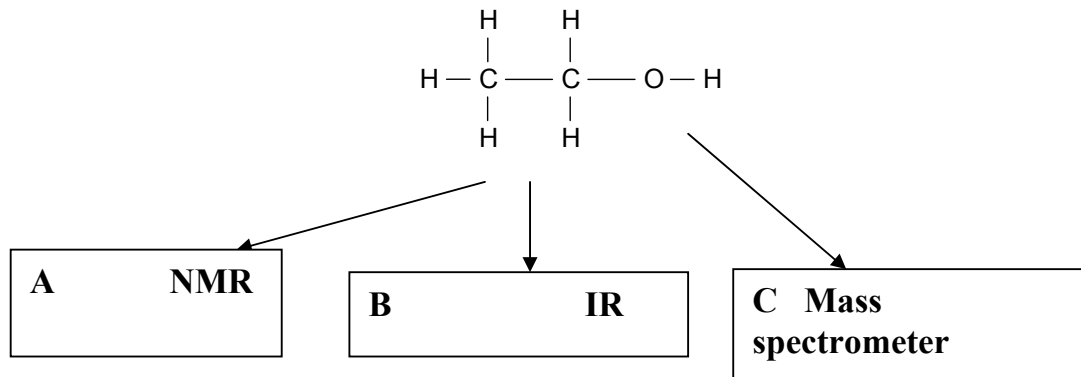
The following questions refer to the testing of ethanol using three different instruments

a. High resolution H NMR is conducted on ethanol.

    i.   How many sets of peaks will there be?   _____

    ii.   What will the ratio of the peak areas be?   _____

    iii.   Describe the splitting that will occur with each peak.

_____

_____

_____

<div align="right">

1 + 1 + 3 = 5 marks

</div>

<div align="right">

SECTION B – Question 7 - continued

</div>

b. A sample of ethanol is passed through an infrared spectrometer.
   i. List two frequencies at which you will expect to see absorption occur and state the bonding present that causes each peak.

   _____

   _____

   ii. The infrared spectrum for ethanol is compared to that of propanol. State one similarity and one difference between the two spectra.

   Similarity _____

   Difference _____

   2 + 2 = 4 marks

c. A mass spectrum of ethanol is obtained.
   i. There is a small peak at 48. Suggest a possible explanation for a peak at this value.
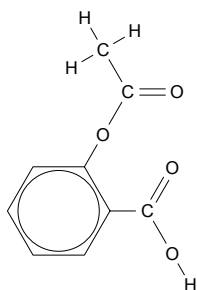
   _____

   ii. Ethanol forms two fragments, one of which is a methyl free radical.
   Draw the other fragment.

   1 + 1 = 2 marks
   Total 11 marks

Question 8

An aspirin molecule is shown below.

Aspirin can also be represented as $CH_3COOC_6H_4COOH$
a. Aspirin is a weak acid. Write a balanced equation for the reaction of aspirin and water.

_____

1 mark

SECTION B – Question 8 - continued
TURN OVER

b. The concentration of an aspirin solution can be determined by titration against dilute sodium hydroxide, NaOH

    i. Write a balanced equation for the reaction of aspirin and NaOH

_____

    ii. The product of this reaction is often used in preference to aspirin. Why is this?

_____

<div align="right">1 + 1 = 2 marks</div>

c. When aspirin solutions are heated with NaOH, hydrolysis of the ester functional group occurs. The products of the hydrolysis are salicylic acid and a carboxylic acid molecule.

    i. Draw structural diagrams of these two products.

    ii. After hydrolysis, the volume of NaOH required to neutralise a set volume of solution is greater than it was before hydrolysis. Explain why this might be.

_____

_____

<div align="right">2 + 1 = 3 marks
Total 6 marks</div>

<div align="center">

END OF QUESTION AND ANSWER BOOK

</div>