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2010 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	7	7	73
			Total 93

- 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 17 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.

Questions 1 and 2 refer to the following information

A 20 mL aliquot of sodium hydroxide solution, NaOH, is added to a flask from a stock solution and it is titrated against 0.66 M sulfuric acid, H_2SO_4. The average titre is 16 mL.

Question 1
Another 20 mL aliquot of NaOH is taken from the same stock solution and is diluted to 100 mL. The volume of 0.66 M sulfuric acid required in the titration this time should be, in mL
A. 3.2
B. 8
C. 16
D. 80

Question 2
Pick the correct statement from the following:
A. The indicator chosen needs to change colour at a low pH because sulfuric acid is diprotic.
B. The number of mole of sodium hydroxide will equal the number of mole of sulfuric acid at the equivalence point.
C. The number of mole of sodium hydroxide will be double that of sulfuric acid at the equivalence point.
D. This titration should not be conducted since neither substance is suitable as a primary standard.

Question 3
722 μg of sodium hydroxide is added to 4.00 mL of water. The concentration of the sodium hydroxide, in M, will be:
A. 0.00451
B. 0.451
C. 0.144
D. 1.44

Question 4
The formula of aluminium oxide is Al_2O_3. When 20.0 g of aluminium reacts with oxygen, the mass of oxide obtained, in g, should be:
A. 30.0
B. 37.7
C. 43.4
D. 75.6

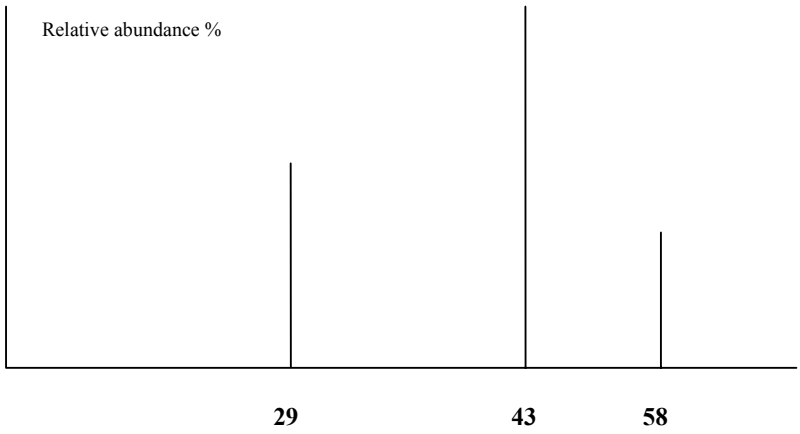
SECTION A - continued

Question 5
Which one of the following represents the greatest mass of hydrogen gas?
A. 5 g of hydrogen gas
B. 2.2 mol of hydrogen gas
C. 30 L of hydrogen gas at STP
D. The hydrogen released when 20 g of magnesium is added to excess hydrochloric acid

Question 6
Barium sulfate is frequently precipitated in gravimetric analysis experiments. This procedure is best used when you want to calculate the:
A. concentration of a barium sulfate solution
B. concentration of a sodium sulfate solution
C. mass of barium sulfate in a solution of barium sulfate
D. concentration of salt in a mineral water solution

Questions 7 and 8 refer to the following information

A simplified mass spectrum for butane is shown below.



Question 7
The mass spectrum for butane shows three peaks. The three peaks correspond to
A. CH_3, CH_3CH_2 and C_4H_{10}
B. $CH_3CH_2^{\cdot}$, $CH_3CH_2CH_2^{\cdot}$ and $C_4H_{10}^{\cdot}$
C. CH_4, CH_3CH_3 and C_4H_{10}
D. $CH_3CH_2^{+}$, $CH_3CH_2CH_2^{+}$ and $C_4H_{10}^{+}$

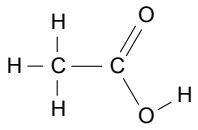
Question 8
The fragment(s) that must have been lost from the molecular ion to form this spectrum would be (Note: electrons are not considered a molecule fragment)
A. CH_3^{+}
B. CH_3^{+}, $CH_3CH_2^{+}$
C. $CH_3^{\cdot}$, $CH_3CH_2^{\cdot}$
D. CH_3^{+},CH_3^{+}

Question 9
In the reaction:

$NH_4^+(aq) + S^{2-}(aq) \rightarrow NH_3(aq) + HS^-(aq)$

A. the S acts as an acid and an oxidant
B. the S acts as a base only
C. the NH_4^+ acts as a base only
D. the NH_4^+ acts as an acid and as a reductant

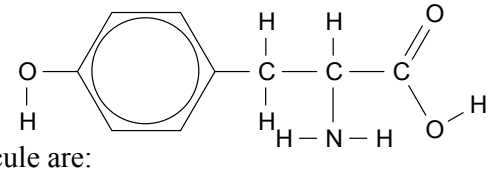
Question 10
The ethanoic acid molecule shown will have:



	^{1}H NMR high resolution	Infrared spectrum cm^{-1}	Mass spectrum
A.	1 peak	2 peaks	3 peaks
B.	2 peaks with no splits	includes a peak at 3000 but no peak at 1700	a base peak at 60
C.	2 peaks with no splits	includes a peak at 3000 and a peak at 1700	includes a peak at 15 and at 45
D.	2 peaks, one a quartet and the other not split	includes a peak at 3000 and a peak at 1700	includes a peak at 15 and at 29

Questions 11 and 12 refer to the following information

Adrenaline is a hormone. The body releases adrenaline when it is subjected to shock or fright. Adrenaline can be prepared synthetically, using tyrosine as a starting point. The structure of tyrosine is drawn below:

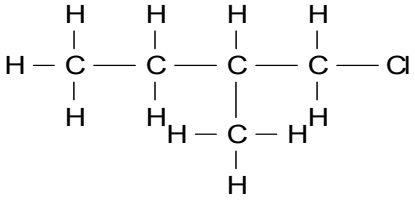


Question 11
The functional groups present in this molecule are:
A. hydroxyl, amine and carboxyl
B. hydroxyl, amide and acid
C. carboxyl, amine and ester
D. ester and amine

Question 12
The molecular formula of tyrosine is:
A. $C_3H_7O_3N$
B. $C_7H_7O_3N$
C. $C_7H_{11}O_3N$
D. $C_9H_{11}O_3N$

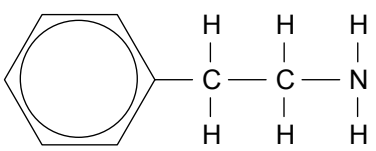
SECTION A - continued

Question 13
The systematic name for the compound drawn is:

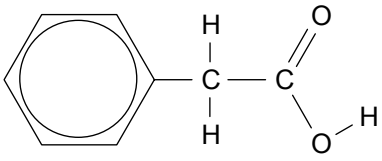


A. 4-chloro-3-methylbutane
B. 3-methyl-4-chlorobutane
C. 1-chloro-2-methylbutane
D. 1-chloro-3-methylpentane

Question 14
Phenylethylamine is a substance found in the brain. A person in love has high levels of this chemical. A person with depression, however, has converted phenyethylamine to phenylacetic acid. The structures of both molecules are shown below.



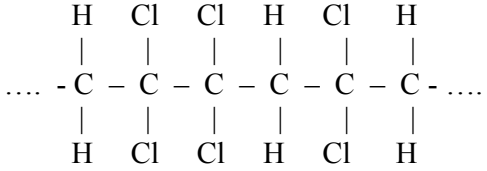
phenylethylamine



phenylacetic acid

The conversion of phenylethylamine to phenylacetic acid occurs in two steps. Possible reagents causing these steps might be:
A. NaOH(aq) then $Cr_2O_7^{2-}/H^+(aq)$
B. $Cr_2O_7^{2-}$ then NaOH
C. Cl_2 then NaOH
D. NaOH then NH_3

Question 15
The monomer used to make the polymer below is:



A. 1,1-dichloroethane
B. 1,1-dichloroethene
C. 1,2-dichloroethane
D. hexachloroethane

SECTION A – continued
TURN OVER

Question 16

hexanol decane pentane hexene methanol

The liquids above are added to a flask and heated in a laboratory distillation experiment. When the liquids are distilled the:

A. ethanol will vaporise before the methanol
B. alkanes will vaporise before the alkenes
C. the order of vaporisation will be alkanes, alkanols then alkenes
D. liquids will vaporise in order of increasing boiling point

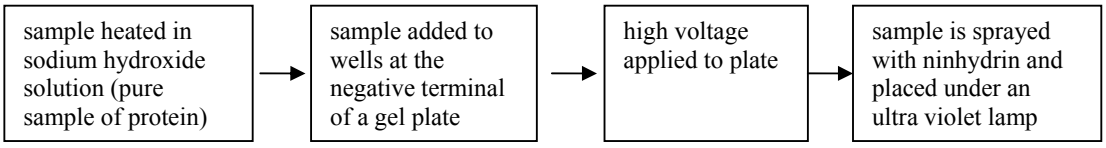
Question 17

Maltose is a disaccharide formed from the reaction between two glucose molecules.
In maltose, the number of hydroxyl and ether functional groups is:

	hydroxyl	**ether**
A.	0	1
B.	2	1
C.	8	1
D.	8	3

Question 18

Gel electrophoresis is used as one of the steps in DNA profiling. This same process of gel electrophoresis can also be used, however, to determine the identity of amino acids present in a sample of protein. When gel electrophoresis is applied to proteins, the following steps are involved;



These steps are performed to

A. cut the protein when a particular amino acid sequence occurs and to separate the fragments
B. hydrolyse the protein, separate the amino acids and make the amino acids visible
C. fragment the protein, separate the proteins and make the amino acids visible
D. hydrolyse the protein, fragment the protein and then separate the amino acids

Question 19

A sample of leucine is added to proline and heated. A series of peptide molecules are formed from the reaction.
The number of different dipeptide molecules possible in the mixture is:

A. 1
B. 2
C. 4
D. 6

SECTION A – continued

Question 20

Ethanol can be formed in biochemical processes from starch. Pick the correct statement about this process from the list below.

A. In fermentation, enzymes in yeast convert glucose and oxygen to ethanol and carbon dioxide
B. Fermentation stops when all glucose has been converted to ethanol.
C. Fermentation involves the distillation of glucose to form ethanol and carbon dioxide.
D. In fermentation, enzymes in yeast convert glucose to ethanol in anaerobic conditions.

END OF SECTION A
TURN OVER

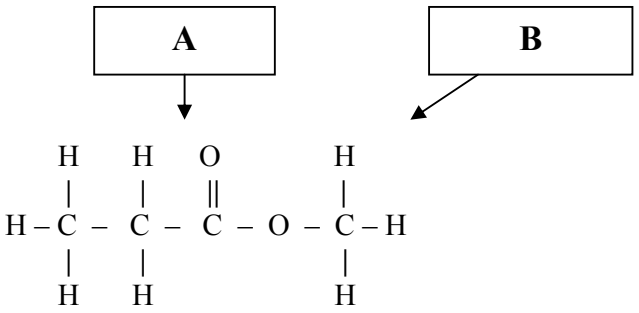
SECTION B – Short-answer questions

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



a. Give a systematic name for the molecule shown. _____

1 mark

b. The molecule drawn above can be produced from two smaller molecules, shown as A and B.

i. Draw molecule A, showing all bonds. Name it.

Name: _____

ii. Draw molecule B, showing all bonds. Name it.

Name: _____

2 + 2 = 4 marks

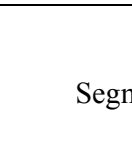
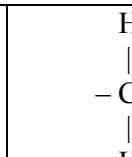
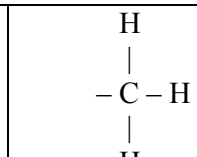
SECTION B - continued

c. The molecule in **part a** is subjected to ^{1}H NMR. It has three peaks, caused by each of the segments shown in the table below.

i. Use the first row of the table to give the ratio of the areas of each peak.

ii. Use the second row to state the number of hydrogen atoms on neighbouring atoms.

iii. Use the third row to give the number of splits each peak would have in high resolution NMR.

Segment			
Area			
Number of hydrogen atoms on neighbouring atoms			
Number of splits			

1 + 1 + 1 = 3 marks

d. The ester in **part a** is one of the esters usually present in red wine. It is the presence of these esters that wine connoisseurs are able to detect when they are wine tasting.

i. Describe how the identities of a mixture of esters can be determined using gas chromatography.

_____

_____

_____

ii. Describe how the concentration of one particular ester could be determined quantitatively using gas chromatography.

_____

_____

2 + 2 = 4 marks

Total 12 marks

SECTION B - continued

TURN OVER

Question 2

A hydrocarbon molecule, X reacts with chlorine gas to form a dichloroalkane compound. There is no other product formed.

compound X + chlorine gas → dichloroalkane

When 1.00 g of chlorine gas is consumed, the product weighs 1.59 g.

a. What type of reaction has occurred between X and chlorine? _____

1 mark

b. Compound X is either ethene or propene.
Determine which it is. Show your working.

_____

_____

_____

_____

_____

3 marks

c. **i**. Draw the chloroalkane molecule showing all bonds.

ii. Name the molecule _____

iii. Will the product formed contain structural isomers? Explain your answer.

_____

_____

1 + 1 + 1 = 3 marks

d. **i.** What is the molecular formula of the chloroalkane molecule? _____

ii. Draw any other possible molecules with the same molecular formula.

1 + 3 = 4 marks
Total 11 marks
SECTION B - continued

Question 3

An α-amino acid has the molecular formula $C_3H_7NO_3$.

a. **i**. Draw the amino acid, showing all bonds:

ii. Name the amino acid: _____

iii. Name all functional groups in the amino acid.

_____

1 + 1 + 1 = 3 marks

At a particular pH, the amino acid can exist as its zwitterion.

b. Draw the structure of the zwitterion.

2 marks

The amino acid above can react with the amino acid alanine.

c. **i**. Draw the structure of one of the dipeptides that can form from this reaction.

ii. Circle the peptide link in the dipeptide you have drawn in **part i** above.

1 + 1 = 2 marks
Total 7 marks

SECTION B – continued
TURN OVER

Question 4

One method used to determine the concentration of iron, Fe^{2+}, solutions is to convert the Fe^{2+} solutions to Fe^{3+} in a redox reaction. Strong oxidants like $Cr_2O_7^{2-}$ can be used to oxidise the Fe^{2+} solutions.
The incomplete half equation for the dichromate ions in this reaction is

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$$

Dichromate ions, $Cr_2O_7^{2-}$ are orange in colour, while Cr^{3+} is green.

a. **i**. What is the oxidation state of chromium in $Cr_2O_7^{2-}$? _____

ii. How many electrons are required in the conversion of $Cr_2O_7^{2-}$ to $2Cr^{3+}$? _____

iii. Is the $Cr_2O_7^{2-}$ losing or gaining electrons in this reaction? _____

iv. Is this process oxidation or reduction? _____

v. Complete the unbalanced half equation for the conversion of $Cr_2O_7^{2-}$ to Cr^{3+}, in acid conditions.

_____

1 + 1 + 1 + 1 + = 5 marks

b. The Fe^{2+} solution is titrated from a burette into a sample of $Cr_2O_7^{2-}$ solution.

i. How will you know when the reaction is complete?

_____

ii. How many Fe^{2+} ions will react with 5400 $Cr_2O_7^{2-}$ ions?

_____

1 + 1 = 2 marks

The progress of the above reaction can also be monitored using UV-visible spectroscopy.
The UV spectrometer is set to a wavelength that corresponds to blue light. The absorption of the solution is tested after the addition of each mL of Fe^{2+} solution from the burette.

c. **i**. Why was blue light selected?

_____

ii. What shape will the absorption curve take as the titration progresses? Explain your answer.

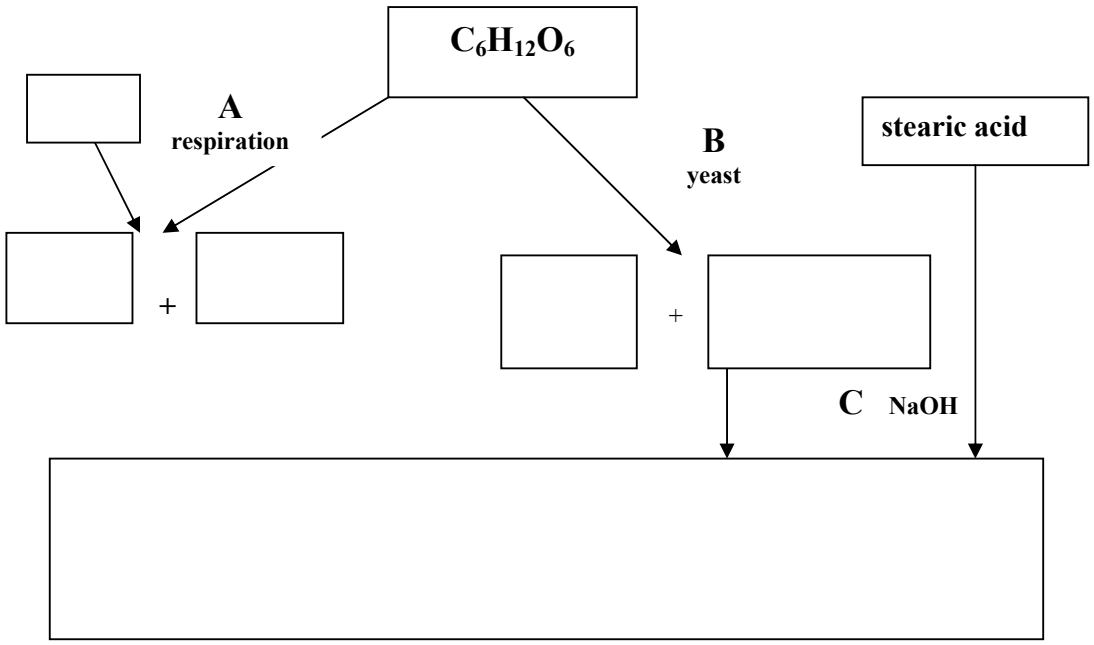
_____

_____

1 + 2 = 3 marks
Total 10 marks
SECTION B - continued

Question 5

Glucose has a molecular formula $C_6H_{12}O_6$. The flowchart below refers to reactions of glucose.



a. Process A is respiration.

i. Write the chemical formulas of the molecules produced by respiration in the boxes on the flowcharts.

ii. Use the box provided to name the other reactant required for respiration.

2 + 1 = 3 marks

b. Process B is the reaction of glucose and yeast in the absence of air.

i. Write a balanced chemical reaction for process B.

_____

ii. Draw the molecules produced by process B in the two boxes provided. Show all bonds.

iii. What is the role of yeast in this reaction?

_____

SECTION B – continued
TURN OVER

iv. If the reacting mixture in process B is heated over 60 °C, the reaction stops. Why do you think this might happen?

_____

1 + 2 + 1 + 1 = 5 marks

c. **i**. One of the products of process B can react with stearic acid to form a biodiesel molecule. This is shown on the diagram as reaction C.
Use the large box provided in the diagram on the previous page to draw this large biodiesel molecule. Show all bonds.

ii. What does the term biochemical fuel mean?

_____

iii. What mass of biodiesel could be formed from 100 kg of stearic acid?

_____

_____

_____

_____

1 + 1 + 2 = 4 marks
Total 12 marks

SECTION B - continued

Question 6

Magnesium fluoride, MgF_2 can be used as an alternative source of fluoride ions in toothpaste. 200 mL of 0.05 M MgF_2 solution is prepared for a trial toothpaste.
A 10.0 mL sample is taken from this solution.

a. Fill in the concentrations, in M, of each of the species in the table in this sample

	MgF_2	**Mg^{2+}**	**F^-**
concentration, M			

1 + 1 + 1 = 3 marks

b. **i**. Calculate the concentration of F^- ions, in **g L^{-1}**, in the 10.0 mL sample.

_____

_____

ii. Calculate the mass of F^- ions, in **mg**, in the 10.0 mL sample.

_____

1 + 1 = 2 marks

c. A second sample is poured from the original 200 mL solution. The mass of F^- ions in this new sample is 0.0020 g.
What is the volume of the sample?

_____

_____

1 mark

d. A third sample is found to contain 2.34×10^{20} F^- ions.
How many mole of Mg^{2+} ions will this solution contain?

_____

_____

2 marks
Total 8 marks

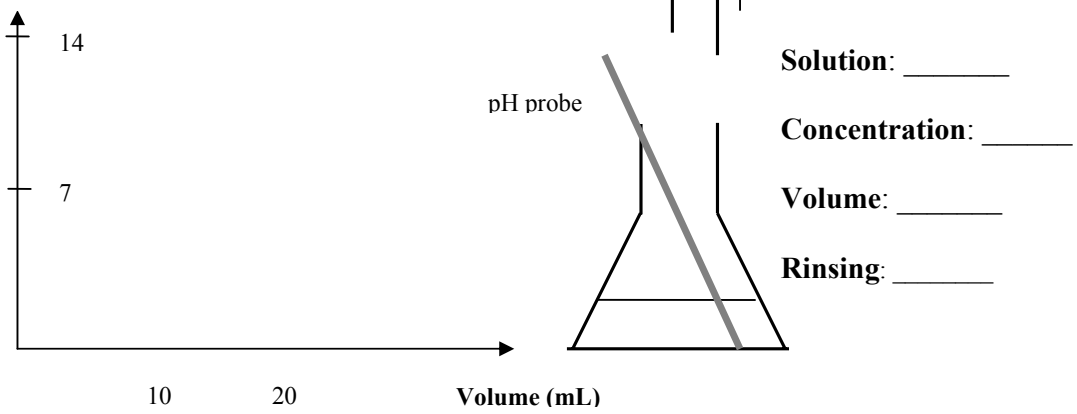
SECTION B - continued
TURN OVER

Question 7

To determine the concentration of a solution of sulfuric acid, a student titrates the sulfuric acid against a 0.200 M sodium hydroxide solution. 20.00 mL aliquots of sodium hydroxide are used.

The average titre is 20.00 mL.

A pH probe has been placed in the flask.



a. Write a balanced chemical equation for the titration reaction occurring.

_____

1 mark

b. Use the spaces provided on the diagram to indicate:

i. the chemical formula of the solution to go in the burette.

ii. what the burette should be rinsed with.

1 mark

c. Use the spaces provided on the diagram to indicate:

i. the chemical formula of the solution in the flask.

ii. the volume of solution in the flask, in L.

iii. the concentration of the solution in the flask.

iv. what the flask should be rinsed with.

½ + ½ + ½ + ½ = 2 marks

SECTION B – continued

d. **i**. Use the pH curve axes provided to draw in the pH of the flask as the titration runs.

ii. About what pH will the equivalence point occur? _____

iii. Suggest a suitable indicator for the titration: _____

1 + 1 + 1 = 3 marks

e. **i**. If the average titre is 20.00 mL, will the concentration of the sulfuric acid be equal to that of the sodium hydroxide? Explain your answer.

_____

_____

ii. The 20.00 mL aliquot of sodium hydroxide has been added to the flask. An extra 40.00 mL of distilled water is now added to the flask. What will the impact on the average titre be of adding the extra water? Explain your answer.

_____

_____

iii. Ammonia is a weak base. If the 0.200 M sodium hydroxide solution is replaced with 0.200 M ammonia, NH_3 solution, will the average titre change? Explain your answer.

_____

_____

2 + 2 + 2 = 6 marks

Total 13 marks

END OF QUESTION AND ANSWER BOOK