



# Year 12 Chemistry Trial Examination 2011

## TIME ALLOWED FOR THIS PAPER

Reading time before commencing work: Ten minutes  
Working time for the paper: Three hours

## MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER

*To be provided by the candidate*

Pens, pencils, calculator satisfying the conditions set by Curriculum Council.

*To be provided by the supervisor*

This Question/Answer Booklet; Multiple-choice Answer Sheet; Chemistry Data Sheet.

Section 1		Section 2			Section 3			Totals		
Mark	Out of	Q	Mark	Out of	Q	Mark	Out of		Mark	Out of
	25	26		6	38		13	Section 1		50
		27		3	39		20	Section 2		70
		28		6	40		21	Section 3		80
		29		6	41		15	Total		200
		30		6	42		11			
		31		8				<b>Total</b>		<b>%</b>
		32		10						
		33		5						
		34		3						
		35		7						
		36		6						
		37		4						
		Total		70	Total		80			

## STRUCTURE OF THE PAPER

Section	Format	No. of questions set	No. of questions to be attempted	Recommend time (minutes)	Marks Allocated	Marks
1	Multiple Choice	25	ALL	50	25	25%
2	Short Answer	12	ALL	60	70	35%
3	Extended Response	5	ALL	70	80	40%

### Instructions to candidates

1. Answer the questions according to the following instructions

**Section 1:** Answer all questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through the square and shade a new answer. Do not erase or use correction fluid. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any one question.

**Section 2 and 3:** Write answers in the Question/ Answer Booklet.

2. When calculating numerical answers, show your working or reasoning clearly unless instructed otherwise
3. You must be careful to confine your answers to the specific question asked and to follow instructions that are specific to a particular question.
4. Spare pages are included at the end of the booklet. They can be used for planning your responses and/ or as additional space if required to continue an answer.
  - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
  - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where an answer is to be continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

**Section 1: Multiple-choice****25% [25 Marks]**

This section has **25** questions. Answer **all** questions on the Multiple-choice Answer Sheet provided. Use only blue or black pen to shade the boxes. If you make a mistake, place a cross through that square. Do not erase or use correction fluid. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is given for any question.

Suggested working time for this section is 50 minutes.

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1. Which of the following has a different number of electrons to the other three?
- A.  $O_3$
  - B.  $Sc^{3+}$
  - C.  $C_2H_6$
  - D.  $CH_3F$

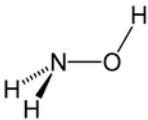
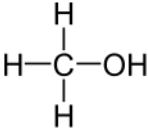
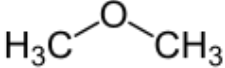
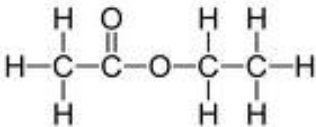
Questions 2 and 3 refer to the following set of successive ionisation energies of the four elements W,X,Y and Z

Ionisation energy kJmol <sup>-1</sup>	1	2	3	4	5	6	7	8	9
W	494	4560	6940	9540	13400	16600	20100	25600	28900
X	2080	3950	6150	9290	12100	15200	20000	23000	115000
Y	519	7300	11800						
Z	1090	2350	4610	6220	37800	47000			

2. Two of these four elements are in the same group of the periodic table. Which one is lower down in the group?
- A. Element W
  - B. Element X
  - C. Element Y
  - D. Element Z
3. Which of the following would most likely have the lowest melting point?
- A. Element Y
  - B. Element X
  - C. Element Z

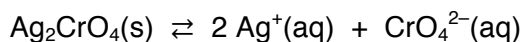
## D. The oxide of W

Questions 4 and 5 refer to the following four substances.

	Name	Structure
I	hydroxylamine	
II	methanol	
III	methoxymethane	
IV	ethyl ethanoate	

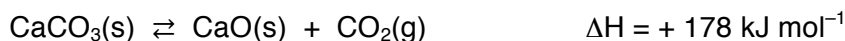
4. In which of the above substances would you expect hydrogen bonding to be present between their molecules?
- A. All of them  
 B. I, II and III  
 C. I and II  
 D. II and IV
5. Which is the only one of the above molecules that has a trigonal planar arrangement of atoms around one of the atoms in the molecule?
- A. hydroxylamine  
 B. methanol  
 C. methoxymethane  
 D. ethyl ethanoate
6. Consider the reaction between 1.00 g of lithium carbonate powder and 100 mL of 0.200 molL<sup>-1</sup> ethanoic acid. Which of the following changes would result in an increase in the initial rate of reaction?
- A. Change the lithium carbonate powder to a single lump.  
 B. Change from ethanoic acid to hydrochloric acid.  
 C. Change from 100mL of ethanoic acid to 200mL of ethanoic acid.  
 D. Increase the pressure.

7. When solid silver chromate is added to water, the following equilibrium is established:



A small quantity of soluble **sodium chromate** solid is added to the solution. Assuming there is no change in the volume of the system, which of the following statements is correct?

- A. The concentration of  $\text{CrO}_4^{2-}(\text{aq})$  will increase and the concentration of  $\text{Ag}^+(\text{aq})$  will not change.
- B. The concentration of  $\text{CrO}_4^{2-}(\text{aq})$  will decrease and the concentration of  $\text{Ag}^+(\text{aq})$  will increase.
- C. The concentration of  $\text{CrO}_4^{2-}(\text{aq})$  will increase and the concentration of  $\text{Ag}^+(\text{aq})$  will decrease.
- D. The concentration of  $\text{CrO}_4^{2-}(\text{aq})$  and  $\text{Ag}^+(\text{aq})$  will not change.
8. If solid calcium carbonate is heated in a sealed container, the following equilibrium is established at 500°C and 600 kPa pressure:



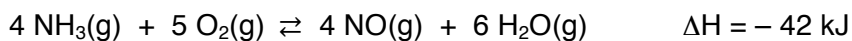
Now consider the following actions:

- I Add more  $\text{CO}_2(\text{g})$  to the system
- II Add more  $\text{CaCO}_3$  to the system
- III Decrease the volume of the system
- IV Increase the temperature of the system

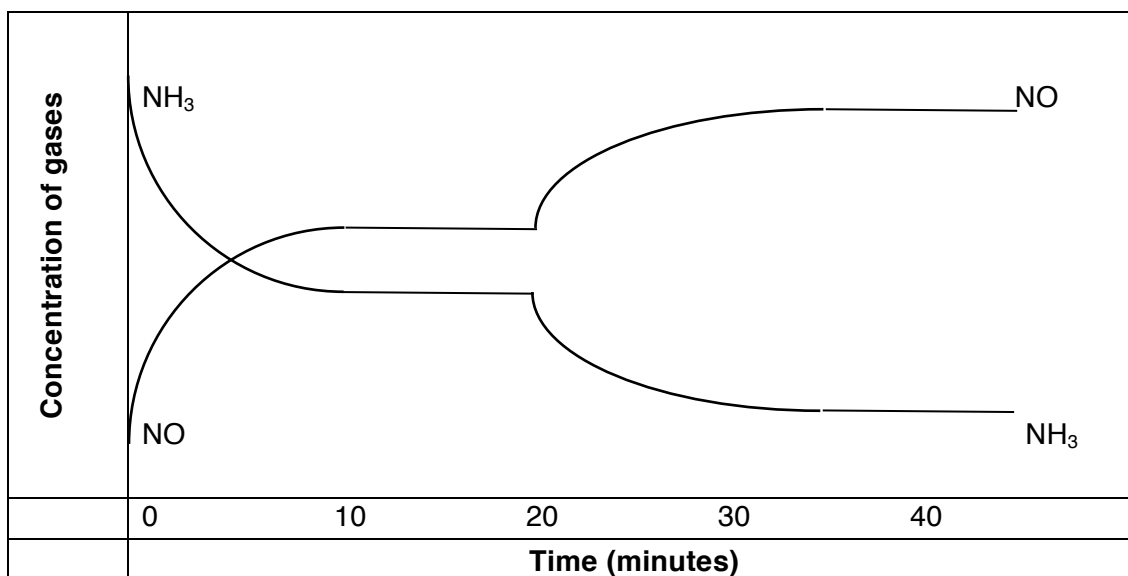
One or more of these actions lead to a change in  $\text{CO}_2(\text{g})$  concentration (after equilibrium is re-established). Which statement below is true?

- A. All actions lead to a change in  $\text{CO}_2(\text{g})$  concentration
- B. Only II, III and IV lead to a change in  $\text{CO}_2(\text{g})$  concentration
- C. Only III and IV lead to a change in  $\text{CO}_2(\text{g})$  concentration
- D. Only IV leads to a change in  $\text{CO}_2(\text{g})$  concentration

Questions 9 and 10 refer to the following equilibrium reaction;



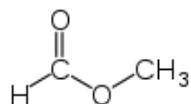
The graph below represents changes in the concentrations of  $\text{NH}_3$  and  $\text{NO}$  over time:



9. At the 20 minute mark, what changes could have been made to the system to produce the effect shown by the graph?
- The temperature of the system is decreased
  - More  $\text{O}_2$  gas is added
  - Some  $\text{H}_2\text{O}(\text{g})$  is removed
  - The volume of the container is decreased
- I, II and III
  - II, III and IV
  - I, III and IV
  - I, II and IV
10. During the time between 20 and 30 minutes, which of the following statements is true about the forward reaction?
- It is faster than the backwards reaction and is slowing down.

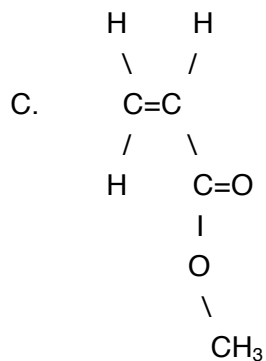
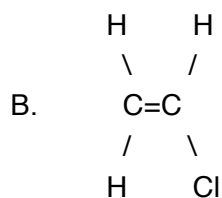


14. Which substances could be reacted together to form this compound?



- A. methanol and acidified potassium dichromate  
 B. methanal and acidified potassium permanganate  
 C. methanoic acid and methanol  
 D. ethyl methanoate and methanol
15. Which of the following reactants are capable of forming a condensation polymer under suitable conditions?

- A.  $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$



- D.  $\text{HOOC}(\text{CH}_2)_7\text{COOH}$  and  $\text{HOOC}(\text{CH}_2)_3\text{COOH}$



16. Which of the following statements is true?
- A. The pH of  $0.100 \text{ molL}^{-1}$  hydrochloric acid is the same as  $0.100 \text{ molL}^{-1}$  ethanoic acid.
  - B. Weak acids and weak bases do not react with each other.
  - C. Water can act as an acid and a base.
  - D. Ammonia is a better proton donor than acceptor.
17. A dilute solution of ammonia (in the conical flask) was titrated against hydrochloric acid (in the burette) using phenolphthalein as the indicator. Which of the following statements is true?
- A. The end point occurs before the equivalence point.
  - B. The end point occurs at the equivalence point.
  - C. The end point occurs after the equivalence point.
  - D. There is no end point because the wrong indicator is being used.
18. When the pH of a solution changes from 9 to 12 the
- A. hydroxide ion concentration increases by a factor of 3.
  - B. hydrogen ion concentration increases by a factor of 3.
  - C. hydroxide ion concentration decreases by a factor of 1000.
  - D. hydrogen ion concentration decreases by a factor of 1000.
19. Consider the equation:  $\text{HSO}_4^-(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons \text{SO}_4^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l})$   
The Brønsted-Lowry acids in this equation are:

- A.  $\text{HSO}_4^-(\text{aq})$  and  $\text{SO}_4^{2-}(\text{aq})$
- B.  $\text{OH}^-(\text{aq})$  and  $\text{SO}_4^{2-}(\text{aq})$
- C.  $\text{OH}^-(\text{aq})$  and  $\text{H}_2\text{O}(\text{l})$
- D.  $\text{HSO}_4^-(\text{aq})$  and  $\text{H}_2\text{O}(\text{l})$

20. A chemist measures the pH of four  $1.00 \times 10^{-2} \text{ mol L}^{-1}$  acid solutions, and obtains the following results. Which experimental result must be incorrect?

Experiment	Solution	pH
A.	$\text{CH}_3\text{COOH}$	3.4
B.	$\text{H}_3\text{PO}_4$	2.2
C.	$\text{HNO}_3$	2.0
D.	$\text{H}_2\text{SO}_4$	1.4

21. An ore of titanium is  $\text{Na}_2\text{TiO}_3$ . The ore was dissolved in sulfuric acid and was then oxidised with  $\text{KMnO}_4$  solution. The titanium in the final solution could be present as:

- A.  $\text{Ti}^{4+}$
- B.  $\text{Ti}^{3+}$
- C.  $\text{Ti}^{5+}$
- D.  $\text{Ti}$

22. Which of the following are redox reactions?

- I. The reaction of magnesium metal with hydrochloric acid
- II. The reaction of magnesium metal with oxygen
- III. The reaction of magnesium oxide and hydrochloric acid
- IV. The reaction of magnesium carbonate with hydrochloric acid

- A. I, II and III
- B. I, II and IV
- C. I and II
- D. II only

23. A metal X in a solution of its ions was connected up to a  $\text{Fe}/\text{Fe}^{2+}(\text{aq})$  half cell and the resultant voltage was recorded. A value of 1.94 V was obtained. Which is a possible identity of metal X?
- A. Al  
B. Au  
C. Na  
D. Ag
24. When using acidified potassium permanganate, the acid used is sulfuric acid rather than hydrochloric acid. The reason for this is:
- A. Sulfuric acid is diprotic and hence gives a higher concentration of hydrogen ions.  
B. The chloride ions in hydrochloric acid are likely to form a precipitate with other ions in the redox titration.  
C. Acidified permanganate ions can oxidise the chloride ions in the hydrochloric acid to chlorine.  
D. Sulfuric acid is a primary standard whilst hydrochloric acid is not.
25. Disproportionation reactions are ones in which an element is both oxidised and reduced. Which of the following are disproportionation reactions?
- I.  $2 \text{H}_2\text{O}_2 \rightarrow 2 \text{H}_2\text{O} + \text{O}_2$   
II.  $2 \text{Cu}^+ \rightarrow \text{Cu} + \text{Cu}^{2+}$   
III.  $2 \text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3 + \text{HNO}_2$   
IV.  $3 \text{Br}_2 + 3 \text{H}_2\text{O} \rightarrow \text{BrO}_3^- + 5 \text{Br}^- + 6 \text{H}^+$
- A. I, II and III  
B. II, III and IV  
C. I, II and IV  
D. All of them

**END OF SECTION ONE**



**Section 2: Short Answer****35% [70 marks]**

This section has **12** questions. Answer all questions. Write your answers in the space provided.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page
- Continuing an answer. If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time for this section is 60 minutes.

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**Question 26****[6 marks]**

Write equations for the reaction that occurs in each of the following procedures.  
If no reaction occurs, write 'no reaction'.

In each case describe what you would observe, including any

- colour change
- odour
- precipitate (give the colour)
- Gas evolutions (state the colour or describe as colourless)

If a reaction occurs but the change is not observable, you should state this.

(a) 1 mol L<sup>-1</sup> iron (III) nitrate solution is added to a 1 mol L<sup>-1</sup> sodium iodide solution.

**[3 marks]**

Equation \_\_\_\_\_

Observation \_\_\_\_\_

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(b) Sodium sulfide solution is added to excess copper (II) chloride solution.

**[3 marks]**

Equation \_\_\_\_\_

Observation \_\_\_\_\_

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**Question 27****[3 marks]**

Butane and propan-1-ol have similar molar masses. Explain, in terms of intermolecular forces, which of the two compounds will have the higher boiling point.

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**Question 28****[6 marks]**

(a) What **chemical test** and **observations** could be used to distinguish between the following:

(i) methylpropan-2-ol and propanoic acid. [3 marks]

Test: \_\_\_\_\_

Observation with methylpropan-2-ol \_\_\_\_\_

Observation with propanoic acid \_\_\_\_\_

(ii) Zinc and Chromium [3 marks]

Test: \_\_\_\_\_

Observation with Zn \_\_\_\_\_

Observation with Cr \_\_\_\_\_



**Question 29****[6 marks]**

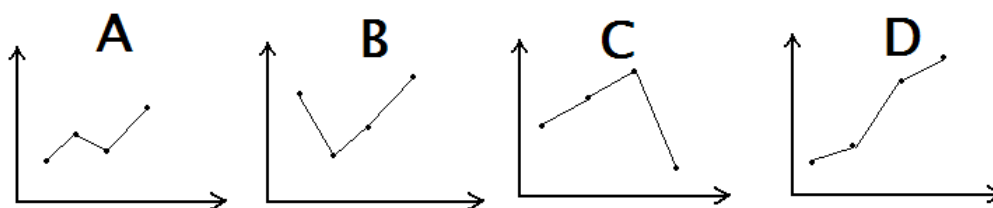
Draw electron-dot diagrams showing the arrangement of all valence electrons in the following chemical species. Describe the shape of each (eg: linear/bent/etc)

<b>NaNO<sub>3</sub></b>	<b>H<sub>2</sub>SO<sub>4</sub></b>
<b>Shape of Anion</b> _____	<b>Shape around the S atom</b> _____

**Question 30****[6 marks]**

(a) For each of the unlabelled graphs below select which one best represents the expected plots for: [3 marks]

- (i) The boiling points of the hydrides of group 16. \_\_\_\_\_
- (ii) The melting points of elements with Atomic numbers 12, 13, 14, 15. \_\_\_\_\_
- (iii) The first four successive Ionisation Energy values for a group 2 element. \_\_\_\_\_



(b) Explain your choice for (iii). [3 marks]

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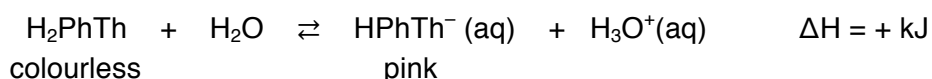
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**Question 31****[8 marks]**

Phenolphthalein is a diprotic acid molecule and has two different equilibrium situations which are sensitive to concentrations of  $\text{OH}^-$  (aq). In pH range less than or equal to 8.3 the fully hydrogenated form is in such high concentrations and there is no evidence of the first ionisation step forming  $\text{H}_3\text{O}^+$ (aq) and a pink coloured ion.

If the phenolphthalein molecule is written as  $\text{H}_2\text{PhTh}$ , then the equilibrium equation for the hydrolysis of phenolphthalein could be written as



- (a) From the information given above, is the K value for the equation as written going to be high or low? Explain your answer. [2 marks]

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- (b) The following changes are imposed on a solution of phenolphthalein at equilibrium. Each change is made to a separate test tube and equilibrium is re-established. Complete the table below, indicating the effect on the concentration of  $\text{HPhTh}^-$ (aq) and the value of K. Use terms 'increase', 'decrease' or 'no change'.

Also describe what you would observe as equilibrium is re-established in the system.

[6 marks]

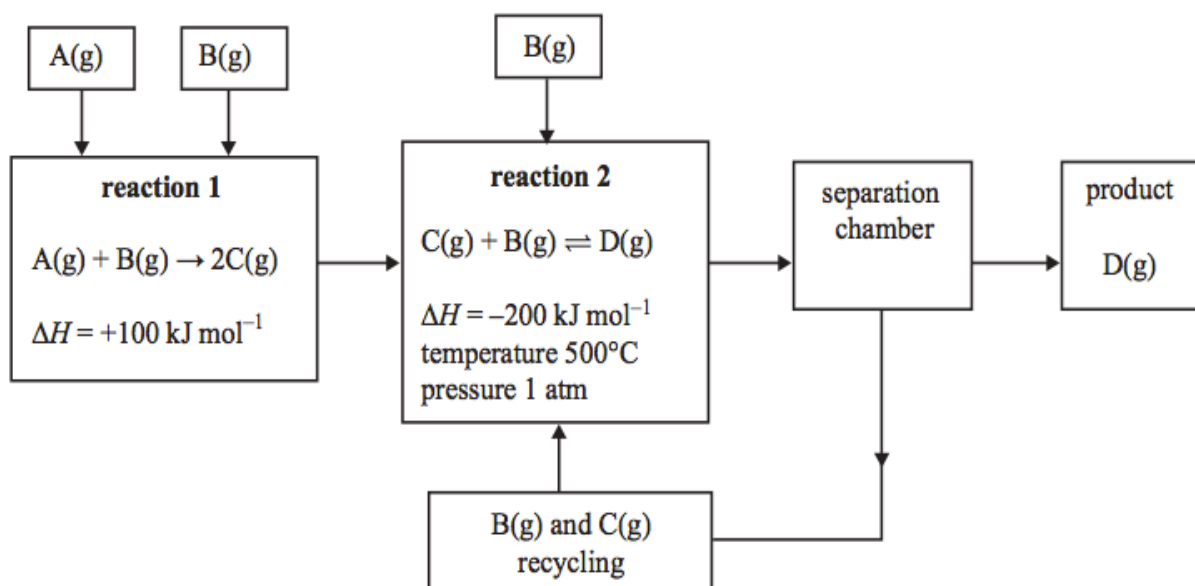
Imposed change	Effect on $[\text{HPhTh}^-]$ (aq)	Effect on K	Observation
HCl(g) is bubbled through the solution			
The solution is heated			

**Question 32****[10 marks]**

A particular industrial process involves the steps shown on the diagram.

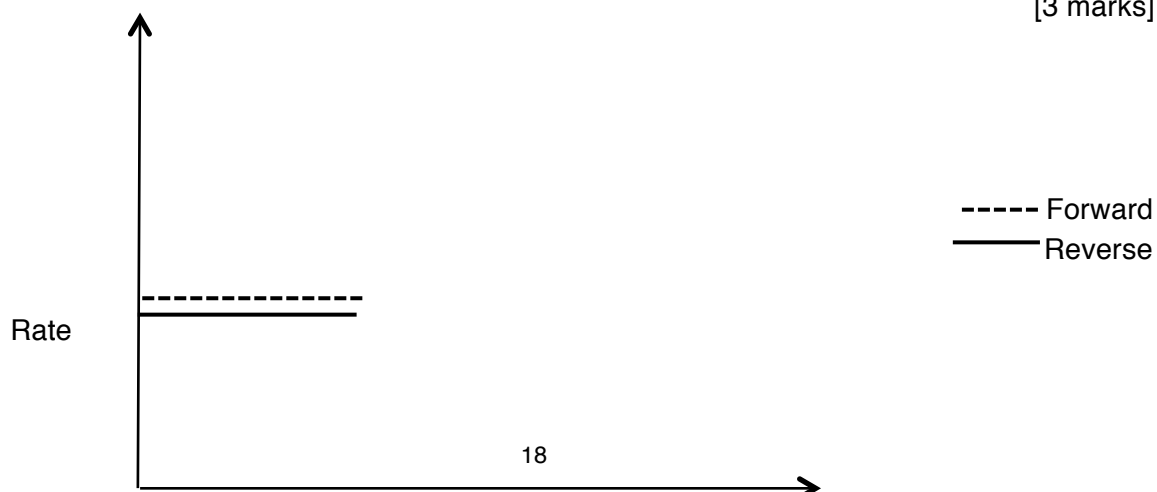
Reaction 1 proceeds to completion but reaction 2 reaches equilibrium and has a high Activation energy.

The product of the industrial process, **D**, passes through a membrane in the separation chamber which is impermeable (resistant) to **B** and **C**.



- (a) D is removed from the system in the separation chamber at  $t_1$ .
- (i) Sketch graphs on the axes below showing how this affect the rates of the forward and reverse reactions. Continue your graph until equilibrium has been re-established at  $t_2$ .

[3 marks]





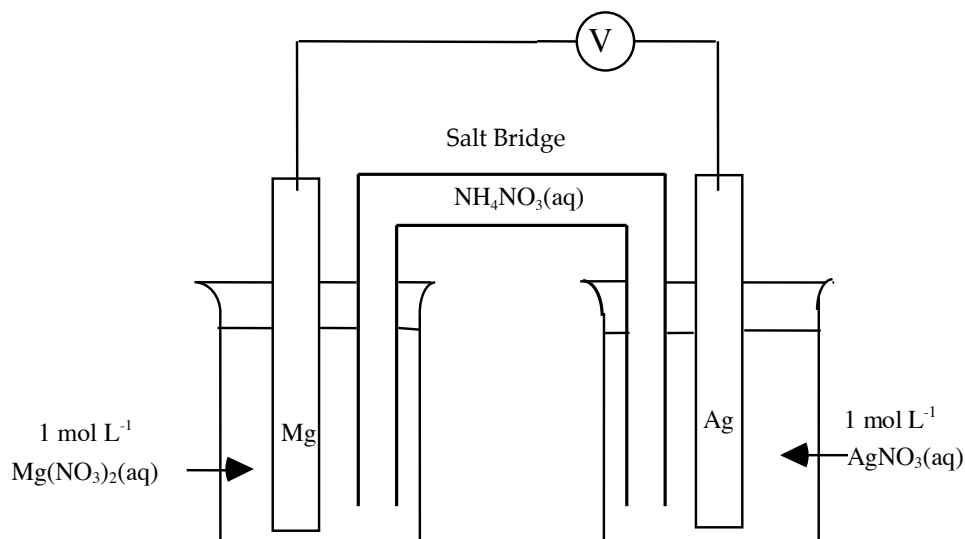


(ii) A Base: \_\_\_\_\_

**Question 35**

**[7 marks]**

Consider the electrochemical below:



(a) Write the half-equation for the reaction which occurs at the positive electrode. [1 mark]

\_\_\_\_\_

(b) Write the equation for the overall redox equation in the cell. [1 mark]

\_\_\_\_\_

(c) Calculate the EMF (voltage) of the cell at standard conditions. [1 mark]

\_\_\_\_\_

(d) Both the anode and cathode have a mass of 5.00 g before they are connected in the cell. The electrodes are connected for 10 minutes and one of the electrodes was found to have a mass of 7.50 g when reweighed. What is the mass of the other electrode after this time?

[4 marks]

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

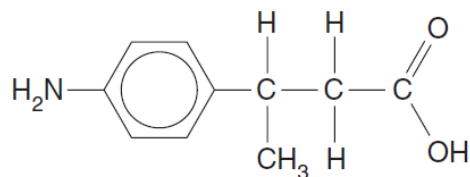
\_\_\_\_\_

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**Question 37****[4 marks]**

Below is a newly developed amino acid that has the potential for development of an anti-inflammatory drug.



- (a) Explain why it is considered to be an amino acid? [1 mark]

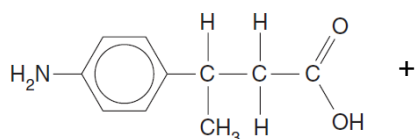
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- (b) The molecule above is not an  $\alpha$ -amino acid. In the space below draw the molecule as an  $\alpha$ -amino acid. [1 mark]

- (c)  
(i) Draw the structural formula of the conjugate base of the original amino acid. [1 mark]

- (ii) Complete the reaction below to show what happens when hydrochloric acid is added to the amino acid. [1 mark]

**END OF SECTION TWO**





**Section 3: Extended answer  
Marks]****40% [80**

This section contains **five** questions. You must answer **all** questions. Write your answers in the spaces provided.

Spare pages are included at the end of the booklet. They can be used for planning your responses and/ or as additional space if required to continue an answer.

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- Continuing an answer: If you need the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time for this section is 70 minutes.

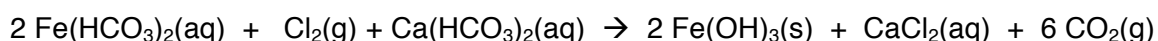
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**Question 38****[13 marks]**

Ground water contains a number of impurities that must be removed during treatment for it to be suitable for drinking. Soluble iron (II) and manganese (II) compounds are often found in ground water. Although they are not toxic they do contribute to unpleasant odours, taste and colour.

One method of the removal of iron (II), in the form of iron (II) hydrogencarbonate, is to add chlorine and calcium hydrogencarbonate. This causes the iron (II) to oxidise to iron (III) hydroxide which precipitates out and can be filtered off. The other products are calcium chloride and carbon dioxide.

The balanced equation for the reaction is:



- (a) Predict the observations for this reaction. [3 marks]
- 
- 
- 

A 1000.0 kg sample of ground water containing 45.6 ppm (mg solute/kg solution) of iron (II) hydrogencarbonate is treated by the addition of 3.22 L of chlorine gas at 25°C and 103.2 kPa and excess calcium hydrogencarbonate.



**Question 39****[20 marks]**

You have been given a bottle of wine for testing the acid content and a standardised sodium hydroxide solution. Assume that the acid is present as tartaric acid, a diprotic weak acid. You place the standard solution in the burette.

- (a) For the equipment listed below, indicate what each should be rinsed with. [4 marks]

Equipment	Rinsed with
Stock bottle to store NaOH solution	
Conical flask	
Pipette	
Burette	

- (b) Which of these two given indicators would be an appropriate indicator for this titration? Explain your choice. [3 marks]

Thymol blue: endpoint range 8.0 – 9.6 colours: yellow (acidic) – blue (basic)

Bromophenol blue: endpoint range 3.0 – 4.6 colours: yellow (acidic) – violet (basic)

Indicator choice: \_\_\_\_\_

Explanation: \_\_\_\_\_

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- (c) The sodium hydroxide needed to be standardised before it can be titrated with the wine since it cannot be used as a primary standard. [4 marks]

List 3 characteristics that make a substance suitable to be used as primary standard?

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Why is sodium hydroxide unsuitable as a primary standard?

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- (d) The wine was diluted before it was titrated with the NaOH solution. 10 mL of wine was added to 100 mL volumetric flask and the solution made up to 100 mL. 25.0 mL aliquots of the diluted wine were then titrated against the standard  $0.102 \text{ mol L}^{-1}$  NaOH solution. The burette readings are as follows:

	1	2	3	4
Final volume, mL	22.56	43.22	22.02	42.73
Initial volume, mL	2.11	22.56	1.40	22.02
Titre used, mL				

- (i) Complete the table and calculate the average titre. [2 marks]
- 

- (ii) Calculate the concentration in  $\text{mol L}^{-1}$  of the tartaric acid in [4 marks]
- the diluted wine and then in
  - the original wine.
- 
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- (iii) Assuming the density of the wine is  $1.05 \text{ g mL}^{-1}$ , calculate the percentage by mass of the tartaric acid in the wine. [3 marks]  
The molar mass of tartaric acid is  $150.0 \text{ g mol}^{-1}$ .

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**Question 40****[21 marks]**

Propan-1-ol and propene are extremely useful carbon compounds used in industry to make ropes, carpets, fuel oils etc. The production of propan-1-ol can be achieved two ways:

- the selective addition of water to propene and
- the hydroformylation of ethene to propanal using CO and H<sub>2</sub> and then the hydrogenation of propanal to propan-1-ol.

(a) Write the equation for the reaction between propene and water to produce propan-1-ol in the presence of phosphoric acid. All reactants and products are in the gas phase.

[1 mark]

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(b) There is a possibility of another alcohol being formed in (a) above, name this alcohol.

[1 mark]

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(c) Write a balanced equation for the reaction between ethene and CO and H<sub>2</sub> to produce propanal.

[1 mark]

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(d) Write a balanced equation for the reaction between propanal and hydrogen to give propan-1-ol.

[1 mark]

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(e) Propene is used by Shell to make the addition polymer polypropene which is used to make carpets and ropes. Draw a piece of polypropene showing at least three monomer units.

[2 marks]





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- (b) At 25°C and 110.1 kPa, 1.84 g of this pesticide has a volume 142.7 mL in the gaseous phase. Determine the molar mass of this pesticide. [2 marks]

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- (c) What is the molecular formula of the pesticide? [2 marks]

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