

Year 12 Semester Two Examination, 2015

Question/Answer Booklet

CHEMISTRY

Stage 3

Student Name: _____

Student Number: _____

Time allowed for this paper

Reading time before commencing work: ten minutes
Working time for paper: three hours

Section	Marks
1	/25
	/50
2	/70
3	/80
total	/200
	%

Materials required/recommended for this paper

To be provided by the supervisor

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

To be provided by the candidate

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction tape/fluid, eraser, ruler, highlighters
Special items: up to three non-programmable calculators approved for use in the WACE examinations

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Multiple-choice	25	25	50	25	25
Section Two: Short answer	11	11	60	70	35
Section Three: Extended answer	5	5	70	80	40
Total					100

Instructions to candidates

1. Answer the questions according to the following instructions.

Section One: 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 that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Sections Two and Three: Write answers in this Question/Answer Booklet.

3. When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.
4. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.
5. 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 that you are continuing to answer at the top of the page.

See next page

Section One: Multiple-choice**25% (25 Marks)**

This section has **25** questions. 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 that square, do not erase or use correction fluid, and shade your new answer. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 50 minutes.

1. Which one of the following elements has the highest electronegativity?
 - (a) B
 - (b) Be
 - (c) Ba
 - (d) Bi

2. Which one of the following elements has the lowest atomic radius?
 - (a) N
 - (b) Ne
 - (c) Na
 - (d) Ni

3. Which one of the following pairs of solutions will **not** form a white precipitate when mixed together?
 - (a) sodium carbonate and magnesium chloride
 - (b) ammonium carbonate and zinc chloride
 - (c) copper(II) sulfate, and barium nitrate
 - (d) sodium iodide and silver nitrate

4. Which one of the statements below best describes the relationship between the solubility of gases in water and the temperature of the water?
 - (a) As the temperature of the water increases the solubility of gases increases.
 - (b) As the temperature of the water increases the solubility of gases decreases.
 - (c) The temperature of the water has no effect on the solubility of gases.
 - (d) The relationship between the solubility of gases in water and temperature is different for every gas so we can't make a generalised statement.

5. Examine the first five ionisation energies of element **A** below.

	1 st	2 nd	3 rd	4 th	5 th
Ionisation Energies (kJ mol ⁻¹)	793	905	3 392	4 167	5 111

Which one of the following is the most likely formula of the oxide of element **A**?

- (a) A₂O₃
(b) AO
(c) A₂O
(d) AO
6. Which of the following will conduct an electric current?
- i molten sulfur
ii a saturated solution of silver sulfate
iii solid silver
iv solid silver sulfide
- (a) i and ii only
(b) ii and iii only
(c) i and iv only
(d) i, ii and iv only
7. In which one of the following substances are dispersion forces the most significant type of intermolecular force?
- (a) solid carbon dioxide
(b) liquid ethanol
(c) solid butanoic acid
(d) solid sodium chloride
8. Which one of the following species contains lone (non-bonding) pairs of valence electrons?
- (a) C₂H₄
(b) NH₄⁺
(c) H₂S
(d) CH₄

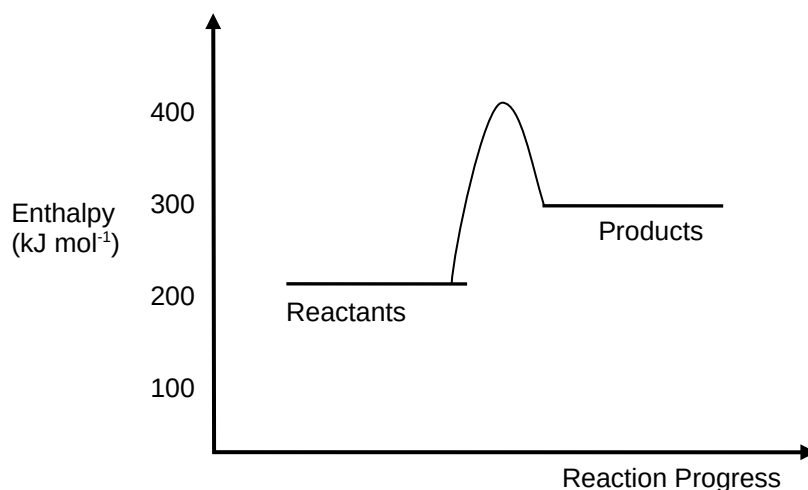
9. Which one of the following substances is likely to be the most soluble in water?

- (a) HF
- (b) H₂S
- (c) H₂
- (d) CH₄

10. Which one of the following statements about absolute zero is **false**?

- (a) Absolute zero is -273.15 °C
- (b) Gases could exist at absolute zero.
- (c) It is impossible to reach temperatures below absolute zero.
- (d) At absolute zero the kinetic energy of particles would be zero.

11. An energy profile diagram for a chemical reaction is shown below.



Estimate the activation energy for the **reverse** reaction.

- (a) + 400 kJ mol⁻¹
- (b) + 200 kJ mol⁻¹
- (c) - 200 kJ mol⁻¹
- (d) + 120 kJ mol⁻¹

12. Which one of the following correctly arranges 0.01 mol L⁻¹ solutions of the substances in the order of decreasing pH, from highest to lowest?

- | | | | | | |
|-----|---------------------|---------------------|---------------------------------|---------------------------------|---------------------------------|
| (a) | Ca(OH) ₂ | NaOH | Na ₂ CO ₃ | NaNO ₃ | NH ₄ NO ₃ |
| (b) | NaOH | Ca(OH) ₂ | Na ₂ CO ₃ | NH ₄ NO ₃ | NaNO ₃ |
| (c) | Ca(OH) ₂ | NaOH | NaNO ₃ | Na ₂ CO ₃ | NH ₄ NO ₃ |
| (d) | NaOH | Ca(OH) ₂ | Na ₂ CO ₃ | NaNO ₃ | NH ₄ NO ₃ |

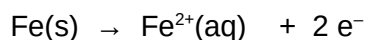
13. Consider the equilibrium system below:



Which one of the following statements is **false**?

- (a) NH_3 is the conjugate base of NH_4^+ .
 - (b) The water is acting as a base.
 - (c) Addition of water will favour the forward reaction.
 - (d) The system can oppose an increase in pH by favouring the reverse reaction.
14. Which one of the following 1.0 mol L^{-1} solutions will have the lowest pH?
- (a) $\text{HCl}(\text{aq})$
 - (b) $\text{H}_3\text{PO}_4(\text{aq})$
 - (c) $\text{H}_2\text{SO}_4(\text{aq})$
 - (d) $\text{NH}_4\text{Cl}(\text{aq})$
15. Which one of the following species listed below contains sulfur with the highest oxidation state?
- (a) H_2SO_3
 - (b) S_8
 - (c) SO_2
 - (d) MgSO_4
16. In which one of the following reactions is oxygen undergoing disproportionation (being oxidised and reduced)?
- (a) $2 \text{ClO}^- + 4 \text{H}^+ \rightarrow \text{Cl}_2 + 2 \text{Cl}^- + 2 \text{H}_2\text{O}$
 - (b) $2 \text{H}_2\text{O}_2 \rightarrow \text{O}_2 + 2 \text{H}_2\text{O}$
 - (c) $5 \text{MnO}_2 + 4 \text{H}^+ \rightarrow 2 \text{MnO}_4^- + 3 \text{Mn}^{2+} + 2 \text{H}_2\text{O}$
 - (d) $2 \text{FeO} + 3 \text{CO}_2 \rightarrow \text{Fe}_2\text{O}_3 + 3 \text{CO}$
17. By referring to the table of standard electrode potentials on the Chemistry Data Sheet, predict which one of the following pairs of substances will undergo a chemical reaction.
- (a) Iron(III) nitrate solution and sodium chloride
 - (b) Sodium chloride solution and solid iodine
 - (c) Gaseous chlorine and solid silver
 - (d) Hydrogen peroxide solution and lead(II) sulfate solution

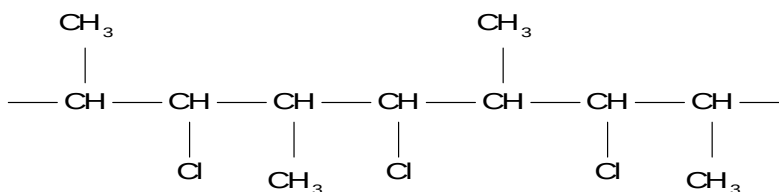
18. Corrosion occurs when a metal is oxidised to its ions. An initial stage in the corrosion of iron can be represented as:



The Iron hulls of ships can be protected from corrosion by adding separate pieces of magnesium to outside of the hull. Which one of the following best explains how this protects iron from corrosion?

- (a) The iron reacts with the magnesium instead of the water.
 - (b) Magnesium protects the iron because it is less reactive than the iron
 - (c) Magnesium is oxidised in preference to the iron.
 - (d) The magnesium prevents iron being exposed to oxygen.
19. Which one of the following has a different empirical formula to the other three?
- (a) butanoic acid
 - (b) methyl propanoate
 - (c) ethanal
 - (d) propyl propanoate
20. Which one of the following pairs of compounds would form propyl methanoate when warmed with concentrated sulfuric acid?
- (a) CH_3OH and $\text{CH}_3\text{CH}_2\text{COOH}$
 - (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ and CH_3OH
 - (c) HCOOH and $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
 - (d) $\text{CH}_3\text{CH}_2\text{CH}_3$ and HCOOH
21. Which one of the following is an addition reaction?
- (a) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 + \text{Br}_2 \rightarrow \text{CH}_3\text{CHBrCH}_2\text{CH}_2\text{CH}_3 + \text{HBr}$
 - (b) $\text{CH}_3\text{CHCHCH}_2\text{CH}_3 + \text{H}_2 \rightarrow \text{CH}_3(\text{CH}_2)_3\text{CH}_3$
 - (c) $\text{C}_6\text{H}_6 + \text{CH}_3\text{Cl} \rightarrow \text{C}_6\text{H}_5\text{CH}_3 + \text{HCl}$
 - (d) $n\text{HOCH}_2\text{CH}_2\text{OH} + n\text{HOCCOOH} \rightarrow (-\text{OCH}_2\text{CH}_2\text{OCOCOO-})_n + 2n\text{H}_2\text{O}$

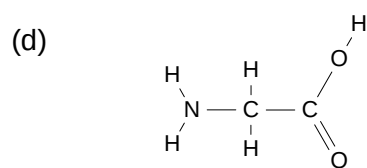
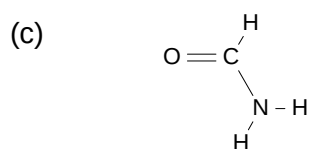
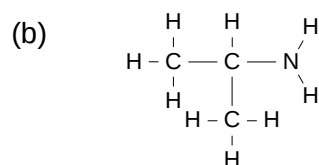
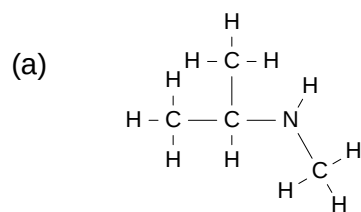
22. Examine the section of the polymer shown below.



Which one of the following is the correct name for the monomer used to make this polymer?

- (a) 1-methyl-2-chloroethene
 - (b) 1-chloroprop-2-ene
 - (c) 2-chloropropene
 - (d) 1-chloropropene
23. Which one of the following is the correct half-equation for the oxidation of propan-1-ol to propanoic acid?
- (a) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}(\text{aq}) + \text{H}_2\text{O}(\ell) \rightarrow \text{CH}_3\text{CH}_2\text{COOH}(\text{aq}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^-$
 - (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}(\text{aq}) \rightarrow \text{CH}_3\text{CH}_2\text{CHO}(\text{aq}) + 2 \text{H}^+(\text{aq}) + 2 \text{e}^-$
 - (c) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}(\text{aq}) + \text{H}_2\text{O}(\ell) \rightarrow \text{CH}_3\text{CH}_2\text{COOH}(\text{aq}) + 4 \text{H}^+(\text{aq}) + 4 \text{e}^-$
 - (d) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}(\text{aq}) + \text{O}_2(\text{g}) \rightarrow \text{CH}_3\text{CH}_2\text{COOH}(\text{aq}) + \text{H}_2\text{O}(\ell)$
24. Which one of the following is an α (alpha)-amino acid?
- (a) $\text{CH}_3\text{CNH}_2\text{COOCH}_3$
 - (b) $\text{CH}_3\text{CNH}_2\text{COOH}$
 - (c) $\text{NH}_2\text{CH}_2\text{CH}_2\text{COOH}$
 - (d) CH_3CONH_2

25. Which one of the following is a primary amine?



End of Section One

See next page

Section Two: Short answer**35% (70 Marks)**

This section has **11** questions. Answer **all** questions. Write your answers in the spaces provided.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

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Suggested working time: 60 minutes.

Question 26**(4 marks)**

Write balanced ionic equations for any reactions that occur in the following situations. If no reaction occurs, state **No Reaction**.

- (a) Solid copper(II) carbonate is added to dilute hydrochloric acid. (2 marks)

- (b) Barium nitrate solution is added to sodium hydroxide solution. (2 marks)

Question 27

(4 marks)

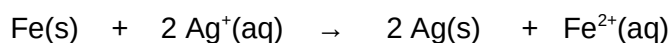
For each of the following reactions, describe expected **observations**, including any:

- colour changes
- odours
- precipitates (give the colour)
- gases evolved (give the colour or describe as colourless)

- (a) Solid sodium hydrogencarbonate is added to dilute hydrochloric acid. (2 marks)



- (b) Iron filings are added to silver nitrate solution. (2 marks)



Question 28

(4 marks)

The table below shows the first four ionisation energies of aluminium.

	1st	2nd	3rd	4th
Ionisation Energies (kJ mol ⁻¹)	577	1817	2744	11577

- (a) Explain why the difference between the 3rd and 4th ionisation energies is greater than the difference between 2nd and 3rd ionisation energies.

Question 29

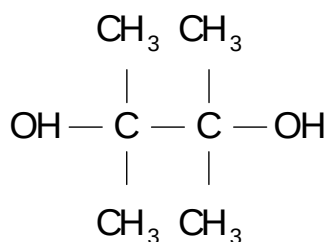
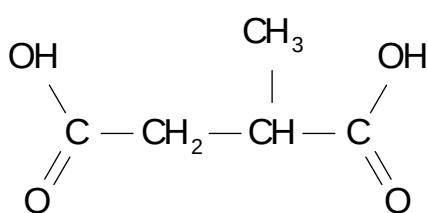
(6 marks)

75.0 mL of sulfuric acid, with a mass of 94.5 g and a concentration of 37.0% by mass was spilt from a car battery. To treat the spill, 350 mL of 2.00 mol L^{-1} sodium hydroxide solution was added to the spilt acid and 10.0 litres of water added to dilute the resulting solution. Calculate the pH of the final solution.

Question 30

(4 marks)

Look at the two molecules below.



- (a) Draw a section of the polymer that would be produced from these two molecules.

(2 marks)

- (b) Write a balanced molecular equation for the formation of this polymer. (2 marks)

Question 31

(8 marks)

A chemist was required to conduct analysis to check that the exact mass of magnesium carbonate present in a 0.500 g indigestion tablet was 460 mg, as claimed by the manufacturer. He decided to carry out the experiment using an indirect (back) titration. This type of titration involves adding excess acid to the tablet, carrying out a titration to calculate the amount of unreacted (excess) acid and using this value to calculate the amount of acid that reacts with the carbonate in the original tablet.

- (a) Explain why an indirect (back) titration is the method used. (2 marks)

(b) The chemist had a solution of 1.00 mol L^{-1} hydrochloric acid and a standardised solution of 0.250 mol L^{-1} sodium carbonate to use in the titration. He was aiming to have a titre of the sodium carbonate of approximately 20 mL. Calculate the approximate volume of the hydrochloric acid he should add to each tablet.

Question 32

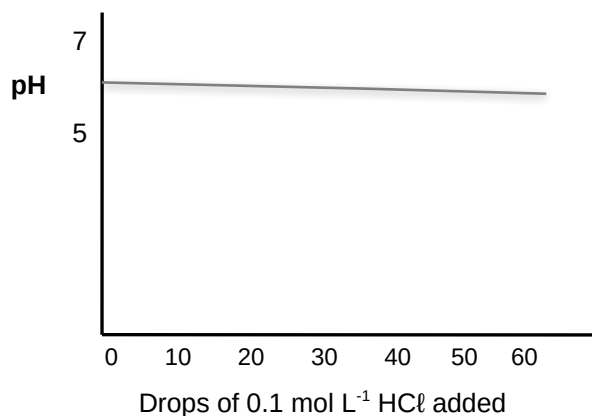
(6 marks)

The following two graphs show the effect on the pH of adding dilute hydrochloric acid drop by drop to:

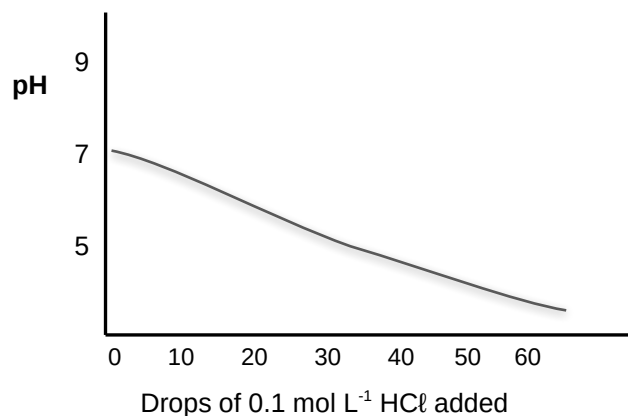
Solution 1: Ammonia (NH_3) solution mixed with ammonium chloride (NH_4Cl) solution

Solution 2: Sodium chloride (NaCl) solution.

Graph 1. The change in pH when adding dilute HCl to an aqueous mixture of $\text{NH}_3/\text{NH}_4\text{Cl}$



Graph 2. The change in pH when adding dilute HCl to a solution of NaCl



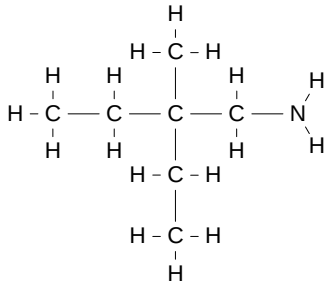
Explain, using equations, the differences between the shape of the two graphs.

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Question 33

(3 marks)

Complete the following table showing the structure and names of three organic compounds.

Structure	IUPAC Name
	methyl propanoate
	3-hexanone
	

Question 34

(11 marks)

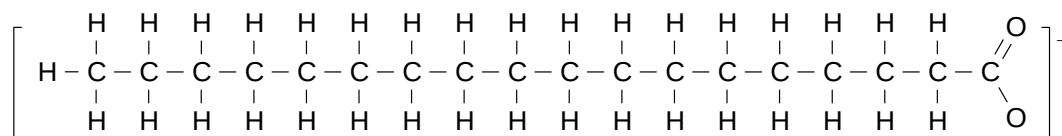
- (a) For each species listed in the table below, draw the structural formula, representing **all** valence shell electron pairs as : or as — and indicate the shape of the species by a sketch or a name. (6 marks)

Species	Electron Dot Diagram (Lewis diagram)	Shape
Carbon monoxide, CO		
Carbon dioxide, CO ₂		
hydrogencarbonate ion, HCO ₃ ⁻		

- (b) Compare the polarities of the carbon dioxide and carbon monoxide molecules, explaining the cause of any differences. (2 marks)

- (c) Sodium hydrogencarbonate is soluble in water. Describe, with the aid of a labelled diagram, the processes occurring when solid sodium hydrogencarbonate dissolves in water. (3 marks)

- (d) Below is the structure of the stearate ion, $\text{CH}_3(\text{CH}_2)_{16}\text{COO}^-$, which is present in a number of types of soap.



Explain why the stearate ion is soluble in water **and** non-polar substances such as oil and grease. (3 marks)

Question 35**(10 marks)**

Consider the reversible reaction below which is used in the production of quick lime (calcium oxide).



- (a) Write the equilibrium constant expression for this reaction. (1 mark)

- (b) For each of the following changes made to the system at equilibrium, predict the changes to the yield of the reaction once equilibrium is re-established, using the terms increase, decrease or no change. Provide a reason for your prediction in each case. (9 marks)

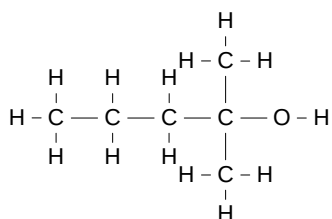
Imposed Change	Effect on Yield increase, decrease or no change	Reason for your prediction
Increase temperature		
Increase pressure		
Remove calcium oxide as it is produced		

Question 36

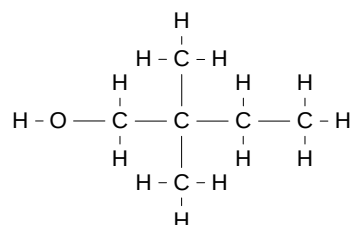
(7 marks)

Consider the two molecules below.

Molecule A



Molecule B



- (a) Write the IUPAC name of the two molecules. (2 marks)

Molecule A

Molecule B

- (b) Describe a chemical test that could be used to distinguish between them. State the expected observations for both substances. (5 marks)

Substance	Description of chemical test	Expected observations
Molecule A		
Molecule B		

End of Section Two

See next page

Section Three: Extended answer**40% (80 Marks)**

This section contains **5** questions. You must answer **all** questions. Write your answers in the spaces provided.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures.

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Suggested working time: 70 minutes.

Question 37**(19 marks)**

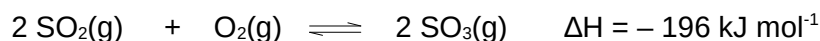
This question is about the production of sulfuric acid (H_2SO_4). This process is carried out through a number of steps:

Step 1

Liquid sulfur is reacted with dry air to produce sulfur dioxide (SO_2).

Step 2

The sulfur dioxide is oxidised to sulfur trioxide using vanadium(V) oxide as a catalyst. This step is called the Contact Process. The equation for the reaction is shown below.

**Step 3**

Concentrated sulfuric acid (98.0 % by mass) is used to dissolve sulfur trioxide where it forms oleum ($\text{H}_2\text{S}_2\text{O}_7$).

Step 4

The oleum is mixed with water to obtain more sulfuric acid.

A team of chemical engineers carried out step 2 at a variety of temperatures to inform decisions about the optimum conditions for the reaction. Their results are shown on the next page.

See next page

Table 1. Yield of sulphur trioxide for contact process reaction carried out at 150 kPa pressure, with a V_2O_5 catalyst at a range of temperatures.

Temperature of reaction vessel ($^{\circ}C$)	Yield of SO_3 (%)
200	95
400	92
500	72
600	40
650	31
700	26
800	18
1000	12

- (a) On the grid below, display this data with a line graph. (4 marks)

Note: A spare grid is provided at the end of the examination if required



- (b) Use your graph to predict the yield of the reaction at 550 $^{\circ}C$. (1 mark)

- (c) Describe the trend shown by these results. (2 marks)

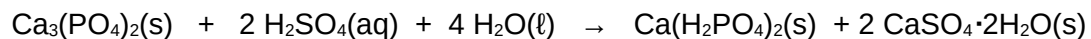
- (d) As a result of these findings, the chemical engineer decided to operate the sulfuric acid plant at a temperature of 200 °C. However, the amount of sulphur dioxide produced was very low. Suggest a reason for this. (1 mark)

- (e) After further tests, it was decided to operate the plant at 400 °C. With reference to your graph, explain why this temperature, and not a higher temperature, was chosen. (2 marks)

- (f) Assuming a yield of 92.0%, Calculate the volume of oxygen, at 400 °C and a pressure of 150 kPa, required to produce 1.00 tonne (1.00×10^6 g) of sulphur trioxide in the Contact Process: (4 marks)



- (g) Sulfuric acid is used to produce agricultural fertiliser, including superphosphate, which is a mixture of two calcium salts. The reaction is shown below:



If 98.0 % (by mass) sulfuric acid is used, calculate the mass of the super phosphate that can be produced from 1.00 tonne of the sulfuric acid. (assume 100% yield)
(5 marks)

Question 38**(12 marks)**

Dopamine is a primary amine that acts as a neurotransmitter, a chemical that send signals between nerve cells. Levels of dopamine in the brain have been linked to a number of medical conditions, including Parkinson's disease and ADHD. Some additive drugs increase the production of dopamine. Dopamine contains carbon, nitrogen, hydrogen and oxygen. In this question you will work out the formula of dopamine.

Two samples of were analysed to determine its empirical formula.

A 12.1 g sample was combusted in oxygen and produced 27.6 g of carbon dioxide and 7.87 g of water.

A separate 17.2 g sample was found to contain 1.57 g of nitrogen.

(a) Determine the empirical formula of dopamine

(7 marks)

See next page

- (b) Dopamine is a weak monoprotic base (it can only accept one proton). 10.0 g of dopamine was dissolved in distilled water and the solution made up to 250.0 mL. When titrated against 0.250 mol L⁻¹ hydrochloric acid, 25.00 mL of this solution required 26.1 mL of the acid for neutralisation.

From this data, calculate the molecular mass of dopamine, and hence determine the molecular formula of dopamine. (5 marks)

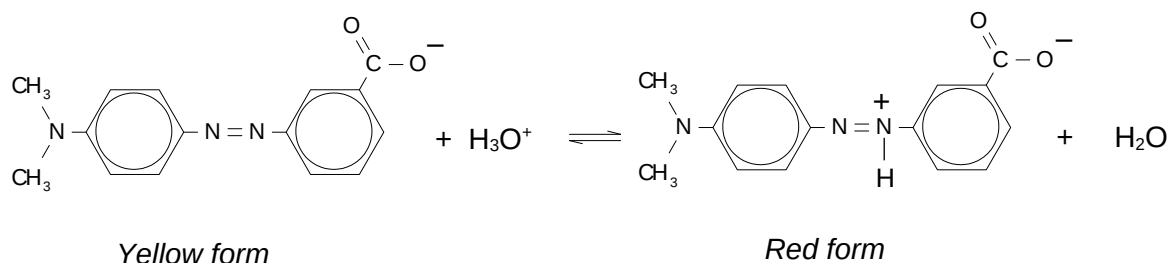
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Question 39

(19 marks)

Methyl red is an indicator that exists in two different coloured forms, depending on the pH of the solution. In solutions below pH 4.4 the indicator will produce a red colour; above pH 6.2 the indicator appears yellow. Between these pH value's, an orange colouration will appear.

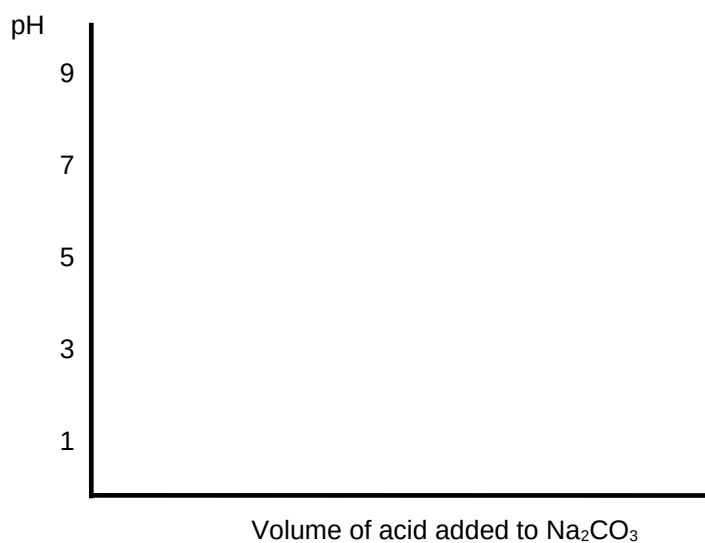
The conversion between the two forms in aqueous solution is shown below.



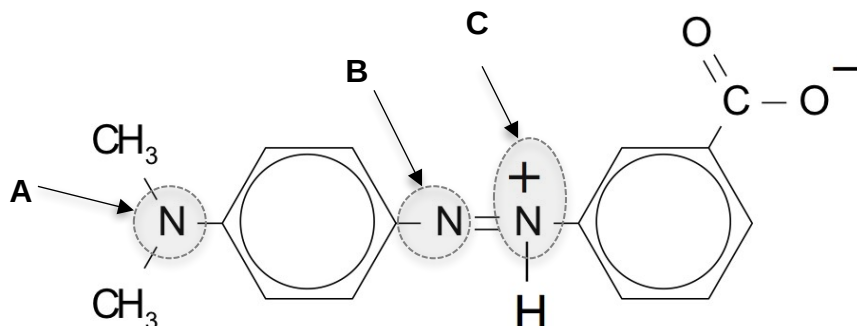
- (a) State why the yellow form of methyl red can be described as the conjugate base of the red form of methyl red. (1 mark)

- (b) Using your knowledge of equilibrium and reaction rates, state and explain how the concentrations of the three ions in the reaction above change when alkali is added. (4 marks)

- (c) Explain, using equations and a graph sketched on the axis below, why methyl red is a suitable indicator for the titration of hydrochloric acid and sodium carbonate solution. (5 marks)



- (d) In the red form of methyl red, the shape of the bonds around each of the three nitrogen atoms **A**, **B** and **C** varies. One is trigonal planar, one is trigonal pyramidal and one is bent (v-shaped).



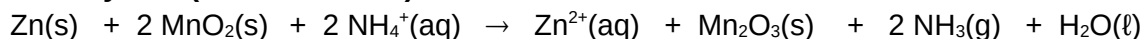
Using the valence shell electron pair repulsion (VSEPR) theory, identify the shape around each of the nitrogen atoms, **A**, **B** and **C** and explain your reasoning, using diagrams where appropriate. (9 marks)

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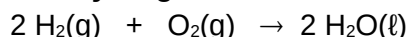
Question 40

(16 marks)

The overall redox equations occurring in the operation (discharging) of three types of commercial electrochemical cells are shown below, along with some information about each cell.

The Dry Cell (Leclanché Cell)

The electrolyte used in this cell is a paste containing ammonium ions with a minimum amount of water. The cathode of the cell is made from graphite, which allows electrons to flow through the cathode, but the carbon is not oxidised or reduced in the process.

The Hydrogen Fuel Cell

Hydrogen gas is bubbled through water so that it is in contact with an electrode made of platinum metal. Oxygen is also bubbled through water in contact with another electrode made of platinum metal. The electrodes are connected by an external circuit.

This cell can be recharged by connecting an external voltage to the cell, which reverses the reaction shown above.

The Lead-acid Cell

The electrolyte used in this cell is dilute sulfuric acid. This cell can also be recharged by connecting an external voltage to the cell.

- (a) With reference to these equations, compare and contrast the three cells by describing the reactions occurring at the **anodes** of the three cells using the relevant half-equations, comparing the role of the anode and explaining what happens to the ions produced by these anode reactions. (8 marks)

[illegible]

- (b) The Hydrogen Fuel Cell and the Lead-acid Cell are described as secondary cells because they can be recharged. In order to recharge the cells, the external voltage supplied must be greater than the potential produced by the cells. Use the standard electrode potentials on the Chemistry Data Sheet to calculate which cell would require the highest external voltage during recharging. (5 marks)

- (c) Describe **two** reasons why the values calculated from the standard electrode potentials may not give accurate results in part (b) above. (3 marks)

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Question 41

(14 marks)

Lawn sand is a mixture of iron compounds (in the form of Fe^{2+}) and sand (mainly SiO_2). It is used to kill moss in lawns. An experiment was carried out to determine the percentage of iron in a sample of lawn sand. The method and student's results are shown below.

Chemicals:

sample of lawn sand

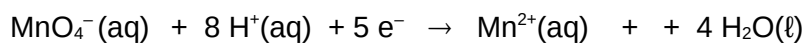
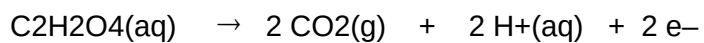
oxalic acid dihydrate ($\text{C}_2\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$) (dried in oven)1.00 mol L⁻¹ sulfuric acid (H_2SO_4)approximately 0.01 mol L⁻¹ potassium permanganate (KMnO_4) solution

distilled water

Method Outline	Student's results and notes				
1. Make up 250.0 mL of a standard solution of approximately 0.03 mol L ⁻¹ oxalic acid.	mass of oxalic acid dihydrate ($\text{C}_2\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$) dissolved in 250.0 mL = 0.920 g				
2. Titrate the 0.01 mol L ⁻¹ potassium permanganate against standard oxalic acid solution to determine its accurate concentration.	volume of oxalic acid = 25.00 mL average volume of KMnO_4 = 26.1 mL				
3. Weigh out approximately 10 g of the lawn sand and dissolve in 100 mL 1.00 mol L ⁻¹ sulfuric acid.	Mass of lawn sand used = 10.21 g				
4. Filter and make the filtrate up to 500.0 mL with distilled water in a volumetric flask.	Filtrate is pale green solution Residue contains sand and other impurities				
5. Titrate a 25.00 mL sample of this solution against the standardised potassium permanganate solution.	Trials				
		Rough	1	2	3
	Final volume (mL)	18.10	35.50	18.55	35.90
	Initial volume (mL)	0.00	18.10	1.10	18.55
	Titre (mL)	18.1	17.40	17.45	17.35

See next page

The relevant half-equations are shown below:



Calculate the percentage by mass of iron in the lawn sand.

[illegible]

Additional Working Space

End of questions

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Spare grid for Question 37



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[illegible]

[illegible]
