



Hale School
Year 12 Semester 1 Examination, 2017

Write your name below:

Yr12 ATAR CHEMISTRY
UNIT 3

Circle your teacher's initials:

TIME ALLOWED FOR THIS PAPER

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

For Examiners only	
Section 1	
Section 2	
Section 3	
Total	

MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER

TO BE PROVIDED BY THE SUPERVISOR

This Question/Answer booklet for Sections 1 & 2.
A separate Question/Answer booklet for Section 3.
A separate Multiple Choice Answer sheet for Section 1.
A Chemistry Data Sheet.

TO BE PROVIDED BY THE CANDIDATE

Standard Items: Pens, pencils, eraser, ruler

Special Items: A calculator satisfying the conditions set by the Curriculum Council, and a '2B' pencil for the separate Multiple Choice Answer sheet.

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. Please check carefully, and if you have any unauthorised material with you, hand it to the supervisor **BEFORE** reading any further.

INSTRUCTIONS TO CANDIDATES

This paper consists of **THREE SECTIONS** as follows:

SECTION 1 contains **25 questions worth 2 marks each**. It is the multiple choice section.

Answer **ALL** questions in Section 1 on the Separate Multiple Choice Answer Sheet. Use a '**2B**' **PENCIL. DO NOT USE A BALL POINT OR INK PEN**. If you consider that two or more of the alternative answers are correct then select the **BEST** alternative. Marks will **NOT** be deducted for incorrect answers. This part is worth 50 marks and should take about 50 minutes.

Do not use pencil for Sections 2 & 3.

SECTION 2 contains **10 short answer questions**. You should answer **ALL** the questions. The answers are to be written in the spaces provided in this Examination booklet. This part is worth 70 marks and should take about 60 minutes.

SECTION 3 contains **5 extended response and calculation questions**. You should answer **ALL** the questions in detail in the **separate question/answer booklet provided**. This part is worth 80 marks and should take about 70 minutes.

At the end of the examination make sure that your **name** is on this Examination paper, the separate Question/Answer Booklet for Section 3 and your Multiple Choice Answer Sheet.

SPECIAL INSTRUCTIONS*Chemical Equations*

For full marks, chemical equations should refer only to those species consumed in the reaction and any new species produced. These species may be **ions** [for example $\text{Ag}^+(\text{aq})$], **molecules** [for example $\text{NH}_3(\text{g})$, $\text{NH}_3(\text{aq})$, $\text{CH}_3\text{COOH}(\text{l})$, $\text{CH}_3\text{COOH}(\text{aq})$] or **solids** [for example $\text{BaSO}_4(\text{s})$, $\text{Cu}(\text{s})$, $\text{Na}_2\text{CO}_3(\text{s})$].

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	50	25
Section Two: Short answer	10	10	60	70	35
Section Three: Extended answer	5	5	70	80	40
Total					100

Section One: Multiple-choice**25% (50 marks)**

This section has **25** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided. Use a '2B' PENCIL. DO NOT USE A BALL POINT OR INK PEN. If you consider that two or more of the alternative answers are correct then select the BEST alternative. Marks will NOT be deducted for incorrect answers. This part is worth 50 marks and should take about 50 minutes.

- The pH of a solution was measured with a pH meter during a titration, and was observed to decrease from 4.0 to 2.0. Which of the following statements about the hydrogen ion concentration in the solution is correct?
 - It doubled.
 - It decreased by half.
 - It increased by a factor of 100.
 - It decreased by a factor of 100.

- The following statements refer to the chemical reaction between magnesium carbonate granules, (MgCO_3) and a dilute hydrochloric acid solution, (HCl). Which one of the following statements about this reaction is FALSE?
 - The rate of the reaction decreases with increasing time.
 - The rate of reaction increases with increasing initial temperature.
 - The rate of reaction increases with increasing initial concentration of HCl (aq).
 - The initial rate of reaction is independent of the state of sub-division of MgCO_3 (s).

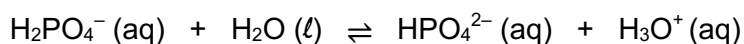
- Which one of the following statements about the following reversible reaction is TRUE?
$$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$$
 - $K = \frac{[\text{SO}_2]^2 [\text{O}_2]}{[\text{SO}_3]^2}$
 - K is constant under all reaction conditions.
 - Sulfur trioxide is being formed when the reaction is at equilibrium.
 - A catalyst increases the yield of sulfur trioxide by increasing ΔH .

- In which of the following reactions at equilibrium and at constant temperature is there a shift to the "left" if the pressure of the closed system is increased?
 - $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$
 - $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
 - $\text{H}_2\text{O}(\text{g}) + \text{C}(\text{s}) \rightleftharpoons \text{H}_2(\text{g}) + \text{CO}(\text{g})$
 - $\text{H}_2(\text{g}) + \text{F}_2(\text{g}) \rightleftharpoons 2\text{HF}(\text{g})$

5. Which choice correctly describes the properties of aqueous solutions of the following salts?

	Sodium ethanoate (NaCH ₃ COO)	Potassium nitrate (KNO ₃)	Ammonium chloride (NH ₄ Cl)
(a)	neutral	acidic	basic
(b)	basic	neutral	acidic
(c)	acidic	neutral	basic
(d)	basic	acidic	neutral

6. Consider the buffer solution represented by the chemical reaction below:



Which of the following would be **true** after the addition of a small volume of 2.0 mol L⁻¹ sodium hydroxide solution to the buffer solution?

- (a) The forward reaction rate would be unaffected.
(b) The concentration of H₂PO₄⁻ (aq) present in the system would increase.
(c) The pH of the system would decrease.
(d) The equilibrium would shift to the right.
7. In which one of the following reactions is water **not** acting as a Brønsted-Lowry acid or base?
- (a) HCO₃⁻(aq) + H₂O(ℓ) ⇌ H₂CO₃(aq) + OH⁻(aq)
(b) CO₂(s) + H₂O(ℓ) ⇌ H₂CO₃(aq)
(c) H₂CO₃(aq) + H₂O(ℓ) ⇌ HCO₃⁻(aq) + H₃O⁺(aq)
(d) CO₃²⁻(aq) + H₂O(ℓ) ⇌ HCO₃⁻(aq) + OH⁻(aq)
8. Which one of the following combinations will **not** form a buffer solution?

- (a) HNO₃(aq) / NO₃⁻(aq)
(b) H₂PO₄⁻(aq) / HPO₄²⁻(aq)
(c) NH₃(aq) / NH₄Cl (aq)
(d) H₃PO₄(aq) / H₂PO₄⁻(aq)

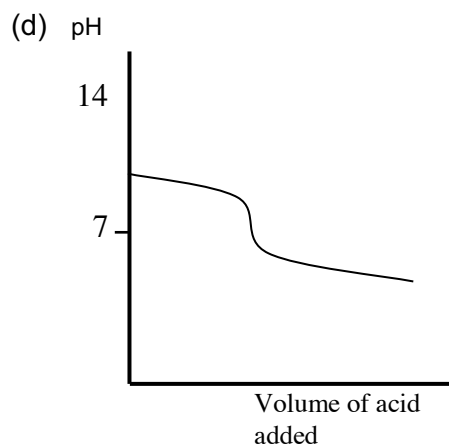
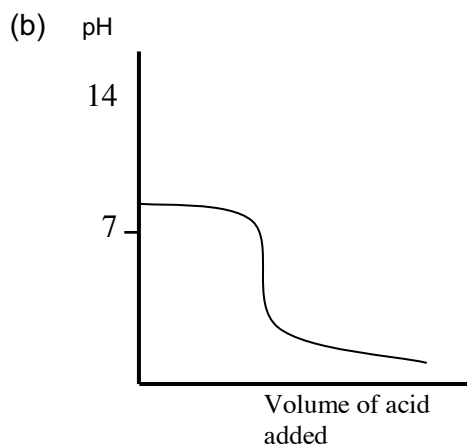
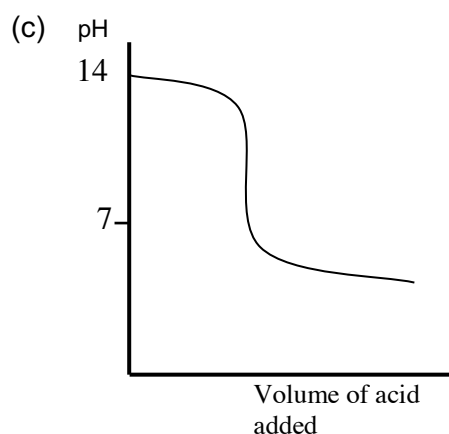
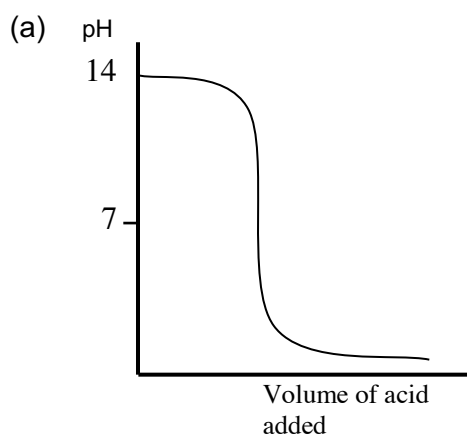
Questions 9, 10 and 11 relate the following information:

A student was asked to determine the concentration of a solution of ethanoic acid that had a concentration of approximately 0.400 mol L^{-1} . He pipetted 20.0 mL of a 0.500 mol L^{-1} solution of sodium hydroxide into a conical flask, and titrated the ethanoic acid against the standardised sodium hydroxide solution, using phenolphthalein as the indicator.

9. What is the pH of the sodium hydroxide solution at the start of the titration?

- (a) 13.7
- (b) 7.00
- (c) 14.0
- (d) 12.7

10. If the ethanoic acid was added until it was slightly in excess, which of the following pH graphs would show the variation of pH during the titration?



11. What approximate volume of ethanoic acid would the student expect to have added at the end point of the titration?

- (a) 20 mL
- (b) 30 mL
- (c) 25 mL
- (d) 35 mL

12. Which one of the following correctly arranges 1.0 mol L⁻¹ solutions of the substances in order of increasing pH?

- (a) NaOH NaCH₃COO NH₄CH₃COO H₂CO₃ HCl
- (b) H₂CO₃ HCl NH₄CH₃COO NaCH₃COO NaOH
- (c) HCl H₂CO₃ NaCH₃COO NH₄CH₃COO NaOH
- (d) HCl H₂CO₃ NH₄CH₃COO NaCH₃COO NaOH

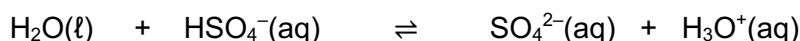
13. Consider the table below showing the colour changes of a range of indicators.

Indicator	pH range	Colour change	
		Acid	Alkali
methyl orange	3.1–4.4	red	yellow
bromothymol blue	6.0–7.6	yellow	blue
phenolphthalein	8.3–10.0	colourless	pink
litmus	5.5–8.8	red	blue

Which one of the following indicators should be used when titrating a solution of ammonia with hydrochloric acid?

- (a) phenolphthalein
- (b) methyl orange
- (c) bromothymol blue
- (d) litmus
14. During an acid-base titration, which one of the following would result in a random error?
- (a) Inconsistent reading of the volume of solution in a burette.
- (b) Using the incorrect mass when making up a standard solution.
- (c) Rinsing the conical flask with distilled water before use.
- (d) Rinsing the pipette with distilled water immediately before use.

15. Consider the equilibrium system below:



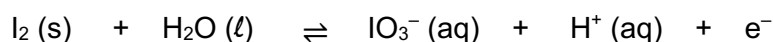
Which one of the following statements is **false**?

- (a) HSO₄⁻ is the conjugate acid of SO₄²⁻.
- (b) HSO₄⁻ is acting as an acid.
- (c) Addition of base will favour the reverse reaction.
- (d) The system could act as a buffer.

16. An experiment is set up to electroplate an antique brass spoon with silver. Which of the following statements describes how the experiment should be set up?

- (a) The cathode is made of silver and the spoon is the anode.
- (b) The spoon is the cathode and the electrolyte is a solution of silver nitrate.
- (c) The spoon is the anode and the electrolyte is a solution of copper sulfate.
- (d) The cathode is made of silver and the electrolyte is a solution of silver nitrate.

17. How many moles of electrons are required when the following half-equation is balanced using the smallest possible coefficients?



- (a) 2
- (b) 5
- (c) 10
- (d) 12

18. Which one of the following statements **BEST** describes the function of an anode in an electrolytic cell?

- (a) The anode is the electrode at which reduction occurs.
- (b) The anode is the only electrode at which OH^- (aq) ions are produced.
- (c) The anode is the electrode which attracts positive ions.
- (d) The anode is the electrode that is oxidised.

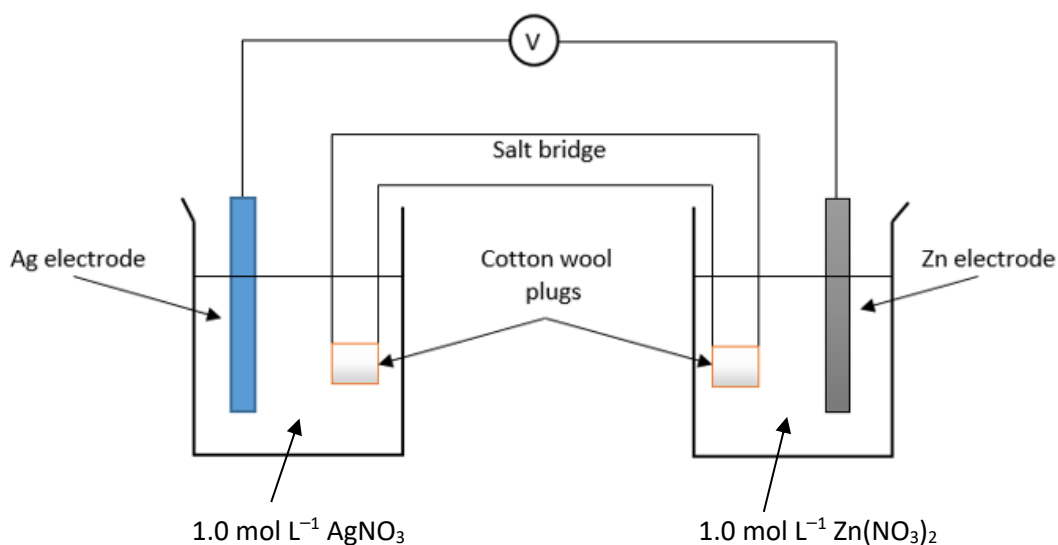
19. In which one of the following processes is the oxidation number of chlorine being increased by 2?

- (a) $\text{PCl}_3 + \text{Cl}_2 \rightarrow \text{PCl}_5$
- (b) $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{Cl}^- + \text{HClO} + \text{H}^+$
- (c) $2 \text{Cl}^- + 2 \text{e}^- \rightarrow \text{Cl}_2$
- (d) $\text{ClO}_3^- + \text{H}_2\text{O}_2 \rightarrow \text{ClO}_4^- + \text{H}_2\text{O}$

20. Which one of the following pairs of chemicals will undergo a spontaneous redox reaction?

- (a) solid iodine and water
- (b) solid lead and liquid bromine
- (c) lead nitrate solution and potassium iodide solution.
- (d) solid copper and a 1.0 mol L^{-1} solution of hydrochloric acid.

Questions 21, 22 and 23 relate to the following electrochemical cell at 25°C:



21. Which of the following reactions will occur during the normal operation of this cell?

- (a) $2\text{Ag}^+(\text{aq}) + \text{Zn}(\text{s}) \longrightarrow 2\text{Ag}(\text{s}) + \text{Zn}^{2+}(\text{aq})$ $E^\circ = 1.56 \text{ V}$
 (b) $2\text{Ag}^+(\text{aq}) + \text{Zn}(\text{s}) \longrightarrow 2\text{Ag}(\text{s}) + \text{Zn}^{2+}(\text{aq})$ $E^\circ = 0.04 \text{ V}$
 (c) $\text{Zn}^{2+}(\text{aq}) + 2\text{Ag}(\text{s}) \longrightarrow \text{Zn}(\text{s}) + 2\text{Ag}^+(\text{aq})$ $E^\circ = 1.56 \text{ V}$
 (d) $\text{Zn}^{2+}(\text{aq}) + 2\text{Ag}(\text{s}) \longrightarrow \text{Zn}(\text{s}) + 2\text{Ag}^+(\text{aq})$ $E^\circ = 0.04 \text{ V}$

22. Which of the following statements about the two electrodes is correct?

- (a) The mass of the silver electrode will decrease.
 (b) The zinc electrode is the cathode.
 (c) The mass of the zinc electrode will decrease.
 (d) The silver electrode is the anode.

23. Which of the following statements about the flow of charge is INCORRECT?

- (a) Electrons will flow from the zinc electrode to the silver electrode through the external circuit.
 (b) Cations will flow through the salt bridge towards the silver half-cell.
 (c) Electrons will flow from the silver electrode to the zinc electrode through the salt bridge.
 (d) Anions will flow through the salt bridge towards the zinc half-cell.

24. The overall redox reaction occurring in a dry cell, (Leclanché cell), is shown below.



Which of the following statements regarding the dry cell are correct?

- I The zinc outer casing is acting as the anode.
- II The oxidation state of manganese decreases from +4 to +3.
- III Ammonium chloride acts as an electrolyte for the cell.

- (a) I and III only.
- (b) I and II only.
- (c) II and III only.
- (d) I, II and III.

25. Consider the following statements about fuel cells.

- I A fuel cell converts chemical energy to electrical energy via a redox reaction.
- II Fuel cell technology involves the continuous supply of reactants to the cells and the continuous removal of the products.
- III A fuel cell can be recharged by reversing the direction of current flow through the cell.
- IV Fuel cells are considered a low-emission technology.

Which of the above statements about fuel cells are true?

- (a) I only
- (b) I and II
- (c) I, III and IV
- (d) I, II and IV

End of section one

Section Two: Short answer

35% (70 Marks)

This section has **ten (10)** 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.

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.

Suggested working time: 60 minutes.

Question 26

(4 marks)

Write observations for any reactions that occur in the following procedures. In each case describe in full what you would observe, including any:

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

If no change is observed, you should state this.

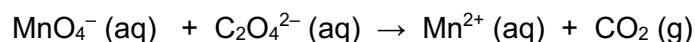
(Note: No chemical equations necessary).

- (a) Some hydrochloric acid solution is mixed with solid sodium carbonate. (2 marks)

- (b) Some solid copper (II) hydroxide is mixed with a dilute nitric acid solution. (2 marks)

Question 27**(4 Marks)**

The following chemical equation represents an unbalanced redox reaction.



In the appropriate spaces below, write the two separate half-equations and the overall balanced redox equation. (4 marks)

Oxidation:

Reduction:

Overall Redox:

Question 28**(6 marks)**

Bromine water, which is a dilute aqueous solution of bromine in water, is slightly acidic because of its reaction with water, represented by the following equation:



In aqueous solution, bromine, $\text{Br}_2 (\text{aq})$ is brown. Hypobromous acid, $\text{HBrO} (\text{aq})$, and bromide ions, $\text{Br}^- (\text{aq})$ are both colourless.

State and explain the colour changes that would be observed, if the following changes are made to the system at equilibrium.

- (a) Addition of $\text{NaOH} (\text{aq})$. (3 marks)

Colour: _____

Explanation:

- (b) Addition of excess $\text{HCl} (\text{aq})$. (3 marks)

Colour: _____

Explanation:

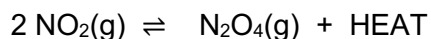
Question 29**(10 Marks)**

Explain how you could distinguish between the following pairs of compounds using chemical tests. For each test, write one equation for a reaction that occurred.

	Compounds	Description of Test	Observations
(a)	$\text{NH}_4\text{Cl}(\text{aq})$		with $\text{NH}_4\text{Cl}(\text{aq})$:
	$\text{MgCl}_2(\text{aq})$		with $\text{MgCl}_2(\text{aq})$:
	Equation:		
(b)	$\text{Sn}(\text{s})$		with $\text{Sn}(\text{s})$
	$\text{Zn}(\text{s})$		with $\text{Zn}(\text{s})$
	Equation:		

Question 30**(13 Marks)**

This question relates to the following reaction:

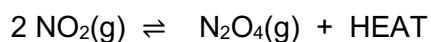


The gases are contained in a sealed vessel with a fixed volume, which is strong enough to resist changes in pressure and temperature without breaking.

- (a) Complete the table by using Le Châtelier's principle or collision theory, as appropriate, to predict the effect on the position of equilibrium (shifted to the right/left/unchanged) of the following imposed changes once equilibrium is re-established. In each case explain your reasoning. One has been partially completed for you. (8 marks)

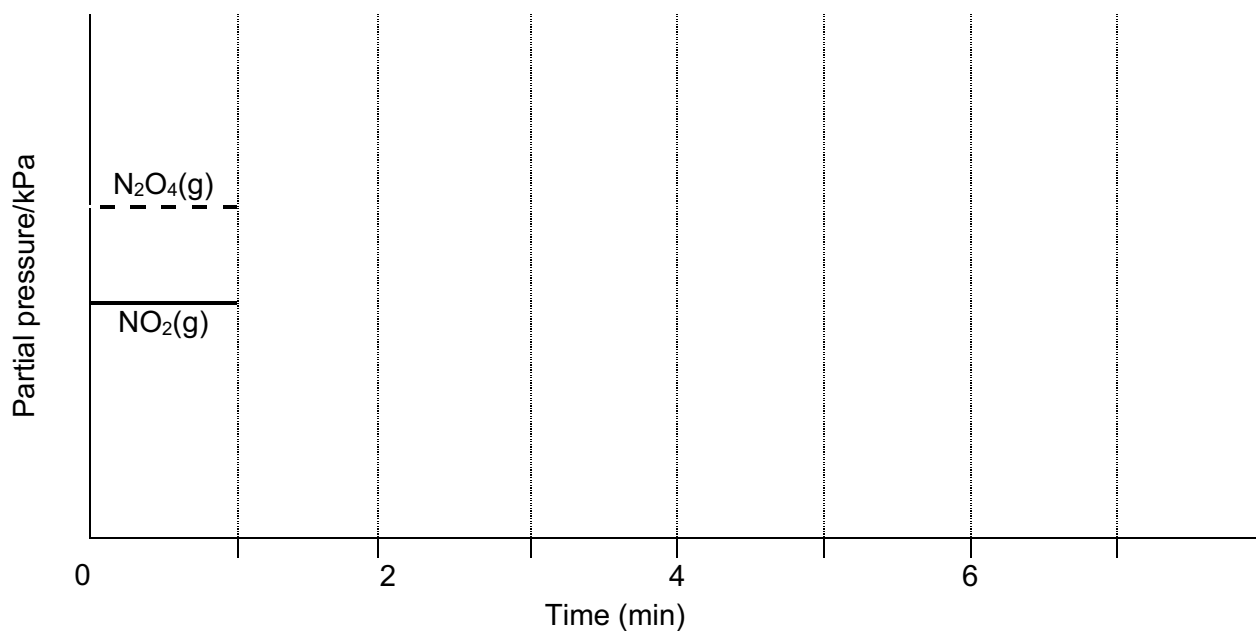
Imposed change	Effect on equilibrium position	Reasoning
Increased temperature	Shifted to the left	
Additional nitrogen dioxide gas is added to the system		
Neon gas is added to the system (fixed volume)		

- (b) A mixture of the gases was placed into a syringe that allowed for the volume of the system to be changed. The partial pressures of the gases were measured and plotted on the graph below.



- After 2 minutes, the volume of the syringe was reduced. The system took one minute to re-establish equilibrium.
- 1 minute after this time, approximately half of the NO_2 was removed from the system. This time it took 2 minutes to return to a state of equilibrium.

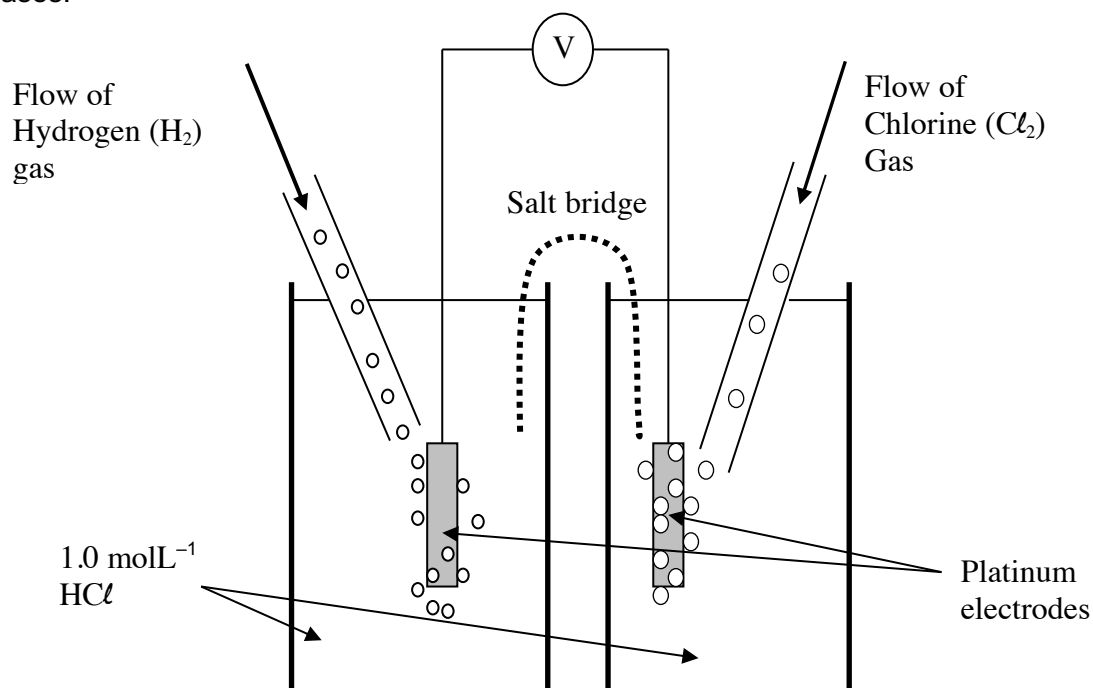
Complete the following graph showing the changes to the partial pressures of nitrogen dioxide and dinitrogen tetroxide during this time. (5 marks)



Question 31

(6 Marks)

Below is a representation of an electrochemical cell, which involves the reaction of hydrogen and chlorine gases:



- (a) Give the half equation for the reactions occurring at the anode and at the cathode, and then write an overall balanced redox equation for the reaction occurring in the cell.

Cathode half-equation:
Anode half-equation:
Overall equation:

(3 marks)

- (b) Using the standard reduction potential values from the data sheet, calculate the maximum theoretical voltage (e.m.f.) that could be produced by this cell.

(1 mark)

- (c) Show the direction of the flow of electrons in the external circuit by means of an **arrow**, “(→)” in the diagram above.

(1 mark)

- (d) Suggest a reason why platinum is used for the electrodes. (1 mark)

Question 32

(9 Marks)

Use the Standard Reduction Potentials from your Data Booklet to answer the following questions. In each case, write all relevant half-equations with their respective E° values. (If the reaction is likely to occur, write an overall balanced redox equation with the resultant cell voltage). Then you must state clearly if the reaction is likely or unlikely to occur as described.

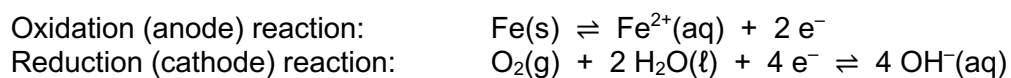
- (a) A piece of aluminium metal is placed in a 1.00 mol L^{-1} nickel nitrate solution. (3 marks)

- (b) Silver metal is added to a 1.00 mol L^{-1} sulfuric acid solution. (3 marks)

- (c) Iron(II) nitrate solution is added to a solution of hydrogen peroxide. (3 marks)

Question 33**(8 marks)**

The two initial reactions involved in the wet corrosion of iron are shown below. Both of these reactions are reversible.



- (a) Combine these two half equations to write a balanced overall redox reaction for the process.

(2 marks)

- (b) Use your knowledge of chemical equilibrium to predict whether iron will corrode more quickly in water that is slightly acidic or water that is slightly basic. Justify your reasoning.

(3 marks)

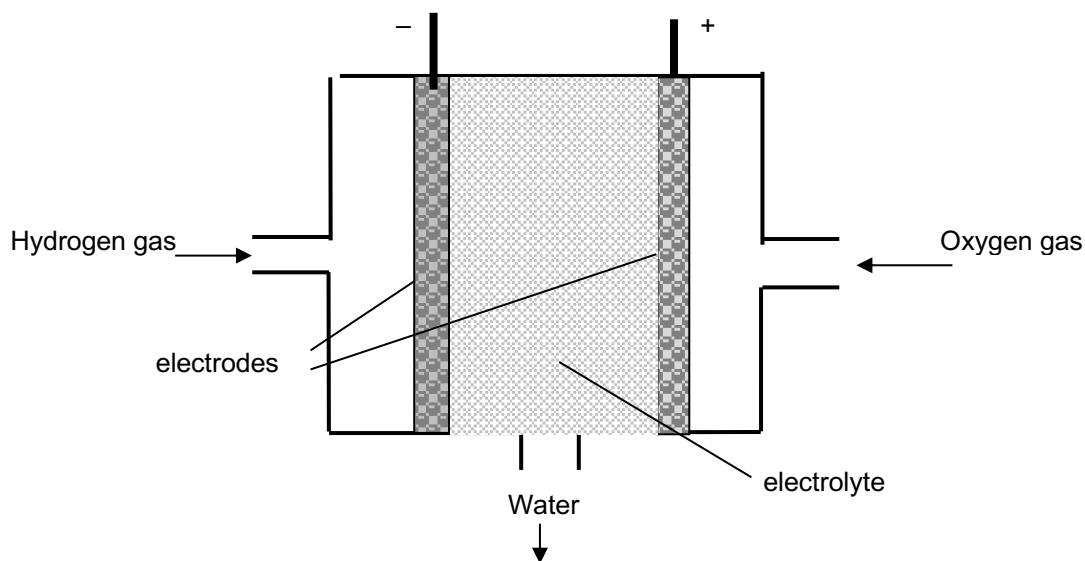
- (c) Water tanks made of steel (an alloy containing a mixture of iron and carbon), can be protected from corrosion by connecting a 'sacrificial' anode made of zinc to the inside of the tank. With reference to the standard reduction potentials of iron and zinc, explain how this reduces the corrosion of iron in the tank.

(3 marks)

Question 34

(5 marks)

The following diagram represents a hydrogen fuel cell.



- (a) Write the overall redox equation, including state symbols, for the reaction occurring in this cell. (2 marks)

- (b) Explain the role of the electrolyte in this fuel cell. (2 marks)

- (c) Explain one environmental advantage of using fuel cells to power vehicles compared to using a fossil fuel. (1 mark)

Question 35

(5 marks)

- (a) Calculate the pH of a solution of $0.0200 \text{ mol L}^{-1}$ sodium hydroxide.

(2 marks)

- (b) 30.0 mL of $0.0200 \text{ mol L}^{-1}$ sulfuric acid was added to 30.0 ml of the sodium hydroxide described in part (a). Calculate the pH of the resulting solution (assume that the sulfuric acid fully ionizes).

(3 marks)

End of section two



**Hale School
Semester One Examination, 2017**

Write your name below:

**Yr12 ATAR CHEMISTRY
UNIT 3**

JWZ

AD

JJF

KF

**Section 3 Question and
Answer Booklet.**

For Examiners only

For Examiners only	
Part 3	

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

This section contains **five (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.

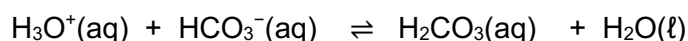
Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- 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.

Suggested working time: 70 minutes.

Question 36**(19 marks)**

Human blood contains a buffer of carbonic acid (H_2CO_3) and bicarbonate anion (HCO_3^-) in order to maintain blood pH between 7.35 and 7.45. This buffer can be represented as shown below.



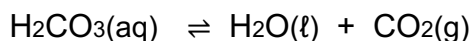
(a) Using the example above,

- (i) describe the action of a buffer. (2 marks)

- (ii) explain the term “buffering capacity”. (3 marks)

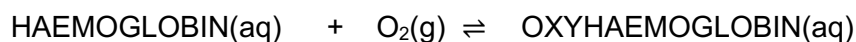
- (b) Explain, using equations, why this system buffers the blood. (4 marks)

The carbonic acid can also decompose into carbon dioxide gas and water, resulting in a second equilibrium system between carbonic acid and water:



- (c) Use this equation, and the earlier equation that represents the buffer, to explain the changes in blood pH caused by an increase in the concentration of carbon dioxide in the blood. (4 marks)

- (d) In human blood, oxygen is transported by combining with haemoglobin according to the following reversible reaction to form oxyhaemoglobin that travels around the body:



“An increase in the acidity of blood causes this equilibrium to shift towards the left, thus releasing oxygen from the oxyhaemoglobin molecules, which allows for cell respiration to provide energy”. Suggest, with an explanation, how an increase in carbon dioxide levels during exercise would affect the concentration of haemoglobin in blood.

(2 marks)

- (e) Buffers can be used to maintain pH in a range of situations, including for scientific research. For example, when preparing biological samples for electron microscopy a buffer of monoprotic cacodylic acid ($C_2H_7AsO_2$) and its conjugate base is used.

Write an equation to show the equilibrium system for this buffer and describe how the system will respond to an **increase** in pH. (4 marks)

Question 37

(14 marks)

The electroplating of various metals plays an extremely important role in industry. These reactions can be carried out on a small scale in the laboratory using standard laboratory equipment. A typical spoon can be electroplated with chromium metal, utilising a chromium electrode and an acidified aqueous chromium nitrate solution. Using a labelled diagram, explain the process involved in electroplating the spoon.

Your answer should pay particular attention to the following areas:

- (a) How the cell can be constructed. (A diagram with clear labels for the anode, cathode, electrolyte, direction of flow of electrons and ions). (6 marks)
- (b) Describe the processes occurring at each electrode. (Including half-equations). (4 marks)
- (c) Observations made at each electrode. (2 marks)
- (d) The role of the electrolyte. (1 mark)
- (e) An example for the industrial importance or application of the process. (1 mark)

Diagram:

Question 38

(10 marks)

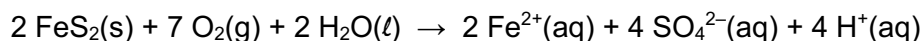
Compare and contrast electrolytic and galvanic cells.

In your answer include similarities and differences between the two types of electrochemical cells in relation to energy, anodes and cathodes, electrode potentials, and the spontaneity of reactions.

Illustrate your answer with examples of your choice. Include equations and clear, labelled diagrams.

Question 39**(14 marks)**

When soils containing iron pyrite (FeS_2) are exposed to air, the following reaction occurs.



These types of soils are called acid sulfate soils. The pH of groundwater in these soils will decrease. If this groundwater discharges into lakes and rivers it will also cause their pH to decrease.

- (a) Explain how this reaction causes the pH of groundwater to decrease. (2 marks)

A titration was carried out on a sample of lake water, suspected of being contaminated with acid soils, to determine its pH.

A student placed a standardised solution of 0.005 mol L^{-1} NaOH in the burette.

The student then titrated the NaOH solution against 50.0 mL samples of the lake water and obtained the following results.

	Trial 1	Trial 2	Trial 3	Trial 4
Final burette reading (mL)	4.25	8.05	12.00	16.05
Initial burette reading (mL)	0.00	4.10	8.10	12.05
Volume of NaOH used (mL)				

- (b) Determine the average volume of NaOH used. (2 marks)

- (c) Calculate the average number of moles of NaOH used to neutralise the acid. (1 mark)

- (d) Assuming that the lake water is the only source of H^+ ions and that complete ionisation of the acid in the lake water has occurred, determine the pH of the lake water. (3 marks)

- (e) Complete the following table (6 marks)

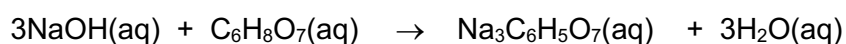
Equipment	What is it used for in this experiment?	What should it be rinsed with before use?
Burette		
Pipette		
Conical flask		

Question 40**(23 marks)**

Citric acid has a formula of $\text{C}_6\text{H}_8\text{O}_7$ and is a weak triprotic acid. A student, Steve, was investigating the amount of citric acid present in a bottle of lemon juice concentrate.

He decided to titrate 25.00 mL samples of the lemon juice against 0.998 mol L^{-1} NaOH solution.

The reaction for the equation is:



Steve's results are shown below.

	Titrations			
	1	2	3	4
Final Reading (mL)	15.60	30.80	46.05	15.75
Initial Reading (mL)	0.00	15.60	30.80	0.60
Titre (mL)				

(a) Calculate the **concentration** of citric acid in the lemon juice

- (i) in moles per litre. (6 marks)
- (ii) as a percentage by mass (assume the mass of a 25.00 mL sample = 25.00 g). (4 marks)

A second student, Claire, wanted to find out the citric acid concentration in a freshly squeezed lemon. As her lemon juice was less homogeneous than the bottled juice, she decided to carry out a 'back titration' to avoid having to measure out accurate aliquots of the lemon juice. Claire added an excess amount of an alkali, sodium hydroxide solution, to the lemon juice, and then titrated the excess sodium hydroxide against hydrochloric acid.

8.00 g of the lemon juice was mixed with 25.00 mL of 0.600 mol L⁻¹ NaOH_(aq) and stirred thoroughly. The resulting solution, containing the excess sodium hydroxide solution, was filtered and immediately titrated against 0.501 mol L⁻¹ hydrochloric acid, with 15.50 mL of the acid being required.

- (b) (i) Calculate the total number of moles of sodium hydroxide added to the 8.00 g of fresh lemon juice.

(1 mark)

- (ii) Calculate the moles of excess sodium hydroxide, and hence calculate the number of moles of sodium hydroxide that reacted with the citric acid in the lemon juice.

(3 marks)

- (iii) Calculate the number of moles of the citric acid in the 8.00 g sample, and hence determine the percentage, by mass, of the citric acid in the fresh lemon juice. (4 marks)

Spare graph paper

Question number: _____

