PENRHOS COLLEGE

STRIVE FOR THE HIGHEST

Western Australian Certificate of Education

Mock Examination, 2012

Question/Answer Booklet

NAME

CHEMISTRY

Stage 3

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

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, pencils, eraser, correction fluid, ruler, highlighters**

Special items: **non-programmable calculators satisfying the conditions set out by the Curriculum Council for this course**

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.

OFFICE USE ONLY

	MARK	TOTAL	%
Section 1		50	
Section 2		70	
Section 3		80	

SEE NEXT PAGE

TOTAL		200	

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	10	10	60	70	35
Section Three: Extended answer	5	5	70	80	40
					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.
   Place a **cross (X)** on each correct answer.
   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.

2. When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and show units where applicable.

3. 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.

4. 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

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.

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1. Consider the ion $^{119}_{50}Sn^{4+}$

Which of the following rows correctly shows the number of protons, neutrons and electrons for this ion?

	Protons	Neutrons	Electrons
(a)	119	49	49
(b)	50	69	49
(c)	119	69	52
(d)	50	69	46

Questions 2 and 3 refer to electron configurations for elements I, II, III, and IV shown below.

I 2, 1
II 2, 3
III 2, 8, 1
IV 2, 8, 4

2. Which of these elements belong to the same group of the periodic table?

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

3. Which of these elements will have the lowest first ionisation energy?

(a) I
(b) II
(c) III
(d) IV

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4. What is the formula of an ionic compound consisting of positive ions with an electron configuration 2, 8, 8 and negative ions with the same configuration?

(a) LiF

(b) MgS

(c) NaF

(d) KCℓ

5. Chromate and dichromate ions form an equilibrium according to the following equation.

$$2CrO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} \quad Cr_2O_7^{2-}{}_{(aq)} + H_2O_{(l)}$$

Which solution would decrease the concentration of the chromate ion (CrO_4^{2-}) when added to the equilibrium mixture?

(a) Sodium ethanoate (acetate)

(b) Ammonium chloride

(c) Sodium nitrate

(d) Sodium chloride

6. Which of the following statements concerning intermolecular forces is/are correct?

I Dispersion forces exist in all molecular solids.

II All molecules that contain polar bonds are polar molecules.

III Hydrogen bonding only occurs for molecules containing O-H bonds.

(a) I only

(b) II only

(c) III only

(d) I and II only

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7. Why is the bond between a sulfur atom and an oxygen atom polar?

(a) The O atom is more electronegative than the S atom.

(b) The S atom has a higher positive charge in the nucleus than the O atom.

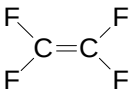
(c) The S atom is larger than the O atom.

(d) The S atom has more electrons than the O atom, so it will be negative relative to the O atom.

8. Which of the following molecules is polar?

(a) CH_4

(b) $CC\ell_4$

(c) 

(d) CO

9. Consider the statements about the following reaction:

$$2\ H_2O_{2(l)} \rightarrow 2\ H_2O_{(l)} + O_{2(g)}$$

I H_2O_2 is reduced.

II H_2O_2 is oxidised.

III H_2O_2 acts as a reducing agent.

IV This is not a redox reaction.

Which of the above statements is/are true?

(a) IV only

(b) II and III only

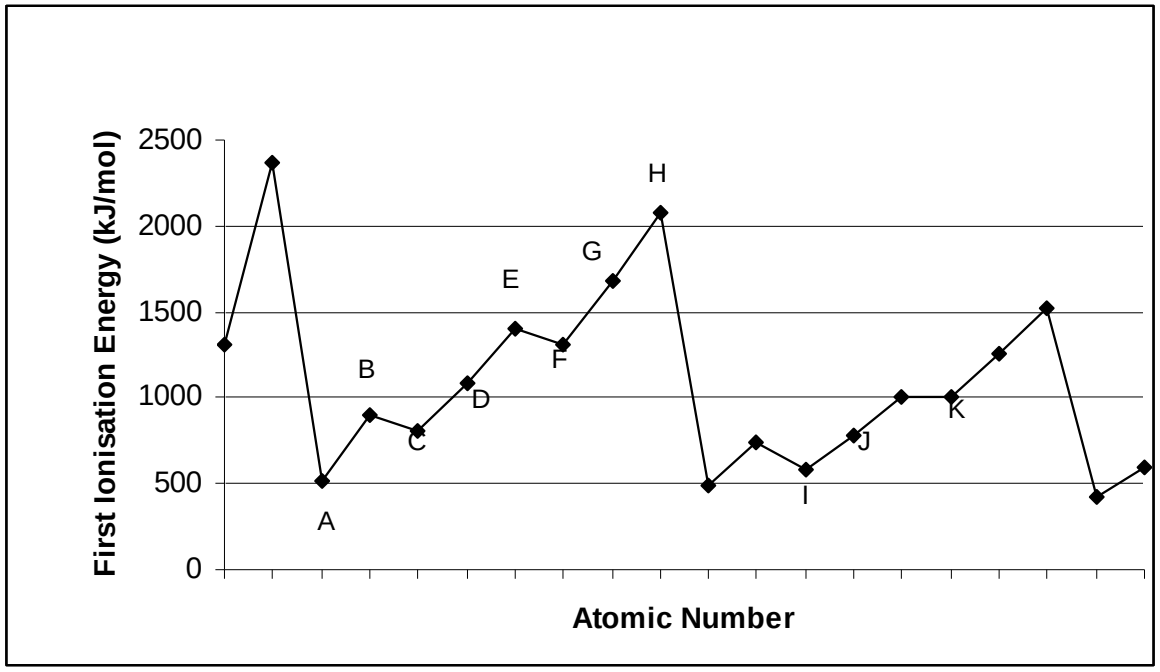
(c) I only

(d) I, II and III only

10. Which one of the following correctly lists important properties of the metals zinc, aluminium and gold?

	Zn	**Al**	**Au**
(a)	Easily oxidised	Low density	Soft
(b)	Hard	Shiny	Easily oxidised
(c)	High density	Poor conductivity	Malleable
(d)	Soft	Good oxidant	Hard

Questions 11, 12 and 13 refer to the following graph, which shows the trend of first ionisation energies for the first 20 elements.



11. Which of the following statements best explains the trend in first ionisation energies for the elements labelled A through to H?

(a) There is an increasing number of electrons in the atoms going from element A to element H.

(b) The atomic radii increase from element A to element H.

(c) There is an increasing number of protons in the nuclei going from element A to element H.

(d) Electrons are being added to the second energy level for elements A to H.

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12. Which of the following combinations of atoms is most likely to result in a covalent molecular compound?

(a) B with F

(b) F with K

(c) C with J

(d) B with C

13. Which of the following elements, when combined with oxygen, would give the compound with the highest melting point?

(a) A

(b) G

(c) E

(d) K

Questions 14 and 15 relate the following information:

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

$$Zn_{(s)} + 2\,NH_4^{+}{}_{(aq)} + 2\,MnO_{2(s)} \rightarrow Zn^{2+}{}_{(aq)} + Mn_2O_{3(s)} + H_2O_{(l)} + 2NH_{3(aq)}$$

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

I Zinc is acting as the anode.

II The oxidation state of manganese drops 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

15. Which of the following will NOT increase the rate of the redox reaction?

(a) Increasing the concentration of ammonium ions.

(b) Grinding up the MnO_2 into a finer powder.

(c) Using a thicker zinc outer casing.

(d) Warming up the cell

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Questions 16, 17 and 18 relate the following information:

A student was asked to determine the concentration of a solution of ethanoic acid that had a concentration of approximately 4.00×10^{-1} mol L^{-1}. He pipetted 20.0 mL of a 0.500 mol L^{-1} solution of sodium hydroxide into a flask and titrated the ethanoic acid against this sodium hydroxide solution, using phenolphthalein as the indicator.

16. What would be the pH of the sodium hydroxide solution at the start of the titration?

(a) 13.7

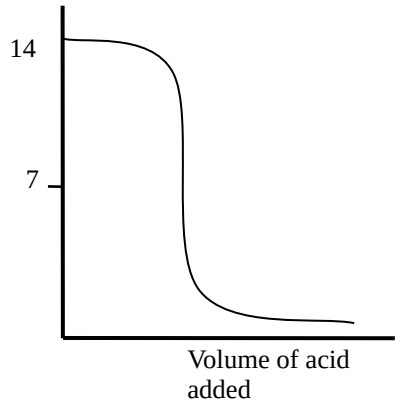
(b) 7.0

(c) 14.0

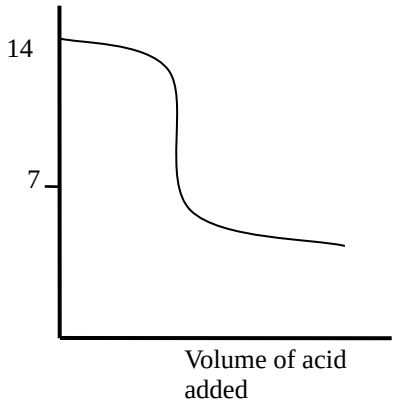
(d) 12.7

17. 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?

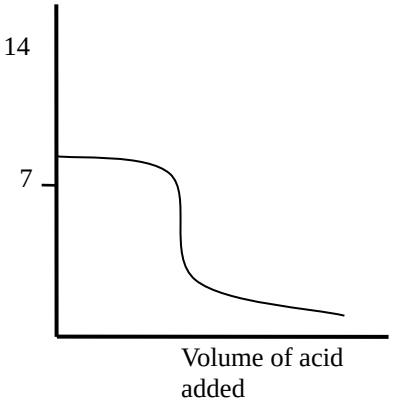
(a)



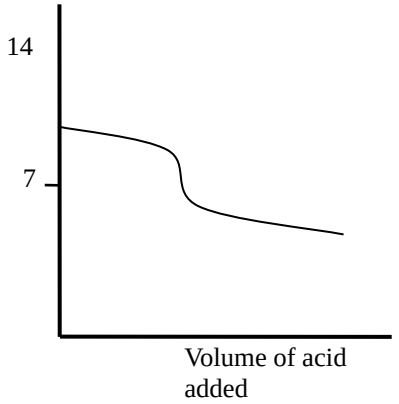
(b)



(c)



(d)



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

(a) 20 mL

(b) 30 mL

(c) 25 mL

(d) 35 mL

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19. Which of the following best explains the increase in electrical conductivity of the elements going down Group 14 of the Periodic Table?

(a) Their first ionisation energies increase as you go down the group.

(b) The elements become increasingly metallic as you go down the group.

(c) Elements with fewer oxidation states are better electrical conductors.

(d) The elements become increasingly basic as you go down the group.

20. The conjugate base of the acid $HCrO_4^-$ is:

(a) H_2CrO_4

(b) $H_2CrO_4^-$

(c) CrO_4^{2-}

(d) CrO_4^-

21. Which of the following molecules is not an isomer of the others?

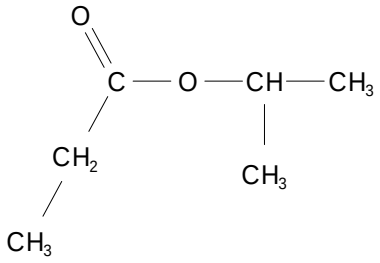
(a) 2-methyl-3-hexene

(b) 1,3-dimethylcyclopentane

(c) 2,3-dimethyl-1-pentene

(d) 3-ethylpentane

22. Which of the pairs of compounds below could be used to make the following molecule?



(a) Propanoic acid and 2-propanol

(b) Propanoic acid and 2-methylpropanol

(c) Ethanoic acid and 2-propanol

(d) Ethanoic acid and 1-propanol

23. What is the concentration, in ppm of a solution of 1.00×10^{-3} mol L^{-1} $NaCl_{(aq)}$?
[M(NaCl) = 58.44 g mol^{-1} and assume that 1 L of solution has a mass of 1 kg]

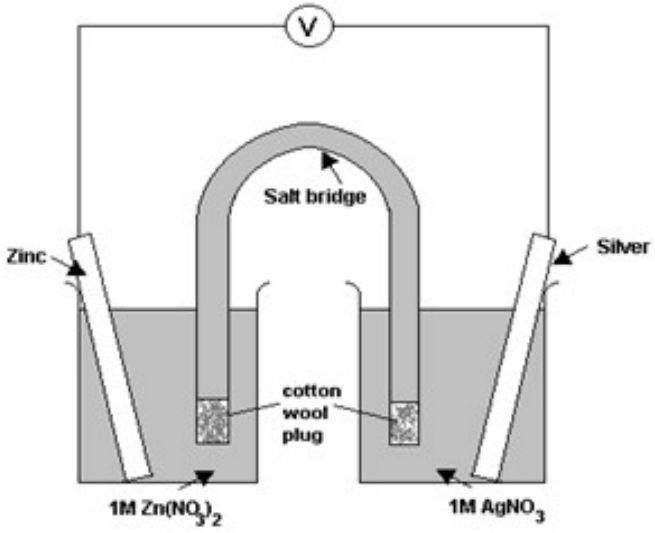
(a) 5.84×10^{-2} ppm

(b) 58.4 ppm

(c) 5.84×10^{4} ppm

(d) 0.171 ppm

24. Which of the following reactions will occur in the electrochemical cell depicted in the diagram below?



(a) $2Ag^{+}(aq) + Zn(s) \Rightarrow 2Ag(s) + Zn^{2+}(aq)$ $E^0 = 1.56$

(b) $2Ag^{+}(aq) + Zn(s) \Rightarrow 2Ag(s) + Zn^{2+}(aq)$ $E^0 = 0.04$

(c) $Zn^{2+}(aq) + 2Ag(s) \Rightarrow Zn(s) + 2Ag^{+}(aq)$ $E^0 = 1.56$

(d) $Zn^{2+}(aq) + 2Ag(s) \Rightarrow Zn(s) + 2Ag^{+}(aq)$ $E^0 = 0.04$

25. When 1.0 mol L^{-1} solutions of the following are mixed, which combinations will result in the formation of precipitates?

i $Ba(NO_3)_2$ and HCl

ii $Ca(NO_3)_2$ and Na_2CO_3

iii $Cu(NO_3)_2$ and KOH

iv $Pb(NO_3)_2$ and H_2SO_4

(a) i, ii and iii only

(b) ii and iii only

(c) i, ii, iii and iv

(d) ii, iii and iv only

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Section Two: Short answer 35% (70 Marks)

This section has **9** questions. Answer **all** questions. Write your answers in the spaces 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: 60 minutes.

Question 26 **[12 marks]**

Write net ionic equations (where appropriate) and 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 (state the colour)
- gases evolved (state the colour or describe as colourless).

If no change is observed, you should write “no visible change”.

(a) Copper(II) nitrate solution is added to excess sodium carbonate solution.

Equation (2 marks)

Observation (1 mark)

(b) A colourless organic liquid 2-methyl-2-propanol is added to a dilute acidified solution of potassium dichromate.

Equation (2 marks)

Observation (1 mark)

(c) Sodium metal is added to pure acetic acid (ethanoic acid).

Equation (2 marks)

Observation (1 mark)

(d) Dilute hydrochloric acid solution is added to solid nickel carbonate.

Equation (2 marks)

Observation (1 mark)

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Question 27 **[10 marks]**

(a) Describe with the aid of diagrams one difference and one similarity in structure between soaps and detergents.

Diagram of soap
Diagram of detergent

(2 marks)

Difference in structure: (1 mark)

Similarity in structure: (1 mark)

(b) Explain how the cleaning action of soaps and detergents differs in “hard” water. (2 marks)

(c) Explain how soap can wash oil from your hands. A diagram may be useful.

(4 marks)

Diagram

SEE NEXT PAGE

Question 28 **[4 marks]**

Chemical tests can be used to distinguish between chemical substances. Outline the steps of a chemical test that can be used to distinguish between cyclohexane and cyclohexene. In your answer, describe the observations that would be made and write an equation to account for these observations.

Chemical test: (1 mark)

Observations: (2 marks)

Equation: (1 mark)

Question 29 **[7 marks]**

(a) Write the electronic configuration of a potassium ion. _____

(1 mark)

(b) The first four successive ionisation energies of potassium are shown in the table below:

	1st	**2nd**	**3rd**	**4th**
Ionisation energy (kJ mol^{-1})	425	3058	4418	5883

(i) Explain what is meant by the term *first ionisation energy* of potassium. (2 marks)

(ii) Explain the trend in the first four ionisation energies of potassium. (2 marks)

(iii) Why is there a **large** difference between the values for the first and the second ionisation energies of potassium? (2 marks)

SEE NEXT PAGE

Question 30 **[9 marks]**

(a) For each species listed in the table below, draw the structural formula, representing all valence shell electron pairs either as **:** or as — **and** state or draw the shape of the molecule and indicate whether the molecule is polar or non-polar. (6 marks)

	Methane	**Ammonia**	**Water**
Lewis structure			
Shape and polarity			

(b) Water and methane have similar relative molecular masses and both contain the element hydrogen. The table below gives some information about water and methane.

	H_2O	**CH_4**
M_r	18.016	16.042
Melting point (K)	273	91

(i) State the strongest type of intermolecular force holding the water molecules together in an ice crystal.

_____

(1 mark)

(ii) State the strongest type of intermolecular force in methane.

_____

(1 mark)

(iii) Explain why the melting point of ice is higher than the melting point of methane.

_____

_____

_____

_____

(1 mark)

SEE NEXT PAGE

Question 31 **[8 marks]**

The atomic radii of some of the elements in groups 1-17 of the Periodic Table are shown in the table below. Some radii have been omitted.

Group	**1**	**2**	**13**	**14**	**15**	**16**	**17**
Period 2 element	**Li**	**Be**	**B**	**C**	**N**	**O**	**F**
atomic radius/nm	0.134	0.125	0.090	0.077	0.075	0.073	0.071
Period 3 element	**Na**	**Mg**	**Al**	**Si**	**P**	**S**	**Cl**
atomic radius/nm	0.154	0.145	0.130	0.118	0.110		0.099
Period 4 element	**K**	**Ca**	**Ga**	**Ge**	**As**	**Se**	**Br**
atomic radius/nm	0.196	0.174		0.122	0.114	0.117	0.114

(a) (i) State the trend shown in atomic radius across a period. (1 mark)

(ii) Explain why this trend occurs. (3 marks)

(b) Mendeleev studied periodic data to make predictions for the properties of elements which had yet to be discovered. Using the data above, suggest values for the atomic radius of

(i) S _____nm, (ii) Ga _____nm. (2 marks)

(c) Explain how the trend in atomic radius relates to the electronegativity values for the elements across Period 2 (lithium to fluorine).

(2 marks)

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Question 32 **[9 marks]**

Le Châtelier's Principle can be used to explain how the kidneys help prevent excessively high blood pH (a condition known as **alkalosis**). HCO_3^- is removed from the blood by the kidneys. The equilibrium reaction is

$$H_3O^+_{(aq)} + HCO_3^{--}{}_{(aq)} \qquad H_2CO_{3(aq)} + H_2O_{(l)} \qquad 2H_2O_{(l)} + CO_{2\,(g)}$$

(a) An emergency medical team evaluates an Olympic athlete and determines that she has alkalosis. How will her kidneys help to counter her alkalosis? (4 marks)

Hyperventilation (very rapid and deep breathing), reduces the concentration of CO_2 in the blood and causes dizziness.

(b) How does hyperventilation affect the pH of the blood (i.e. does the pH increased or decrease as a result of hyperventilation)? Briefly, explain your answer in terms of equilibrium shifts. (3 marks)

(c) The normal first-aid treatment for hyperventilation is to have the patient breathe in and out of a paper bag. Briefly, explain why this treatment works and explain what effect the paper-bag treatment has on the pH of the blood. (2 marks)

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Question 33 **[5 marks]**

Arrange the following compounds in order of decreasing boiling point.

In the table write “1” for the compound with the highest boiling point, down to “5” for the compound with the lowest boiling point.

Compound	Boiling points in order (1=highest, 5=lowest)
$CH_3CH_2CH_2CH_2CH_2CH_3$	
$CH_3CH_2CH_2COOH$	
$CH_3CH_2CH_2CH(CH_3)_2$	
$CH_3CH_2CH_2CH_2CH_2OH$	
$CH_3CH_2CH_2CH_2CHO$	

(1 mark)

Explain why the boiling point of $CH_3CH_2CH_2CH_2CH_2CH_3$ and $CH_3CH_2CH_2CH(CH_3)_2$ are different.

_____

_____

_____

_____

_____

_____

(2 marks)

Explain why the boiling point of $CH_3CH_2CH_2CH_2CH_2OH$ and $CH_3CH_2CH_2CH_2CHO$ are different.

_____

_____

_____

_____

_____

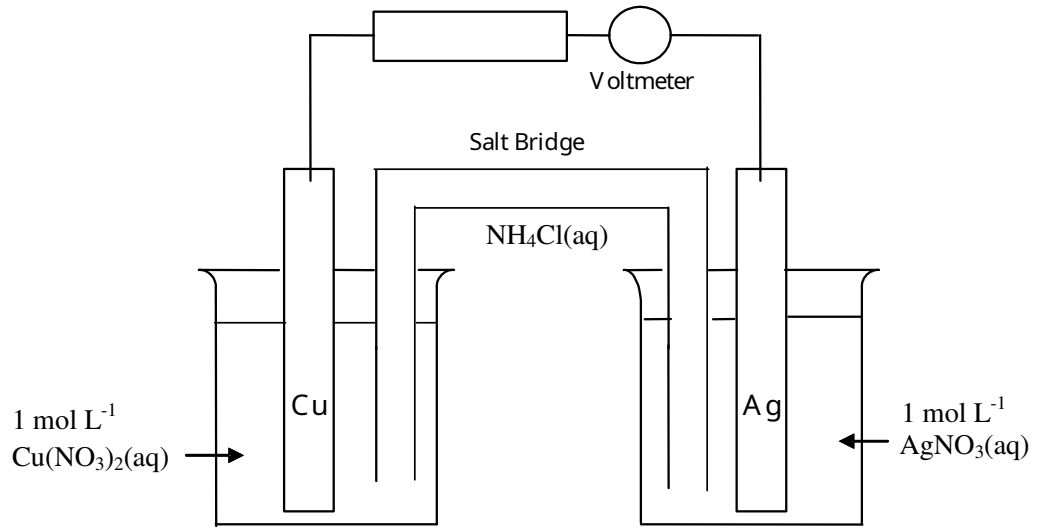
_____

(2 marks)

SEE NEXT PAGE

Question 34 **[6 marks]**

Below is a diagram of an electrochemical cell.



(a) Write a half equation to show the reaction at the cathode of the cell.

_____

(1 mark)

(b) Draw an arrow **in the box** provided on the diagram to indicate the flow of electrons in the external circuit.

(1 mark)

(c) What would you expect to observe in the Cu/Cu^{2+} half-cell.

_____

_____

_____

(2 marks)

(c) Give the formula of one ion that will move from the Cu/Cu^{2+} half-cell towards the Ag/Ag^{+} half-cell through the salt bridge.

_____

(1 mark)

(e) Under standard conditions, what is the maximum expected reading on the voltmeter in the external circuit?

_____

(1 mark)

End of Section Two, go on to Section Three

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 **three (3) significant figures**.

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- 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: 70 minutes.

Question 35 **[18 marks]**

A student carried out TWO experiments with magnesium.

(a) In the FIRST experiment, the student heated a piece of magnesium in a flask of oxygen gas.

(i) State what the student would observe in this reaction. (1 mark)

_____

_____

(ii) Write a balanced chemical equation for the reaction. (1 mark)

_____

(iii) The product is a solid with a melting point of 2852 ^{0}C. Explain why the melting point is so high.

(2 marks)

_____

_____

_____

(iv) The student added water to the product of the reaction. Some of the product reacted, forming a solution. Write an equation to represent this reaction.

(1 mark)

_____

Predict a value for the pH of this solution. _____(1 mark)

SEE NEXT PAGE

(b) In a SECOND experiment, the student added 1.20 g of magnesium to 50 mL of 2.00 mol L^{-1} hydrochloric acid.

(i) Write a balanced chemical equation to represent the reaction. (1 mark)

(ii) Determine the limiting reagent in the experiment. (3 marks)

(iii) Calculate the volume of H_2 gas that would be produced at 0 ^{0}C and 100 kPa. (1 mark)

(iv) Calculate the pH of the solution when the reaction is complete. (4 marks)

(c) The student repeated both experiments with calcium.

(i) What difference would you expect in reactivity? (1 mark)

(ii) Explain your answer to (i). (2 marks)

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Question 36 **[15 marks]**

The Haber process for the manufacture of ammonia is operated by passing a mixture of nitrogen and hydrogen gases over finely divided iron at a pressure of 300 atm (1 atm = 101.3 kPa) and a temperature of 450 °C. The reaction is exothermic.

(a) Write a balanced chemical equation for the reaction between nitrogen and hydrogen in the production of ammonia. (1 mark)

_____

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

(c) What is the purpose of the finely divided iron? (2 marks)

_____

_____

_____

(d) Explain why a high pressure is used. (3 marks)

_____

_____

_____

_____

_____

_____

(e) Using pressures above 300 atm would be chemically advantageous. In practice, such high pressures are not used. Suggest a reason why. (1 mark)

_____

_____

_____

SEE NEXT PAGE

(f) Temperatures much higher than 450 ^{0}C could be used. Explain one advantage and one disadvantage of using a higher temperature. (2 marks)

advantage: _____

_____

_____

_____

disadvantage: _____

_____

_____

_____

(g) Ammonium sulfate reacts with sodium hydroxide to form ammonia, sodium sulfate and water as shown in the equation below.

$$(NH_4)_2SO_{4(s)} + 2NaOH_{(aq)} \rightarrow 2NH_{3(g)} + Na_2SO_{4(aq)} + 2H_2O_{(l)}$$

A 3.14 g sample of ammonium sulfate reacted completely with 39.30 mL of a sodium hydroxide solution. Calculate the concentration, in mol L^{-1}, of the sodium hydroxide solution used.

(3 marks)

_____

_____

_____

_____

_____

(h) A sample of ammonia gas occupied a volume of 1.53×10^{-2} L at 37 °C and a pressure of 100 kPa. Calculate the amount, in grams, of ammonia in this sample.

(2 marks)

_____

_____

_____

_____

_____

SEE NEXT PAGE

Question 37 **[18 marks]**

Carbon is able to form an enormous number of chemical compounds because of its ability to bond not only with other elements but with other carbon atoms to form chains and rings.

(a) A student burned (completely combusted) a paraffin candle ($C_{25}H_{52}$) in an open beaker. Write a balanced chemical equation for the reaction.

_____

_____

(2 marks)

(b) The following data was recorded:

Time (min)	Mass of candle and beaker (g)
0.0	175.00
2.0	173.20

Calculate how long it would take to produce 0.70 g of CO_2.

_____

_____

_____

_____

_____

_____

_____

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(4 marks)

Alkanes such as those in a paraffin candle ($C_{25}H_{52}$) are not particularly useful fuels. The petroleum industry uses a process called catalytic cracking whereby large alkanes such as $C_{25}H_{52}$ are converted to shorter, more useful alkanes. Alkenes are also a product of the cracking process. One such alkene is butene.

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(c) Butene exists in a number of isomeric forms.

Draw (write) structural diagrams for 4 of the unsaturated isomers of butene and assign each an IUPAC or systematic name.

(8 marks)

Structural formula	***IUPAC Name***

This question continued on the next page

(d) Butene can exist as a SATURATED isomer. Draw (write) a structural diagram for one SATURATED isomer of butene and assign it an IUPAC or systematic name.

(2 marks)

Structural formula	***IUPAC Name***

(e) 2-Butene is used to make a commercially important polymer. Name the type of polymerization that takes place.

(1 mark)

_____

(f) Draw a structural diagram of this polymer showing TWO repeating units. (1 mark)

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Question 38 **[10 marks]**

The amount of iron, as Fe^{2+}, present in a multivitamin tablet may be determined by titrating against potassium permanganate, $KMnO_4$. In one determination, two tablets were dissolved in 20.00 mL of distilled water in a conical flask. 0.002500 M potassium permanganate solution was then titrated against this 20.00 mL aliquot of the tablet solution. This was repeated several times. The results are shown in the table below.

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**
Final reading (mL)	17.06	32.91	17.33	33.19	16.51
Initial reading (mL)	0.85	17.06	1.14	17.33	0.67
Titre volume (mL)					

(a) Calculate the mass of iron in ONE multivitamin tablet. (8 marks)

(b) Suggest the most suitable indicator for this titration and describe the colour change that would be observed during the titration. (2 marks)

Indicator	
Description of colour change	

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Question 39 **[19 marks]**

The amide or peptide link is found in synthetic polyamides such as nylon and also in naturally occurring polymers such as proteins.

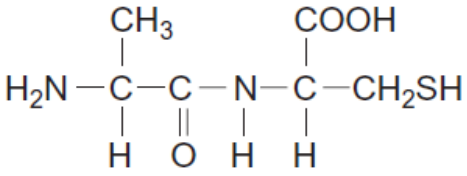
(a) Draw the repeating unit of the polyamide formed by the reaction of propan-1,3-dioic acid with hexan-1,6-diamine.

(1 mark)

(b) In terms of the intermolecular forces between the polymer chains, explain why polyamides such as the one above can be made into fibres suitable for use in sewing and weaving, whereas polyalkenes (e.g. polyethene) usually produce fibres that are too weak for this purpose.

(3 marks)

(c) The dipeptide shown below is formed from two different amino acids.



(i) Draw the structure of the alternative dipeptide that could be formed by these two amino acids.

(1 mark)

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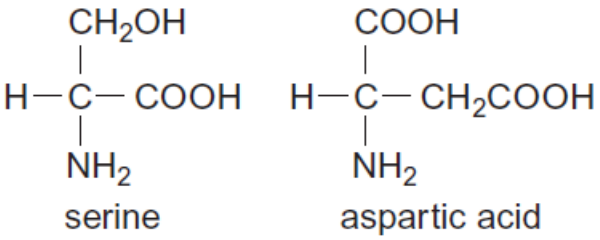
(ii) Name the process by which the dipeptide is split into two amino acids.

_____

(1 mark)

(d) The amino acids serine and aspartic acid are shown below.



(i) Draw the structure of the species formed when aspartic acid reacts with aqueous sodium hydroxide.

(1 mark)

(ii) Draw the structure of the species formed when serine reacts with dilute hydrochloric acid.

(1 mark)

This Question continued on the next page

(e) The diprotic amino acid, glutamic acid, which contains carbon, hydrogen, oxygen and nitrogen, underwent analysis to determine its formula.

When a 5.00 g sample of glutamic acid was combusted in oxygen, 7.48 g of carbon dioxide and 2.77 g of water was produced.

A separate 3.00 g sample produced 0.938 g of nitrogen dioxide when burnt in oxygen.

4.56 g of glutamic acid was dissolved in 100.0 mL of water. 20.0 mL of this solution required 24.8 mL of 0.500 mol L^{-1} sodium hydroxide for complete neutralisation.

(i) Calculate the empirical formula of glutamic acid. (7 marks)

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(ii) Calculate the molecular mass of glutamic acid. (4 marks)

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