CHEMISTRY

STAGE 3

2014

Name: _____

Teacher: CIRCLE YOUR TEACHERS NAME

Mr SMITH LYLE LLOYD GRASL Ms SMITH

TIME ALLOWED FOR THIS PAPER

Reading time before commencing work: Ten minutes
Working time for the 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 (blue/black preferred), pencils (including coloured), sharpener, eraser, correction tape/fluid, ruler, highlighters
- Special items: 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	/50	/25
Section Two: Short answer	9	9	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. For each questions 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 your 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 include appropriate 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.

5. The Chemistry Data Sheet is **not** handed in with your Question/Answer Booklet.

Section One: Multiple-choice **25% (50 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 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.

Suggested working time: 50 minutes.

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1. A single molecule of XF_2 has a total of 34 electrons. The electron configuration of element X is;

   (a) 2, 8, 6
   (b) 2, 6
   (c) 2, 8, 5
   (d) 2, 4

2. Which of the following alcohols would **not** decolorise an acidified potassium permanganate solution?

   (a) $CH_3CH(CH_3)CH(CH_3)CHOHCH_3$
   (b) $CH_3C(CH_3)OHCH(CH_3)\ CH_2CH_3$
   (c) $CH_2OHC(CH_3)_2CH_2CH_2CH_3$
   (d) $CH_3CH(CH_3)CHOHCH(CH_3)CH_3$

3. A student noted the following observations in her laboratory book;

   "A green solid dissolved in a colourless solution to produce a blue solution and colourless, odourless gas"

   Which of the reactants below was she most likely mixing?

   (a) Nickel hydroxide powder and hydrochloric acid
   (b) Copper(II) carbonate powder and nitric acid
   (c) Chromium carbonate powder and hydrochloric acid
   (d) Copper(II) chloride powder and silver nitrate solution

4. In which of the following lists do all the species have the same shape?

   (a) $SO_3,\ NH_3,\ NO_3^-,\ PF_3$
   (b) $CO_2,\ N_2,\ SO_2,\ NO_2$
   (c) $H_2O,\ SO_2,\ NO_2^-,\ CH_2O$
   (d) $HCN,\ O_2,\ HF,\ C_2H_2$

5. Which of the following statements is correct?

   (a) The electronegativity of Al is greater than that of Si
   (b) The ionisation energy of Li is less than that of Cs
   (c) The electronegativity of Ne is less than that of F
   (d) The ionisation energy of I is greater than that of Cl

SEE NEXT PAGE

6. Carbon monoxide can be manufactured via the reaction of steam and carbon. The following equation represents a closed equilibrium system.

$$H_2O\ (g) + C\ (s) \rightleftarrows H_2\ (g) + CO\ (g) \qquad \Delta H = +131\ kJ/mol$$

If the temperature of the system was decreased, which of the following changes would occur?

(a) Increased reaction rate, increased yield of carbon monoxide
(b) Increased reaction rate, decreased yield of carbon monoxide
(c) Decreased reaction rate, increased yield of carbon monoxide
(d) Decreased reaction rate, decreased yield of carbon monoxide

Questions 7 and 8 refer to the information shown in the table below.

	Melting point (°C)	Conductivity as solid	Conductivity as liquid
W	-114	x	x
X	1495	✓	✓
Y	1725	x	x
Z	1087	x	✓

7. Which statement is the most likely to be correct?

(a) Z will conduct electricity when added to water
(b) W will appear as coloured crystals when solid
(c) Y has a shiny lustre when solid
(d) X will not dissolve in water

8. When W is dissolved in water, the solution conducts electricity. Substance W could be;

(a) $CuCl_2$ (s)
(b) CH_4 (g)
(c) C_2H_5OH (l)
(d) HCl (g)

9. Consider the ethanoic acid / ethanoate buffering system shown below.

$$CH_3COOH\ (aq) + H_2O\ (l) \rightleftarrows CH_3COO^-\ (aq) + H_3O^+\ (aq)$$

Which of the following conditions would be most effective in producing the greatest buffering capacity when a small amount of either acid or base is added?

(a) A high concentration of CH_3COOH
(b) A high concentration of CH_3COO^-
(c) A high, equimolar concentration of both CH_3COOH and CH_3COO^-
(d) A low, equimolar concentration of both CH_3COOH and CH_3COO^-

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10. The radioactive isotope phosphorus-32 (P-32) is often used in the detection of tumours. Which of the following statements regarding the electrons of a P-32 atom is correct?

(a) An atom of P-32 would have one more electron than would normally be found in a phosphorus atom
(b) An atom of P-32 would have electrons existing in three distinct energy levels
(c) The electron configuration of a P-32 atom would be 2, 8, 18, 4
(d) It would be difficult to tell how many electrons an atom of P-32 has because it is radioactive

11. Which of the following equations correctly represents a reaction that ethane (C_2H_6) is likely to undergo?

(a) $C_2H_6 + 3\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$
(b) $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$
(c) $C_2H_6 + O_2 \rightarrow CH_2OHCH_2OH$
(d) $C_2H_6 + Cl_2 \rightarrow C_2H_4Cl_2 + H_2$

12. The boiling points of two geometric isomers are shown in the table below.

	Boiling point (°C)
cis-1,2-dichloroethene	60.2
trans-1,2-dichloroethene	48.5

Which of the following statements best explains the difference in boiling point?

(a) The *cis* isomer has stronger dispersion forces
(b) The *cis* isomer has stronger dipole-dipole forces
(c) The *cis* isomer has hydrogen bonding
(d) The *cis* isomer has a larger molecular mass

13. The following equation represents a closed equilibrium system.

$$2\ O_3\ (g) \rightleftarrows 3\ O_2\ (g)$$

The value of K for this system at 2300 °C is 2.5×10^{12}. This value tells us that;

(a) The reaction is extremely exothermic
(b) The reaction is extremely fast
(c) The reaction essentially goes to completion
(d) The reaction essentially does not occur

14. Which of the following lists contain substances that, when mixed and shaken, would form a solution (i.e. form only one layer when shaken together)?

(a) Ethanol, water, magnesium sulfate
(b) Hexane, silver chloride, kerosene
(c) Water, methanol, silver chloride
(d) Methanol, hexane, magnesium sulfate

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15. Which of the following gives the correct pH for each of the salts shown?

	NH_4Cl	$Ba(HSO_4)_2$	NaF	$Mg(NO_3)_2$
(a)	Acidic	Basic	Basic	Neutral
(b)	Basic	Neutral	Acidic	Basic
(c)	Basic	Acidic	Neutral	Basic
(d)	Acidic	Acidic	Basic	Neutral

16. Which of the following pairs of half-cells would produce the greatest voltage under standard conditions?

(a) Pb / Pb^{2+} and Ag^{+} / Ag
(b) Zn / Zn^{2+} and Ni^{2+} / Ni
(c) Ni / Ni^{2+} and Pb^{2+} / Pb
(d) Zn / Zn^{2+} and Ag^{+} / Ag

Questions 17 and 18 refer to the equilibrium system below. The equation represents the decomposition of phosgene to produce carbon monoxide and chlorine gas.

$$\underset{\textit{colourless}}{COCl_2\,(g)} + \text{heat} \rightleftarrows \underset{\textit{colourless}}{CO\,(g)} + \underset{\textit{green-yellow}}{Cl_2\,(g)}$$

17. If the system had established equilibrium, which of the following conditions would be met?

(i) The pressure of the system would be constant
(ii) The colour of the system would be constant
(iii) The decomposition of $COCl_2$ would have stopped
(iv) The system would slowly become cooler
(v) The concentration of all three gases would be equal

(a) (i) only
(b) (i) and (ii) only
(c) (i), (ii) and (v) only
(d) (ii) and (v) only

18. Which of the following correctly describes what would happen to the above equilibrium system if the stated change was imposed?

(a) Decreasing the volume of the system would decrease the rate of decomposition of $COCl_2$ (g)
(b) Injecting some Cl_2 (g) into the system would cause the forward reaction to be favoured
(c) Removing some CO (g) as it forms would increase the rate of decomposition of $COCl_2$ (g)
(d) Decreasing the temperature of the system would decrease the value of K

19. When pure water is kept in the fridge, the pH rises above 7. This is because;

(a) The water has become slightly basic
(b) There is a higher concentration of OH^{-} ions than H_3O^{+} ions
(c) The self-ionisation of water occurs to a lesser extent
(d) The value of K_w is higher

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20. Which of the following gives the correct oxidation state for chlorine in each of the species shown?

	H<u>Cl</u>O	<u>Cl</u>$_2$	<u>Cl</u>O_4^-	H<u>Cl</u>	O<u>Cl</u>$_2$
(a)	+1	-1	+7	+1	-1
(b)	-1	0	+5	-1	+2
(c)	+1	0	+7	-1	+1
(d)	-1	-1	+5	0	+1

21. Which of the following species are non-polar?

(i) CO
(ii) CH_2F_2
(iii) PO_4^{3-}
(iv) N_2
(v) $CH_3CH_2CH_3$

(a) (iii), (iv) and (v) only
(b) (iv) and (v) only
(c) (ii), (iv) and (v) only
(d) (ii), (iii), (iv) and (v) only

22. Which of the following statements regarding the manufacture and cleaning action of soaps and detergents is **not** correct?

(a) Detergents are more effective in hard water as they do not form an insoluble scum
(b) Soaps and detergents are made from fats and oils in a process called saponification
(c) Detergent and soap molecules both have a hydrophilic and hydrophobic region
(d) The mechanism of cleaning for both soaps and detergents involves a surfactant ion

23. The boiling points of the first three Group 15 hydrides are shown in the table below.

	Boiling point (°C)
NH_3	-33
PH_3	-88
AsH_3	-63

Which of the following statements are correct?

(i) NH_3 has the strongest dispersion forces
(ii) All the molecules have dipole-dipole forces
(iii) NH_3 has the strongest intermolecular forces
(iv) NH_3 is the only molecule to have hydrogen bonding
(v) AsH_3 is the most polar molecule

(a) (ii) and (iv) only
(b) (i), (ii) and (iv) only
(c) (i), (iii) and (iv) only
(d) (ii), (iii) and (iv) only

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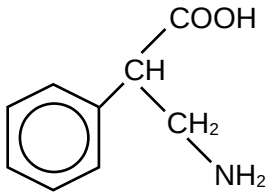
24. Which of the following lists the reducing agents (reductants) in order of decreasing strength?

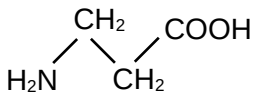
(a) Calcium, oxalic acid, hydrogen gas, iron(II) ions
(b) Hydrogen gas, iron(III) ions, gold, oxalic acid
(c) Oxalic acid, zinc, hydrogen gas, iron(III) ions
(d) Silver, iron(II) ions, hydrogen gas, oxalic acid

25. Which of the following is an α-amino acid?

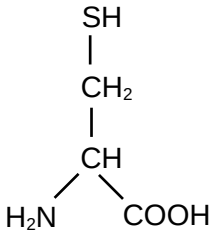
(a)



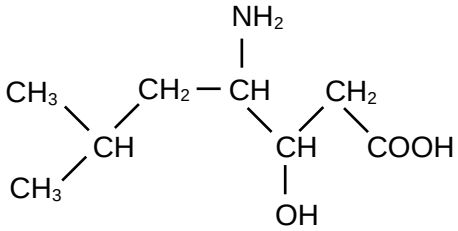
(b)



(c)



(d)



End of Section One

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

This section has 9 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 three 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.

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Suggested working time: 60 minutes.

Question 26 **(6 marks)**

Esters are sweet smelling liquids produced in a reversible process called esterification. The equilibrium constant expression for a particular esterification reaction is shown below.

$$K = \frac{[CH_3(CH_2)_2COOCH(CH_3)_2]}{[CH_3(CH_2)_2COOH]\,[CH_3CHOHCH_3]}$$

(a) Write the equation for the esterification reaction taking place. (2 marks)

(b) Draw the structure of the ester formed in this reaction. (1 mark)

(c) Name the reactants used to produce this ester. (2 marks)

_____

_____

(d) Name the catalyst required for this reaction. (1 mark)

_____

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Question 27 **(8 marks)**

Potassium (K) is a metallic element and has atomic number 19. It is situated in group 1, period 4 of the periodic table.

(a) Explain why potassium has the largest atomic radius of all the period 4 elements. (2 marks)

(b) Is the first ionisation energy of potassium smaller or larger than sodium? (1 mark)

The first 5 ionisation energies for potassium are shown in the table below.

	1st	2nd	3rd	4th	5th
Ionisation energy (kJ mol^{-1})	419	3052	4420	5877	7975

(c) Why is the increase between the first and second ionisation energy so large compared with the subsequent increases? (2 marks)

If potassium metal was placed in a flask of fluorine gas (F_2) an instant, exothermic reaction would take place.

(d) Name the substance that would form. (1 mark)

(e) Explain, in terms of ionisation energy and electronegativity, why this reaction between potassium and fluorine occurs. (2 marks)

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Question 28 **(10 marks)**

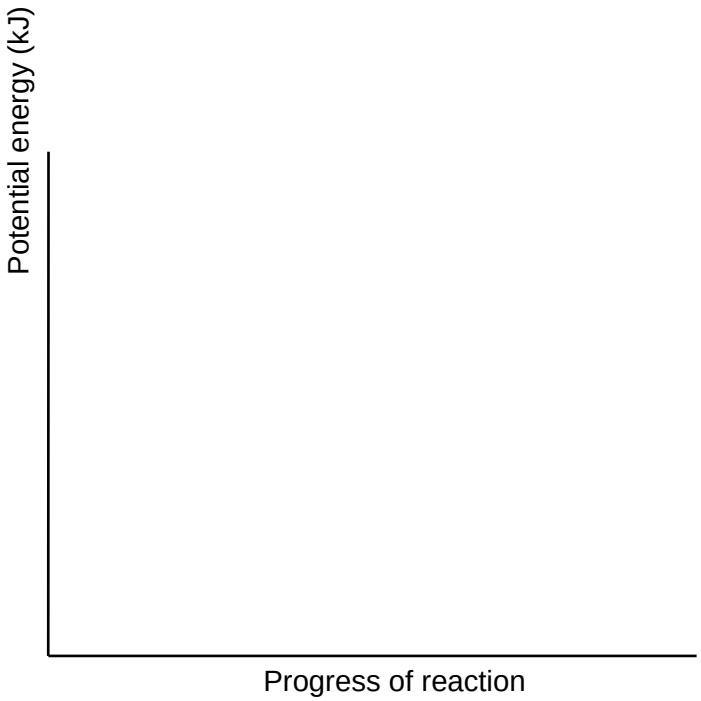
The equilibrium system below forms when concentrated hydrochloric acid is added to a solution containing the blue hexaaquacopper(II) ion. This forms the olive green tetrachlorocuprate(II) ion. When the temperature of this system is increased the solution becomes more green in colour.

$$[Cu(H_2O)_6]^{2+}\,(aq) + 4\,Cl^-\,(aq) \rightleftarrows [CuCl_4]^{2-}\,(aq) + H_2O\,(l)$$

blue *olive green*

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

(b) Sketch a potential energy diagram for the above reaction. Label the activation energy and the enthalpy change. (4 marks)



(c) If some silver nitrate ($AgNO_3$) solution was added to the equilibrium system above, and the system allowed to re-establish equilibrium, what effect would this have on the; (5 marks)

(i) rate of forward reaction _____

(ii) rate of reverse reaction _____

(iii) equilibrium position _____

(iv) value of K _____

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(v) colour of system _____

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Question 29 **(9 marks)**

Five sulfur-containing species are listed below. Each of these species has a different shape.

sulfite ion	*hydrogen sulfide*	*carbon disulfide*	*sulfur trioxide*	*sulfate ion*
SO_3^{2-}	H_2S	CS_2	SO_3	SO_4^{2-}

(a) In the table below, draw the structural formula for each species next to its corresponding shape. Represent all valence shell electron pairs either as : or –. (5 marks)

	Structure (showing all valence electrons)
Linear	
Trigonal (triangular) planar	
Tetrahedral	
Pyramidal	
V-shaped / Bent	

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(b) Which of the molecules would be regarded as non-polar? (1 mark)

_____

(c) Which of the molecules contains the most polar intramolecular bonds? (1 mark)

_____

(d) When sulfur trioxide is dissolved in water, an acidic solution forms. Use the Bronsted-Lowry theory and chemical equations to show how this occurs. (2 marks)

_____

_____

_____

_____

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Question 30 **(8 marks)**

A variety of substances are listed below. Use these substances to answer the following questions. Not all substances must be used, but each substance can only be used **once**.

Na_2CO_3	Na	H_3PO_4	NaCl
Au	H_2SO_4	Na_3PO_4	Cu
$CuCl_2$	Na_2SO_4	Ni	

(a) Which two substances could be mixed together to form a buffer? (1 mark)

_____

(b) Which two substances could be mixed together in water to form a green precipitate? (1 mark)

_____

(c) Which substance could be classified as a 'basic salt'? Write an hydrolysis equation to support your answer. (2 marks)

_____

_____

(d) Which substance would react with acid to produce hydrogen gas? (1 mark)

_____

(e) Which substance would react with water to produce hydrogen gas? (1 mark)

_____

(f) Which metal would displace the silver ions from a solution of silver nitrate? Write the equation for this reaction including only those species that react. (2 marks)

_____

_____

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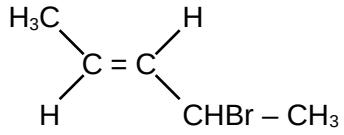
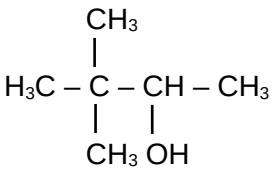
Question 31 **(8 marks)**

(a) Complete the following table by either naming the molecule using the IUPAC system or drawing a structural diagram of the molecule. (4 marks)

	IUPAC Name	Structural Diagram
A	chloroethanal	
B		
C	butyl methanoate	
D		

(b) Draw and name the organic product formed when compound B is mixed with iodine water. (2 marks)

Structural Diagram:

IUPAC Name:

(c) Draw and name the organic product formed when compound D is mixed with acidified potassium permanganate solution. (2 marks)

Structural Diagram:

IUPAC Name:

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Question 32 **(6 marks)**

For each of the following pairs of molecules;

(i) Circle the one that you would expect to have the highest boiling point, and
(ii) Give a brief explanation for your choice.

(a) ethan-1-amine OR pentan-1-amine (2 marks)

(b) carbon dioxide OR sulfur dioxide (2 marks)

(c) methanol OR methanal (2 marks)

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Question 33 **(8 marks)**

The final step in the production of methanol is shown in the equation below.

$$CO\,(g) + 2\,H_2\,(g) \rightleftarrows CH_3OH\,(g) + \text{heat}$$

This reaction is carried out at a high pressure of 50-100 atmospheres, using a $Cu/ZnO/Al_2O_3$ catalyst.

(a) Explain how the use of high pressure will affect the reaction rate. (2 marks)

(b) Explain how the use of high pressure will affect the yield of methanol. (3 marks)

(c) What conditions of temperature would increase the yield of methanol? (1 mark)

(d) State two (2) benefits of using a catalyst in an industrial process. (2 marks)

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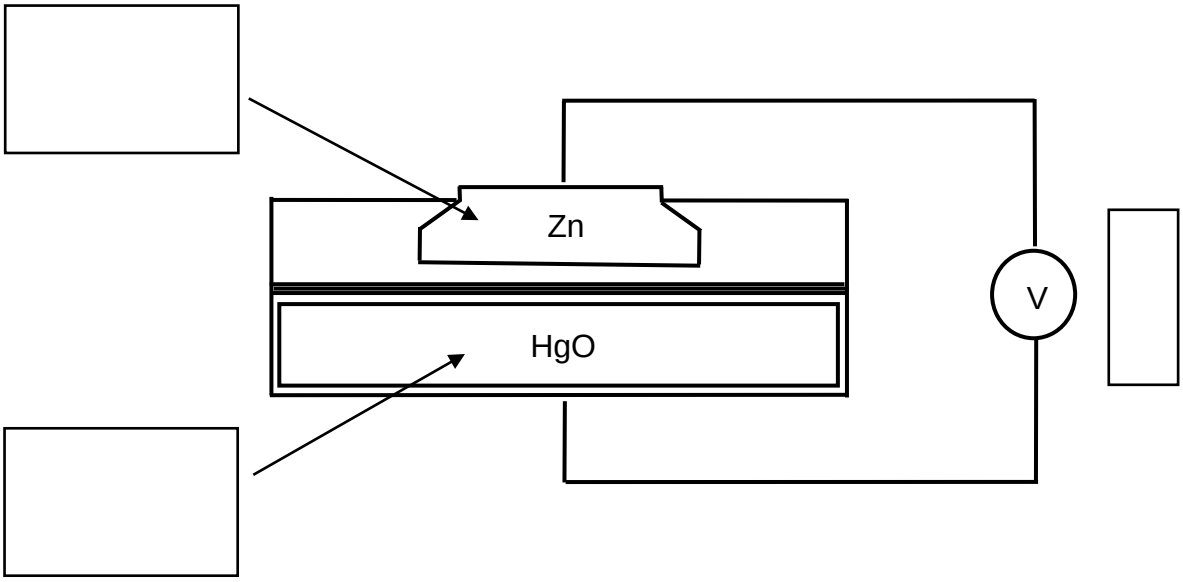
Question 34 **(7 marks)**

The mercury cell is used in watches, calculators and hearing aids due to its small size and long life. It is based on the redox reaction between the mercuric oxide (HgO) and zinc electrodes. As the cell operates, metallic mercury and zinc hydroxide are formed.

(a) Write the oxidation and reduction half equations and the overall redox equation for the mercury cell. (3 marks)

Oxidation half equation	
Reduction half equation	
Overall redox equation	

A diagram of the cell is shown below.



(b) In the boxes on the diagram above, label the cathode and anode, the charge of each electrode, and the direction of electron flow. (3 marks)

(c) State an environmental concern associated with this electrochemical cell. (1 mark)

End of Section Two

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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 below.

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 significant figures.

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Suggested working time: 70 minutes.

Question 35 **(20 marks)**

Soda ash (sodium carbonate, Na_2CO_3) has been used for centuries in the manufacturing of glass, soap, textiles and paper. By the 18th century, production of soda ash had become very expensive so King Louis XVI of France offered a prize to anyone who could devise a method to produce soda ash from sea salt (sodium chloride, NaCl). In 1791 a physician named Nicholas Leblanc developed such a method, known as the Leblanc process.

In the first step, sea salt is mixed with sulfuric acid at a low temperature to produce salt cake (Na_2SO_4).

Step 1: $2\ NaCl\ (s) + H_2SO_4\ (aq) \rightarrow Na_2SO_4\ (s) + 2\ HCl\ (g)$

In the second and third steps, the salt cake is mixed with coal (C) and crushed limestone ($CaCO_3$) and heated at about 1000 $^{\circ}$C. This converts the salt cake to sodium sulfide. The calcium and sodium then swap ions to produce soda ash and the waste product calcium sulfide.

Step 2: $Na_2SO_4\ (s) + 2\ C\ (s) \rightarrow Na_2S\ (s) + 2\ CO_2\ (g)$

Step 3: $Na_2S\ (s) + CaCO_3\ (s) \rightarrow Na_2CO_3\ (s) + CaS\ (s)$

The final mixture of sodium carbonate and calcium sulfide is called ‘black ash’, due to remaining carbon in the product. The soda ash is separated from the black ash by washing with water. The water is then evaporated to leave solid $Na_2CO_3.10H_2O$. The solid calcium sulfide waste slowly releases hydrogen sulfide (H_2S) gas as it reacts with water and breaks down.

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(a) The Leblanc process produces the gases HCl and H_2S as waste products. State a negative environmental consequence associated with each gas. (2 marks)

HCl	
H_2S	

(b) Step 2 of the Leblanc process is a redox reaction. Identify the substance oxidised and the substance reduced. Use oxidation numbers to support your answer. (4 marks)

After the final step, the soda ash is separated from the black ash by washing with water.

(c) Why is this method able to separate the two components of the black ash? (1 mark)

(d) In terms of bonding and intermolecular forces, describe what would be happening to the soda ash during this washing process. (2 marks)

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A factory owner wants to produce 45.0 tonnes of soda ash (Na_2CO_3) using the Leblanc process. He knows that the overall yield of the three-step process is 72.8%.

(e) What mass of sea salt would he need to begin with? (5 marks)

Many people who lived near the soda ash factories had complained about the ill effects caused by the unrestricted release of hydrogen chloride gas (HCl) into the atmosphere. In 1863, the British parliament passed legislation requiring the factories using the Leblanc process to release no more than 5% of the hydrogen chloride gas into the atmosphere.

By the 1880's a method had been devised to convert the hydrogen chloride gas into chlorine (Cl_2), and then use the chlorine to produce a sodium hypochlorite solution (NaClO).

The two-step reaction process used to recycle the HCl is shown below.

Step 4: $4\ HCl\ (g) + O_2\ (g) \rightarrow 2\ Cl_2\ (g) + 2\ H_2O\ (l)$

Step 5: $Cl_2\ (g) + Na_2CO_3\ (aq) \rightarrow NaClO\ (aq) + CO_2\ (g) + NaCl\ (aq)$

The NaClO solution, commonly known as bleach, was then used as a hospital antiseptic.

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If the factory produced 18.0 x 10^6 L of HCl gas at 142 kPa and 88 ˚C;

(f) What mass of NaClO could theoretically be produced using this two-step recycling process? Assume the maximum allowable HCl emission of 5.00% was released into the atmosphere. (4 marks)

(g) If 157 kL of 1.94 mol L^{-1} NaClO solution was actually produced, what is the combined yield of the two-step recycling process? (Assume the maximum allowable HCl emission of 5.00% was released into the atmosphere.) (2 marks)

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Question 36 **(18 marks)**

Tartaric acid is an antioxidant found in many fruits such as grapes, bananas, plums, cherries and avocados. It can be mixed with baking soda to act as a raising agent in baking and is also one of the main acids present in wine. Tartaric acid contains only the elements carbon, hydrogen and oxygen.

A sample of tartaric acid was isolated and analysed to determine its molecular structure. A 0.273 g sample of tartaric acid was burnt in air to produce 0.320 g of carbon dioxide and 0.0990 g of water.

(a) Determine the empirical formula of tartaric acid. (8 marks)

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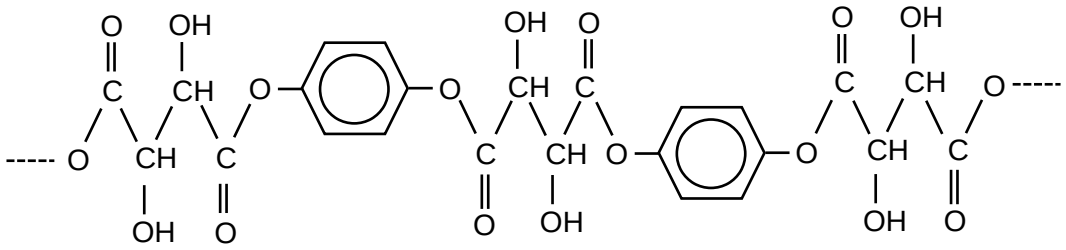
When a sample of tartaric acid was vaporised at 142 kPa and 355 ˚C, it was found to have a density of 4.08 g L^{-1}.

(b) Determine the molecular formula of tartaric acid. (4 marks)

The section of polymer shown below has been formed from tartaric acid and a second molecule called hydroquinone.



(c) Draw the structure of the two monomers used to create this polymer. (3 marks)

tartaric acid

hydroquinone

(d) Is this an example of addition or condensation polymerisation? (1 mark)

(e) Briefly explain the difference between addition and condensation polymerisation. (2 marks)

Question 37 **(13 marks)**

It was the night of the Year 12 Ball and everything had been going well until Mr Crucible, the chemistry teacher, saw some students acting suspiciously near the punch bowl. Suspecting that the punch had been spiked, he quickly confiscated the whole bowl and took a sample back to the lab so he could perform a titration to determine the alcohol concentration (if indeed there was any).

The bowl had contained 12.0 L of punch in total. Mr Crucible took a 50.0 mL sample of the punch and diluted it to 250 mL in a volumetric flask. He then took 20.0 mL aliquots of the dilute solution and titrated them against a standard solution of 0.0200 mol L^{-1} sodium dichromate.

The relevant half equations for the titration are shown below;

ox: $CH_3CH_2OH\ (aq) + H_2O\ (l) \rightarrow CH_3COOH\ (aq) + 4\ H^+\ (aq) + 4\ e^-$

red: $Cr_2O_7^{2-}\ (aq) + 14\ H^+\ (aq) + 6e^- \rightarrow 2\ Cr^{3+}\ (aq) + 7\ H_2O\ (l)$

(a) Write the overall equation for the titration reaction. (1 mark)

_____

(b) What observations would you expect to see as this reaction took place? (1 mark)

_____

_____

The results of Mr Crucible's titration are shown in the table below.

	1	2	3	4	5
Final (mL)	24.15	45.45	22.20	43.90	47.90
Initial (mL)	1.70	24.15	0.85	22.20	26.60
Titre (mL)					

(c) Calculate the average titre of sodium dichromate used. (1 mark)

_____

_____

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(d) Calculate the concentration (in mol L^{-1}) of alcohol in the punch. (5 marks)

Mr Crucible weighed a sample of the punch and found the density to be 1.03 g mL^{-1}.

(e) Calculate the concentration of alcohol in the punch in parts per million. (5 marks)

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Question 38 **(17 marks)**

A mechanic was working on an engine when he knocked over an old car battery and sulfuric acid started to leak out onto the floor. He knew that sulfuric acid was quite corrosive and dangerous so he looked around for something to clean up the mess. He saw some 'Drano' (drain cleaner) in the kitchen cupboard, which the label said contained 350 g L^{-1} sodium hydroxide. He took the bottle and poured some on the acid spill to try and neutralise it.

(a) A car battery is an example of a secondary cell. What does this mean? (1 mark)

_____

(b) What is the function of the sulfuric acid in a car battery? (1 mark)

_____

The equation for the neutralisation reaction that took place is shown below.

$$H_2SO_4\ (aq) + 2\ NaOH\ (aq) \rightarrow Na_2SO_4\ (aq) + 2\ H_2O\ (l)$$

The mechanic had spilled 217 mL of sulfuric acid with a concentration of 4.60 mol L^{-1}. If he poured 234 mL of 'Drano' over the spill;

(c) Calculate the limiting reagent. (6 marks)

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(d) Calculate the mass of excess reagent. (3 marks)

(e) Calculate the final pH of the spilled mixture. (4 marks)

(f) Give a brief description of how an electrochemical cell produces electricity. (2 marks)

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Question 39 **(12 marks)**

Two high school chemistry students were carrying out a titration to determine the concentration of acetic (ethanoic) acid in a sample of white vinegar.

Firstly they measured exactly 25.0 mL of the vinegar into a clean, dry 250 mL volumetric flask. They added distilled water to the flask until the bottom of the meniscus of the water was exactly on the 250 mL line. They inverted the flask to mix the solution thoroughly.

The students then took a clean 20.0 mL pipette, rinsed it with some distilled water, and placed an aliquot of the diluted vinegar into a clean, dry conical flask. They added 3 drops of methyl orange to the flask and set it aside while they prepared the primary standard.

They decided to use sodium hydroxide as a primary standard, so they carefully weighed out and recorded the mass of sodium hydroxide to three decimal places. They dissolved the sodium hydroxide in some distilled water, transferred all the solution to a clean, dry 500 mL volumetric flask and then added more distilled water until the bottom of the meniscus of the water was exactly on the 500 mL line.

The students used some of the sodium hydroxide solution to rinse the burette and then filled the burette with the solution, ensuring they didn't go over the maximum 50.0 mL level.

They then performed and repeated the titration until they obtained 3 consistent results from which to calculate the average titre.

(a) State three (3) things the students did **correctly**. (3 marks)

1. _____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

(b) Find three (3) things that the students did **incorrectly** and;

(i) State the error they made
(ii) State and explain what they should have done.

(9 marks)

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1. (i)

(ii)

2. (i)

(ii)

3. (i)

(ii)

End of questions

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Spare answer page

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