TERTIARY INSTITUTIONS SERVICE CENTRE INC

WESTERN AUSTRALIAN UNIVERSITIES' PREPARATORY PROGRAM EXAMINATION 2011

CHEMISTRY STAGE 3

CANDIDATE NUMBER – IN FIGURES | | | | | | | | |

IN WORDS _____

_____

_____

TIME ALLOWED FOR THIS EXAMINATION

Reading 10 minutes
Working 3 hours

MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER

TO BE PROVIDED BY THE SUPERVISOR
This Question/Answer Booklet
Separate Multiple Choice Answer Sheet
Chemistry Data Sheet

TO BE PROVIDED BY THE CANDIDATE
Standard items: Pens, pencils, eraser or correction fluid, ruler.
Special items: Non-programmable calculators satisfying the conditions set by theCurriculum Council.

STRUCTURE OF THIS PAPER

Section	Suggested working time	Number of questions Available	Number of questions to be Attempted	Marks
ONE: Multiple-choice	50 minutes	25	25	50
TWO: Short response	60 minutes	14	14	70
THREE: Extended response	70 minutes	6	6	80
			(Total marks)	200

INSTRUCTIONS TO CANDIDATES

1) Sitting this examination implies that you agree to abide by the rules outlined:
   - In your WAUPP 2011 Student Handbook
   - On the front cover of this Question/Answer Booklet, and
   - By the supervisor.

   Failure to abide by these rules may result in a penalty or the cancellation of your paper.

2) Answer the questions according to the following instructions.

   Section One
   Answer all questions on the separate Multiple-choice answer sheet provided. Use only a blue or black pen to put a cross over the answer of your choice. To change an answer, black out the cross you have made and put a cross over your new answer. Do not erase or use correction fluid. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

   Sections Two and three: Write all answers in this Question/Answer booklet in blue or black pen.

3) When calculating numerical answers, show your working or reasoning clearly unless instructed otherwise.

4) You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

5) Spare pages are provided at the end of this booklet which you may use for planning responses or continuing an answer. If you need to use the space to continue an answer, indicate in the original answer space the page number where the answer is continued.

6) Check that you have written your candidate number, in figures and words, in the spaces provided on the front cover of this booklet.

SECTION 1: MULTIPLE CHOICE 25 QUESTIONS (50 marks 25 %)

Answer **ALL** questions on the separate Multiple Choice Answer Sheet provided.
Each question in this part is worth 2 marks.

1. Element X has six (6) valence electrons. If it could form a hydride of formula XH_2 the angle between the bonds would most probably be about

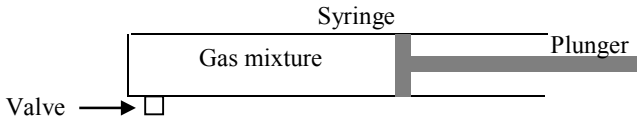
   (a) 90^o
   (b) 109^o
   (c) 120^o
   (d) 180^o

2. Which of the following molecules are polar?

   I. Cl_2O
   II. SiF_4
   III. SF_2
   IV. CH_4
   V. NBr_3

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

3. Consider the chemical equilibrium between four gases in a syringe whose volume can be changed by moving the plunger in or out. There is a small valve that allows gas to be injected into the syringe.



$2\ NO\ (g) + O_3\ (g) + 100\ kJ \rightleftharpoons N_2O_3\ (g) + O_2\ (g)$

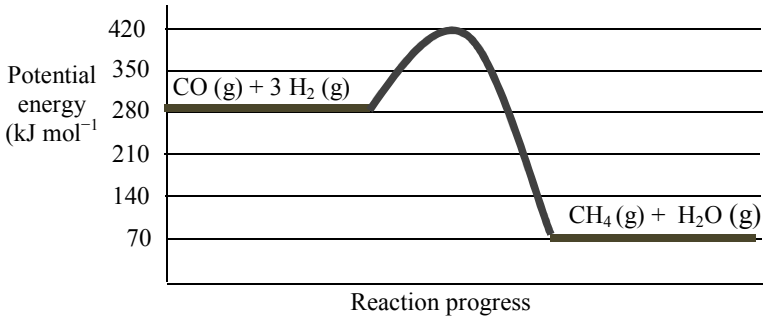
Which of the following imposed changes will cause a shift in equilibrium that results in an increase in the mass of N_2O_3?

(a) Cooling the mixture.
(b) Pushing the plunger in to reduce the volume.
(c) Injecting some helium into the syringe, without changing the volume.
(d) Injecting some oxygen, without changing the volume.

SEE NEXT PAGE

4. Consider the potential energy diagram for the reversible reaction

$$CO\ (g) + 3\ H_2\ (g) \rightleftharpoons CH_4\ (g) + H_2O\ (g)$$



For the **reverse** reaction $CH_4\ (g) + H_2O\ (g) \rightleftharpoons CO\ (g) + 3\ H_2\ (g)$ which of the following statements is true?

(a) It is an exothermic reaction with the heat of reaction equal to 210 kJ

(b) It is an endothermic reaction with the heat of reaction equal to 140 kJ

(c) It is an exothermic reaction with the activation energy equal to 420 kJ

(d) It is an endothermic reaction with the activation energy equal to 350 kJ

5. Novelty devices for predicting rain contain cobalt (II) chloride and are based on the following reversible reaction.

$$\underset{\text{blue}}{CoCl_2\ (s)} + 6\ H_2O\ (g) \rightleftharpoons \underset{\text{pink}}{CoCl_2 \bullet 6\ H_2O\ (s)}$$
$$\text{colourless}$$

What colour will the device be when it is about to rain?

(a) Blue

(b) Colourless

(c) Pink

(d) White

6. For a reversible chemical reaction at constant temperature, which of the following statements best describes the effect of adding a catalyst?

(a) It increases the amount of product formed.

(b) It decreases the time taken to reach equilibrium.

(c) It decreases the amount of energy released or absorbed in the reaction.

(d) It increases the amount of energy released or absorbed in the reaction.

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7. Pure water ionises according to the equation

$$H_2O\ (l) \rightleftharpoons H^+\ (aq) + OH^-\ (aq)$$

The equilibrium constant (K_W) for the reaction has values of 1.0×10^{-14} at 25 ^oC and 4.0×10^{-14} at 45 ^oC. Which of the following statements is correct?

(a) At 45^o C pure water is still neutral and the pH must be 7.0

(b) At 45^o C the pH of pure water is less than 7.0 and therefore the water is acidic.

(c) At 45^o C the concentration of hydroxide ion is more than 1×10^{-7} mol L^{-1} and therefore the water is basic.

(d) At 45^o C the pH of pure water is less than 7.0 but the water is still neutral.

8. Sulfuric acid is a stronger acid than ethanoic acid. Which of the following statements best explains this?

(a) Concentrated sulfuric acid has a concentration of 18 mol L^{-1} while concentrated ethanoic acid has a concentration of 17 mol L^{-1}.

(b) Sulfuric acid has two hydrogen atoms per molecule available for ionisation, while ethanoic acid has only one hydrogen atom per molecule available for ionisation.

(c) Sulfuric acid ionises to a greater extent than ethanoic acid.

(d) Sulfuric acid is more soluble in water than ethanoic acid is.

9. Five bottles labelled A, B, C, D and E each contains one of the following solutions, in random order:

- barium chloride
- hydrochloric acid
- sodium carbonate
- nickel (II) nitrate
- cobalt (II) nitrate

Mixing solutions A and D produces a colourless gas.

Solutions B and C are coloured.

Which solution is E?

(a) nickel (II) nitrate

(b) hydrochloric acid

(c) sodium carbonate

(d) barium chloride

SEE NEXT PAGE

10. Which of the following lists contains only substances whose aqueous solutions are acidic?

(a)	NH_4NO_3	$FeCl_3$	$NaHSO_4$
(b)	K_2CO_3	KF	CH_3COOK
(c)	KH_2PO_4	K_2PO_4	K_3PO_4
(d)	NaCl	$NaClO_4$	$NaNO_3$

11. The pH of a hydroiodic acid (HI) solution was found to be 2.00. Given that HI is a strong acid, what is the hydrogen ion concentration of the solution?

(a) 1.00×10^{-1} mol L^{-1}
(b) 1.00×10^{-2} mol L^{-1}
(c) 1.00×10^{-12} mol L^{-1}
(d) 0.500 mol L^{-1}

12. In which of the following reactions does the first shown reactant act as a base?

(a) $HPO_4^{2-}(aq) + H_2O(l) \rightleftharpoons H_2PO_4^{-}(aq) + OH^{-}(aq)$
(b) $NH_4^{+}(aq) + OH^{-}(aq) \rightleftharpoons NH_3(aq) + H_2O(l)$
(c) $HSO_3^{-}(aq) + CO_3^{2-}(aq) \rightleftharpoons HCO_3^{-}(aq) + SO_3^{2-}(aq)$
(d) $NH_3(aq) + CH_3COO^{-}(aq) \rightleftharpoons NH_2^{-}(aq) + CH_3COOH$

13. A 0.02 mol L^{-1} hydrochloric acid solution has a pH of 1.70. It is diluted by adding an equal volume of distilled water. What is the final pH of the diluted acid?

(a) 0.85
(b) 1.70
(c) 2.00
(d) 3.40

14. From an examination of all the species NH_3, N_2, NH_4Cl, N^{3-} and NO_2^{-}, it can be concluded that nitrogen can have an oxidation number of

(a) 0 or −3 or +2 or +3
(b) −3 only
(c) 0 or −3 or +3
(d) 0 or −3 only

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15. Many small 'batteries' used in hearing aids, watches and other devices, are silver oxide – zinc electrochemical cells.
The net reaction can be written as $Zn\ (s) + Ag_2O\ (s) + H_2O\ (l) \rightarrow 2\ Ag\ (s) + Zn(OH)_2\ (s)$.

From this equation it can be concluded that

(a) zinc is oxidised and is the anode.

(b) zinc is reduced and is the cathode.

(c) silver oxide is reduced and is the anode.

(d) silver oxide is oxidised and is the cathode.

16. In the procedure for standardising a potassium permanganate ($KMnO_4$) solution using standard oxalic acid (HOOCCOOH) solution, which of the following would you expect to find in the instructions?

(a) Dry the conical flask before pipetting 20.00 mL of a standard oxalic acid solution into it.

(b) Pipette 20.00 mL of a standard oxalic acid solution into the flask and add about 20 mL of 2 mol l^{-1} hydrochloric acid.

(c) Add a few drops of methyl orange indicator.

(d) Warm the conical flask and contents to about 80^o C before titrating with the permanganate solution.

17. One mole of each of the following compounds is completely burned in oxygen. Which one will produce four moles of water?

(a) ethane

(b) propane

(c) propene

(d) butane

18. Which of the following compounds has geometric (cis-trans) isomers?

(a) 1 – butene

(b) 2 – methyl – 1 – butene

(c) 2 – methyl – 2 – butene

(d) 2 – pentene

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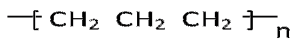
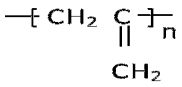
19. Which of the following monomers, or pairs of monomers, could be used to produce a polyester?

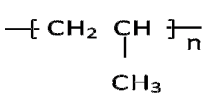
I. $HOOCCH_2COOH$ and $HOCH_2CH_2CH_2OH$
II. $HOOCCH_2COOH$ and $HOCH_2CH_2CHO$
III. $HOCH_2CH_2COOH$
IV. $HOOCCH_2CHO$

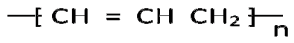
(a) I or II only
(b) I or III only
(c) III only
(d) II or IV only

20. For the monomer, $CH_2 = CH - CH_3$, which of the following best represents the polymer obtained from it?

(a) 

(b) 

(c) 

(d) 

21. An organic substance A is oxidised, producing substance B. Substance A and B react to form a substance C, which has a sweet odour. Which of the following substances could be A?

(a) propanone
(b) propanoic acid
(c) 1 – propanol
(d) 2 – propanol

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22. Which of the following pairs represent a primary amine and an α–amino acid?

(a) $CH_3\,CH(CH_3)\,CH_2\,NH_2$ and $CH_3\,CH_2\,CH(NH_2)\,COOH$

(b) $CH_3\,CH_2\,CH_2\,NH_2$ and $CH_3\,CH(COOH)\,CH_2\,NH_2$

(c) $CH_3\,CH(NH_2)\,CH_2\,CH_3$ and $CH_3\,CH_2\,CH(NH_2)\,COOH$

(d) $CH_3\,CH_2\,CH(NH_2)\,CH_3$ and $CH_3\,CH(NH_2)\,CH_2\,COOH$

23. A sample of hydrated magnesium sulfate ($MgSO_4 \bullet n\,H_2O$) was heated to constant mass, which showed that the percentage by mass of water was 13.0%. What is the value of n?

(a) 1

(b) 2

(c) 5

(d) 7

24. The energy released by the combustion of fuels is often expressed as the **fuel value** measured in kilojoules per gram of fuel (kJ g^{-1}). This value is related to the heat of combustion of the fuel, expressed in kilojoules per mole of fuel (kJ mol^{-1}).

From the following table of heats of combustion, select the fuel that has the largest fuel value.

	Fuel	Formula	ΔH (kJ mol^{-1})
(a)	methane	CH_4	889
(b)	ethanol	CH_3CH_2OH	1366
(c)	acetylene (ethyne)	CHCH	1298
(d)	hydrogen	H_2	284

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25. Iron deficiency is sometimes treated by the patient taking a liquid supplement of 10 mg of iron per dose. The prescribed solution is made from a stock solution of 1.00 mol L^{-1} of iron (II) sulfate by diluting 10.0 mL to 1.00 L. The diluted solution is made available in 250 mL bottles.

What volume of this solution should be taken for the patient to receive a dose of approximately 10 mg iron (Fe)?

(a) 2 mL

(b) 9 mL

(c) 18 mL

(d) 36 mL

END OF SECTION ONE

SECTION 2 SHORT RESPONSE 14 QUESTIONS (70 marks 35 %)

Answer **ALL** questions in the spaces provided below.

1. Write the **equation** for the reaction that occurs in each of the following procedures.

   For full marks, chemical equations should refer only to those species consumed in the reaction and the new species produced.

   (a) Dilute sulfuric acid is added to a solution of strontium chloride.

   _____

   _____

   (2 marks)

   (b) Acidified potassium dichromate solution is added to a solution of potassium bromide.

   _____

   _____

   (2 marks)

2. Write **observations** for any reactions that occur in the following procedures.
   If no reaction occurs, write 'no reaction'.

   In each case describe in full what you would observe, including any
   * colour
   * precipitate (give the colour)
   * gas (state the colour or describe as colourless)

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

   (a) A dilute solution of silver nitrate is added to a solution of copper (II) chloride.

   _____

   _____

   _____

   (2 marks)

   (b) A piece of copper wire is added to concentrated nitric acid.

   _____

   _____

   _____

   (2 marks)

3. For each of the species listed in the table below
   (a) draw an electron-dot diagram, showing the arrangement of all valence electrons (including lone pairs)
   (b) sketch clearly, or name, the shape of the species, and
   (c) describe the species as 'polar' or 'non-polar'.

Species	Draw and electron-dot diagram	Sketch or name the shape of species	Describe the polarity
Oxygen difluoride OF_2			
Dichloromethane CH_2Cl_2			
Iodate ion IO_3^-			Polarity not required

(8 marks)

4. Ethylene glycol (1,2 – ethanediol) is used in car radiators to lower the freezing point or raise the boiling point of the coolant water. Explain, with the aid of a diagram, why ethylene glycol is completely miscible with (soluble in) water.

(3 marks)

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5. Using an appropriate molecular energies distribution graph, explain why a catalyst increases the rate of a chemical reaction.

(4 marks)

6. Consider the following equilibrium systems.

$2\ COF_2\ (g) \rightleftharpoons CF_4\ (g) + CO_2\ (g)$ and $COCl_2\ (g) \rightleftharpoons CO\ (g) + Cl_2\ (g)$

In each of these systems the total pressure can be increased by the procedures (i), (ii) and (iii) listed in the first column of the table below. In each case, predict the immediate effect on the quantity referred to in the table in the second and third columns. Use the words "increased", "decreased" or "unchanged".

Procedure	$2\ COF_2\ (g) \rightleftharpoons CF_4\ (g) + CO_2\ (g)$	$COCl_2\ (g) \rightleftharpoons CO\ (g) + Cl_2\ (g)$
(i) Decrease the volume of the system without changing the temperature	Effect on mass of CO_2	Effect on mass of CO
(ii) Add more COF_2 (or $COCl_2$) to the system without changing the volume or temperature	Effect on mass of CF_4	Effect on mass of Cl_2
(iii) Add an inert gas without changing the volume or temperature	Effect on mass of COF_2	Effect on mass of $COCl_2$

(6 marks)

7. A solution of equimolar concentrations of potassium dihydrogenphosphate (KH_2PO_4) and sodium monohydrogenphosphate (Na_2HPO_4) has an almost constant pH when either acid or base is added.

   Explain, with relevant equations, how the system is able to maintain a nearly constant pH, **and** name this type of system. (3 marks)

8. 1.00 mol of barium hydroxide, $Ba(OH)_2$, is dissolved in water to produce 4.00 L of solution. Calculate:

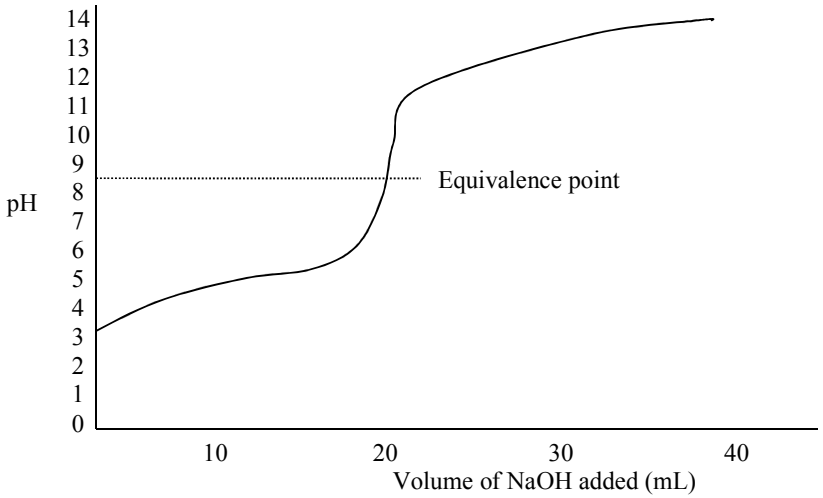
   (a) the concentration of the solution, in mol L^{-1}. (1 mark)

   (b) the concentration of hydroxide ion, in mol L^{-1}. (1 mark)

   (c) the concentration of hydrogen ion, in mol L^{-1}. (1 mark)

   (d) the pH of the solution. (1 mark)

9. The following graph shows the changes in pH during the progress of a titration involving the addition of sodium hydroxide solution to a 20 mL aliquot of an acid solution.



(a) Is the acid strong or weak? _____

(b) Name an example of such an acid. _____

(c) What type of indicator should be used for this titration? Give a reason for your answer.

_____

_____

_____

_____

(4 marks)

10. Magnetic iron oxide, Fe_3O_4, is mined as magnetite. It exists in ionic, crystalline form. Explain how this formula is possible, given that iron forms only the iron (II) and iron (III) ions.

(3 marks)

SEE NEXT PAGE

11. Indicators are usually organic acids or bases that react to basic or acidic solutions by changing colour according to the pH. The general form of an indicator can be represented by the formula HIn, and in solution its equilibrium can be represented by the equation $HIn \rightleftharpoons H^+ + In^-$.

The molecular and ionic species have different colours, or one may be coloured and the other colourless. For example, phenolphthalein changes from colourless in acidic solutions, to pink in basic solutions. Methyl orange changes from red in acidic solutions, to yellow in basic solutions.

For these two indicators, complete the following table.

Indicator	Equilibrium equation	Colour and formula of species in **acid** solution	Colour and formula of species in **basic** solution
Phenolphthalein HPh		Colour	Colour
		Formula	Formula
Methyl orange HMo		Colour	Colour
		Formula	Formula

(6 marks)

12. Complete the following table by writing the name or formula of a substance that corresponds to each description.

Description	Name or formula of substance
A salt that dissolves to produce an acidic solution	
A metal used as a sacrificial anode to protect steel from corrosion	
A primary standard used for redox titrations.	
A gas that can be used as an oxidising agent.	
An element whose compounds are all soluble	

(5 marks)

SEE NEXT PAGE

13. When chlorine gas dissolves in water an equilibrium is established.

$$Cl_2\,(aq) + H_2O\,(l) \rightleftharpoons H^+\,(aq) + Cl^-\,(aq) + HClO\,(aq)$$

(a) What is the oxidation state of chlorine in each of the following species?

Cl_2 _____ Cl^- _____

HClO _____

(b) Name the type of change that is illustrated in the above reaction.

_____

(4 marks)

14. (a) In the following table write a structural formula for each type of organic compound listed. Name each of your examples.
ALL examples must have FOUR (4) carbon atoms per molecule.

Compound	Formula	Name
1 Alkene		
2 Carboxylic acid		
3 Ester		
4 Aldehyde		
5 Ketone		

(10 marks)

(b) Which two of the above compounds are isomers of each other? [Use the numbers given.]

_____ and _____

(2 marks)

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SECTION 3 EXTENDED RESPONSE 6 QUESTIONS (80 marks 40 %)

Answer **ALL** questions in the spaces provided.

1. **9 marks**

In a laboratory experiment 14.0 g of barium chloride dihydrate, $BaCl_2 \cdot 2H_2O$, was dissolved in water and made up to 100.0 mL in a volumetric flask.

A 25.0 mL sample of this solution was added to 50.0 mL of 0.245 mol L^{-1} sulfuric acid solution and the $BaSO_4$ precipitate formed was collected by filtration, and dried.

(a) Calculate the mass of precipitate collected. (5 marks)

(b) Calculate the concentration of chloride ion in the 75.0 mL filtrate. (4 marks)

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2. **13 marks**

A particular brand of vinegar was analysed to determine its ethanoic (acetic) acid content.
A 25.0 g sample of the vinegar was diluted to 250.0 mL in a volumetric flask.
This diluted vinegar was titrated against standardised 0.121 mol L^{-1} sodium hydroxide solution.

(a) (i) Which of these two indicators should be used: **phenolphthalein** (which changes colour at about pH 9) or **methyl orange** (which changes colour at about pH 4)?

_____ (1 mark)

(ii) Explain why.

_____

_____

_____

(1 mark)

Four separate 20.0 mL aliquots of the 0.121 mol L^{-1} sodium hydroxide solution required titres of 36.2, 35.78 ml, 35.74 mL and 35.76 mL of diluted vinegar to reach the end point.

(b) What colour change occurred at the end point?

_____ (1 mark)

(c) Write a balanced equation for the reaction.

_____ (1 mark)

(d) Determine an appropriate titre volume.

_____ (1 mark)

(e) Calculate the concentration of ethanoic acid in the diluted vinegar.

(3 marks)

SEE NEXT PAGE

(f) Calculate the mass of ethanoic acid in the 250.0 mL diluted vinegar.

(2 marks)

(g) Calculate the percentage by mass of ethanoic acid in the undiluted vinegar.

(2 marks)

(h) Vinegar is often manufactured by oxidising ethanol.
Write a half equation for this oxidation.

_____ (1 mark)

SEE NEXT PAGE

3. **14 marks**

Platinum (Pt, element 78; atomic weight 195.1), like many other transition metals, forms a number of complex compounds. One such compound contains only platinum, chlorine, carbon and hydrogen. It has the formula $Pt_X(C_2H_4)_YCl_Z$.

Three samples, each containing 3.625 g of the compound, were analysed as follows.

(i) One sample was burned, leaving a solid residue of 2.146 g of platinum.

(ii) A second sample was reacted to release all the chlorine as hydrogen chloride gas (HCl). This gas was absorbed in a solution of sodium hydroxide, which increased in mass by 1.203 g.

(iii) The third sample was burned and the carbon dioxide produced occupied 524 mL at 23.0^o C and 103.4 kPa.

a) Determine the empirical formula of the compound. (11 marks)

b) The molecular weight is found to be 659.

What are the values of X, Y and Z in the formula? (3 marks)

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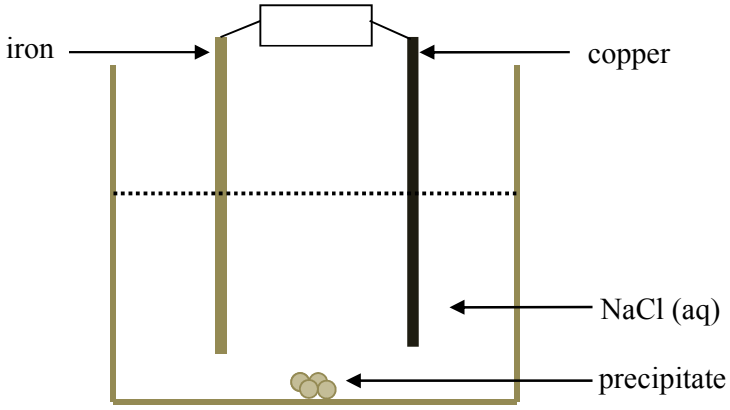
4. **15 marks**

A student investigating the rusting of iron performs several experiments.
Firstly, he set up the following cell. A copper rod and an iron rod in a salt solution are connected by a wire.



(a) Use the Table of Standard Reduction Potentials to predict which metal will be oxidised, and write the half equation for the reaction.

_____

Will this metal electrode be the anode, or the cathode? _____

(2 marks)

(b) In the box above the cell draw an arrow to show the direction of electron flow.

(1 mark)

(c) The student then aerates the salt solution at the **other** electrode (by bubbling air through) so that hydroxide ions are produced. Write the half equation for the production of hydroxide ions.

_____

(1 mark)

(d) After stopping the aeration the student now adds a few drops of *ferroxyl indicator* to the salt solution. This indicator turns deep blue in the presence of iron (II) ions and pink in basic/alkaline solution.

(i) Near which electrode will blue colour appear? _____

(ii) Near which electrode will pink colour appear? _____

(2 marks)

(e) The student notices that a pale green precipitate forms and sinks to the bottom of the beaker between the electrodes.

Consider the direction of movement of ions produced in the salt solution.

(i) What is the formula of the precipitate? _____

What is the oxidation state of iron in this compound? _____

(ii) Write the equation showing how the precipitate forms.

_____

(3 marks)

(f) The green precipitate slowly turns to a red-brown colour as it combines with water and dissolved oxygen to form iron (III) hydroxide, $Fe(OH)_3$.

(i) Write the equation for this reaction.

_____

(ii) In changing from green to red-brown, what change in oxidation state has occurred?

_____

(2 marks)

(g) The red-brown solid changes to become hydrated iron oxide.

(i) Balance the equation

$$Fe(OH)_3 \rightarrow Fe_2O_3 \cdot 3H_2O$$

(ii) This hydrated oxide partially dehydrates to become a mixture of $Fe_2O_3 \cdot 2H_2O$ and $Fe_2O_3 \cdot H_2O$.

The $Fe_2O_3 \cdot H_2O$ is then converted to FeO(OH).

Write an equation for the conversion of $Fe_2O_3 \cdot H_2O$ to FeO(OH).

_____

(iii) What is the oxidation state of iron in $Fe_2O_3 \cdot H_2O$? _____

What is the oxidation state of iron in FeO(OH)? _____

(4 marks)

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5. **17 marks**

A chemist was asked to analyse some rust. She dissolved a 2.285 g sample in sulfuric acid and then added zinc powder to reduce all the Fe^{3+} ions to Fe^{2+} ions.

(a) Write the equation for the reaction between zinc and Fe^{3+}.

_____

(1 mark)

She then filtered the solution containing the Fe^{2+} ions into a 250.0 mL volumetric flask and added distilled water to the 250 mL mark.
25.00 mL aliquots of this solution were titrated with standardised 0.0206 mol L^{-1} $KMnO_4$ solution.

(b) What colour change is observed in the flask at the end point?

_____

_____

(c) Why is this change seen?

_____

_____

(d) Write the half equations for the half reactions occurring.

_____

_____

(e) Write the net redox equation.

_____

(5 marks)

(f) Titre values of 23.4 mL, 22.70 mL, 22.68 mL and 22.72 mL were recorded. What average titre value should be used?

_____

_____

(1 mark)

(g) Use the average titre value to calculate

(i) the number of moles of permanganate in the average titre

(1 mark)

(ii) the number of moles of Fe^{2+} in a 25.00 mL aliquot

(2 marks)

(iii) the mass of iron in the rust sample

(2 marks)

(iv) the percentage by mass of iron in the rust

(1 mark)

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(h) (i) Calculate the percentage of iron in $Fe_2O_3 \cdot 2H_2O$ and $Fe_2O_3 \cdot H_2O$.

(2 marks)

(ii) From your answers in (g) (iv) and (h) (i) decide whether the rust sample was mainly $Fe_2O_3 \cdot 2H_2O$ or $Fe_2O_3 \cdot H_2O$.

_____ (1 mark)

(iii) When dissolving the rust, the chemist used sulfuric acid and not hydrochloric acid. Why did she not use hydrochloric acid?

_____

_____

_____

_____

_____

(1 mark)

6. **12 marks**

The simplest unsaturated hydrocarbon is commonly known as ethylene, C_2H_4.

(a) What is its IUPAC systematic name? _____

(1 mark)

(b) Write a structural formula for ethylene. _____

(1 mark)

Ethylene can be converted to ethanol by reaction with water in the presence of a catalyst such as sulfuric acid.

(c) Write an equation for this reaction, using structural formulas.

_____

(1 mark)

(d) Is this reaction an addition, or a substitution? _____

(1 mark)

(e) Name two compounds that can be produced by oxidising ethanol with acidified potassium dichromate solution.

_____

_____

(2 marks)

(f) Ethylene can be reacted with chlorine to form 1,2 – dichloroethane. Write the equation for this reaction, using structural formulas.

_____

(1 mark)

(g) When 1,2 – dichloroethane is heated under pressure with sodium hydroxide it forms chloroethene, commonly known as vinyl chloride.

(i) Write the equation for this reaction, using structural formulas.

_____

(1 mark)

(ii) Vinyl chloride polymerises to form PVC. Draw a structural formula for PVC, showing three repeating monomer units.

(1 mark)

(iii) What type of polymerisation is this called?

_____

(1 mark)

(iv) What two types of intermolecular bonding occur between PVC molecules?

_____

_____

(2 marks)

END OF QUESTIONS

Additional working space:

END OF PAPER

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