2011
WAUPP

PROGRAM EXAMINATION 2011

CHEMISTRY STAGE 3 Solutions

MULTIPLE CHOICE ANSWER SHEET

CANDIDATE NUMBER - IN FIGURES | | | | | | | | |

IN WORDS

_____

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_____

Put a cross over the answer of your choice eg

(a) (b) (c) (d)

To change an answer black out the cross and put in your new answer

1. (a) (b) (c) (d)
2. (a) (b) (c) (d)
3. (a) (b) (c) (d)
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25. (a) (b) (c) (d)

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.

   $Sr^{2+} + SO_4^{2-} \rightarrow SrSO_4$

   (2 marks)

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

   $Cr_2O_7^{2-} + 14H^+ + 6Br^- \rightarrow 2Cr^{3+} + 3Br_2 + 7H_2O$.

   (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.

   colourless solution + blue solution produce white precipitate in paler blue solution.

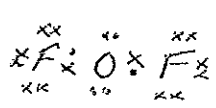
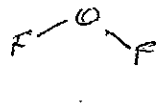
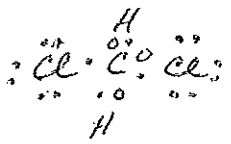
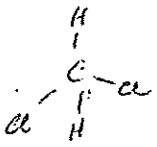
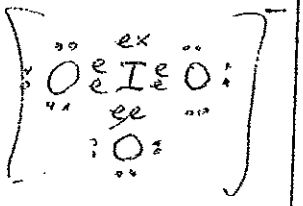
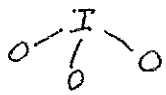
   (2 marks)

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

   brown solid wire added to colourless solution producing (green then) blue solution with evolution of (pungent) brown gas.

   (2 marks)

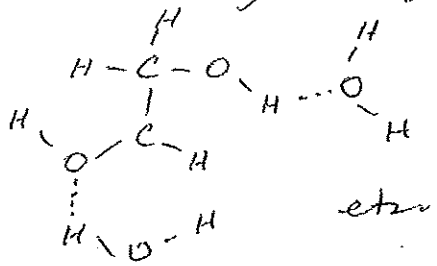
3. For each of the species listed in the table below
   (a) draw an electron-dot diagram, showing the arrangement of all valence electrons (including lone pairs)
   (b) sketch clearly, or name, the shape of the species, and
   (c) describe the species as 'polar' or 'non-polar'.

Species	Draw and electron-dot diagram	Sketch or name the shape of species	Describe the polarity
Oxygen difluoride OF_2		 or bent	polar
Dichloromethane CH_2Cl_2		 or tetrahedral	polar
Iodate ion IO_3^-		 or pyramidal	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.

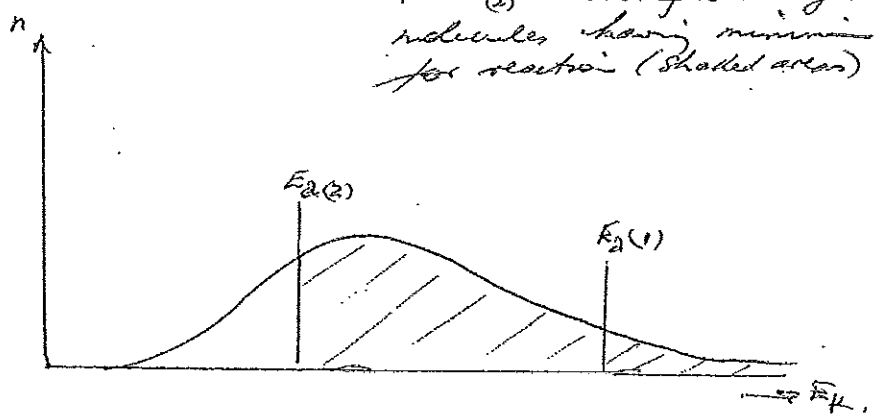
Hydrogen bonding between alcohol groups of glycol and –OH groups of water are numerous, linking the molecules for complete miscibility.



ethane

(3 marks)

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: unchanged	Effect on mass of CO: decreased
(ii) Add more COF_2 (or $COCl_2$) to the system without changing the volume or temperature	Effect on mass of CF_4: increased	Effect on mass of Cl_2: increased
(iii) Add an inert gas without changing the volume or temperature	Effect on mass of COF_2: unchanged	Effect on mass of $COCl_2$: unchanged

(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, an name this type of system. (3 mark

Equilibrium established:

$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+$

(or equiva

Addition of H^+ (H_3O^+) shifts eqm to left from excess maintaining similar conc of H_3O^+, hence pH.

Addition of OH^- reacts with H_3O^+ ($H_3O^+ + OH^- \rightleftharpoons 2H_2O$). Equilibrium shifts right maintaining similar conc of H_3O^+, hence pH.

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)

$C = \frac{n}{V} = \frac{1.00}{4.00} = 0.250 \text{ mol } L^{-1}$

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

$Ba(OH)_2 \rightarrow Ba^{2+} + 2OH^-$

$[OH^-] = 2 \times [Ba(OH)_2] = 0.500 \text{ mol } L^{-1}$

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

$K_w = [H^+][OH^-] = 1.00 \times 10^{-14}$

$[H^+] = \frac{1.00 \times 10^{-14}}{[OH^-]}$

$= \frac{1.00 \times 10^{-14}}{0.500} = 2.00 \times 10^{-14} \text{ mol } L^{-1}$

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

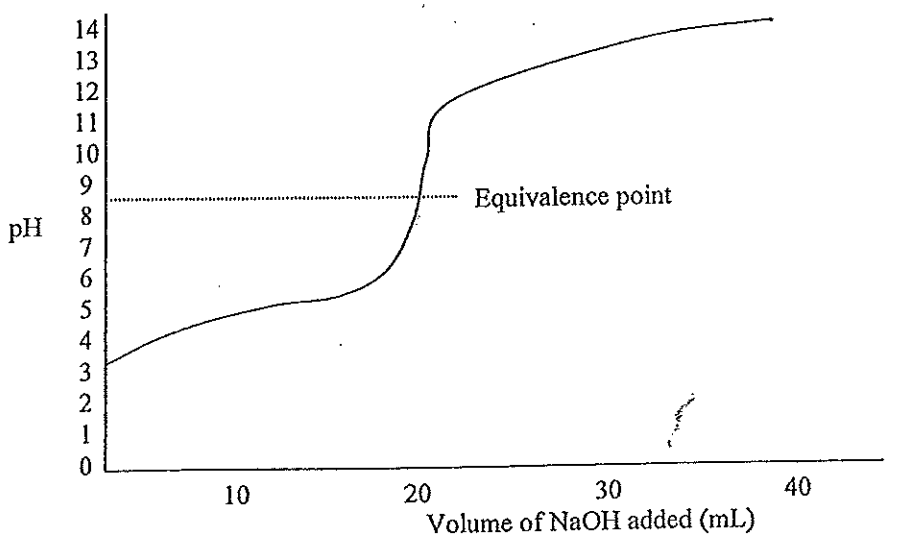
$pH = -\log_{10}[H^+]$

$= -\log 2.00 \times 10^{-14}$

$= -(-13.7)$

$= 13.7$

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? weak

(b) Name an example of such an acid. ethanoic / citric / etc.

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

One which has an alkaline (pH > 7) colour change eg. phenolphthalein. This is so the end point coincides with the equivalence point.

(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.

iron (II) has oxide FeO
iron (III) has oxide Fe_2O_3

So Fe_3O_4 could be equimolar combination of the two oxides ie $FeO.Fe_2O_3$
or Fe_3O_4 as "molecular" formula

(3 marks)

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	$HPh \rightleftharpoons H^+ + Ph^-$	Colour: colourless	Colour: pink
		Formula: HPh	Formula: Ph^-
Methyl orange HMo	$HMo \rightleftharpoons H^+ + Mo^-$	Colour: red	Colour: yellow
		Formula: HMo	Formula: Mo^-

(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	sodium sulfate / Na_2SO_4 or copper sulfate / $CuSO_4$ etc
A metal used as a sacrificial anode to protect steel from corrosion	zinc / Zn or aluminium / Al or magnesium / Mg
A primary standard used for redox titrations.	iron ammonium sulfate / $Fe(NH_4)_2(SO_4)_2.6H_2O$ or oxalic acid / $H_2C_2O_4.2H_2O$
A gas that can be used as an oxidising agent.	oxygen / O_2 or chlorine / Cl_2
An element whose compounds are all soluble	sodium / Na or potassium / K

(5 marks)

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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 0 Cl^- −1

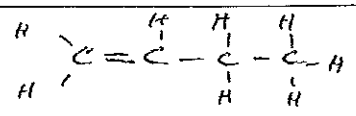
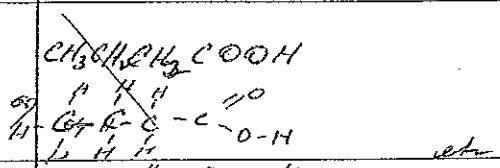
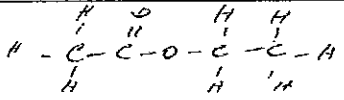
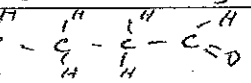
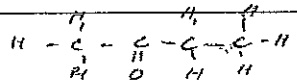
HClO +1

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

disproportionation or, auto-oxidation

(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	 or $CH_2=CHCH_2CH_3$	1- butene
2 Carboxylic acid		butanoic acid ethanoic acid
3 Ester	 or $CH_3COOCH_2CH_3$	ethyl ethanoate
4 Aldehyde	 or $CH_3CH_2CH_2CHO$	butanal
5 Ketone	 or $CH_3COCH_2CH_3$	butanone

(10 marks)

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

2 and 3
or 4 and 5

(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)

(a) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4(s) + 2HCl$

$n(BaCl_2) = \frac{14.0}{244.232} = 5.732 \times 10^{-2}$ mol in 100 mL

Ba = 137.3
Cl$_2$ = 70.90
2H$_2$O = 36.03
244.23

$\therefore$ 25.0 mL contains $\frac{25.0}{100} \times 5.732 \times 10^{-2}$

$= 1.433 \times 10^{-2}$ mol

$n(H_2SO_4) = \frac{50.0}{1000} \times \frac{0.245}{1}$

$= 1.225 \times 10^{-2}$ mol

$\therefore$ XS $BaCl_2$, and H_2SO_4 is limiting Reagent.

$n(BaSO_4) = n(H_2SO_4) = 1.225 \times 10^{-2}$ mol

$m(BaSO_4) = 1.225 \times 10^{-2} \times 233.36$ g.

$= 2.86$ g

(b) All Cl^- stays in solution

$$c(Cl^-) = \frac{n}{V} = \frac{2 \times 1.433 \times 10^{-2}}{(25+50) \times 10^{-3}}$$

$$= \frac{2.866 \times 10^{-2}}{7.5 \times 10^{-2}}$$

$$= \underline{0.382 \text{ mol } L^{-1}}$$

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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)?

phenolphthalein (1 mark)

(ii) Explain why.

Titration of weak acid with strong base has alkaline / basic equivalence point, so end point (colour change) should be @ pH > 7

(1 m

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?

magenta/pink to colourless (1 mark)

(c) Write a balanced equation for the reaction.

$CH_3COOH + OH^- \rightarrow CH_3COO^- + H_2O$ (1 mark)

(d) Determine an appropriate titre volume.

Ignore 1st ✗ for 3 titres → 35.76 mL. (1 mark)

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

Eqn alignment: $n(NaOH) = \frac{20.0}{1000} \times \frac{0.121}{1}$ mol

$= 2.42 \times 10^{-3}$ mol

$n(CH_3COOH)$ per titre $= 2.42 \times 10^{-3}$ mol

$c(CH_3COOH) = \frac{2.42 \times 10^{-3}}{35.76 \times 10^{-3}}$

$= 6.767 \times 10^{-2}$ mol L^{-1}

(3 mark

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

$m(CH_3COOH) = 6.767 \times 10^{-2} \times 60.05$

$= 4.064\ g$

$C_2 = 24.02$
$H_4 = 4.032$
$O_2 = 32.00$
60.052

(2 marks)

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

mass of CH_3COOH in sample = mass in 250 mL dilute solution

$= 4.064\ g.$

$\therefore\ \%(CH_3COOH) = \frac{4.064}{25.0} \times \frac{100}{1}$

$= 16.26$

$\therefore$ 16.3 %

(2 marks)

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

$CH_3CH_2OH + H_2O \rightarrow CH_3COOH + 4H^+ + 4e^-$ (1 mark)

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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 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)

In 3.625 g sample:

(a) (i) $n(Pt) = \frac{2.146 g}{}$

(ii) $n(HCl) = 1.203 g = \frac{1.203}{36.458}$ mol ($HCl + NaOH \rightarrow NaCl + H_2O$)

H = 1.008
Cl = 35.45
36.458

$m(Cl) = \frac{1.203}{36.458} \times \frac{35.45}{1}$

$= 1.1697 g$

(iii) $V(CO_2) = 524 mL @ 23.0°C$ & 103.4 kPa

$= \frac{524}{1} \times \frac{273}{296} \times \frac{103.4}{101.3}$ mL @ STP

$= 493.3$ mL @ STP

$n(CO_2) = \frac{493.3}{22.41 \times 10^3} = 0.0220$ mol

$\therefore n(C) = n(CO_2) = 0.0220$ mol

$m(C) = 0.0220 \times 12.01$

$= 0.264 g$

$m(C + Cl + Pt) = 0.264 + 1.1697 + 2.146 =$

$\therefore m(H) = 3.625 - 3.580 = 0.045 g$.

	H	Cl	C	Pt
mass in sample	0.045 g	1.1697 g	0.264 g	2.146 g
rel. moles	$\frac{0.045}{1.008}$	$\frac{1.1697}{35.45}$	$\frac{0.264}{12.01}$	$\frac{2.146}{195.1}$
	0.04464	0.0330	0.02198	0.0110
simplified ratio	4	3	2	1

Empirical formula = $PtC_2H_4Cl_3$

(b) Emp. formula wt: Pt 195.1
C_2 24.02
H_4 4.032
Cl_3 106.35
329.50u

Molecular wt = 659
= 2 × emp. formula wt.

∴ Molecular formula = $Pt_2C_4H_8Cl_6$
→ $Pt_2(C_2H_4)_2Cl_6$

∴ X = 2
Y = 2
Z = 6

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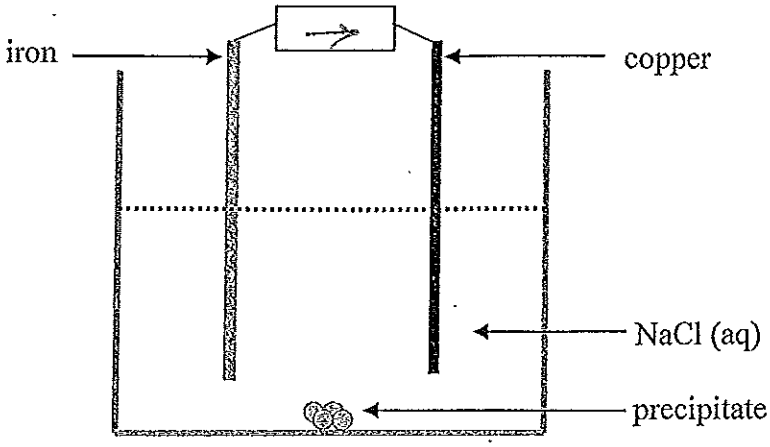
4. **15 marks**

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.

Fe $\quad Fe \rightarrow Fe^{2+} + 2e^-$

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

(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.

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

(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? iron or anode

(ii) Near which electrode will pink colour appear? copper or cathode

(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? $Fe(OH)_2$

What is the oxidation state of iron in this compound? $+2$

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

$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$

(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, $Fe(OH)_3$. $4(Fe^{2+} \rightarrow Fe^{3+} + e^-)$

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

(i) Write the equation for this reaction.

$4Fe(OH)_2 + O_2 + 2H_2O \rightarrow 4Fe(OH)_3$

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

$+2$ to $+3$

(2 marks)

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

(i) Balance the equation

$2\ Fe(OH)_3 \rightarrow Fe_2O_3 \cdot 3H_2O$

(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).

$Fe_2O_3 \cdot H_2O \rightarrow 2\ FeO(OH)$

(iii) What is the oxidation state of iron in $Fe_2O_3 \cdot H_2O$? $+3$

What is the oxidation state of iron in FeO(OH)? $+3$

(4 marks)

5. **17 marks**

A chemist was asked to analyse some rust. She dissolved a 2.285 g sample in sulfuric acid a 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+}.

$Zn + 2Fe^{3+} \rightarrow Zn^{2+} + 2Fe^{2+}$

(1 m

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?

decolourised solution becomes permanently pin

(c) Why is this change seen?

because MnO_4^- ion with intense purple colou

is slight excess in solution giving pink

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

$Fe^{2+} \rightarrow Fe^{3+} + e^-$

$MnO_4^- + 5e^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O$

(e) Write the net redox equation.

$5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} +$

(5

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

Ignore 1st $\bar{x}$ of 2nd 3 → 22.70 mL

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(g) Use the average titre value to calculate

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

$n(MnO_4^-) = \frac{22.70}{1000} \times \frac{0.0206}{1}$ mol

$= 4.676 \times 10^{-4}$ mol.

(1 mark)

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

$n(Fe^{2+}) = 5 \times n(MnO_4^-)$

$= 5 \times 4.676 \times 10^{-4}$

$= 2.338 \times 10^{-3}$ mol

(2 marks)

(iii) the mass of iron in the rust sample

$n(Fe^{2+})$ in 250 mL $= \frac{250}{25} \times \frac{2.338 \times 10^{-3}}{1}$

$= 2.338 \times 10^{-2}$ mol

$\therefore n(Fe^{2+})$ in sample $= 2.338 \times 10^{-2}$ mol

$m(Fe)$ " " $= 2.338 \times 10^{-2} \times 55.85$

$= 1.306$ g.

(2 marks)

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

$\% (Fe) = \frac{1.306}{2.285} \times \frac{100}{1}$

$= 57.1\%$

(1 mark)

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

$Fe_2 = 111.70$
$O_5 = 80.00$
$H_4 = 4.032$
195.732

$\%(Fe) = \frac{111.70}{195.732} \times \frac{100}{1}$

$= 57.1\%$

$Fe_2 = 111.70$
$O_4 = 64.00$
$H_2 = 2.016$
177.716

$\%(Fe) = \frac{111.70}{177.716} \times \frac{100}{1}$

$= 62.9\%$

(2 m

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

$\Rightarrow 57.1\%$, rust is $Fe_2O_3 \cdot 2H_2O$ (1 m

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

Sulfuric acid provides the H^+ needed for hydrol
but does not react

Hydrochloric acid provides H^+, but the Cl^- also
reacts with MnO_4^- making reaction inaccurate.

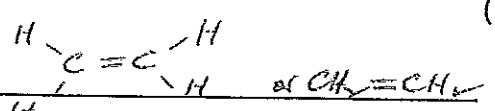
(1 m

6. **12 marks**

The simplest unsaturated hydrocarbon is commonly known as ethylene, C_2H_4. $CH_2=CH_2$

(a) What is its IUPAC systematic name? ethene

(1 mark)

(b) Write a structural formula for ethylene.  or $CH_2=CH_2$

(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.

$CH_2=CH_2 + H_2O \xrightarrow{[H^+]} CH_2(H)-CH_2(OH) \rightarrow CH_3CH_2OH$

(1 mark)

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

(1 mark)

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

ethanal + ethanoic acid

(2 marks)

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

$CH_2=CH_2 + Cl_2 \rightarrow CH_2(Cl)-CH_2(Cl)$

(1 mark)

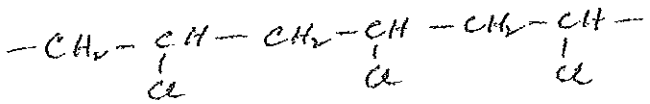
(g) When 1,2 – dichloroethane is heated under pressure with sodium hydroxide it forms chloroethene, commonly known as vinyl chloride.

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

$NaOH + CH_2(Cl)-CH_2(Cl) \rightarrow CH_2=CH(Cl) + NaCl + H_2O$

(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?

addition polymerisation

(1 mark)

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

dipole - dipole

& dispersion

(2 marks)

END OF QUESTIONS