Examiners' Report

June 2012

GCE Chemisty 6CH05 01

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June 2012

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Introduction

Examiners were privileged to see some really excellent work from some extremely well prepared candidates.

There were no dead marks and there was little evidence of candidates failing to complete the paper.

There were the usual problems with written communication such as the inappropriate use of chemical terms like molecule, ion and atom.

Question 12 (a) (i)

Almost all candidates gained the mark here. The correct sign was required. Correct units should also be given, though on this occasion their absence was not penalised.

Question 12 (a) (ii)

This was a very discriminating question. A significant number of candidates scored only 1 or 2 marks and very few scored all 4 . A common problem was failure to read part or parts of the question sufficiently carefully. The hardest mark to achieve was the fourth for appreciating that substitution reactions maintain the stable delocalised system.

(a) A Kekulé structure of benzene suggests the molecule consists of alternate double and single carbon to carbon bonds.
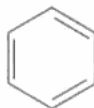
The standard enthalpy change of hydrogenation of a carbon to carbon double bond is -120 kJ mol^{-1}.

(i) Calculate the standard enthalpy change of hydrogenation of benzene for the Kekulé structure.

(1)

$$(3 \times -120) = -360 \text{ kJ mol}^{-1}$$

*(ii) The actual standard enthalpy change of hydrogenation of benzene is -208 kJ mol^{-1}.

Use this information and your answer to (i), to calculate the difference in stability of benzene and the Kekulé structure.

What does this tell us about the bonding in benzene?

Explain how this influences the type of chemical reactions that benzene undergoes.
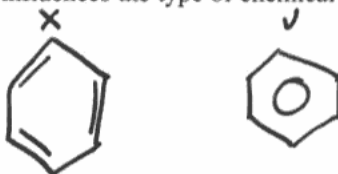
(4)

· Stability of benzene must be greater than kekulé structure suggests, as hydrogenation is less exothermic, so more energy must be needed to the break the bonds in benzene to hydrogenate the molecule. This tells us that the bonds in benzene cannot be simple C=C double bonds, they must have stronger bonding (due to the delocalised ring of electrons). This means benzene will not easily undergo reactions like bromination, as there are no C=C bonds to break. (using a δ+ Br, as there will be no high electron density)

*(ii) The actual standard enthalpy change of hydrogenation of benzene is
−208 kJ mol⁻¹.

Use this information and your answer to (i), to calculate the difference in
stability of benzene and the Kekulé structure.

What does this tell us about the bonding in benzene?

Explain how this influences the type of chemical reactions that benzene
undergoes.

(4)

Benzene is −152 kJmol⁻¹ more stable than a Kekulé
structure. This means that the bonding in benzene
must stabilise the ring. Delocalised electrons above
and below the plane of the molecule. Because
benzene is stable because of the delocalised ring it
is more likely to undergo electrophilic substitution
rather than addition to keep the stable ring intact.

Question 12 (b) (i)

Most candidates gained full credit here. A few gave hydrochloric acid instead of either of the correct answers. A common problem was to omit the term 'concentrated'.

(b) The flow chart shows some typical reactions of benzene.

$$C_6H_5NO_2 \longleftarrow C_6H_6 \xrightarrow{Br_2/FeBr_3} C_6H_5Br$$

nitrobenzene   benzene   bromobenzene

| fuming sulfuric acid

Compound **A**
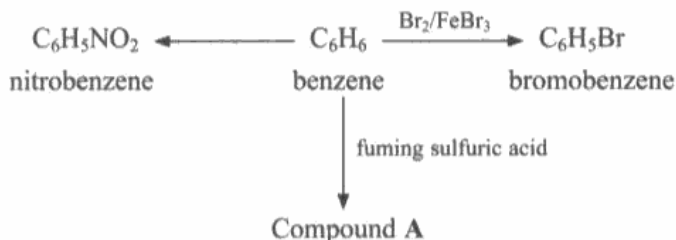
(i) Identify the two chemicals needed to make nitrobenzene from benzene.

(2)

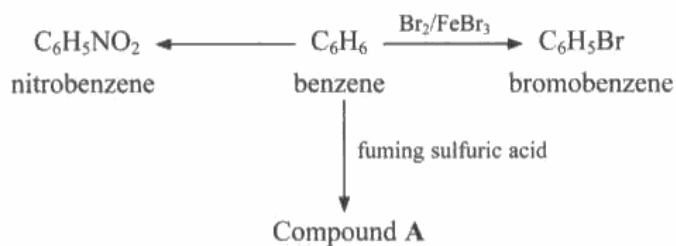HNO_3 & H_2SO_4

ResultsPlus
Examiner Comments

The common problem!

ResultsPlus
Examiner Tip

Remember conditions as well as reactants when learning Organic reactions.

(b) The flow chart shows some typical reactions of benzene.

$$C_6H_5NO_2 \longleftarrow C_6H_6 \xrightarrow{Br_2/FeBr_3} C_6H_5Br$$

nitrobenzene   benzene   bromobenzene

| fuming sulfuric acid

Compound **A**

(i) Identify the two chemicals needed to make nitrobenzene from benzene.

(2)

concentrated sulfuric (VI) acid and concentrated nitric (V) acids.

ResultsPlus
Examiner Comments

This is an excellent answer, but the oxidation states are unnecessary.

ResultsPlus
Examiner Tip

Only give extra information if you are sure it is correct.

Question 12 (b) (ii)

This was answered correctly by a majority of the candidates. Recognisable spellings were accepted but be warned examiners will not always be so lenient.

(ii) Classify the type of reagent required in all three reactions.

(1)

Conc Strong acid

ResultsPlus
Examiner Comments

This was the most common wrong response.

ResultsPlus
Examiner Tip

It is important to know the types of reagent and the types of reaction in Organic reactions.

Question 12 (b) (iii)

Candidates are generally good at this. Many gained full credit. The common error was poor drawing of curly arrows or the delocalisation in the intermediate. The arrow to the electrophile needs to start from the inner circle of the hexagon. The arrow showing the breaking of the carbon-hydrogen bond must go from the bond, and not the hydrogen, into the ring.

(iii) Show, with appropriate diagrams, the mechanism for the reaction of benzene with bromine, in the presence of iron(III) bromide, to form bromobenzene. Include the formation of the ion attacking the benzene molecule.

(4)

$$FeBr_3 + Br_2 \rightarrow FeBr_4^- + Br^+$$

$$+ FeBr_3 + HBr$$
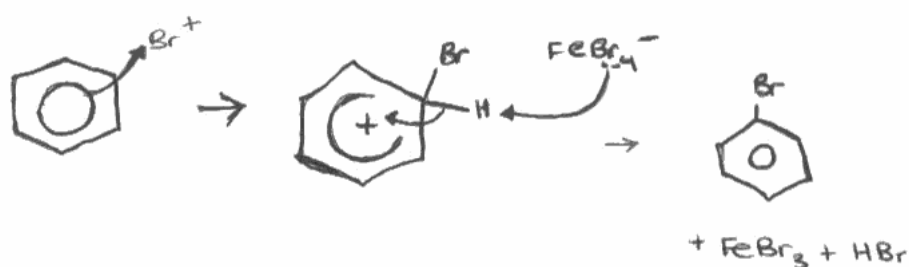
ResultsPlus
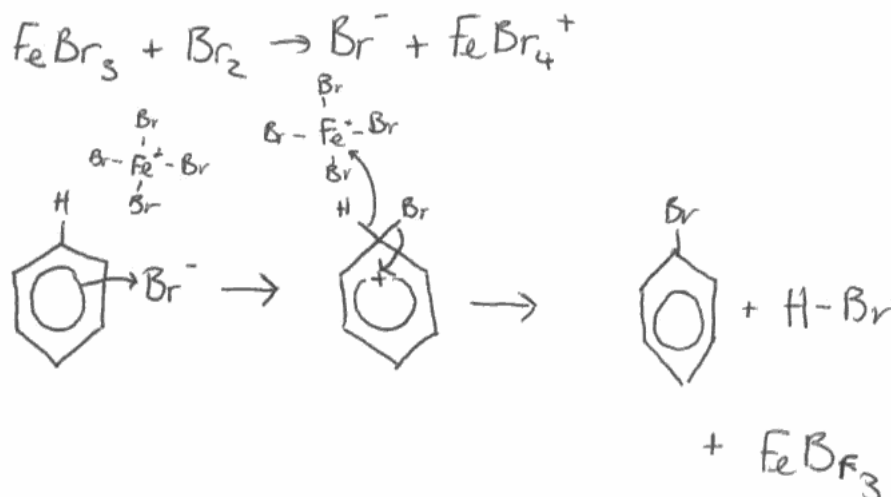**Examiner Comments**

An excellent answer.

ResultsPlus
Examiner Tip

Try to present mechanisms as clearly as this.

(iii) Show, with appropriate diagrams, the mechanism for the reaction of benzene with bromine, in the presence of iron(III) bromide, to form bromobenzene. Include the formation of the ion attacking the benzene molecule.

(4)

$$FeBr_3 + Br_2 \rightarrow Br^- + FeBr_4^+$$

Question 12 (b) (iv)

The marks here were equally distributed. Many knew neither the structural formula nor the name. The bond from a benzene ring must be drawn to the sulfur, and the hydrogen must be attached to oxygen not sulfur, in the formula.

(iv) Give the structural formula and the name for compound **A**.

$$SO_3H$$

(2)

$$C_6 H_5 SO_3 H$$

Name...............benzenesulfonic...acid...

ResultsPlus
Examiner Comments

This is a case of incorrect additional information. The second formula was perfectly satisfactory as a structural formula, but the incorrect bond to sulfur in the first costs a mark.

ResultsPlus
Examiner Tip

Check answers to ensure they are fully correct.

Question 12 (c) (i)

About half the candidates scored 2 marks. The first mark was most discriminating. In both compounds it is the non-bonding electrons on the oxygen that are delocalized into the ring.

(c) (i) Explain why phenol, C_6H_5OH, and methoxybenzene, $C_6H_5OCH_3$, are much more reactive than benzene with bromine.

(3)

In phenol, the lone pairs of electrons in the -OH group increased the electron density of the benzene ring, making it more susceptible to electrophilic attack. In methoxybenzene, the CH_3 group donates electrons to the benzene ring, similarly increasing the electron density of the ring : this makes it more susceptible to electrophilic attack than benzene.

(ii) Write the equation for the reaction between phenol and bromine water. State

ResultsPlus
Examiner Comments

Here the candidate has made a correct statement about the methyl group but failed to realise that it would need to be directly attached to the benzene ring.
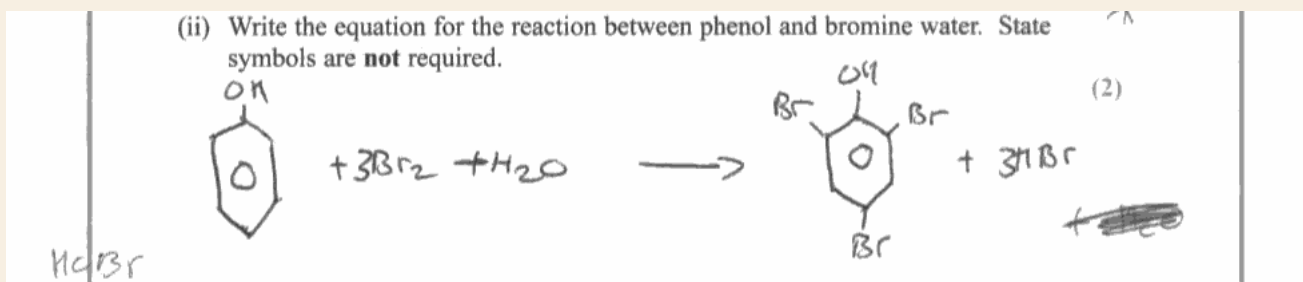
ResultsPlus
Examiner Tip

Look at the formulae given in questions carefully.

Question 12 (c) (ii)

There was an equal distribution of marks between candidates in the answers to this question. The product with bromine water is the tribromo compound, so mono or dibromination cost a mark. Care was needed with the number of hydrogens in the formula for the organic product. The other product, HBr was often forgotten.
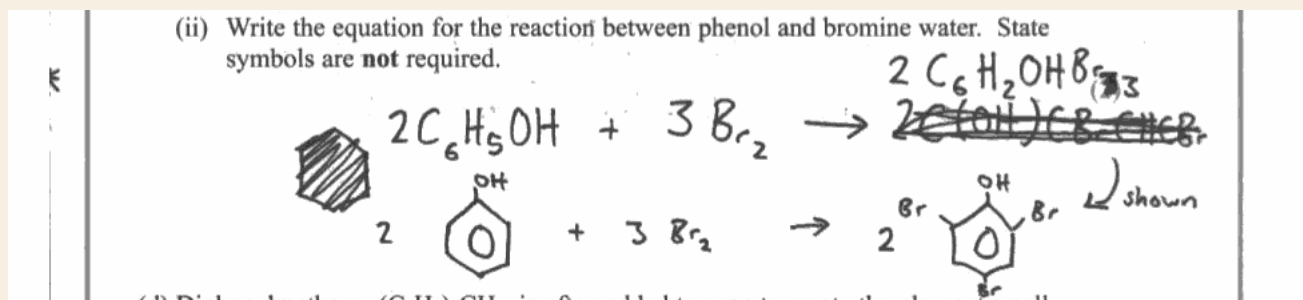

ResultsPlus
Examiner Comments

Water was ignored, and the position of the bond from the ring was not penalised on this occasion.

ResultsPlus
Examiner Tip

This reaction does not involve water.

ResultsPlus
Examiner Comments

Both product formulae are fine, but HBr has been forgotten.

ResultsPlus
Examiner Tip

Do not forget the inorganic products in organic reactions.

Question 12 (d)

Less than half of the candidates gained full credit, with equal numbers on 1 and 0. The catalyst was well known. The organic chemical was the discriminator.

(d) Diphenylmethane, $(C_6H_5)_2CH_2$, is often added to soap to create the pleasant smell of geraniums. It can be made from benzene and one other reagent, using a suitable catalyst.

Identify the other starting material and the catalyst by name or formula.

(2)

$AlCl_3$ is catalyst
starting material is $C_6H_5CH_2Cl$

ResultsPlus
Examiner Comments
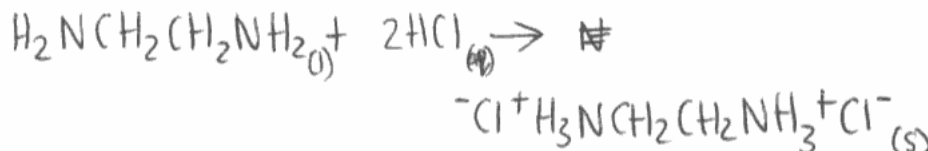
A fully correct answer.

Question 13 (a)

Only a relatively small fraction of candidates gained full credit, with many scoring 0.

This apparently simple reaction always seems to give difficulties. Ammonia and amines are not sufficiently familiar to many. Organic products which had lost hydrogen were common. More understandable was failure to balance for hydrogen and chlorine.

13 This question is about 1,2-diaminoethane, $H_2NCH_2CH_2NH_2$.

(a) Write an equation for the reaction between 1,2-diaminoethane and **excess** dilute hydrochloric acid.

(2)

$$H_2NCH_2CH_2NH_{2(l)} + 2HCl_{(aq)} \rightarrow$$
$$^-Cl^+H_3NCH_2CH_2NH_3^+Cl^-_{(s)}$$

ResultsPlus
Examiner Comments

An excellent fully correct answer.

13 This question is about 1,2-diaminoethane, $H_2NCH_2CH_2NH_2$.

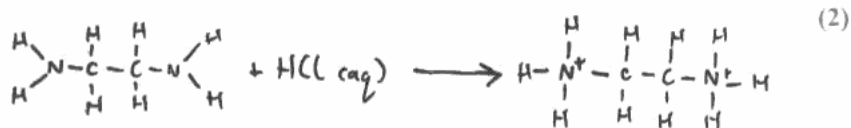(a) Write an equation for the reaction between 1,2-diaminoethane and **excess** dilute hydrochloric acid.

(2)

Question 13 (b) (i)

Most candidates gave a sensible colour from their experience of nickel compounds.

Question 13 (b) (ii)

It is important to recognise that the entropy change of the **system** is positive due to the increase in the number of particles. The term 'molecules' was often used incorrectly.

(ii) Without using the data booklet, suggest why the complex formed is more stable than $Ni(H_2O)_6{}^{2+}$ by considering the appropriate entropy change.

(2)

In $Ni(H_2O)_6{}^{2+}$ there are 7 molecules making up the complex. In $Ni(H_2NCH_2CH_2NH_2)_3{}^{2+}$ there are only 4 molecules so the entropy is lower to form $Ni(H_2NCH_2CH_2NH_2)_3{}^{2+}$ therefore it is more favourable.

(ii) Without using the data booklet, suggest why the complex formed is more stable than $Ni(H_2O)_6^{2+}$ by considering the appropriate entropy change.

(2)

There is a positive system entropy change. There are 6 ligand molecules/moles of H_2O on right side and 1 complex ion but only 3 molecules on left (+complex ion). Increase in number of molecules = more disorder/chaos as more ways of being arranged = reaction occurs/spontaneous = Ni complex = more stable.

Question 13 (b) (iii)

The majority of candidates were correct here. Those who failed to score were insufficiently succinct in their responses. The terms 'rotate', and 'plane' were often omitted.

(iii) This complex can exist as two structures, which are non-superimposable mirror images.

Suggest the <u>physical property</u> that would enable you to distinguish between these two structures.

(1)

Their optical activity – ability to rotate plane polarised light.

(iii) This complex can exist as two structures, which are non-superimposable mirror images.

Suggest the physical property that would enable you to distinguish between these two structures.

(1)

Their effect on plane polarised light.

ResultsPlus
Examiner Comments

This is insufficient. The word 'effect' needs to be explained.

ResultsPlus
Examiner Tip

Learn that chiral compounds rotate the plane of plane-polarized light.

Question 13 (c)

Many candidates scored over half marks on this question. The first two parts were rarely answered incorrectly. A small number of candidates could not draw the amide link in part (i) and a very small number gave 'addition' in part (ii). The last part was discriminating, many gave only one force with a description; those giving all three often gave inadequate explanations. In this type of question it is important to relate the explanation to the compound.

(c) 1,2-diaminoethane reacts with butane-1,2-dioyl dichloride, $ClOCCH_2CH_2COCl$, to form a polymer.

(i) Draw a displayed formula for this polymer showing one repeat unit.

(2)
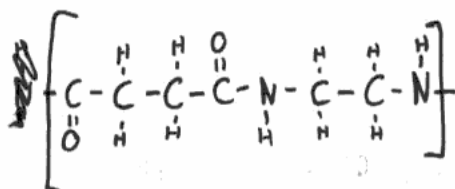
(ii) Give, and explain, the name for this type of polymerization reaction.

(2)

Neucleophilic substitution.

The nitrogen attacks the electron dizzicient carbon causing the Cl and H to be substituted.

*(iii) State and explain the intermolecular forces between two of these polymer chains.

(5)

The chains will have london gorces present as there are electrons in the structure.

As there are C=O present there will be PD-PD bonds.

There will also be some Hydrogen bonding due to the presence of the nitrogen.

ResultsPlus Examiner Comments

Part (i) is fine, (ii) is a rare wrong answer. In the last part, London forces do not mention the large number of electrons, the term pdpd was not acceptable and the polarity of C=O was not mentioned. The hydrogen bond description is also inadequate but it does mention nitrogen. For so many near misses the candidate has been given 1 mark.
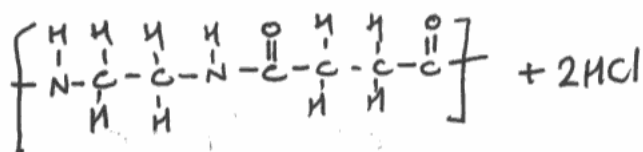
ResultsPlus Examiner Tip

Practice applying your knowledge of intermolecular forces to new organic molecules.

(c) 1,2-diaminoethane reacts with butane-1,2-dioyl dichloride, $ClOCCH_2CH_2COCl$, to form a polymer.

(i) Draw a displayed formula for this polymer showing one repeat unit.

(2)

$+ 2HCl$

(ii) Give, and explain, the name for this type of polymerization reaction.

(2)

~~Addization~~ Condensation – ~~a~~ two Molecules of HCl are eliminated.

*(iii) State and explain the intermolecular forces between two of these polymer chains.

(5)

There will be both london forces and dipole-dipole interactions between two polymer chains. London forces are present wherever there is electrons and the c=o bond is polar. allowing dipole-dipole interactions to occur.
Finally, there will be some hydrogen bonding.
Hydrogen is attached to ~~a~~ Nitrogen, which is electronegative and so hydrogen bonds can form.

Question 14

This question was challenging for weaker candidates but despite failing on the early parts those who persevered found they could still do well on the later parts.

There are several ways of carrying out the calculation in part (i), but the most popular was to find the numbers of moles and masses of carbon, hydrogen and nitrogen and hence find the mass and number of moles of oxygen by subtraction from the mass of the compound. In part (b) the working 12 x 4 + 1 x 8 etc. needed to be shown. In part (c)(i) there was often confusion about the significance of the tests. For example ninhydrin was thought to be a test for an amine. Part (c)(ii) asked for a displayed formula which means all atoms and bonds must be shown. Part (c)(iii) was only given correctly by the best candidates.

---

14 An organic compound **X** contains carbon, hydrogen, oxygen and nitrogen.

0.132 g of **X** is burned completely in oxygen to produce 0.072 g of water, 0.176 g of carbon dioxide and 24.0 cm³ of nitrogen.

[Molar volume of nitrogen under the conditions of the experiment = 24 000 cm³ mol⁻¹]

(a) Calculate the empirical formula of compound **X**.   (5)

H_2O CO_2 N_2.

0.072   0.176   24 cm³

moles: $\frac{0.072}{18}$ $\frac{0.176}{44}$ $\frac{24}{24000}$

$= 4 \times 10^{-3}$ $= 4 \times 10^{-3}$ $\approx 1 \times 10^{-3}$

1 moles of H_2O 1 : 1 Carbon. 1×10^{-3}.

has 2 H So   so 4×10^{-3}

$4 \times 10^{-3} \times 2$

$= 8 \times 10^{-3}$

mass of H : 8×10^{-3}

mass of C : $4 \times 10^{-3} \times 12 = 0.048$

mass of N : 1×10^{-3}

mass of O : $0.132 - (8 \times 10^{-3} + 0.048 + 1 \times 10^{-3})$

$= 0.132 - 0.057$

$= 0.075$.

moles of O : $\frac{0.075}{16} = 4.6875 \times 10^{-3}$

H : C : N : O   empirical formula:

4 : 4 : 1 : 5 $C_4H_4NO_5$

(b) The molar mass of **X** is 132 g mol⁻¹. Deduce the molecular formula for **X**. Show how you arrived at your answer.   (1)

$4(12) + 4(1) + (14) + 5(16) = 146$

$\frac{146}{132} = 1.06$

$= 1$ (rounded)

molecular formula = $C_4H_4NO_5$

$C_4H_4NO_5$

(c) When **X** is refluxed with concentrated hydrochloric acid for several hours, cooled and neutralized, there is only one organic product, **Y**, which has the molecular formula $C_2H_5O_2N$.   ~~tutors~~
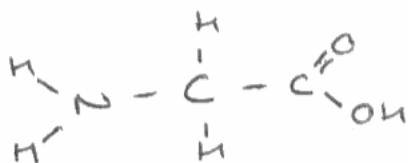
One mole of **Y** will react with either one mole of hydrochloric acid or one mole of sodium hydroxide solution.

When **Y** is sprayed with a solution of ninhydrin and heated, a purple colour is observed.   amino acid.

(i) Use **all** the information above to deduce the functional groups present in **Y** and to classify the type of compound it is. Justify your answer.   (3)

Functional groups are amino and carboxyl groups. The fact it can react with either acid or HCl or NaOH hydrochloric acid or sodium hydroxide shows that it is amphoteric, so must have two charges. If it has reacted with ~~ath~~ ninhydrin to form a ~~purple~~ purple colour it must be an amino acid. So functional groups present are NH_3 and $COOH$ (amino group and carboxyl group).   (2)

(ii) Deduce the displayed formula for **Y** and give its name.

Name of Y 2-amino-ethanoic acid ↗ (or glycine)

(iii) Hence give the structural formula for **X**.   polymer.   (1)

14 An organic compound **X** contains carbon, hydrogen, oxygen and nitrogen.

0.132 g of **X** is burned completely in oxygen to produce 0.072 g of water, 0.176 g of carbon dioxide and 24.0 cm³ of nitrogen.

[Molar volume of nitrogen under the conditions of the experiment = 24 000 cm³ mol⁻¹]

(a) Calculate the empirical formula of compound **X**. (5)

H_2O :

CO_2 :

$24 cm^3$

$= 0.024 dm^3$
of nitrogen

$\dfrac{0.072g}{18} = 4 \times 10^{-3}$

$\dfrac{0.176g}{44} = 4 \times 10^{-3}$

$= 0.001$ moles
of nitrogen

$= 4 \times 10^{-3}$

$= 0.004$ moles
of H_2O

$=$

0.004 moles of
CO_2

$= 0.002$ moles of N

$\dfrac{0.014g}{} = 0.008$ moles
of Hydrogen

$=$
of nitrogen

$= 0.004$ moles of
carbon

$= 0.008g$ of Hydrogen

$= (0.004 \times 12)$ grams of
carbon =

$= 0.048g$

$0.132 - \left[(0.008 + 0.048) \right] = 0.076g$ of Oxygen

$0.132 - \left(0.008 + 0.048 + 0.014 \right) = \dfrac{0.062g}{16} = 3.875 \times 10^{-3}$
moles of oxygen

$= NO_4H_8C_4$

(b) The molar mass of **X** is 132 g mol⁻¹. Deduce the molecular formula for **X**. Show how you arrived at your answer.

$NH_8C_4O_4$ (1)

$= \quad C_4H_6NO_4$

(c) When **X** is refluxed with concentrated hydrochloric acid for several hours, cooled and neutralized, there is only one organic product, **Y**, which has the molecular formula $C_2H_5O_2N$.
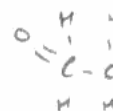
One mole of **Y** will react with either one mole of hydrochloric acid or one mole of sodium hydroxide solution.

When **Y** is sprayed with a solution of ninhydrin and heated, a purple colour is observed.

Amino acid

(i) Use **all** the information above to deduce the functional groups present in **Y** and to classify the type of compound it is. Justify your answer.

(3)

When Y is sprayed with a solution of ninhydrin, a purple color observed means that Y is an amino acid. This means it contains the amine , -NH₂ group, and the carboxylic acid group, -COOH. As Y reacts with one mole of HCl or one mole of NaOH, it suggests it has one amine group, and one carboxylic acid group, 1:1 ratio. The molecular formula contains Nitrogen, so it can have an amine group, it has 2 oxygens, so can contain a carboxylic acid group.

(ii) Deduce the displayed formula for **Y** and give its name.

(2)

$$\begin{array}{c} H \\ | \\ H\diagdown \quad \quad \quad O \\ N - C - C \diagup \diagdown \\ H\diagup \quad | \quad \quad \diagdown \\ \quad \quad H \quad \quad OH \end{array}$$
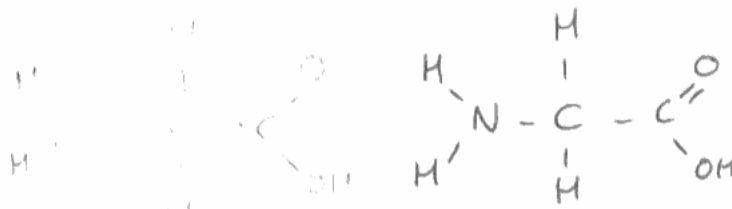
Name of **Y** .... *Glycine*

(iii) Hence give the structural formula for **X**.

(1)

$NH_2 CH_2 CH_2 OH$

Question 15 (a) (i)

This was correctly answered by most candidates. Wrong answers were usually manganate ions.

Question 15 (a) (ii)

The majority of candidates scored at least 1 mark with many giving fully correct answers. Often candidates were distracted into referring to gas adsorption but still managed to get the more general aspects of catalytic activity.

> (ii) How do catalysts speed up reactions?
> (2)
>
> They provide an alternate path of lower activation energy, meaning a higher proportion of the reactant molecules have the necessary activation energy to react

ResultsPlus Examiner Comments

A fully corrrect answer.

> (ii) How do catalysts speed up reactions?
> (2)
>
> They provide an alternative route with a lower activation energy for the reactants to take

ResultsPlus Examiner Comments

This answer is not quite enough. It misses the important final point that the rate of successful collisions increases.

ResultsPlus Examiner Tip

Answer each question as fully as possible.

Question 15 (a) (iii)

A majority of candidates gained no credit. Many described and explained heterogeneous catalysis.

(iii) Explain how transition metal ions can act as homogeneous catalysts.

(2)

ions are in the same phase as the reactants

variable oxidation states allow the transition metal ions to

donate a or accept electrons - can be oxidised or reduced, changing

between oxidation states, allowing reactions to happen more quickly

ResultsPlus
Examiner Comments

An excellent answer.

ResultsPlus
Examiner Tip

This is probably the most important aspect of homogeneous catalysis in the course.

(iii) Explain how transition metal ions can act as homogeneous catalysts.

(2)

The reactants are adsorbed onto the surface of the solid catalyst, which weakens their bonds, lowering the activation energy of the process, which takes place on the solids surface before the liquid or gas phase products are released.

ResultsPlus
Examiner Comments

Heterogeneous catalysis is being described.

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Examiner Tip

Underline key words in the question like heterogeneous.

Question 15 (b) (i)

One mark was available for simply giving the appropriate oxidation states of manganese, many did not do this. Poor language cost others – it was necessary to say that the same **element** is oxidised and reduced in the same reaction in disproportionation.

(b) (i) Suggest why the preparation of manganate(VI) ions, MnO_4^{2-}, in **equation 1**, may be described as a reverse disproportionation reaction by considering the relevant oxidation states.

(2)

Disproportionation reactions split atoms into different oxidation states. In this reaction the ~~Mn~~ +7 oxidation state combines with the +4 oxidation state to form the +6 oxidation state so it does the opposite to a disproportionation reaction.

ResultsPlus Examiner Comments

The term 'atom' is inappropriate and fails to score the second mark.
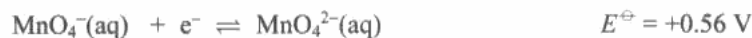
ResultsPlus Examiner Tip

Take care in using chemical terms.

Question 15 (b) (ii)

Good candidates often gained full credit here. But there was much confusion shown by many weaker candidates. However, the first mark, for stating that the second equilibrium shifts to the left, was commonly awarded.

(ii) The two half-equations which are combined to form **equation 1** are

$$MnO_4^-(aq) + e^- \rightleftharpoons MnO_4^{2-}(aq) \qquad E^\ominus = +0.56 \text{ V}$$

$$MnO_4^{2-}(aq) + 2H_2O(l) + 2e^- \rightleftharpoons MnO_2(s) + 4OH^-(aq) \qquad E^\ominus = +0.59 \text{ V}$$

Explain, by reference to these half-equations, why increasing the concentration of hydroxide ions alters the electrode potential to make the preparation of manganate(VI) ions more likely.

(3)

Increasing the concentration of hydroxide ions would shift the equilibrium of the second half equation to the left, meaning that the chance of MnO_4^{2-} ions being formed increases.

ResultsPlus
Examiner Comments

This is the typical one mark response.

ResultsPlus
Examiner Tip

Notice that electrode potential is not mentioned though it is clearly part of the question. Read the question twice.

(ii) The two half-equations which are combined to form **equation 1** are
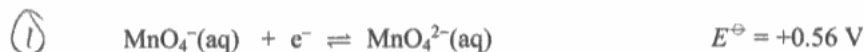
① $$MnO_4^-(aq) + e^- \rightleftharpoons MnO_4^{2-}(aq) \qquad E^\ominus = +0.56 \text{ V}$$

② $$MnO_4^{2-}(aq) + 2H_2O(l) + 2e^- \rightleftharpoons MnO_2(s) + 4OH^-(aq) \qquad E^\ominus = +0.59 \text{ V} (\leftrightarrow) = -0.59$$

Explain, by reference to these half-equations, why increasing the concentration of hydroxide ions alters the electrode potential to make the preparation of manganate(VI) ions more likely.

(3)

↑OH⁻ shifts equil to ① for reaction ② this would ↓ value for $E^\ominus$ cell ; as this ½ eqn is reversed for reaction to occur it makes the value less negative ; Therefore overall $E^\ominus$ cell more positive + ∴ more feasible.

ResultsPlus
Examiner Comments

Though cryptic in parts this answer covers the essential points.

ResultsPlus
Examiner Tip

Do not be discouraged from trying to express some of the more complex principles of the course.

Question 15 (c) (i)

Most candidates were successful. Wrong answers were hydrogen and, strangely but frequently, potassium hydroxide!

Question 15 (c) (ii)

Like part (i) this involved working with two half equations in the passage. Many responses were fully correct. Of those scoring 1 mark, the common errors were to include water or hydroxide ion on both sides of the equation, or to lose a negative charge.

> (ii) By appropriately combining these two equations, write the ionic equation for the formation of manganate(V) ions from manganate(VII) ions.
>
> (2)
>
> $$2MnO_8^- + O_2 \rightarrow 2MnO_a^-{}_{(aq)}$$
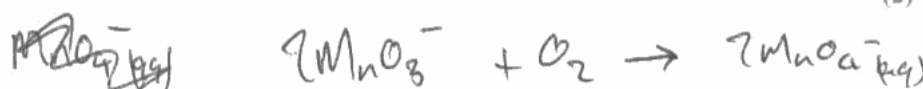
ResultsPlus
Examiner Comments

This is the correct equation but it has been reversed.

ResultsPlus
Examiner Tip

Always check answers to see if the question asked has been answered.

Question 15 (c) (iii)

Very few candidates clearly identified the risk and hazard by naming them, which may be penalised in future. One mark answers often failed to recognise that sodium hydroxide is corrosive (saponifying the skin), or that it damages the eye (attacking the cornea), but realised that gloves and safety glasses were needed.

> (iii) Identify the main hazard and state how you would minimize the associated risk in this preparation of manganate(V) ions.
>
> (2)
>
> You are using very concentrated (12mol dm⁻³) aqeous NaOH. This is very corrosive and you will need to wear gloves at all times during the experiment.

ResultsPlus
Examiner Comments

A correct answer - it would have been even better if the corrosive nature of sodium hydroxide had been recognised as the hazard and the wearing of gloves to minimise the risk.

ResultsPlus
Examiner Tip

Understand the terms hazard and risk.

> (iii) Identify the main hazard and state how you would minimize the associated risk in this preparation of manganate(V) ions.
>
> (2)
>
> Manganese Potassium manganate (VII) will have to be used which is a very strong oxidising agent. Gloves and eye protection must be worn.

ResultsPlus
Examiner Comments

This is incorrect. Certain medical conditions require bathing in a solution of potassium manganate(VII)!

ResultsPlus
Examiner Tip

Strong alkali is at least as hazardous as strong acid.

Question 15 (d)

A majority of candidates did not score and very few achieved full marks. Sodium hydroxide gained one mark provided it was not given with an acid which was quite common. The need for a soluble manganese salt was not known.

(d) Identify the reagents you would use to make manganese(II) hydroxide for the preparation of manganese(III) ions.

(2)

...... to a solution of $MgSO_4$ add excess $NaOH$ solution and the $Mn(OH)_2$ precipitate will form

ResultsPlus
Examiner Comments

An unfortunate slip which cost a mark.

ResultsPlus
Examiner Tip

Always check answers.

(d) Identify the reagents you would use to make manganese(II) hydroxide for the preparation of manganese(III) ions.

(2)

Add a little sodium hydroxide to Mn^{2+} ions.

ResultsPlus
Examiner Comments

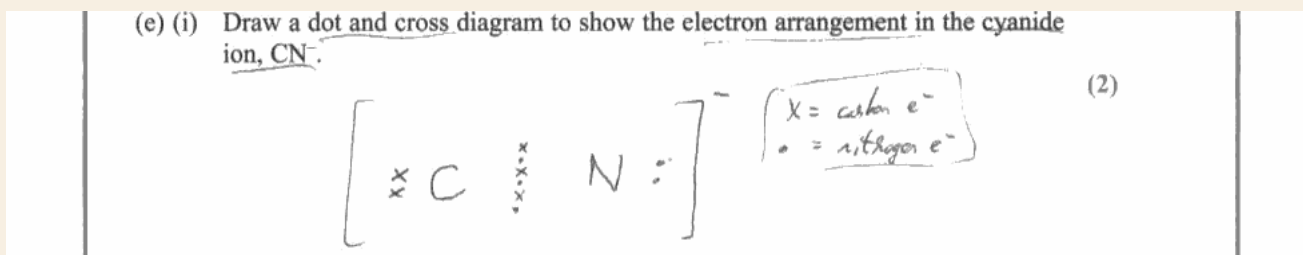This is how most candidates scored 1 mark.

ResultsPlus
Examiner Tip

Think what would be written on the bottle of the reagent.

Question 15 (e) (i)

On this question very few candidates scored both marks. The first mark required a triple bond between the carbon and the nitrogen. If that was correct then a mark was awarded for the two lone pairs of electrons. Few realised that the negative charge meant an extra electron was present.
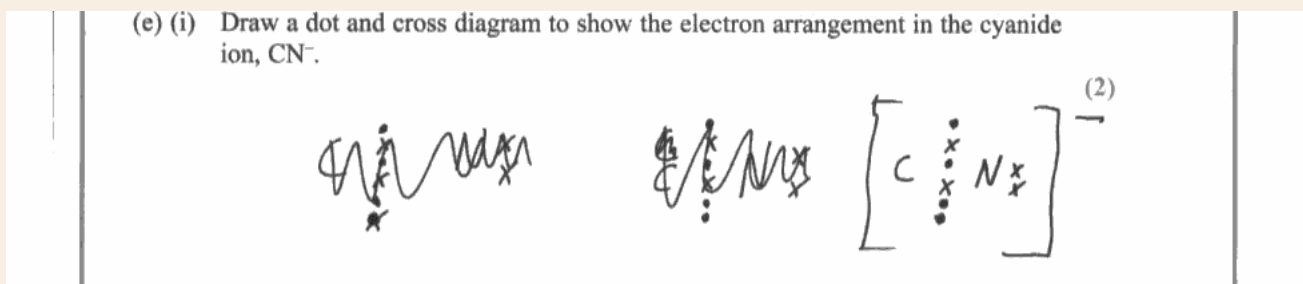
(e) (i) Draw a dot and cross diagram to show the electron arrangement in the cyanide ion, CN⁻.

(2)

$$\left[\overset{x}{\underset{x}{\times}} C \overset{\overset{x}{\cdot}}{\underset{x}{\cdot}} N \overset{\cdot}{\cdot} \right]^{-}$$

x = carbon e⁻
• = nitrogen e⁻

ResultsPlus
Examiner Comments

A good answer.

ResultsPlus
Examiner Tip

A negative charge means an extra electron is present.

(e) (i) Draw a dot and cross diagram to show the electron arrangement in the cyanide ion, CN⁻.

(2)

$$\left[C \overset{\overset{x}{\cdot}}{\underset{\cdot}{\times}} N \overset{x}{\underset{x}{}} \right]^{-}$$

ResultsPlus
Examiner Comments

A rather weak 1 mark answer.

ResultsPlus
Examiner Tip

It is best to draw the atoms separately first with their correct number of outer shell electrons, then proceed to draw the dot and cross diagram for the molecule.

Question 15 (e) (ii)

Almost half the candidates received full credit. Those who scored only 1 mark usually omitted to mention which lone pair of electrons formed the dative covalent bond.

> (ii) Explain how the cyanide ion acts as a ligand.
>
> (2)
>
> It donates it's lone pairs by dat forming dative covalent bond.

ResultsPlus Examiner Comments

A typical 1 mark answer.

ResultsPlus Examiner Tip

Try to be as specific as possible - which lone pair of electrons?

> (ii) Explain how the cyanide ion acts as a ligand.
>
> (2)
>
> The carbon on cyanide has a lone pair of electrons which act as a ligand to form a dative covalent bond with a metal ion.

ResultsPlus Examiner Comments

This candidate does not understand the term ligand.

ResultsPlus Examiner Tip

Learn the precise meaning of chemical terms.

Question 15 e) (iii)

An easy question at the end, one which most candidates were successful.

Paper Summary

The multiple choice section proved accessible to all but the less able candidates; a score of 11-12 was typical for Grade E grade candidates and 16 for Grade A candidates.

Arene chemistry seems to be well learned by able candidates and even less able candidates could gain 8-9 marks on this question (12).

For some candidates, questions 13 and especially 14 proved most testing, but there were parts of these questions and of question 15 that they did quite well.

Question 14 proved a good discriminator for able candidates.

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