



VICTORIA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE
NAME

CT GROUP

CHEMISTRY

9729/02

Paper 2 Structured Questions

29 August 2025

2 hours

Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name and CT group on this cover page.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer all questions in the spaces provided on the Question Paper.

A Data Booklet is provided.
The use of an approved scientific calculator is expected, where appropriate.

The number of marks is given in brackets [] at the end of each question or part question.

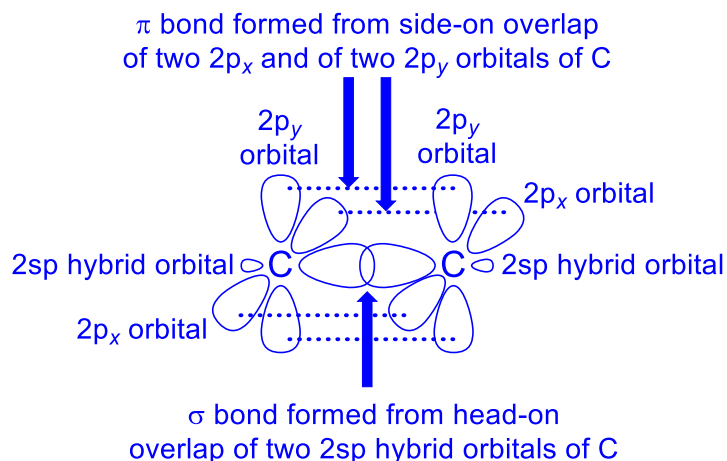
For Examiner's Use	
1	/ 18
2	/ 16
3	/ 17
4	/ 9
5	/ 15
Total	/ 75

This document consists of **18** printed pages and **2** blank pages

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

1 Alkynes are a class of organic compounds with the general formula C_nH_{2n-2} .

- (a) (i) With the aid of a labelled diagram, explain how the orbitals overlap to form the $C\equiv C$ bond in ethyne, $H-C\equiv C-H$. [3]



- correct diagram
- correct description for σ bond
- correct description for the two π bonds

(ii) Table 1.1 shows the carbon-hydrogen bond length in ethane, ethene and ethyne.

Table 1.1

Molecule	Carbon-hydrogen bond length / nm
ethane	0.114
ethene	0.109
ethyne	0.106

Use the concept of hybridisation to explain the difference in bond length of the carbon-hydrogen bond between the molecules as shown in Table 1.1. [2]

Bond length decreases in the following manner: ethane, ethene, ethyne.
Hence bond strength increases in the following manner: ethane, ethene, ethyne

- The sp hybridised carbon atom in ethyne has the highest percentage s character, followed by the sp^2 hybridised carbon atom in ethene and lastly, sp^3 hybridised carbon atom in ethane.
- Hence, the extent of orbital overlap between the sp hybridised carbon atom and the s orbital of H atom is the largest, resulting in a shortest bond length.

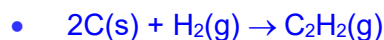
(b) Table 1.2 contains data that is relevant for this question.

Table 1.2

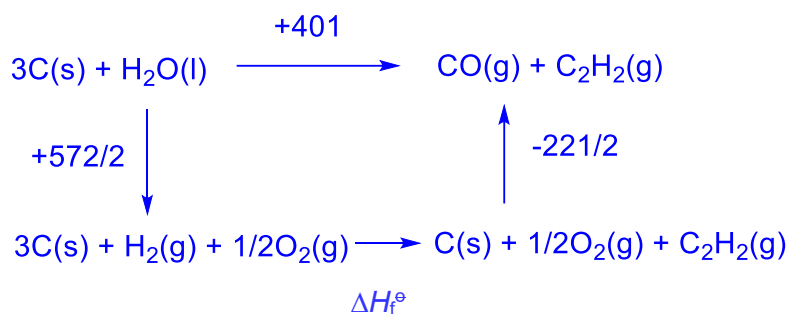
Equation	$\Delta H^\circ / \text{kJ mol}^{-1}$
$3C(s) + H_2O(l) \rightarrow CO(g) + C_2H_2(g)$	+401

$2\text{C(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{CO(g)}$	-221
$2\text{H}_2\text{O(l)} \rightarrow 2\text{H}_2\text{(g)} + \text{O}_2\text{(g)}$	+572

- (i) Write an equation to represent the standard enthalpy change of formation of $\text{C}_2\text{H}_2\text{(g)}$. [1]

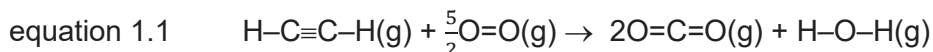


- (ii) Use data from Table 1.2 to calculate the standard enthalpy change of formation of $\text{C}_2\text{H}_2\text{(g)}$. [2]



- correct energy cycle or working
By Hess' Law,
 $\Delta H_f^\ominus = 401 - 572/2 + 221/2$
- $= +225.5 \text{ kJ mol}^{-1}$

- (c) (i) Using the bond energies in the *Data Booklet*, calculate the enthalpy change of combustion of ethyne shown in equation 1.1.



[2]

- $\Delta H_c = [2\text{BE(C-H)} + \text{BE(C}\equiv\text{C)} + \frac{5}{2}\text{BE(O=O)}] - [4\text{BE(C=O)} + 2\text{BE(O-H)}]$
- $= [2(410) + (840) + 5/2(496)] - [4(805) + 2(460)]$
- $\Delta H_c = -1240 \text{ kJ mol}^{-1}$

- (ii) Explain what is meant by the term *entropy*. [1]

- Entropy is a measure of the randomness or disorder of matter and energy of a system. The higher the disorderliness, the higher is the entropy.

- (iii) The entropy change of combustion of ethyne is $-2150 \text{ J K}^{-1} \text{ mol}^{-1}$ at 305°C .

With reference to equation 1.1, explain why the entropy change of combustion of ethyne has a negative sign. [1]

- There is a decrease from 3.5 moles of gaseous reactants to 3 moles of gaseous products, hence $\Delta S < 0$.

- (d) Alkynes undergo similar reactions as alkenes. Ethyne can be reduced to ethane in a two-stage process using a transition metal as the *heterogeneous catalyst* as shown in Fig. 1.1.

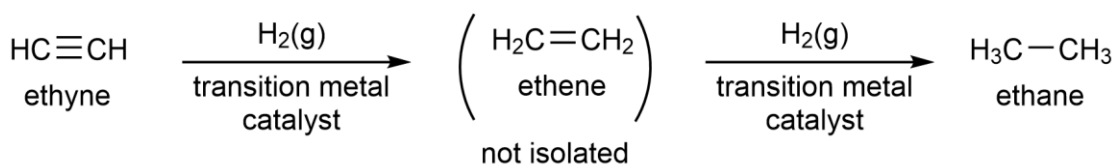


Fig. 1.1

The higher the activity of a catalyst, the more effective it is at catalysing the reaction.

Fig 1.2 shows the relative activity of each catalyst against ΔH_{ads} , the enthalpy change of adsorption of hydrogen gas onto the catalyst surface in the reduction of alkyne.

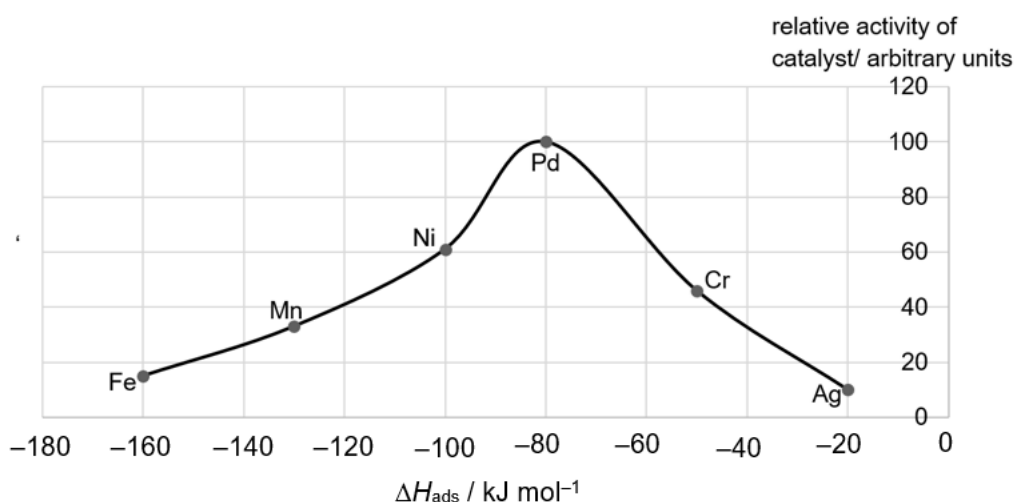


Fig. 1.2

- (i) State the meaning of the term *heterogenous catalyst*. [1]
- A catalyst increases rate of reaction, by providing an alternative pathway with lower activation energy, and remains chemically unchanged at the end of the reaction.
A heterogenous catalyst exists in a different phase OR physical state from the reactants.
- (ii) State which catalyst is the most effective in the reduction of alkyne. [1]
- Pd
- (iii) Use your knowledge of the mode of action of heterogenous catalysts, suggest an explanation for the trend observed in Fig.1.2. [2]
- When ΔH_{ads} is less negative/ less exothermic, relative activity is low as the hydrogen gas is only weakly bound to the catalyst. The covalent bond in the hydrogen molecule is not weakened sufficiently for the reaction to occur. Or Reactant molecules desorb before reaction can occur.
 - When ΔH_{ads} is very negative/ highly exothermic, the hydrogen molecule is too strongly adsorbed so it is unable to react with ethyne/the product formed is unable to desorb from the catalyst surface.
- (iv) In 1952, Herbert Lindlar found that adding a thin layer of impurity, such as lead(II) oxide, to palladium catalyst reduced its activity, allowing the reaction to stop at the alkene stage rather than reducing to the alkane as shown in Fig. 1.3.

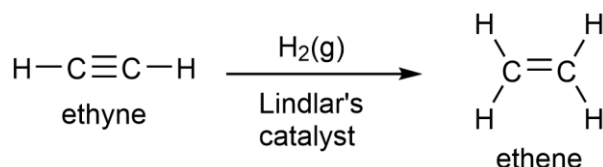


Fig. 1.3

This is also known as “poisoning” the catalyst.

By considering the shape of the molecules shown in Fig. 1.3, suggest how the addition of lead(II) oxide “poisons” the palladium catalyst. [2]

- With addition of lead(II) oxide, active sites on the catalyst surface is no longer flat or active sites blocked partially
- preventing the bigger ethene from adsorbing efficiently, thus decreasing activity of the catalyst. Ethyne is smaller and hence can access the active site more readily.

[Total: 18]

2 An aquatic system thrives on a delicate balance based on key chemical processes.

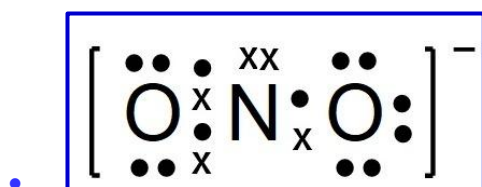
- (a) Ammonia is the primary component of fish waste. When the concentration of ammonia in an aquatic system is too high, aquatic life is adversely affected.

Ammonia can be removed with oxygen in the presence of nitrifying bacteria to form nitrite, NO_2^- , and water.

- (i) Write a balanced equation for the reaction of ammonia and oxygen. [1]



- (ii) Draw the dot-and-cross diagram of nitrite ion, NO_2^- . [1]



- (iii) Some NO_3^- ions may also be formed from ammonia by the action of nitrifying bacteria. Given that the shape of NO_3^- ion is trigonal planar, use VSEPR theory to explain the difference in the bond angles between NO_2^- and NO_3^- ion. [2]

- Nitrate ion has 3 bond pairs and 0 lone pairs of electrons about the N atom and a trigonal planar shape. Nitrite ion has 2 bond pairs and 1 lone pair of electrons about the N atom. As the lone pair-bond pair repulsion is greater than bond pair-bond pair repulsion,
 - hence bond angle of nitrite ion is smaller
- OR 118° compared to 120° for nitrate ion.

- (iv) The ammonia levels in a 50 dm^3 freshwater aquarium tank was investigated. It is found that the concentration of dissolved ammonia and oxygen in the tank were $0.020 \text{ mol dm}^{-3}$ and $0.030 \text{ mol dm}^{-3}$ respectively. Upon adding nitrifying bacteria, 50% of ammonia was converted to NO_2^- ions after one hour.

Use your answer to (a)(i) and the information given, determine the mass of NO_2^- ions formed. [2]

(in mol dm ⁻³)	2NH ₃ (aq)	+ 3O ₂ (aq)	+ 2OH ⁻ (aq)	⇌	2NO ₂ ⁻ (aq)	+ 4H ₂ O(l)
Initial	0.020	0.030	-		0	-
Change	-0.010	$-\frac{3}{2}(0.010)$	-		+0.010	-
Eqm	0.010	0.015	-		0.010	-

- Molar mass of NO₂⁻ = 14.0 + (16.0 × 2) = 46.0
Amount of NO₂⁻ = 0.010 × 50 = 0.500 mol
- Mass of NO₂⁻ formed = 0.500 × 46.0 = 23.0 g (ecf)

(b) Calcium and magnesium ions can be used to estimate the total dissolved solids (TDS) in an aquatic system. Different aquatic species require different TDS levels for optimal health and survival.

(i) Explain why calcium has a lower first ionisation energy than magnesium. [2]

- Calcium atom has a greater number of protons and hence larger nuclear charge than magnesium atom,
- The outermost electrons of a calcium atom are further from the nucleus compared to magnesium atom, leading to a weaker electrostatic forces of attraction. Therefore, less energy is required to remove the outermost electron in calcium atom.

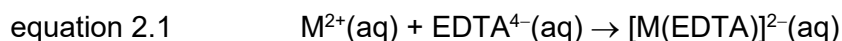
(ii) State two reasons why magnesium and calcium tend to form cations with +2 charge. [2]

- Both Ca and Mg atoms have two electrons in their outermost s orbital (4s² for Ca, 3s² for Mg). Removing these two electrons results in a stable noble gas configuration.
- The relatively low 1st and 2nd ionisation energies of Ca and Mg make the formation of divalent cation favourable.

(c) An aquarist wishes to determine the TDS in a freshwater aquarium. For this investigation, the TDS is taken to be the combined amount of Ca²⁺ and Mg²⁺ ions, in mol, present in the water.

The ethylenediaminetetraacetate ion (EDTA⁴⁻) was used as a reagent to analyse a sample of tank water.

EDTA⁴⁻ reacts with M²⁺ ions (M = metal) to form complexes according to equation 2.1.



A 25.0 cm³ sample of tank water was treated with an excess of 50.0 cm³ of 0.0500 mol dm⁻³ EDTA⁴⁻ solution.

10.0 cm³ of the resulting reaction mixture then required 19.40 cm³ of 0.0100 mol dm⁻³ zinc nitrate solution to react completely with the unreacted EDTA⁴⁻ solution.

(i) Determine the TDS that were originally present in the 25.0 cm³ sample of tank water. [3]

- Amount of Zn²⁺ = (19.40/1000) × 0.0100 = 1.94 × 10⁻⁴ mol = amount of EDTA⁴⁻ unreacted in 10.0 cm³ of resulting reaction mixture
Total volume of mixture = 25.0 + 50.0 = 75.0 cm³
- Amount of EDTA⁴⁻ unreacted in 75.0 cm³ mixture
= (75.0/10.0) × 1.94 × 10⁻⁴ = 1.455 × 10⁻³ mol
- Amount of EDTA⁴⁻ reacted with Mg²⁺ and Ca²⁺

= Total amount of TDS (Mg^{2+} and Ca^{2+})

$$= (50/1000) \times 0.0500 - 1.455 \times 10^{-3} = 1.05 \times 10^{-3} \text{ mol}$$

1m: Correct calculation of either the original amount or reacted amount of EDTA

1m: Correct calculation of TDS

1m: Correct scaling

- (ii) A list of aquatic species is shown below in Table 2.1 with their recommended TDS ranges in ppm. (1 ppm = 1 g per 1000 dm³ of water)

Table 2.1

Species	Recommended TDS Range (ppm)
Cherry Shrimp	150 – 350
African Cichlid	300 – 600
Guppy	700 – 1500
Mollies	1000 – 2800
Archerfish	1500 – 5000
Green Spotted Puffer	5000 – 15000
Marine Reef Tank (Clownfish + Corals)	30000 – 40000

Using your answer in **(d)(i)**, determine the TDS in ppm in the tank water and hence state the species that is best suited for the tank.

If you were unable to obtain the answer in **(d)(i)**, use 1.50×10^{-3} mol in your calculation. This is **not** the correct value.

Assume that the concentrations of Mg^{2+} and Ca^{2+} contributing to the TDS are in a 1:1 ratio. [3]

Total mass of TDS in 25.0 cm³ = $1.05 \times 10^{-3} \times \frac{1}{2} \times (40.1 + 24.3) = 0.033649 \text{ g}$

- Concentration of TDS in g dm⁻³ = $0.033649 / (25.0/1000) = 1.346 \text{ g dm}^{-3}$
- Concentration of TDS in ppm = $1.346 \times 1000 = 1350 \text{ ppm}$

Species: • Mollies and Guppy

OR

using 1.50×10^{-3} mol

Total mass of TDS in 25.0 cm³ = $1.50 \times 10^{-3} \times \frac{1}{2} \times (40.1 + 24.3) = 0.0483 \text{ g}$

- Concentration of TDS in g dm⁻³ = $0.0483 / (25.0/1000) = 1.932 \text{ g dm}^{-3}$
- Concentration of TDS in ppm = $1.932 \times 1000 = 1930 \text{ ppm}$

Species: • Mollies and Archerfish

[Total: 16]

3 Pyruvic acid, $\text{CH}_3\text{COCO}_2\text{H}$, is an important intermediate in several metabolic pathways.

- (a) A synthetic pathway involving pyruvic acid and other organic compounds is shown in Fig. 3.1.

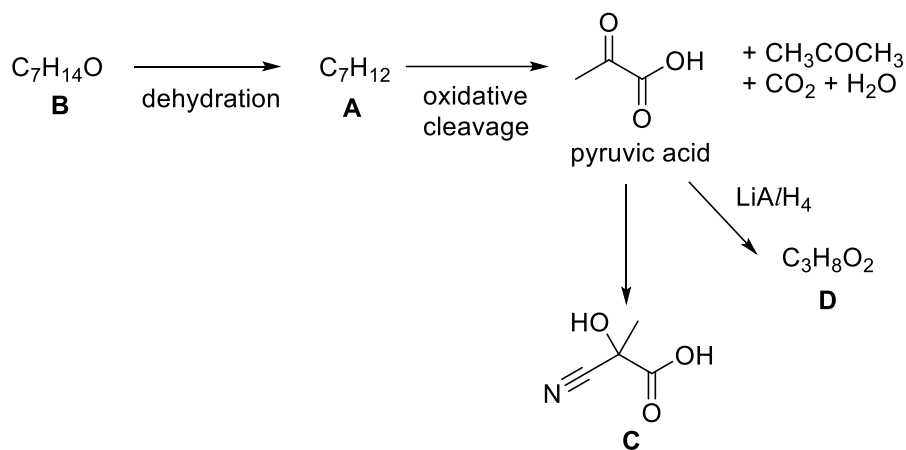
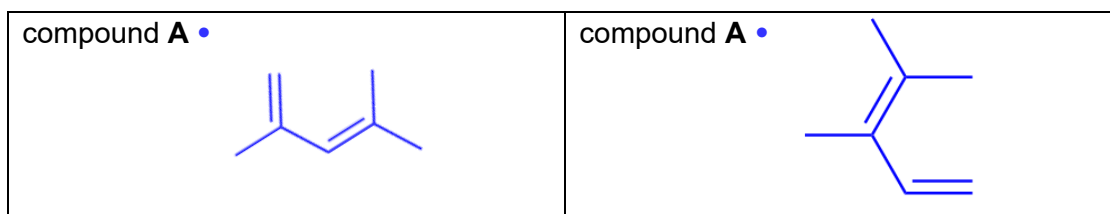


Fig. 3.1

- (i) Suggest two possible structures of **A**. [2]



- (ii) **B** is non-chiral and does not react with acidified $\text{K}_2\text{Cr}_2\text{O}_7$.

Use your answer in (a)(i), suggest a structure for **B**. [1]



- (iii) Name the type of reaction, and state the reagents and conditions, for the conversion of pyruvic acid to **C**. [2]

Type of reaction: • nucleophilic addition

Reagents and conditions: • HCN , trace NaOH/NaCN

- (iv) State and explain whether **C** synthesised from pyruvic acid is optically active. [2]

- The shape of the pyruvic acid molecule with respect to the carbonyl carbon atom is trigonal planar. There is an equal probability of CN^- nucleophile attacking from either side of the plane.
- Both enantiomers of **C** are formed in equal proportions or racemic mixture of **C** is formed, which is optically inactive.

- (v) When pyruvic acid reacts with LiAlH_4 , **D** is produced.

Name **D**.

- Propane-1,2-diol

- (b) Pyruvic acid behaves as a weak Brønsted–Lowry acid in water.

Fig 3.2 shows the pH curve when aqueous pyruvic acid was titrated with aqueous sodium hydroxide. The equivalence point was reached when 24.00 cm³ of aqueous sodium hydroxide had been added.

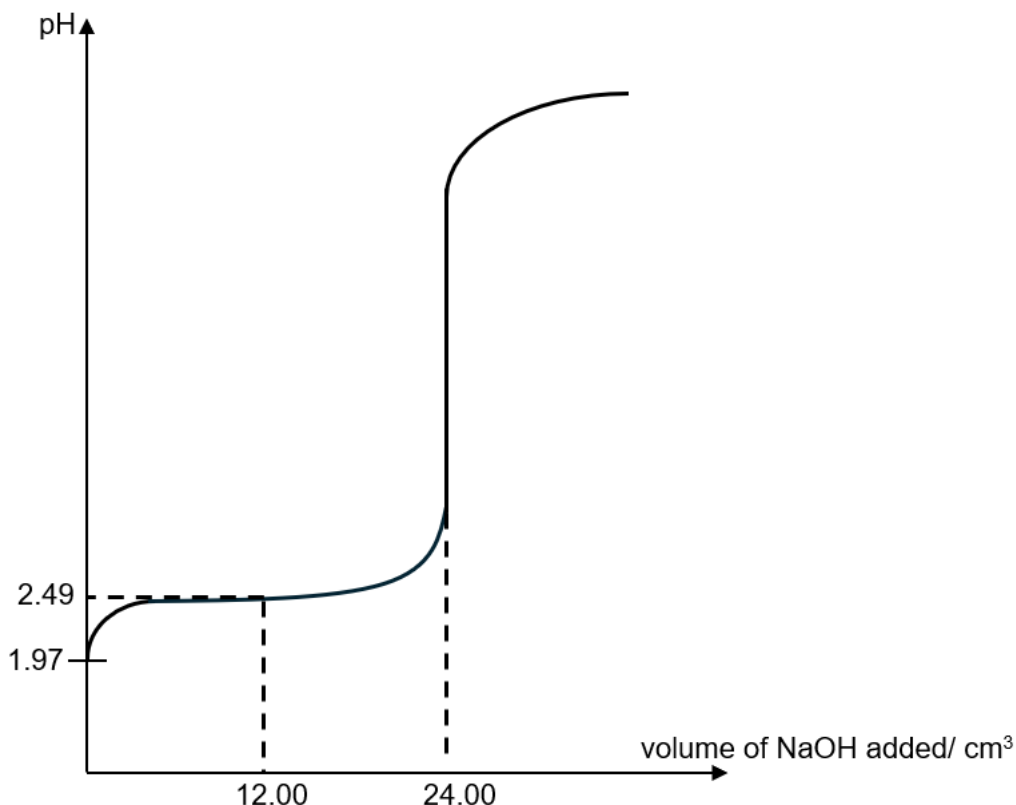


Fig. 3.2

(i) Define the term *Brønsted–Lowry acid*. [1]

- Proton donor.

(ii) Calculate the acid dissociation constant, K_a , of pyruvic acid. [1]

At half equivalence point volume (12.00 cm³ of base added), $\text{pH} = \text{p}K_a = 2.49$

- $K_a = 10^{-2.49} = \underline{3.24 \times 10^{-3} \text{ mol dm}^{-3}}$

(iii) Calculate the concentration of aqueous pyruvic acid. [2]

- $K_a = \frac{[\text{H}^+][\text{CH}_3\text{COCOO}^-]}{[\text{CH}_3\text{COCOOH}]} = \frac{[\text{H}^+]^2}{[\text{CH}_3\text{COCOOH}]}$
initial $\text{pH} = 1.97$ and this implies $[\text{H}^+] = 10^{-1.97} \text{ mol dm}^{-3}$
- $[\text{CH}_3\text{COCOOH}] = \frac{(10^{-1.97})^2}{3.24 \times 10^{-3}} = \underline{0.0354 \text{ mol dm}^{-3}}$

(iv) Explain, with the aid of an equation, why pH at the equivalent point is more than 7. [2]

- At equivalence point, the salt formed undergoes hydrolysis to produce OH^- , making $[\text{OH}^-] > [\text{H}^+]$. Hence $\text{pH} > 7$.
- $\text{CH}_3\text{COCO}_2^- + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COCO}_2\text{H} + \text{OH}^-$

- (v) Use your value of K_a calculated in (b)(ii) to determine the pH of the solution when 0.300 g of solid sodium hydroxide is dissolved in 500 cm³ of 0.080 mol dm⁻³ aqueous pyruvic acid.

If you were unable to obtain a value of K_a in (b)(ii), use $K_a = 3.0 \times 10^{-3}$ mol dm⁻³ in your calculation. This is **not** the correct value. [3]



- initially, $n_{\text{pyruvic acid}} = 0.5 \times 0.08 = 0.04$ mol; $n_{\text{NaOH}} = \frac{0.300}{23.0+1.0+16.0} = 0.0075$ mol
therefore, after addition of solid NaOH,
 $n_{\text{pyruvate formed}} = 0.0075$ mol;
 $n_{\text{pyruvic acid left}} = 0.04 - 0.0075 = 0.0325$ mol
- $K_a = \frac{[\text{H}^+][\text{CH}_3\text{COCO}_2^-]}{[\text{CH}_3\text{COCO}_2\text{H}]}$
 $3.24 \times 10^{-3} = [\text{H}^+] \times \frac{\frac{0.0075}{0.5}}{\frac{0.0325}{0.5}}$
- $[\text{H}^+] = 0.0140$ mol dm⁻³; pH = 1.85

OR

using $K_a = 3.0 \times 10^{-3}$ mol dm⁻³, pH = 1.89

[Total: 17]

- 4 *p*-Coumaric acid, C₉H₈O₃, occurs in some fruits and is thought to help prevent the development of stomach cancer.

p-Coumaric acid is an aromatic organic compound with two substituents occupying positions 1 and 4 of the benzene ring. Four possible structures of *p*-coumaric acid are given below.

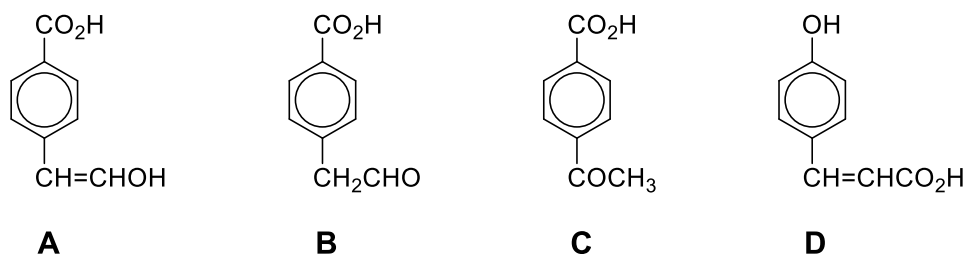


Fig. 4.1

- (a) A series of tests are carried out on *p*-coumaric acid. Table 4.1 shows the compound formed, when *p*-coumaric is added to different reagents under specific conditions.
- (i) Complete the last column of Table 4.1 by using only the letters A, B, C or D to represent structures in Fig. 4.1 that give the results as described in each test.

Table 4.1

test	reagents and conditions	compound formed	possible structure(s)
1	Tollens' reagent	no reaction	A, C, D
2	2,4-dinitrophenylhydrazine	no reaction	A, D
3	HBr	C ₉ H ₉ O ₃ Br	A, D

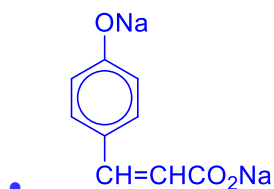
4	Na	$C_9H_6O_3Na_2$	A, D
5	NaOH(aq)	$C_9H_6O_3Na_2$	D

[5]

(ii) One of the tests in Table 4.1 confirms the structure of *p*-coumaric acid.

Suggest the structural formula of the product formed in this test.

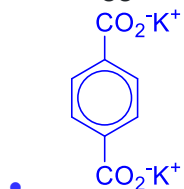
[1]



(b) When compounds **A**, **B** and **C** are heated separately under reflux with alkaline $KMnO_4$, the same compound is formed in each case.

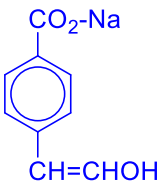
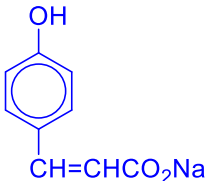
Suggest the structure of this compound.

[1]



(c) Draw the structures of the compound formed when **A** and **D** are separately reacted with Na_2CO_3 .

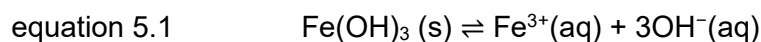
[2]

A produces	D produces
	

[Total: 9]

5 This question is about Fe and its compounds.

- (a) In human blood plasma under physiological condition of pH 7.4, Fe^{3+} has low solubility due to its tendency to form insoluble $\text{Fe}(\text{OH})_3$. The dissolution of $\text{Fe}(\text{OH})_3$ is represented by the equation 5.1.



The solubility product of $\text{Fe}(\text{OH})_3$ at 25 °C is $2.6 \times 10^{-39} \text{ mol}^4 \text{ dm}^{-12}$.

- (i) Write the expression for the solubility product of $\text{Fe}(\text{OH})_3$. [1]

- $K_{\text{sp}} = [\text{Fe}^{3+}][\text{OH}^{-}]^3$

- (ii) Calculate the concentration of Fe^{3+} in blood plasma at 25 °C, assuming the pH remains constant at 7.4. [2]

- $\text{pOH} = 14.0 - 7.4 = 6.6$
 $[\text{OH}^{-}] = 10^{-6.6} \approx 2.512 \times 10^{-7} \text{ mol dm}^{-3}$
 $K_{\text{sp}} = [\text{Fe}^{3+}][\text{OH}^{-}]^3$
 $2.6 \times 10^{-39} = [\text{Fe}^{3+}](2.512 \times 10^{-7})^3$
- $[\text{Fe}^{3+}] = 2.6 \times 10^{-39} / (1.5849 \times 10^{-20}) = 1.64 \times 10^{-19} \text{ mol dm}^{-3}$

- (b) Fe^{2+} is able to form complexes with various ligands. Fig. 5.1 shows how the d orbitals of Fe^{2+} are split when the shape of the complex formed is octahedral.

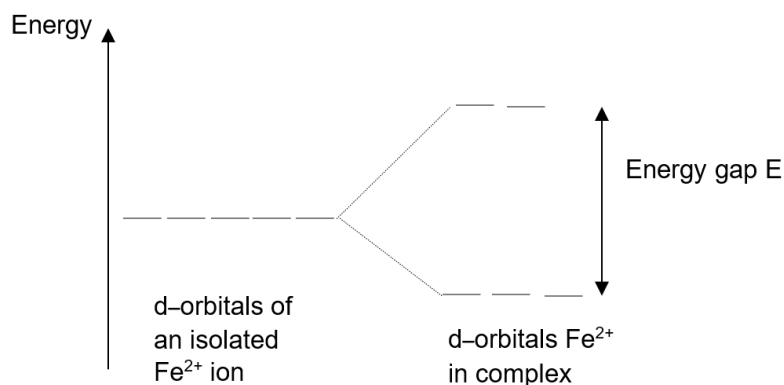


Fig. 5.1

- (i) State the full electronic configuration of Fe^{2+} . [1]

- $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$

- (ii) Using the axes below in Fig. 5.1, draw the shape of a 3d orbital of a higher energy level and of a lower energy level, in the octahedral Fe^{2+} complex.

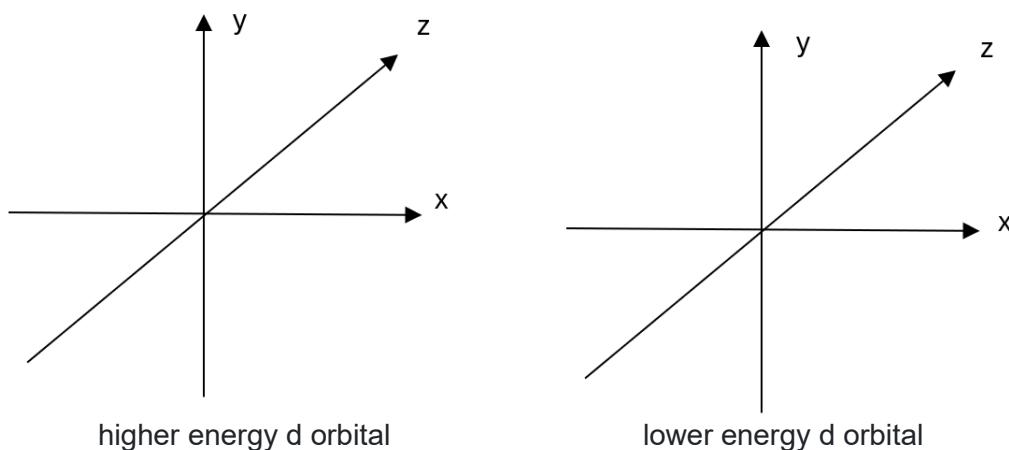
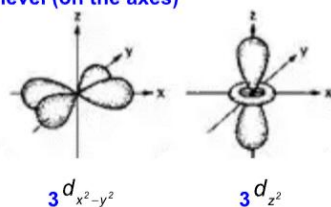


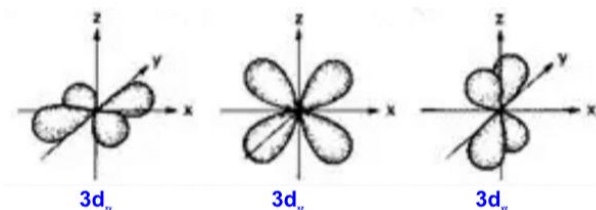
Fig. 5.2

Any one from higher and lower energy d orbitals

Higher energy level (on the axes)



Lower energy level (in between axes)



[2]

- (c) Ligands can be classified as strong field or weak field. In an octahedral complex, strong field ligands are known to give rise to a larger energy gap E between the two sets of d orbitals as compared to weak field ligands.

Octahedral complexes can be classified as either high spin or low spin state.

In the high spin state, the electrons occupy all the d orbitals singly before starting to pair up in the lower energy d orbitals.

In the low spin state, the lower energy d orbitals are filled first, by pairing up, if necessary, before the higher energy d orbitals are used.

- (i) Using \uparrow or \downarrow to represent electrons, complete the two diagrams in Fig. 5.3 like in Fig. 5.1 to show the electronic distribution of Fe^{2+} in a high spin and in a low spin state.

The energy axis is not drawn to scale, i.e. $E_1 \neq E_2$.

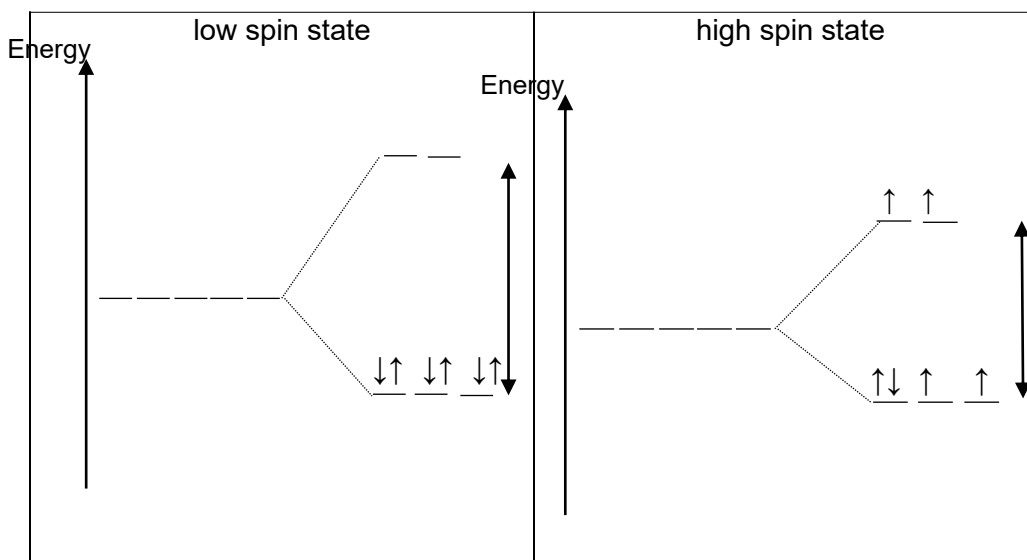


Fig. 5.3

[2]

(ii) Suggest why electrons usually prefer to occupy orbitals singly, rather than in pairs. [1]

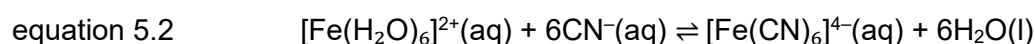
- Electrons occupy orbitals singly first to minimize interelectronic repulsion.

(ii) Fe^{2+} in $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ has a high spin state while in $[\text{Fe}(\text{CN})_6]^{4-}$ has a low spin state.

State and explain which of the above two complexes will contain the larger energy gap, E , between the d orbitals of Fe^{2+} and hence predict which is a strong field ligand. [2]

- $[\text{Fe}(\text{CN})_6]^{4-}$ has a larger energy gap, E . $[\text{Fe}(\text{CN})_6]^{4-}$ is a low spin state complex. This means that the d electrons are paired up and occupy the lower energy d orbitals first. CN^- will cause a larger energy gap E between the d orbitals and more energy is required to overcome the energy gap E than to overcome the interelectronic repulsion.
- Hence, CN^- is a strong field ligand (H_2O is a weak field ligand).

(d) The equilibrium constant, K_{stab} , measures the stability of a complex. For equation 5.2 below,



$$K_{\text{stab}} = \frac{[\text{Fe}(\text{CN})_6]^{4-}}{[\text{Fe}(\text{H}_2\text{O})_6]^{2+}[\text{CN}^-]^6}$$

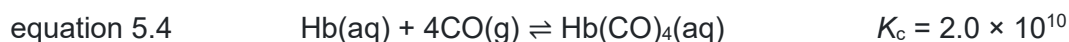
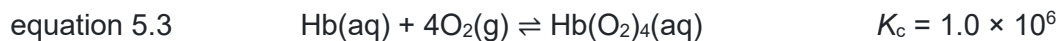
It is given that the $\log_{10} K_{\text{stab}}$ values of $[\text{Fe}(\text{CN})_6]^{4-}$ and $[\text{FeF}_6]^{4-}$ are 35 and 15 respectively.

Using only the information above, explain which ligand is better able to stabilise Fe^{2+} .

[1]

- The K_{stab} of $[\text{Fe}(\text{CN})_6]^{4-}$ is larger than that of $[\text{FeF}_6]^{4-}$. This means that CN^- forms strong dative bonds with Fe^{2+} and $[\text{Fe}(\text{CN})_6]^{4-}$ is more stable than $[\text{FeF}_6]^{4-}$. Thus CN^- is better able to stabilise Fe^{2+} .
- (e) Haemoglobin (Hb) is a large protein complex that contains an Fe^{2+} centre that can bind to ligands such as O_2 and CO. In the lungs, O_2 binds to Hb to form oxyhaemoglobin, $\text{Hb}(\text{O}_2)_4$ as shown in equation 5.3. $\text{Hb}(\text{O}_2)_4$ is essential in transporting oxygen to the rest of the human body.

CO competes with O₂ in the lungs, binding with Hb to form carboxyhaemoglobin, Hb(CO)₄ as shown in equation 5.4.



Use the above information to explain why exposure to carbon monoxide can be potentially life threatening. [2]

- Carbon monoxide binds more strongly to haemoglobin than oxygen, forming carboxyhaemoglobin with a larger K_c . Position of equilibrium of equation 5.3 lies more on the right.
 - This reduces the availability of haemoglobin to bind oxygen in equation 5.2, lowering the concentration of oxyhaemoglobin.
- (f) Iron deficiency in bacterial cells trigger secretion of enterobactin, a hexadentate ligand, which combines with one Fe³⁺. Enterobactin is a very strong field ligand and forms very stable Fe³⁺ complex with a K_{stab} value of approximately 1×10^{49} .

Fig. 5.4 shows the structure of the deprotonated form of enterobactin.

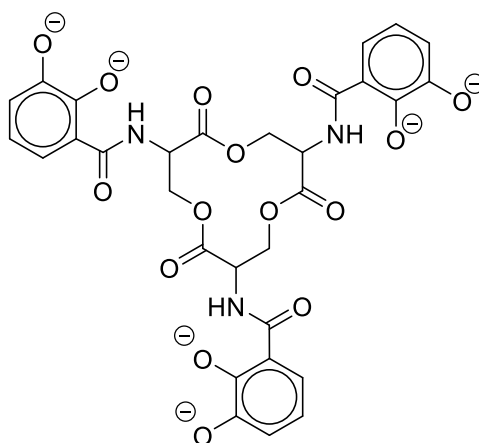
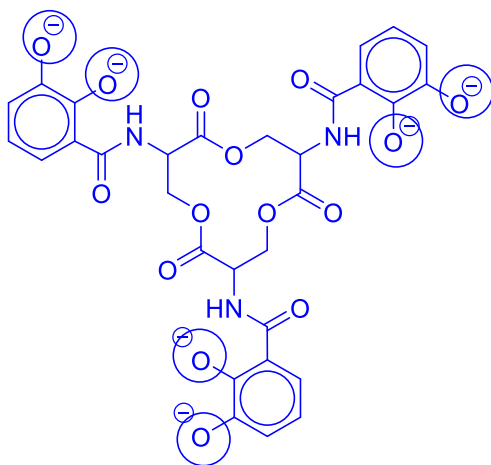


Fig. 5.4

Circle on the structure of the deprotonated form of enterobactin in Fig. 5.4 the six atoms that form bonds with Fe³⁺. [1]



[Total: 15]