

Section A

Four suggested answers labelled A, B, C and D are given for each question. Choose one correct answer.

1. Ascorbic acid (vitamin C) cures scurvy and may help prevent the common cold. It is composed of 40.92% carbon, 4.58% hydrogen and 54.50% oxygen by mass. Determine its empirical formula. [relative atomic mass of C=12;H=1;O=16]

- A. $C_3H_4O_3$
- B. $C_2H_3O_2$
- C. $C_4H_5O_4$
- D. C_8HO_{12} \times

2. Calculate the relative atomic mass of naturally occurring Rhenium from the following data:

Isotope	Relative mass	Relative abundance
Rhenium-185	184.95	37.07
Rhenium-187	186.96	62.93

- A. 185.02
- B. 185.72
- C. 186.21
- D. 187.03

3. The ionization energy of the hydrogen atom can be calculated from the Lyman series in the hydrogen emission spectrum by determining the frequency of the

- A. spectral line with the shortest wavelength. Δ
- B. spectral line with the longest wavelength. \times
- C. spectral line with highest intensity.
- D. first spectral line in the series. Δ

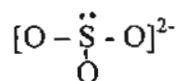
4. A small bubbles rises from the bottom of a lake, where the temperature and pressure are 8°C and 6.4 atm, to the water surface, where the temperature is 25°C and pressure is 1.0 atm. Calculate the final volume (in cm^3) of the bubble if its initial volume was 2.1 cm^3

- A. 0.35
- B. 12.7
- C. 14.3
- D. 42.0

5. The valence shell electronic configuration of two elements X and Y are respectively ns^2np^3 and ns^2np^5 . Which of the following represent the formula and type of compound formed between X and Y.

- A. XY, covalent
- B. XY_2 , covalent
- C. X_2Y , ion
- D. XY_3 , covalent

6. The structural formula of the sulphite ion is shown below



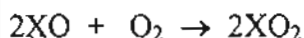
What is the angle of the O-S-O bond?

- A. 90° ×
- B. 107° Δ
- C. $109^\circ 28'$ Δ
- D. 120°

7. Phosphorus forms PCl_3 and PCl_5 while nitrogen forms only NCl_3 and not NCl_5 . Which of the following best explain this difference?

- A. Phosphorus has more metallic character than nitrogen.
- B. The size of the phosphorus atom is larger than that of nitrogen.
- C. Phosphorus is in Group 15 of the Periodic Table whereas nitrogen is in Group 13. ×
- D. Phosphorus is in Period 3 of the Periodic Table whereas nitrogen is in Period 2

8. The table shows experimental results obtained for the following reaction:

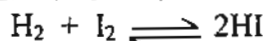


Partial pressure of XO/Pa	100	100	50 ²	50
Partial Pressure of O ₂ /Pa	100	25 ⁴	100	-
Relative rate	1.0	0.25	0.50	0.125 ⁵

What is the missing value of the partial pressure of O₂ in the table?

- A. 50
- B. 25
- C. 40
- D. 12.5

9. Known amounts of hydrogen and iodine are allowed to come to equilibrium at 500°C in a vessel of known volume.



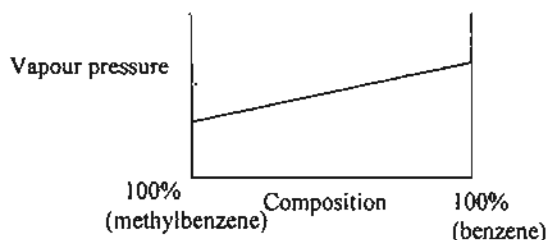
From which experimental method can K_c be found?

- A. measuring the total pressure in the vessel.
- B. slow cooling to 20°C , breaking open vessel under aqueous potassium iodide, and titrating the iodine present with aqueous sodium thiosulphate.
- C. rapid cooling to 20°C , breaking open vessel under aqueous potassium iodide, and titrating the iodine present with aqueous sodium thiosulphate.
- D. withdrawal of a measured sample of the equilibrium mixture, followed by complete decomposition of the hydrogen iodide present and then titrating the total amount of iodine with aqueous sodium thiosulphate.

10. The density of glacial ethanoic acid CH_3COOH is 1.05gcm^{-3} . What is the pH of the solution formed when 2.0cm^3 of the acid is dissolved in distilled water and the volume made up to 200cm^3 ?
[R.a.m: C = 12; H = 1; O = 16, K_a of ethanoic acid = $1.8 \times 10^{-5}\text{mol dm}^{-3}$]

- A. 0.76
B. 2.45
C. 2.75
D. 2.90

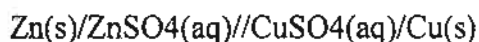
11. The vapour pressure-composition curve for a mixture of benzene and methylbenzene is shown below:



When a mixture containing 60% benzene and 40% methylbenzene is fractionally distilled what is the composition of the first distillate and the residue in the flask at the end of the process?

- | First distillate | Residue |
|------------------|--------------------------------------|
| A. benzene | methylbenzene |
| B. methylbenzene | benzene |
| C. benzene | mixture of benzene and methylbenzene |
| D. methylbenzene | mixture of benzene and methylbenzene |

12. Consider the Daniel cell below:



Which of the following statements is **not** correct regarding the cell above?

- A. The sulphate ions migrate through the salt bridge from the zinc compartment to the copper compartment.
B. The standard e.m.f of the cell is 1.10V
C. The zinc electrode gradually dissolves.
D. Electrons flow from zinc to copper through the external circuit.

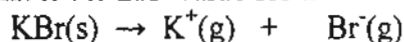
13. Which of the following ions has the most exothermic enthalpy of hydration?

- A. Na^+
B. Al^{3+}
C. Mg^{2+}
D. Ca^{2+}

14. The table below shows the enthalpies of the elements potassium and bromine, and potassium bromide.

Ionization energy of K = 496 kJmol^{-1}
Electron affinity of Br = -349 kJmol^{-1}
Enthalpy of atomization of Br = 121 kJmol^{-1}
Enthalpy of atomization of K = 108 kJmol^{-1}
Enthalpy of formation of KBr = -411 kJmol^{-1}

What is the ΔH^θ value for the reaction below?



- A. $+133 \text{ kJmol}^{-1}$
B. -414 kJmol^{-1}
 C. $+787 \text{ kJmol}^{-1}$
D. -787 kJmol^{-1}
15. Which of the following statements regarding electrolysis is correct?
- A. Oxidation occurs at the cathode while reduction occurs at the anode.
B. Electrons flow from the cathode to the anode through the external circuit.
C. Electrons help to conduct electricity through the electrolyte.
 D. The ease of cations to be discharged during electrolysis is inversely proportional to the reactivity of the metals.
16. Which oxide can form a solution with the lowest pH when 1 mole of the oxide is dissolved in 1 dm^3 of distilled water?
- A. P_4O_{10}
 B. Cl_2O_7
C. SO_2
D. MgO
17. AlCl_3 reacts with LiAlH_4 and $(\text{CH}_3)_3\text{NAlH}_3$. Which statement about $(\text{CH}_3)_3\text{NAlH}_3$ is correct?
- A. It is dimeric
 B. It contains hydrogen bonding.
C. The Al atom is electron deficient.
 D. The bonds around the Al atom are tetrahedrally arranged.
18. The same amount of an electric current flow through molten sodium chloride and molten aluminium oxide mixed with molten cryolite. If 4.6g of sodium is produced in one cell, what is the mass of aluminium produced in the other cell?
[Relative atomic mass; Al = 27, Na = 23]
- A. 0.9g
 B. 1.8g
C. 2.7g
D. 3.6g

19. Which of the following statements about the oxides of nitrogen is **not** correct?

- A. N_2O_4 is colourless
- B. NO_2 is a brown gas
- C. NO has an unpaired electron in its structure.
- D. The hybridization of nitrogen atom in NO_2 is sp^3 .

20. When concentrated sulphuric acid is added to separate solid samples of sodium chloride, sodium bromide, and sodium iodide, which set of halogen-containing substances is produced?

- A. Cl_2 , Br_2 and I_2 only.
- B. HCl , Br_2 and I_2 only.
- C. HCl , HBr and HI only.
- D. HCl , HBr , HI , Br_2 and I_2 only.

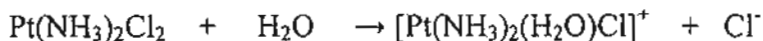
✓ 21. Three elements in Group 17, P, Q, and R have the following properties,

- P is a liquid at room temperature
- Q is the strongest oxidising agent
- The hydride of R has the highest K_a value

Based on the above, the correct arrangement of the elements in order of increasing proton number is

- A. P, Q, R
- B. P, R, Q
- C. R, P, Q
- D. Q, P, R

22. The anti-cancer drug cisplatin has the formula $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$. In the human body, one of the chloride ions of cisplatin is replaced by one water molecule.



What is the oxidation number of platinum in each of these substances?

	Cisplatin	In the aqua complex
A.	+2	+1
<input checked="" type="radio"/> B.	+2	+2
C.	+4	+3
D.	+4	+4

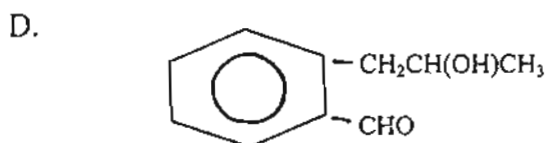
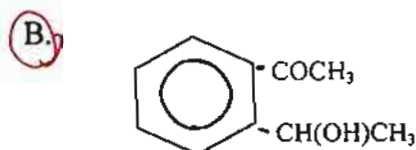
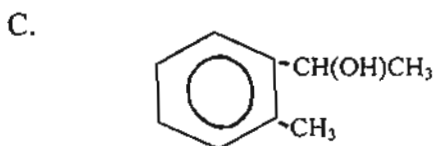
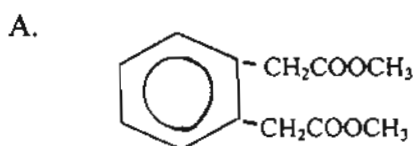
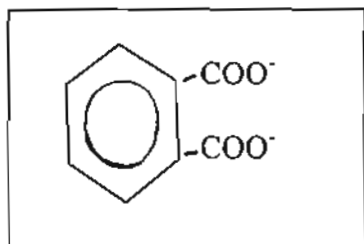
✗ 23. Which of the following statements about geometrical isomerism is true?

- A. The molecule must be planar.
- B. The melting points of the *cis* and *trans* isomers are different.
- C. The chemical properties of the *cis* and *trans* isomers are different. ✗
- D. Two groups of atoms must be on each carbon atom that is covalently bonded by a single bond.

24. Monosubstituted benzene has the formula C_6H_5X . When C_6H_5X reacts with an electrophile Y , a trisubstituted benzene compound, Z is formed. Which of the following statements is correct?

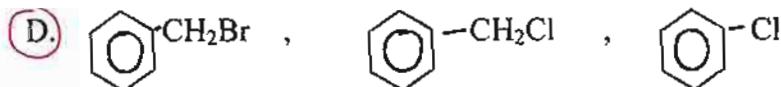
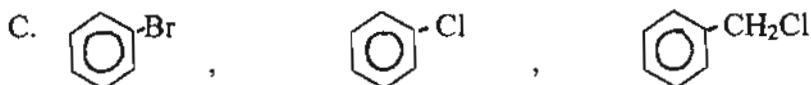
- A. The molecular formula of Z is $C_6H_3XY_2$
- B. The molecular formula of Z is $C_6H_4XY_2$
- C. The number of isomers of Z is 3.
- D. The number of isomers of Z is 7

25. Which of the following compounds will react with alkaline iodine to give



26. Which sequence shows the correct order of **decreasing** ease of hydrolysis?

- A. CH_3CH_2Cl , CH_3CH_2Br , CH_3CH_2I
- B. $(CH_3)_2CHCl$, $(CH_3)_2CHI$, $(CH_3)_2CHBr$



27. A mixture is made by adding together one mole of sodium hydroxide, one mole of phenol (C_6H_5OH) and one mole of hexan-1-ol ($C_6H_{13}OH$), each solute being in aqueous solution. Which organic species are present in the final solution?

- A. Mainly C_6H_5OH and $C_6H_{13}OH$
- B. Mainly $C_6H_{13}OH$ and $C_6H_5O^-Na^+$
- C. Mainly C_6H_5OH and $C_6H_{13}O^-Na^+$
- D. Approximately equal quantities of C_6H_5OH , $C_6H_{13}OH$, $C_6H_5O^-Na^+$ and $C_6H_{13}O^-Na^+$

28. Which one of the following pairs of reagent **cannot** be used to prepare $\text{CH}_3\text{CH}_2\text{Cl}$?

- A. $\text{CH}_2=\text{CH}_2 + \text{HCl}$
- B. $\text{CH}_2=\text{CHCl} + \text{H}_2$
- C. $\text{CH}_3\text{CH}_2\text{OH} + \text{HCl}$
- D. $\text{CH}_3\text{CH}_2\text{OH} + \text{Cl}_2$

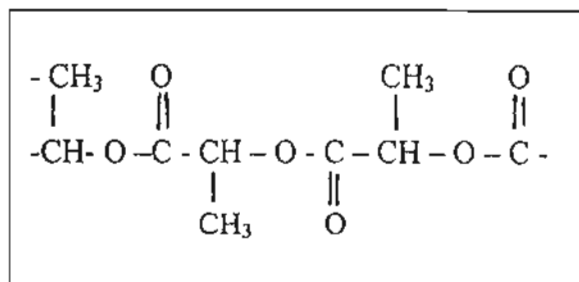
29. A compound X, $\text{C}_4\text{H}_{10}\text{O}$ gives the compound Y, $\text{C}_4\text{H}_8\text{O}$ on oxidation. Y gives a yellow precipitate on warming with alkaline aqueous iodine. Which of the following could be X?

- A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- B. $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$
- C. $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
- D. $(\text{CH}_3)_3\text{COH}$

30. Compound Y changes the colour of acidified sodium dichromate (VI) from orange to green. 1 mole of Y reacts with 2 mole of HCN (g). What could Y be?

- A. $\text{CH}_3\text{COCH}_2\text{COCH}_3$
- B. $\text{OHCCH}_2\text{CH}_2\text{CHO}$
- C. $\text{CH}_3\text{CHBrCH}_2\text{CHO}$
- D. $\text{CH}_3\text{CHBrCH}_2\text{CH}_2\text{Br}$

31. One form of the biodegradable polymer, used for plastic bags has the following structure



What would be the monomer for this polymer?

- A. $\text{CH}_3\underset{\text{OH}}{\text{CH}}\text{COOH}$
- B. $\text{CH}_3\underset{\text{Cl}}{\text{CH}}\text{COOH}$
- C. $\text{CH}_3\text{CH}_2\text{COC}\text{Cl}$
- D. $\text{CH}_3\underset{\text{OH}}{\text{CH}}\text{CHO}$

32. Ethene reacts with aqueous bromine to give two products, $\text{CH}_2\text{BrCH}_2\text{Br}$ and $\text{CH}_2\text{BrCH}_2\text{OH}$.

Which statement is correct for these products?

- A. Both products can be hydrolysed to form the same diol.
 B. Both products can form hydrogen bond with water. \times
 C. Both products are obtained in this reaction by electrophilic substitution. \times
 D. Both products are obtained in this reaction by nucleophilic addition. Δ

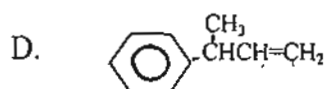
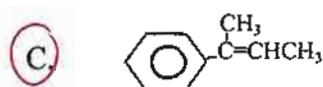
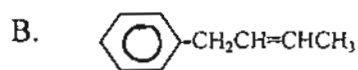
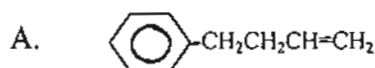
33. Which one of the following gives the correct order of acid strength for ethanoic acid, chloroethanoic acid and phenol?

- | Strongest | Weakest |
|---|---------|
| A. $\text{CH}_3\text{CO}_2\text{H} > \text{C}_6\text{H}_5\text{OH} > \text{CH}_2\text{ClCO}_2\text{H}$ | |
| B. $\text{C}_6\text{H}_5\text{OH} > \text{CH}_2\text{ClCO}_2\text{H} > \text{CH}_3\text{CO}_2\text{H}$ | |
| C. $\text{CH}_2\text{ClCO}_2\text{H} > \text{C}_6\text{H}_5\text{OH} > \text{CH}_3\text{CO}_2\text{H}$ | |
| <input checked="" type="radio"/> D. $\text{CH}_2\text{ClCO}_2\text{H} > \text{CH}_3\text{CO}_2\text{H} > \text{C}_6\text{H}_5\text{OH}$ | |

34. Compound Z

- has the molecular formula $\text{C}_{10}\text{H}_{14}\text{O}$
- is unreactive towards mild oxidizing agents.

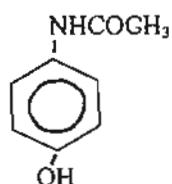
What is the structure of the compound formed by dehydration of Z?



35. Which one of the following compounds will give a precipitate of triiodomethane (iodoform) when reacted with iodine and aqueous sodium hydroxide?

- A. $\text{C}_6\text{H}_5\text{CHO}$
 B. $(\text{CH}_3)_3\text{COH}$
 C. $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
 D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

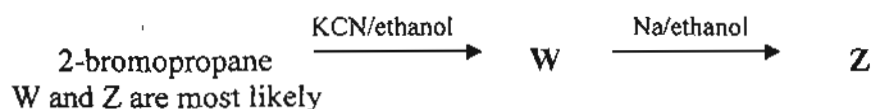
36. Paracetamol is a pain -killing drug:



What are the products from its reaction with excess of boiling aqueous NaOH?

- A.
- B. + $\text{CH}_3\text{COONa}^+$
- C.** + $\text{CH}_3\text{COONa}^+$
- D. + CH_3OH

37. W and Z are the products in a two steps reaction with 2-bromopropane, as shown below.

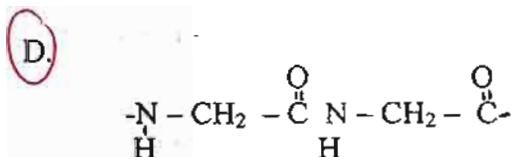
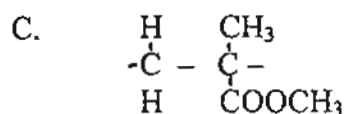
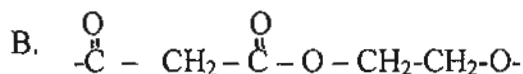
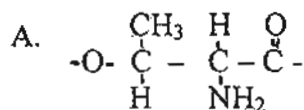


- | W | Z |
|----------------------------------|-----------------------------------|
| A. 2-butanitrile | butyl ethanoate |
| B. ethyl propoxide | pentanamine [×] |
| C. 2-methylpropanonitrile | 2-methyl propanamine [×] |
| D. 2-methylpropanonitrile | butanamine [×] |

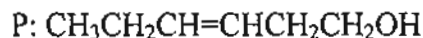
38. Which reagent could be used to separate a mixture of phenylamine, $C_6H_5NH_2$ and methylbenzene, $C_6H_5CH_3$?

- A. dilute aqueous sodium hydrogencarbonate
- B. dilute hydrochloric acid
- C. propanone
- D. dilute aqueous sodium hydroxide

39. Which structure represents the repeating unit of a protein?



40. The compound hex-3-en-1-ol, P, has a strong 'leafy' smell of newly cut grass and used in perfumery



What is produced when P is treated with an excess of hot concentrated acidic $KMnO_4$?

- A. $CH_3CH_2CH(OH)CH(OH)CH_2CH_2OH$
- B. $CH_3CH_2CH=CHCH_2COOH$
- C. CH_3CH_2COOH and $HO_2CCH_2CO_2H$
- D. CH_3CH_2CHO and $OCHCH_2CH_2CHO$

Section B

For each question in this section, one or more of the three numbered statements 1 to 3 may be correct. The responses A to D should be selected as follows:

A	B	C	D
1 only is correct	1 and 2 only are correct	2 and 3 only are correct	1,2 and 3 are correct

41. The table below shows the equilibrium constants at different temperatures for the reaction



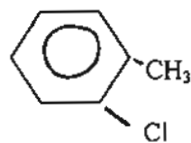
Temperature / K	Equilibrium constant, K_p
600	1.78×10^4 kPa
1000	2.82×10^4 kPa

The above information shows that:

1. Dissociation of dinitrogen tetraoxide is an endothermic process.
 2. When temperature increases, the colour intensity of the gas mixture will increase.
 3. Increase in pressure will shift the equilibrium position to the left.
42. When ammonia gas reacts with hydrogen chloride gas, white fumes of ammonium chloride is formed. Which of the following statements is true of ammonium chloride?
1. it has both covalent and ionic bonds.
 2. It is soluble in water.
 3. The cation is tetrahedral in shape.
43. An aqueous copper(II) salt is electrolysed between copper electrodes, using a constant current. What affects the mass of copper deposit on the cathodes?
1. the time taken
 2. the concentration of the solution
 3. the nature of the anion present.
44. An oxide Q gives off chlorine gas when heated with concentrated hydrochloric acid. When all of the chlorine gas has evolved, the remaining solution is mixed with dilute sulphuric acid. A white precipitate is formed. Q is probably
1. PbO_2
 2. SnO_2
 3. PbO
45. Which of the following is true about an acid-base indicator?
1. the ions and molecules in the indicator must have different colour.
 2. It must change colour at $\text{pH} = 7$
 3. It can only be used for the titration between a strong acid and strong base

46. A hydrocarbon, P, with molecular formula C_7H_8 , reacts with chlorine gas in the presence of iron(III)chloride, $FeCl_3$ as catalyst. A product, Q, with molecular formula C_7H_7Cl , is produced. The possible structural formula(e) of Q includes

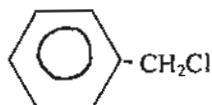
1.



2.



3.



47. Which of the following molecules undergoes sp^2 hybridisation?

A

1. SO_2
2. HCN
3. C_2H_6

48. The ester with structural formula

A



can be synthesized by the reaction between

1. butanoyl chloride and propan-2-ol
2. butanoic acid and propan-1-ol
3. propanoyl chloride and propan-2-ol

49. Cobalt form a complex with formula $[Co(H_2NCH_2CH_2NH_2)_2Cl_2]^+$. This complex

C

1. contain cobalt with an oxidation number of +1
2. can exist as geometrical isomers
3. can exist as optical isomers

50. Which of the properties of group 14 elements will increase with the increase in proton number?

A

1. The metallic property
2. The stability of the tetrachloride
3. The first ionization energy.

Section A [40 marks]

Answer all questions in this section

1. (a) The typical automobile antifreeze is ethylene glycol, $C_2H_2(OH)_2$. It is a good idea to leave the ethylene glycol-water mixture in the cooling system at all times to provide all-weather protection.

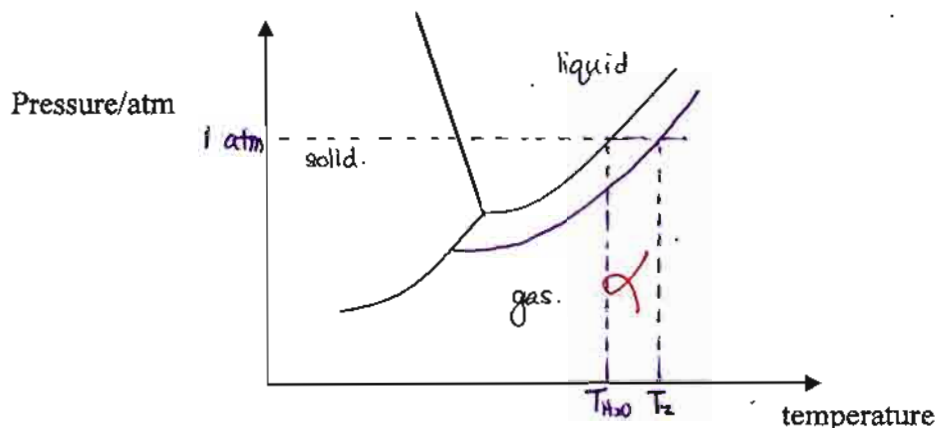
(i) State why ethylene glycol can mix with water. [1]

..... Ethylene glycol have hydroxyl group can form H-bonding with water.....

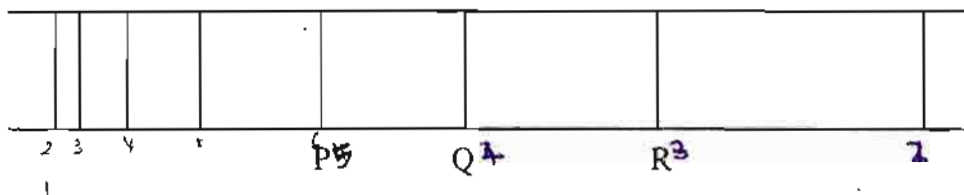
(ii) What is the effect of adding ethylene glycol to the boiling point of water in summer. [1]

..... It will increase.....

(iii) The phase diagram of water is shown in figure 1 below. Show and label the effect of adding ethylene glycol in water from (a)(ii) in the diagram below [2]



(b) Figure 2 shows the Lyman series of hydrogen emission spectrum.



(i) Name the region of electromagnetic spectrum of hydrogen emission spectrum. [1]

..... ultraviolet radiation light.....

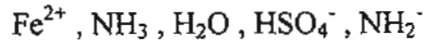
(ii) State the transition of electron which produce the line P. [1]

..... $n=5$ to $n=1$
 $n=6$ to $n=1$

(iii) Arrange the frequency of lines P, Q and R in descending order. [1]

..... P, Q, R
R, Q, P.....

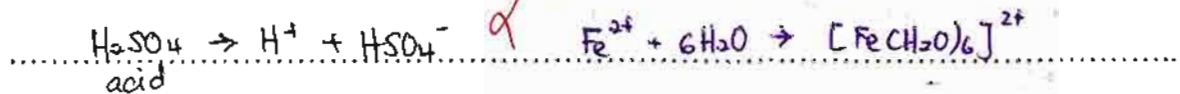
(b) Choosing suitable examples from the following :



Using a different equation in each case to explain the terms below.

(i) Lewis acid

[1]



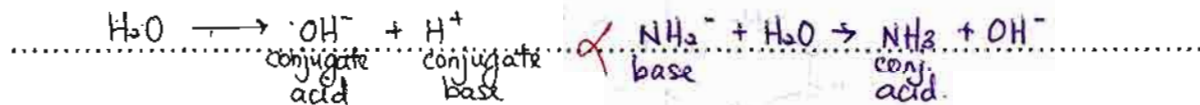
(ii) Bronsted-Lowry acid

[1]



(iii) Conjugate acid-base pair (identify each member of both acid-base pairs)

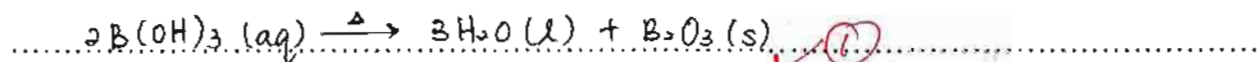
[1]



3. (a) Strong heating of boric acid, $\text{B}(\text{OH})_3$ drives off water molecules and gives molten boron oxide.

(i) Write balanced equation for the above reaction.

[1]



When the molten boron oxide dissolves metal oxides and mixed with silica, it forms a type of glass.

(ii) Name the type of glass.

[1]

Borosilicate glass

(iii) State one of the metal oxides that existed in the above glass.

[1]

Na_2O

(iv) Gives one use of the glass mentioned in (b)(ii).

[1]

window cooking utensils

(b) Lime, CaO , is one of the most abundantly produced chemicals in the world.

(i) Write balanced equation for the preparation of lime from natural sources.

[1]



(ii) Name the chemical reaction that occurred in (a)(i).

[1]

decomposition

(iii) State why the chemical reaction is occurred in (a)(i).

[1]

the oxide formed will be more stable / ionic bond btw CaO more stronger

(iv) A gas is given off from the above reaction. Gives the reagent which can be used to detect the presence of the gas.

[1]

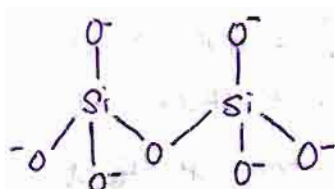
lime water solution

(c) Hemimorphite, $[Zn_4(OH)_2Si_2O_7 \cdot H_2O]$ is a type of silicate minerals.

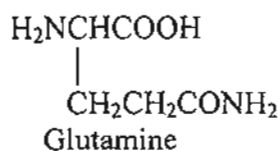
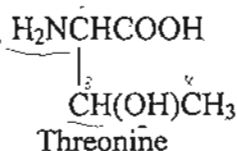
(i) Name the silicate ion that existed in hemimorphite. [1]

pyrosilicate ion

(ii) Draw the structure of silicate ion that mentioned in (c)(i). [1]



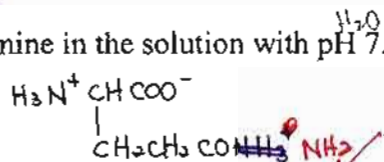
4. (a) Amino acids are the building blocks in proteins. The structures of Threonine, and Glutamine are shown below.



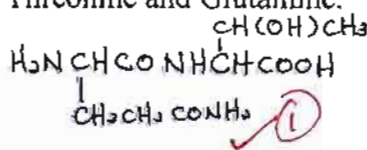
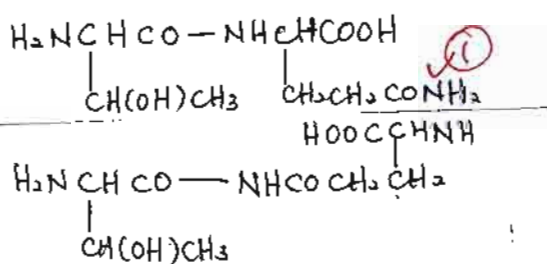
(i) Gives the IUPAC name of Threonine. [1]

2-amino-3-hydroxybutanoic acid

(ii) Draw the structure of Glutamine in the solution with pH 7. [1]



(iii) Draw the dipeptides which are comprised of Threonine and Glutamine. [2]



(iv) Name the linkage group formed between Threonine and Glutamine. [1]

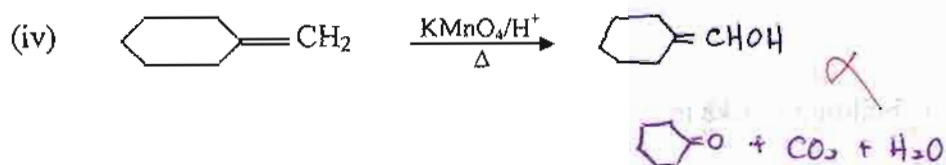
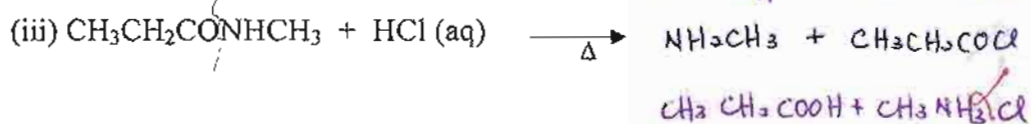
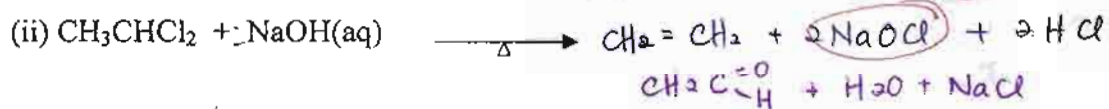
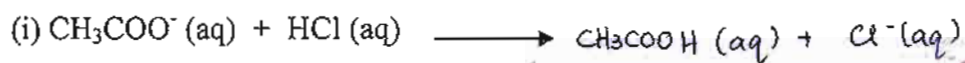
peptide linkage

(v) Name the bond or interaction that is formed between the R side group of Threonine and Glutamine amino acids. [1]

Hydrogen bond

<http://edu.joshuatly.com/>
<http://www.joshuatly.com/>

(b) Write the structural formulae of the products formed in each of the following reactions: [4]



Section B [60 marks]

5. (a) Using the ideal gas equation, derive an expression which relates density, ρ , and pressure, p , of a particular gas. Calculate the value of gas constant, R , if the density of oxygen gas at STP is 1.428 g dm^{-3} . [5]

(b) Hydrazoic acid, N_3H , can be represented by several possible Lewis Structures in which the atoms are arranged as NNNH. Draw two Lewis Structures of N_3H and state the type of hybridisation of N atom bonded to the hydrogen atom in each structure. [4]

(c) Lead and chlorine combine to form two different compounds. Which of these compounds has a higher boiling point? Explain your answer. [6]

6. (a) A compound S with an initial concentration of 4.00 mol dm^{-3} undergoes decomposition to form T. The rate constant of this reaction at 298 K is $2.95 \times 10^{-2} \text{ mol}^{-1} \text{ dm}^3 \text{ s}^{-1}$ and the activation energy is 70.8 kJ mol^{-1} . Determine the half-life and calculate the rate constant of the reaction at 350 K. [7]

(b) Magnesium and Barium are the two elements in Group 2 of the Periodic Table.

(i) Compare and explain the solubility of their sulphate compounds in Group 2. [5]

(ii) Construct a labeled energy level diagram for the solubility of magnesium sulphate. [3]

7. (a) Aluminium is protected against reaction with water in the pH range 4.5 – 8.5 by a thin coating layer.

(i) Explain why aluminium reacts with water out of the pH range 4.5 – 8.5. [6]

(ii) State the process which is used to thicken the coating layer. [1]

(b) Zinc hydroxide is formed when sodium hydroxide aqueous solution is added to an aqueous solution containing zinc ions. When excess of sodium hydroxide aqueous solution is added, colourless solution is formed.

(i) State and explain the observation. [4]

(ii) What is the solubility of the zinc hydroxide.
[Solubility product for zinc hydroxide is 4.1×10^{-17}] [4]

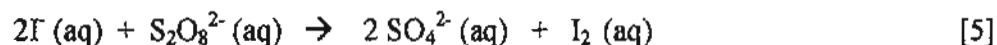
8. (a) Nitrogen monoxides occur in exhaust gases of auto running engines.

(i) State and explain the reaction that occurred in the auto running engines to produce nitrogen monoxides. [3]

(ii) State the reactions in the catalytic converter that occurred to remove the undesirable gases from the exhaust. [3]

(b) Explain the relative reactivity of elements (chlorine to iodine) with hydrogen when descending Group 17. [4]

(c) One of the features of a catalyst is it is chemically involved but at the end of the reaction is chemically unchanged. Explain this feature by using Fe^{3+} as the catalyst in the reaction below.



9. (a) The table below shows the K_b values of three different amines in aqueous solution at 298K.

Amines	K_b at 298K
Aniline	3.8×10^{-10}
<i>p</i> -Chloroaniline	1.0×10^{-10}
<i>p</i> -Methylaniline	1.2×10^{-9}

- (i) Arrange the three bases above in increasing order of basicity. Explain your answer. [7]
 (ii) State a chemical test to differentiate aniline from *p*-Methylaniline. Write equation for the reaction involved. [3]

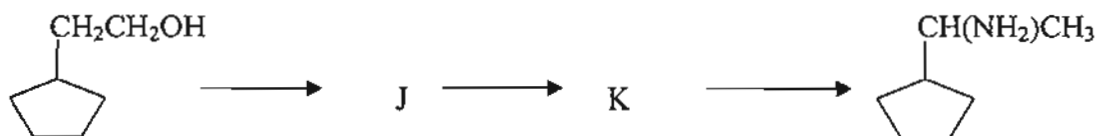
(b) A cyanohydrin, B, $C_6H_5CH(OH)CN$, can be prepared by the reaction between an aldehyde A and sodium cyanide in dilute hydrochloric acid.

- (i) Identify A. [1]
 (ii) Write the mechanism for the formation of B. [4]

10. (a) An organic compound D, $C_9H_{11}Br$, is warmed with aqueous potassium hydroxide to form E. E responded to oxidation in two different ways. With aqueous sodium hydroxide and iodine it yielded F, $C_8H_7O_2Na$ and a yellow precipitate. With hot, acidic potassium manganate(VII) it yielded G, $C_7H_6O_2$.

Identify compound D to G, giving equations for reactions which occur. [8]

(b) A reaction scheme is shown below.



Suggest the reagents and conditions required for the above transformation and determine the structural formulae of J and K. [5]

(c) Nylon has similar characteristics with a few natural compounds. State one of these compounds and explain. [2]

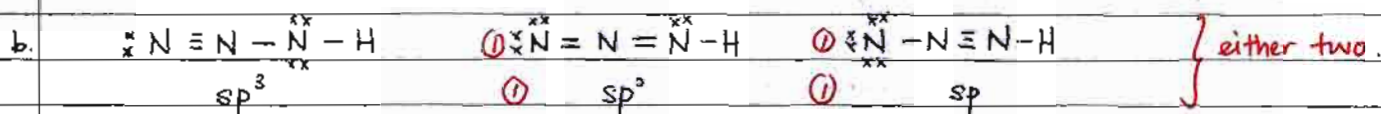
END OF QUESTION PAPER

STPM Trial 2010

1a. $pV = nRT$ (1)
 $= \frac{m}{M_r} RT$ (1)

$pM_r = \frac{m}{V} RT$
 $f = \frac{pM_r}{RT}$ (1)

$R = \frac{pM_r}{fT} = \frac{101 \times 10^3 \times 2(16.0)}{1.428 \times 10^3 \times 0.73}$ (1)
 $= 8.09 \text{ J mol}^{-1} \text{ K}^{-1}$ (1)



- c. PbCl_2 : ionic compound (1)
 strong ionic bond between Pb^{2+} & Cl^- ions (1)
 PbCl_4 : simple covalent compound (1)
 the weak Van der Waals forces between molecules (1)
 PbCl_2 has higher boiling point. (1)

6a. Rate = $k[A]^2$
 $k = \frac{\text{mol dm}^{-3} \text{ s}^{-1}}{\text{mol}^2 \text{ dm}^{-6}}$
 $= \text{mol}^{-1} \text{ dm}^3 \text{ s}^{-1} \rightarrow 2^{\text{nd}} \text{ order}$ (1)

$t_{1/2} = \frac{1}{k[A]_0}$ (1)
 $= \frac{1}{(2.95 \times 10^{-2})(4.00)}$ (1)
 $= 8.47 \text{ s}$ (1)

$\ln k = \ln A - \frac{E_a}{RT}$ (1)

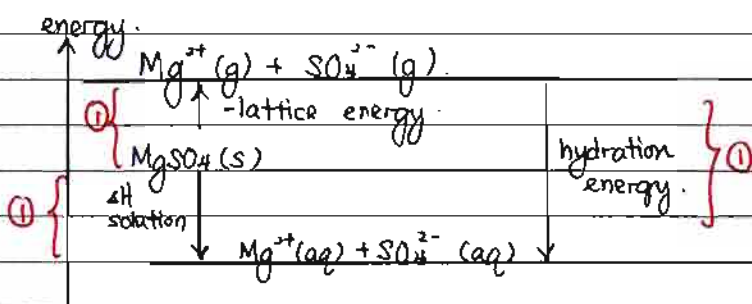
$\ln k - \ln A = -\frac{E_a}{RT}$

$\ln \frac{k}{2.95 \times 10^{-2}} = \frac{70.8 \times 10^3}{8.31} \left(\frac{1}{298} - \frac{1}{350} \right)$ (1)

$k = 2.06 \text{ mol}^{-1} \text{ dm}^3 \text{ s}^{-1}$ (1)

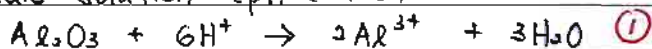
- bi Solubility of sulphate compounds depends on lattice energy & hydration energy.
 Solubility of MgSO_4 is higher than BaSO_4 . (1)
 Ionic radius: $\text{Mg}^{2+} < \text{Ba}^{2+}$ (1)
 Hydration energy of Mg^{2+} is more exothermic than Ba^{2+} . (1)
 Due to bigger ionic size of SO_4^{2-} , lattice energy of MgSO_4 is slightly more exothermic than BaSO_4 . (1)

ii

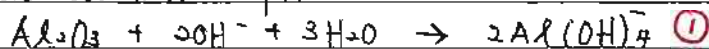


7a i Al_2O_3 : ionic compound with covalent character $\textcircled{1}$
 has amphoteric property $\textcircled{1}$
 high charge density. $\textcircled{1}$

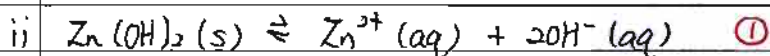
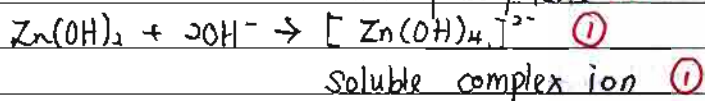
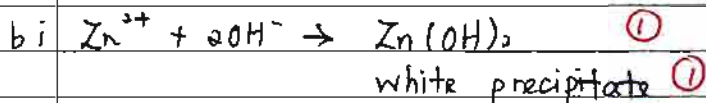
Acidic solution ($pH < 4.5$)



Basic solution ($pH > 8.5$)



ii Anodisation $\textcircled{1}$



x = solubility of $Zn(OH)_2$

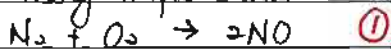
$$K_{sp} = [Zn^{2+}][OH^-]^2 \quad \textcircled{1}$$

$$4.1 \times 10^{-17} = x(2x)^2 \quad \textcircled{1}$$

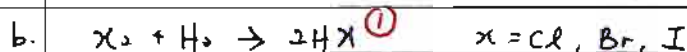
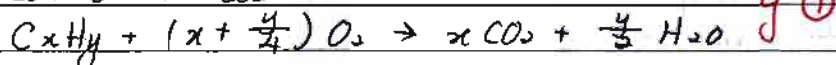
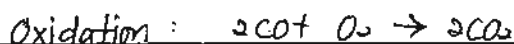
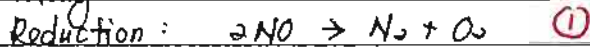
$$x = 2.2 \times 10^{-6} \text{ mol dm}^{-3} \quad \textcircled{1}$$

8a i High temperature $\textcircled{1}$

Strong triple bond in N_2 is broken. $\textcircled{1}$



ii catalyst : Pd / Pt / Rh $\textcircled{1}$

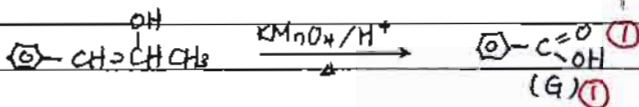
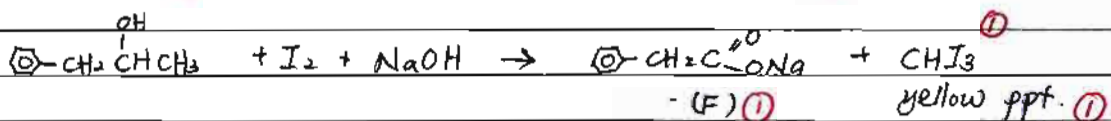
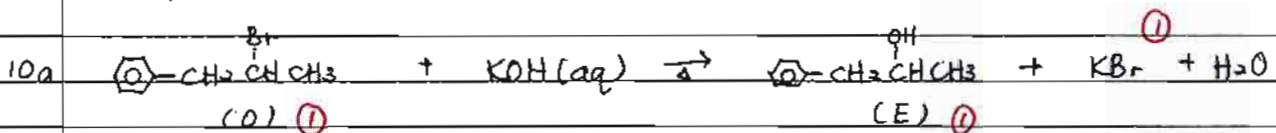
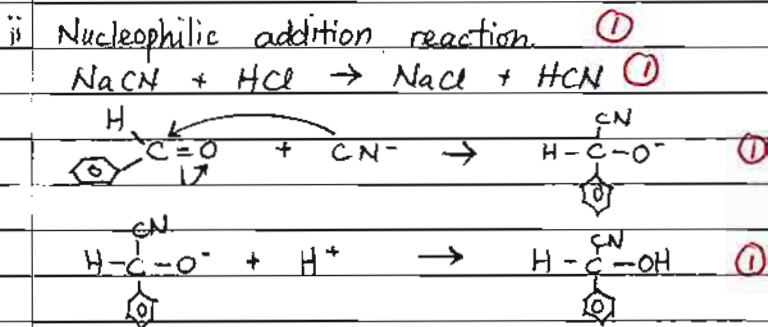
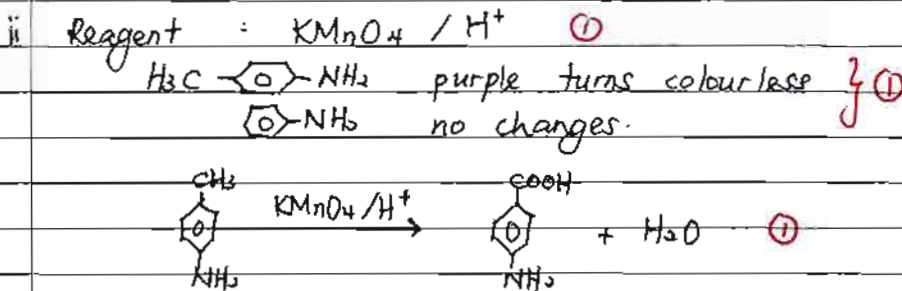
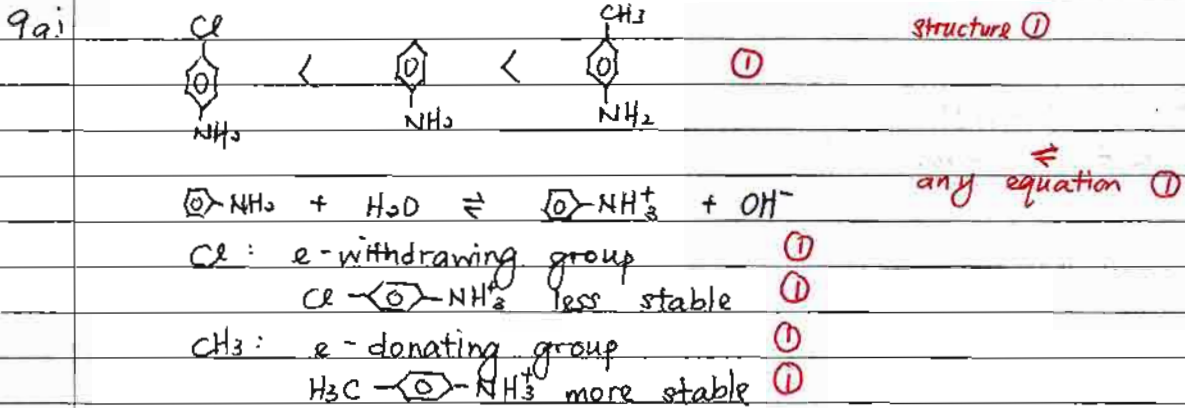


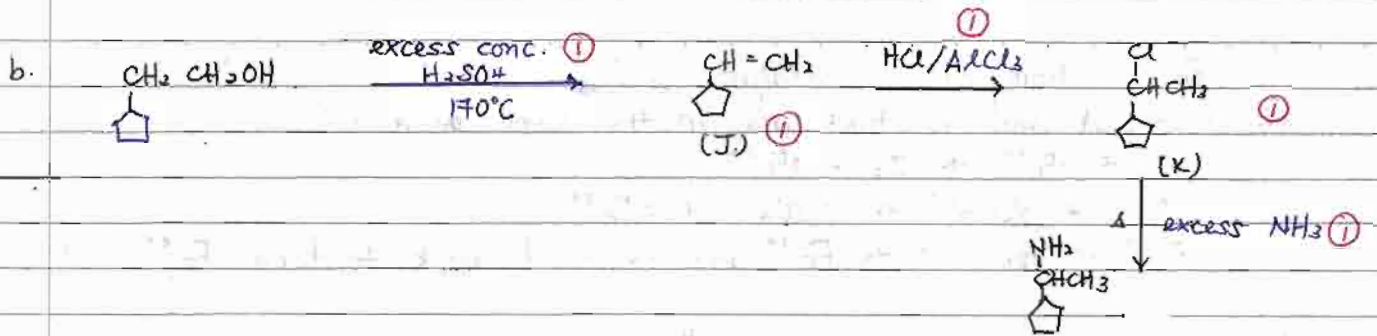
Hydrogen halide is formed. $\textcircled{1}$

Going down Group 17 : oxidising strength decrease $\textcircled{1}$

relative reactivity decrease $\textcircled{1}$

- c. Fe^{3+} : homogeneous catalyst. (1)
 -catalyst and reactant are in the same phase (1)
 $2I^- + 2Fe^{3+} \rightarrow I_2 + 2Fe^{2+}$ (1)
 $2Fe^{2+} + S_2O_8^{2-} \rightarrow 2SO_4^{2-} + 2Fe^{3+}$ (1)
 Fe^{3+} is reduced to Fe^{2+} and oxidised back to form Fe^{3+} . (1)





c. protein or polypeptide $\text{\textcircled{1}}$
 has peptide linkage $\text{\textcircled{1}}$