

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CHEMISTRY

9729/01

Paper 1 Multiple Choice

21 September 2021

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, CT and NRIC / FIN on the Answer Sheet in the spaces provided.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

- 1 The mass percentage of magnesium in a mixture of magnesium chloride and magnesium nitrate was found to be 21.25 %. What mass of magnesium chloride is present in 100 g of the mixture?

A 47 g **B** 53 g **C** 56 g **D** 61 g

- 2 10.00 cm³ of 0.500 mol dm⁻³ of a metal oxide, M₂O_n, reacted exactly with 20.00 cm³ of 0.300 mol dm⁻³ of acidified potassium manganate(VII) solution.

Given that the oxidation state of M in the product is +6, what is the value of n?

A 1 **B** 2 **C** 3 **D** 4

- 3 The first six ionisation energies of an element, Q, in kJ mol⁻¹ are shown.

660; 1267; 2218; 3313; 7863; 9500

What can be inferred from the data provided?

- A** Q is a Period 3 element.
B Q forms an oxide with a giant molecular structure.
C Q is likely to form a chloride with the formula QCl₄ when reacted with chlorine.
D Q has a lower first ionisation energy than the element preceding it in the Periodic Table.

- 4 Which of the following statements are correct?

- 1 The van der Waals radius of chlorine is larger than the van der Waals radius of argon.
2 The boiling point of N₂H₄ is higher than CH₃CH₂CHO as hydrogen bonds between N₂H₄ molecules are more extensive than the hydrogen bonds between CH₃CH₂CHO molecules.
3 The carbon–carbon bond length is longer in diamond than in graphite.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

- 5 What is the pressure (in Pa) of a sample of hydrogen gas that has density of 8 g m^{-3} at 300°C ?

A $\frac{573 \times 4 \times 22.7 \times 10^5}{273}$

B $\frac{573 \times 8 \times 22.7 \times 100}{273}$

C $\frac{273 \times 8 \times 22.7 \times 10^5}{573}$

D $\frac{573 \times 4 \times 22.7 \times 100}{273}$

- 6 Given the following enthalpy changes,

	enthalpy change/ kJ mol^{-1}
$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$	−92
$\text{N}_2(\text{g}) + 4\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{NH}_4\text{Cl}(\text{s})$	−629
$\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s})$	−176

What is the standard enthalpy change of formation of gaseous hydrogen chloride?

A $-46.3 \text{ kJ mol}^{-1}$

B $-92.5 \text{ kJ mol}^{-1}$

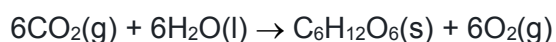
C -180 kJ mol^{-1}

D -361 kJ mol^{-1}

- 7 Some ΔH_f° values are given below.

compound	$\Delta H_f^\circ / \text{kJ mol}^{-1}$
$\text{H}_2\text{O}(\text{l})$	-286
$\text{CO}_2(\text{g})$	-394
$\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$	-1273

The overall reaction in photosynthesis can be represented by the following equation.



Which of the following statements are correct?

- 1 The enthalpy change of the reaction is $+2807 \text{ kJ mol}^{-1}$.
- 2 In the formation of products, the system becomes less disordered.
- 3 The reaction is not spontaneous at all temperatures.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 1 only

- 8 The decomposition of a sample of H_2O_2 solution is a first order reaction with a rate constant of $7.70 \times 10^{-4} \text{ s}^{-1}$. What is the initial concentration of the H_2O_2 solution, in mol dm^{-3} , if its concentration has dropped to $0.0315 \text{ mol dm}^{-3}$ in 80 min?

A 0.109 **B** 0.158 **C** 1.01 **D** 1.27

- 9 For the hydrolysis of methyl propanoate, $\text{CH}_3\text{OCOCH}_2\text{CH}_3$, in dilute HCl , the following rates of reactions were measured at 25°C .



experiment	[methyl propanoate] / mol dm^{-3}	[HCl] / mol dm^{-3}	initial rate / $\text{mol dm}^{-3} \text{ min}^{-1}$
1	0.10	0.20	0.192
2	0.15	0.10	0.144
3	0.10	0.10	0.096
4	0.30	0.15	?

Which statements are **incorrect**?

- The initial rate for experiment 4 is $0.432 \text{ mol dm}^{-3} \text{ min}^{-1}$.
- The rate constant is $9.6 \text{ mol}^{-2} \text{ dm}^6 \text{ min}^{-1}$.
- If the half-life of methyl propanoate in experiment 1 is 6 minutes, then the half-life of methyl propanoate in experiment 4 is 8 minutes.

A 1, 2 and 3 **B** 2 and 3 only **C** 3 only **D** 2 only

- 10 At a total pressure of 1.0 atm and a temperature of 60°C , dinitrogen tetraoxide is 50 % dissociated according to the following equation:



What is the value of the equilibrium constant, K_p , for the dimerisation of NO_2 at 60°C ?

A $\frac{2}{3}$ **B** $\frac{3}{4}$ **C** $\frac{4}{3}$ **D** $\frac{3}{2}$

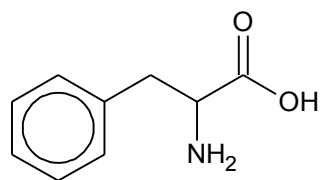
- 11 Nitrogen is discharged from wastewater treatment facilities into rivers and streams, usually as NH_3 and NH_4^+ .

The fraction of the total nitrogen present in the water to be discharged as NH_3 is defined as:

$$\frac{[\text{NH}_3]}{[\text{NH}_3] + [\text{NH}_4^+]}$$

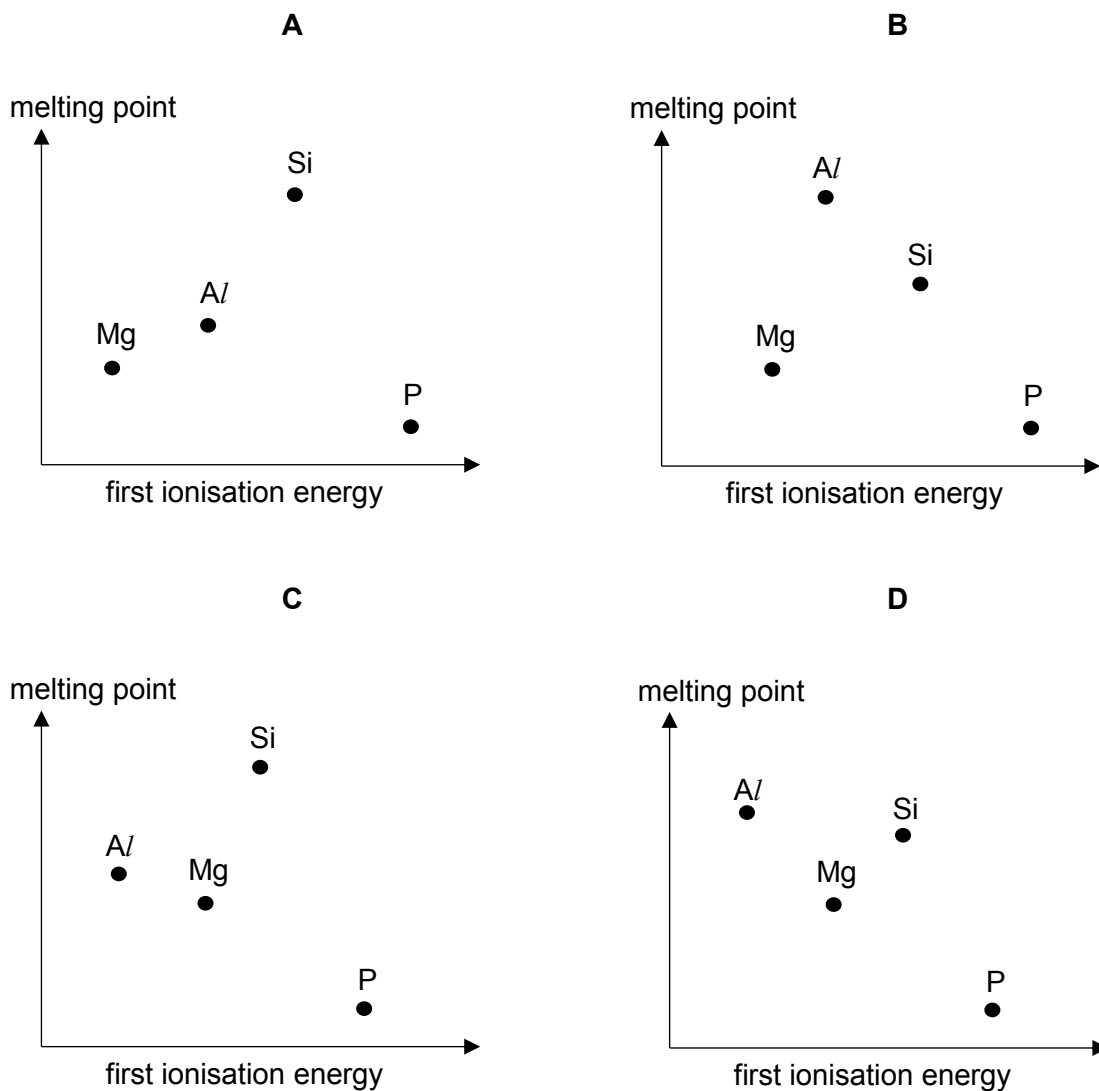
Given that the base dissociation constant, K_b of NH_3 is $1.76 \times 10^{-5} \text{ mol dm}^{-3}$, what is the fraction of the total nitrogen in the water to be discharged as NH_3 at pH 7?

- A 9.94×10^{-1}
 B 5.00×10^{-1}
 C 5.65×10^{-3}
 D 1.76×10^{-3}
- 12 Which solution's pH will **not** change significantly when a small amount of alkali is added?
- 1 20 cm^3 of 0.15 mol dm^{-3} of ethanoic acid mixed with 10 cm^3 of 0.20 mol dm^{-3} of potassium hydroxide
 - 2 10 cm^3 of 0.25 mol dm^{-3} of K_2HPO_4 mixed with 5 cm^3 of 0.15 mol dm^{-3} of KH_2PO_4
 - 3 20 cm^3 of 0.10 mol dm^{-3} phenylalanine,



- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 only

- 13 Which graph correctly shows the relative melting points of the elements Mg, Al, Si and P plotted against their relative first ionisation energies?



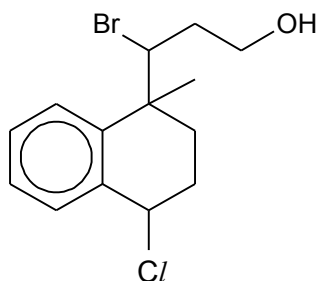
- 14 Which property of Group 2 elements (magnesium to barium) or their compounds increases with increasing proton number?
- A the first ionisation energies of the elements
 - B the acidity of aqueous solutions of the chlorides
 - C the solubility of Group 2 sulfates
 - D the decomposition temperature of the carbonates

15 Which trends concerning halogens from fluorine to iodine and their compounds are **incorrect**?

- 1 The volatility of hydrogen halides decreases down the group.
- 2 The thermal stability of hydrogen halides increases down the group.
- 3 The reducing power of halide ions increases down the group.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

16 What is the total number of stereoisomers exhibited by the product formed when the following compound reacts with excess ethanolic sodium hydroxide?



A 2 **B** 4 **C** 8 **D** 16

17 A non-cyclic organic molecule contains only carbon atoms, hydrogen atoms and one oxygen atom. The molecule is a ketone and contains a chiral carbon atom.

How many carbon atoms can the molecule contain?

- 1 five
- 2 six
- 3 seven

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

- 18** Both maleic acid and fumaric acid are organic compounds with the formula $\text{HO}_2\text{CCH}=\text{CHCO}_2\text{H}$.

Data about the acids are given below.

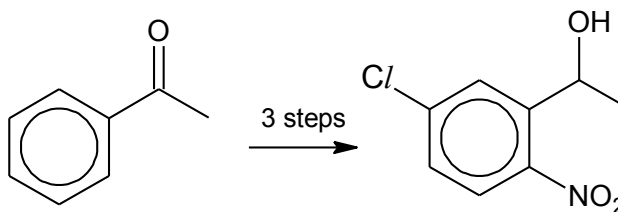
	$\text{p}K_{\text{a}1}$	$\text{p}K_{\text{a}2}$	boiling point / $^{\circ}\text{C}$
maleic acid	1.9	6.2	202
fumaric acid	3.0	4.4	522

Which of the statements are true?

- 1 Maleic acid is the cis-isomer while fumaric acid is the trans-isomer.
- 2 Boiling point of fumaric acid is higher as it has a more elongated shape and a larger surface area of contact, hence more energy is required to overcome the stronger intermolecular forces.
- 3 $\text{CH}(\text{OH})(\text{CO}_2\text{H})\text{CH}(\text{Br})\text{CO}_2\text{H}$ can be prepared using $\text{HO}_2\text{CCH}=\text{CHCO}_2\text{H}$ as a starting material.
- 4 Four moles of CO_2 are produced when it is treated with hot alkaline potassium manganate(VII).

A 1 and 3 only **B** 1 and 4 only **C** 2 and 3 only **D** 2 and 4 only

- 19** The following synthesis takes place in three steps.



Which route forms the highest yield of the product?

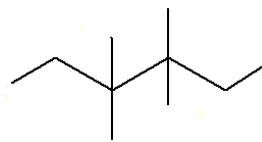
	step 1	step 2	step 3
A	H_2 , Pt	conc HNO_3 , conc H_2SO_4	Cl_2 , FeCl_3
B	Cl_2 , FeCl_3	H_2 , Pt	conc HNO_3 , conc H_2SO_4
C	H_2 , Pt	Cl_2 , FeCl_3	conc HNO_3 , conc H_2SO_4
D	Cl_2 , FeCl_3	conc HNO_3 , conc H_2SO_4	H_2 , Pt

- 20** In the free radical substitution of 2-methylbutane with bromine, a mixture of mono-brominated compounds was obtained.

Which statements are correct?

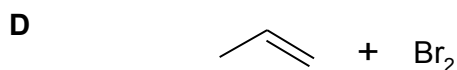
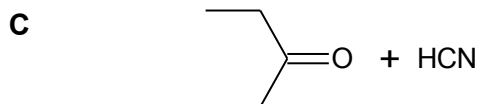
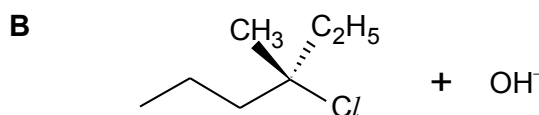
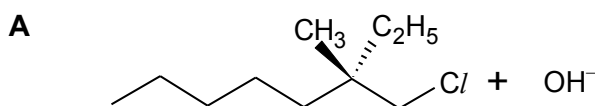
- 1 The statistical ratio of the two compounds with the highest yield is 1 : 2.
- 2 Homolytic fission only occurs in the initiation step.

- 3 One of the products formed in this reaction is



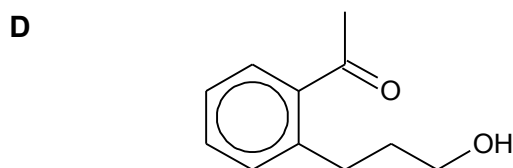
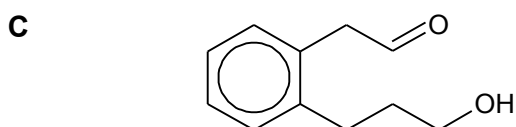
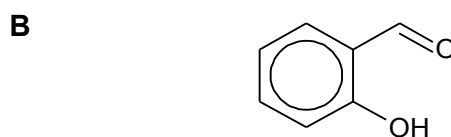
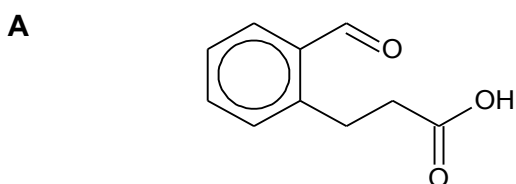
- A** 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1 only

- 21** Which reaction will **not** produce a mixture of two enantiomers in aqueous solution?

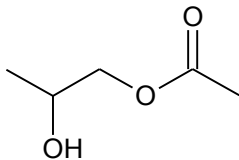


- 22** Compound R gives a positive result when separate samples were treated with $[\text{Ag}(\text{NH}_3)_2]^+$ and PCl_5 but a negative result when treated with alkaline $\text{Cu}(\text{II})$ complex.

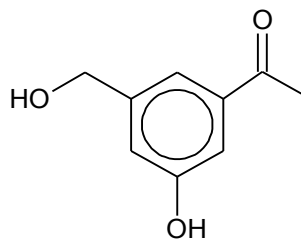
What could R be?



- 23** The following two compounds reacted with alkaline aqueous iodine to form a yellow precipitate. What is the number of moles of sodium hydroxide required to react with one mole of compound S and one mole of compound T respectively?



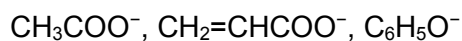
compound S



compound T

	compound S	compound T
A	6	4
B	7	4
C	6	5
D	7	5

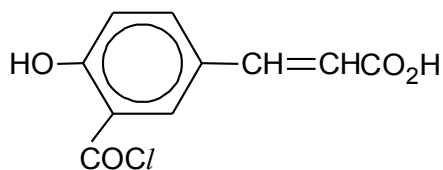
- 24** An equal amount of each of the following species was dissolved separately in 1 dm³ of water. The pH of the resultant solutions were measured.



Which row is correct?

	lowest pH	—————→	highest pH
A	$\text{C}_6\text{H}_5\text{O}^-$	CH_3COO^-	$\text{CH}_2=\text{CHCOO}^-$
B	CH_3COO^-	$\text{CH}_2=\text{CHCOO}^-$	$\text{C}_6\text{H}_5\text{O}^-$
C	$\text{CH}_2=\text{CHCOO}^-$	CH_3COO^-	$\text{C}_6\text{H}_5\text{O}^-$
D	$\text{CH}_2=\text{CHCOO}^-$	$\text{C}_6\text{H}_5\text{O}^-$	CH_3COO^-

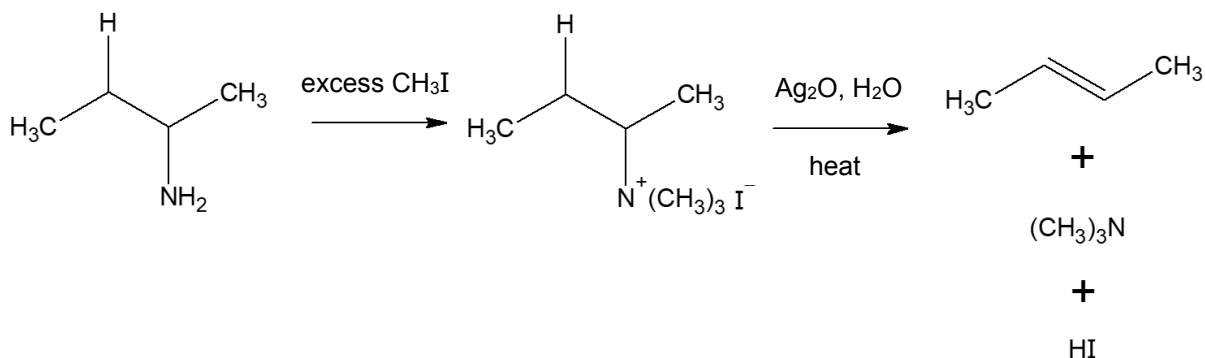
- 25 Compound V is dissolved in heavy water, D_2O , to form compound W. Compound V contains a number of hydrogen atoms which can easily be replaced by deuterium, D.
[D, deuterium = 2_1H]



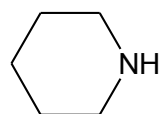
compound V

What is the maximum number of deuterium atoms present in one molecule of compound W?

- A 1 B 2 C 3 D 4
- 26 The Hofmann elimination is a process where an amine undergoes treatment with excess methyl iodide to form an intermediate, which is then treated with silver oxide, water and heat to form an alkene.



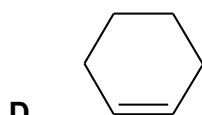
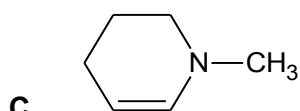
What is the structure of the alkene formed when piperidine, undergoes the Hofmann elimination?



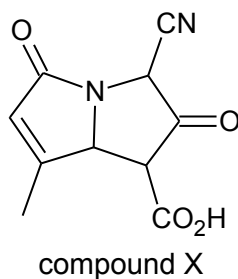
piperidine

A $CH_2=CHCH_2CH_2CH_2N(CH_3)_2$

B $CH_2=CHCH_2CH_2CH_3$



- 27 The structure of compound X is shown below.



Compound X reacts with excess LiAlH_4 in dry ether to yield compound Y.

Which statement about compound Y is correct?

- A** One mole of Y reacts with two moles of HBr .
- B** One mole of Y reacts with two moles of SOCl_2 .
- C** One mole of Y reacts with four moles of CH_3COCl .
- D** One mole of Y reacts with sodium metal to produce three moles of H_2 gas.
- 28 Upon complete hydrolysis, a tetrapeptide Z gives the following amino acids.

amino acid	Structure	M_r	mass of amino acid obtained from hydrolysis / g
aspartic acid	$\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{N}-\text{C}-\text{COOH} \\ \\ \text{CH}_2\text{COOH} \end{array}$	133	53.2
glutamine	$\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{N}-\text{C}-\text{COOH} \\ \\ \text{CH}_2\text{CH}_2\text{CONH}_2 \end{array}$	146	29.2
proline		115	23.0

What is the M_r of tetrapeptide Z?

- A** 340 **B** 394 **C** 473 **D** 527

- 29 *Use of the Data Booklet is relevant to this question.*

A student connects a Zn^{2+}/Zn half-cell to a $\text{Fe}^{3+}/\text{Fe}^{2+}$ half-cell. The voltage measured across the electrodes is found to be +1.50 V.

Which of the following could be a reason for the discrepancy between the measured value above and the $E^\ominus_{\text{cell}}$ expected?

- A Water is added to the Zn^{2+}/Zn half-cell.
- B Water is added to the $\text{Fe}^{3+}/\text{Fe}^{2+}$ half-cell.
- C The piece of zinc in the Zn^{2+}/Zn half-cell used is too small.
- D A small amount of $\text{NaOH}(\text{aq})$ is added to the $\text{Fe}^{3+}/\text{Fe}^{2+}$ half-cell.

- 30 Two separate electrolyses were performed as follows, under the same conditions of temperature and pressure.

experiment 1: When molten magnesium chloride was electrolysed for five minutes, 60 cm^3 of chlorine was collected from the anode.

experiment 2: When aqueous sulfuric acid was electrolysed for five minutes, 90 cm^3 of oxygen was collected from the anode.

If the current used in experiment 1 was I , what was the current used in experiment 2?

- A $0.7I$ B I C $3I$ D $4I$