

NANYANG JUNIOR COLLEGE JC 2 Preliminary Examination Higher 2

CHEMISTRY

9729/01

Paper 1 Multiple Choice

16 Sep 2024

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 Use of the Data Booklet is relevant to this question.

Group 1, 2 and 3 metals form cations with +1, +2 and +3 oxidation states respectively.

Calcium and **V** are adjacent elements in Group 2 of the Periodic Table.

V and W are adjacent elements in the same period of the Periodic Table.

The table shows the angle of deflection of cations of these elements in an electric field.

element	calcium	V	W
angle of deflection	+12°	+5.5°	+8.1°

What is the proton number of W?

Α	11	в	13	С	37	D	39
~	11		10	0	51		00

2 Use of the Data Booklet is relevant to this question.

The successive ionisation energies, in kJ mol⁻¹, of elements **G** and **H** are given below.

G	580	1820	2740	11600	14800	18400	23300
Н	940	2050	2970	4140	6590	7880	14900

Which statements about elements G and H can be deduced from the data?

- 1 There is inter-electron repulsion in only one valence p orbital of **H**.
- 2 The 3rd ionisation energy of **H** is greater than the 3rd ionisation energy of **G** because nuclear charge of **H** is larger.
- 3 The compound formed by **G** and **H** is AI_2Te_3 .

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

3 In which of the following pairs, is the bond angle in the first molecule larger than in the second?

- A NO₃⁻, BeCl₂
- **B** BrO_3^- , PCl_4^+
- **C** As F_6^- , Xe F_4
- **D** SO₂, SO₄²⁻

4 What is the trend in bond energy and in bond length of the carbon to hydrogen bond from C_2H_2 to C_2H_4 to C_2H_6 ?

	bond length	bond energy
Α	increase	decrease
В	increase	increase
С	decrease	increase
D	decrease	decrease

5 When hexanol is mixed with water, two distinct layers is observed.



Which two intermolecular forces of attraction are best used to explain this observation?

- 1 instantaneous dipole induced dipole interactions between hexanol molecules
- 2 hydrogen bonding between hexanol molecules
- 3 hydrogen bonding between water molecules
- 4 instantaneous dipole induced dipole interactions between hexanol and water molecules

A Tand 3 B Tand 4 C 2 and 3 D 3 and	A	1 and 3	В	1 and 4	С	2 and 3	D	3 and
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- 6 Which oxide will **not** dissolve in dilute NaOH(aq) at room temperature?
 - A Na₂O
 - B MgO
 - C Al_2O_3
 - **D** P₄O₁₀
- 7 Which statements explain the difference in thermal decomposition temperature between MgCO₃(s) and BaCO₃(s)?
 - 1 Mg^{2+} has a smaller ionic radius than Ba^{2+} .
 - 2 CO_3^{2-} electron cloud is less polarised in MgCO₃.
 - 3 C–O bond is stronger in MgCO₃.
 - A 1, 2 and 3 B 1 and 2 only C 2 and 3 only D 1 only
- 8 2 cm³ solution of Cl₂(aq) is added to 2 cm³ solution of I⁻(aq). The resulting mixture is added to 4 cm³ of octane in a boiling tube. The contents of the boiling tube was shaken and left to stand to reach equilibrium.

Which statement is correct?

- A Brown colour is seen in the octane layer.
- **B** Brown colour is seen in the aqueous layer.
- **C** The attraction of chlorine nucleus to an incoming electron is stronger than the attraction of iodine nucleus to an incoming electron, hence chlorine is a stronger oxidising agent than iodine.
- **D** The attraction of iodide nucleus for its valence electrons is weaker than the attraction of chloride nucleus to its valence electrons, hence iodide is a weaker reducing agent than chloride.

9 Use of the Data Booklet is relevant to this question.

A Jones reductor is a column containing zinc amalgam. When a solution containing a metal ion is passed through a Jones reductor, zinc metal is oxidised and the metal ion is reduced.

When 40.0 cm³ of an acidified solution of 0.200 mol dm⁻³ ReO₄⁻(aq) is added to a Jones reductor, 2.09 g of Zn metal was lost from the column.

What is the final oxidation state of Re in this reaction?

Α	-1	В	0	С	+2	D	+3

10	Which of the following	g shows a correct	enthalpy change?
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A	ΔH_{neut}^{Θ}	$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(I)$
В	ΔH_{f}^{Θ}	$2Na(s) + \frac{1}{2}O_2(g) \rightarrow Na_2O(s)$
С	ΔH_{hyd}^{Θ}	$NaCl(s) \rightarrow Na^{+}(aq) + Cl^{-}(aq)$
D	LE	$NaOH(s) \rightarrow Na^{+}(g) + OH^{-}(g)$

11 The $\Delta H_{\rm f}^{\Box}$ for steam is shown.

 $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g) \qquad \Delta H_f^{[1]} = -241.5 \text{ kJ mol}^{-1}$

Which statement is correct?

- **A** The reaction is always spontaneous.
- **B** The reaction is more spontaneous at lower temperatures.
- **C** The reaction is more spontaneous at higher temperatures.
- **D** The reaction is never spontaneous.

12 ²²²Rn is a radioactive isotope found naturally in soil. It can build up in indoor air from soil under foundations of buildings. ²²²Rn has a half-life of 3.82 days.

Radiation in air is measured in units of picocurie (pCi) per dm³ of air. Outdoor air generally contains 0.4 pCi dm⁻³ of 222 Rn. The air in a sealed disused building contains 15 pCi dm⁻³ of 222 Rn.

How many days does it take for ²²²Rn in the building to decompose to a safe level?

- **A** 0.04
- **B** 0.15
- **C** 5.23
- **D** 19.97
- **13** The Haber process is used in the industry for the synthesis of ammonia from nitrogen and hydrogen gas.

$$N_2(g) + 3H_2(g) \implies 2NH_3(g) \qquad \Delta H < 0$$

Which statements about the operating conditions of the Haber process are correct?

- 1 Perforated Pt mesh with a large surface area is used to ensure the rate of the forward reaction is greater than the rate of the backward reaction.
- 2 A temperature below 500 K is not used as the rate of reaction will be too slow.
- 3 A pressure of 2.03×10^7 Pa is used to reduce the total number of gas particles in the reaction chamber.
- **A** 1, 2 and 3 **B** 1 and 2 **C** 2 and 3 **D** 3 only

14 Malonic acid has the structure $HO_2CCH_2CO_2H$.

A 25.0 cm³ solution contains a mixture of malonic acid and its conjugate base $HO_2CCH_2CO_2^-$. It is titrated against a 0.100 mol dm⁻³ NaOH(aq) to obtain the graph below.



15 Some metal hydroxides and carbonates are separately dissolved in distilled water to produce saturated solutions.

Given K_b of CO_3^{2-} is 2.1×10^{-4} mol dm⁻³, which compound will give a solution with the highest pH?

		magnitude of K_{sp}
Α	MgCO ₃	$3.5 imes 10^{-8}$
В	MnCO₃	1.8 × 10 ^{−11}
С	Ni(OH) ₂	2.0 × 10 ⁻¹⁵
D	Sc(OH) ₃	8.0 × 10 ⁻³¹



Lenacapavir

Given that

- all N atoms in Lenacapavir are sp² hybridised,
- halogen atoms bonded to sp² carbon atoms are sp² hybridised.

What is the total number of π electrons in Lenacapavir?

Α	26	В	44	С	46	D	52
	-	_		-	-	_	-

17 Alkanes undergo free radical substitution (FRS) reaction with chlorine gas in sunlight. In FRS reactions, alkanes are converted to chloroalkanes in two steps.

When 2-methylbutane is reacted with chlorine gas in sunlight, a total of four monochlorinated products are obtained. One of the products is 2-chloro-3-methylbutane.



The energy profile for step 1 of FRS is shown, showing the energy changes when the intermediate of each of the four products is formed.

Which profile shows the energy change for the formation of 2-chloro-3-methylbutane?



Progress of reaction

18 Compound N undergoes the reaction as shown below to form the major product P.



Compound ${\bf N}$

When $Br_2(aq)$ is added to **P**, an orange solution is observed.

Which statements about **P** are correct?

- 1 **P** reacts with HBr(g) to form a compound with the formula $C_9H_{15}Br_3$.
- 2 **P** is resonance stabilised.
- 3 1 mol of **P** reacts with hot acidified KMnO₄ to form two mol of $CO_2(g)$.

\mathbf{A} 1, 2 and \mathbf{D} 1 and 20 million \mathbf{C} 2 and 30 million \mathbf{D}	1, 2 and 3	, 2 and 3 B	T and Z only	L L	2 and 3 only	U	1 only
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11

The following mechanism has been proposed for the formation of the major product.



Which statements about the reaction are true?

- 1 The formation of the major product involves the movement of an H^- ion.
- 2 Step II occurs because the product is more stable than the reactant.
- 3 Step II is faster than step III.

Α	1. 2 and 3	В	1 and 2	С	2 and 3	D	1 only
~	1, z anu 5		T and Z	U	2 and 5		i Oniy

20 Menthol is a compound found in mint leaves.



What is the IUPAC name of menthol?

- A 2-(propan-2-yl)-5-methylcyclohexan-1-ol
- B 5-methyl-2-(propan-2-yl)cyclohexan-1-ol
- **C** 1-(propan-2-yl)-4-methylcyclohexan-2-ol
- **D** 1-methyl-4-(propan-2-yl)cyclohexan-3-ol

21 Aldol addition products are formed when a small amount of NaOH(aq) is added to an aldehyde at room temperature.



Which product is **not** formed when a small amount of NaOH(aq) is added to an equimolar mixture of ethanal and propanal?



22 Four simple tests are carried out on two organic compounds shown.



How many observations can be used to distinguish between them?

- 1 White precipitate formed.
- 2 Yellow precipitate formed.
- 3 Orange precipitate formed.
- 4 Brick-red precipitate formed.

A 0 B 1 C 3 D	Α	0	В	1	С	3	D	4
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- 23 Which reaction involves an intermediate that has a planar carbon with three different groups?
 - **A** $CH_3CH=CHCH_2CH_3 + HBr$
 - **B** $(CH_3)_2CBrCH_2CH_3 + NH_3$
 - C CH₃COCH₂CH₂CH₃ + NaBH₄
 - **D** $CH_3CH(OH)CH_2CH_3 + CH_3COCI$

CH ₃ SH	СН3 ОН	CH ₃ SH	СН3 ОН
thioacetic acid	ethanoic acid	ethanethiol	ethanol
3.33	4.76	10.6	16.0

24 The pK_a of some organic compounds are shown.

Which statement explains the trend in pK_a ?

- 1 (CH_3CH_2-) is an electron donating group.
- 2 There are delocalised π electrons between the C–S bond in the conjugate base of thioacetic acid.
- 3 The S-H bond is weaker than the O-H bond.

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

25 N-phenylbenzamide can react with concentrated nitric acid and concentrated sulfuric acid at 30 °C



What could be the structure of the main organic product?





26 Histidine, an α -amino acid, exist as a triprotic acid in a strongly acidic solution. The three p K_a values of the different functional groups present on histidine are α -carboxyl group = 1.82, side chain = 6.04 and α -amino group = 9.18.



triprotic histidine

Which statement is true?

- A At pH 1.00, a solution of histidine will not rotate plane-polarised light.
- **B** At pH 5.20, there will be a sharp increase in pH when NaOH(aq) is added.
- **C** At pH 7.61, histidine will move neither to the anode nor the cathode in electrophoresis.
- **D** At pH 13.0, the compound containing histidine will have a low melting point.

27 The polypeptide shown below is heated with 6 mol dm⁻³ HCl(aq) to ensure complete hydrolysis.



What is the total number of amino acids and the number of unique amino acids obtained from the hydrolysis?

	total number of amino acids	number of unique amino acids
Α	11	6
В	11	5
С	12	7
D	12	6

28 Use of the Data Booklet is relevant to this question.

The cell notation for a galvanic cell at 25 °C is given.

Pt(s)
$$|V^{2+}(aq), V^{3+}(aq)|$$
 Cu²⁺(aq) Cu(s)

The E_{cell}^{Θ} for the reaction is +0.60 V.

Which of the step below will increase the E_{cell} for the reaction?

- A Increase [V³⁺(aq)]
- **B** Decrease [V²⁺(aq)]
- **C** Increase [Cu²⁺(aq)]
- **D** Decrease the size of the Cu electrode
- **29** Use of the Data Booklet is relevant to this question.

An electrolytic cell is set up as follows

- Platinum cathode
- Platinum anode
- Electrolyte of 2 mol dm⁻³ Na₂SO₄(aq)

A current of 0.8 A is passed through the cell for 81 minutes.

Which statements regarding the electrolytic cell are correct?

- 1 At room temperature pressure, 242 cm³ of gas is produced at the anode.
- 2 When a small sample of solution is collected at the cathode and universal indicator added, the colour turns blue.
- 3 A voltage larger than +2.06 V is required to run the electrolytic cell.

Α	1, 2 and 3	В	1 and 2 only	С	2 and 3 only	D	1 only
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30 Two chromium(III) complexes, **J** and **K**, both with the formula, CrH₁₅N₅SClO₄, are dissolved separately in deionised water. Neither has water ligands present in their complex.

The table shows some similarities and differences between J(aq) and K(aq).

	J(aq)	K (aq)
number of different types of ligand in complex ion	2	2
observation on addition of nitric acid followed by aqueous silver nitrate	white precipitate is seen	no observable change
observation on addition of nitric acid followed by aqueous barium nitrate	no observable change	white precipitate is seen

Which statements are correct?

- 1 The complex ion in J(aq) is $[Cr(NH_3)_5(SO_4)]^+$.
- 2 The complex ion in $\mathbf{K}(aq)$ is $[Cr(NH_3)_5Cl]^+$.

A both 1 and 2 B 1 c	nly C	2 only	D neither 1 nor 2
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