

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CHEMISTRY

9729/01

Paper 1 Multiple Choice

September 2025

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 X is a transition element that forms ions of various oxidation states. One ion, X^{2+} , reduces $Cr_2O_7^{2-}$ in acid solution.

If 1 mol of $Cr_2O_7^{2-}$ is reduced by 2 mol of X^{2+} , which of the following species is formed in the reaction?

- A XO_4^{2-} B XO_2^+ C XO^{2+} D X^{3+}

- 2 M and T are cations. M contains n protons and has a charge of 3+. T contains (n–2) protons and has the same number of electrons as M.

What is the formula of the oxide formed by T?

- A TO
B T_2O
C T_2O_3
D TO_2

- 3 The boiling point of methane is $-161.5\text{ }^{\circ}\text{C}$ while that of neon is $-264\text{ }^{\circ}\text{C}$.

Why is the boiling point of methane greater than that of neon?

- A Molecules of methane have a larger surface area to form stronger intermolecular forces than those of neon
B A molecule of methane has more electrons than an atom of neon.
C A molecule of methane has a greater relative molecular mass than an atom of neon.
D Molecules of methane form hydrogen bonds, but those of neon do not.

- 4 Boron trifluoride is a highly reactive gas at room temperature and hence it is difficult to handle. To store it in liquid form, 2 mol of BF_3 reacts with 1 mol of $CH_3CH_2OCH_2CH_3$ to form compound N. Which of the following statements is correct?

- A The boron atom in compound N has an incomplete octet.
B 2 mol of AlF_3 can also react with 1 mol of $CH_3CH_2OCH_2CH_3$ to form a similar compound.
C Two dative bonds are formed from the boron atom in two BF_3 molecules towards the O atom in $CH_3CH_2OCH_2CH_3$.
D The bond angle with respect to boron atom in BF_3 is bigger than the bond angle with respect to boron in compound N.

- 5 Which pairs of ions give an ionic compound with the lowest melting point?

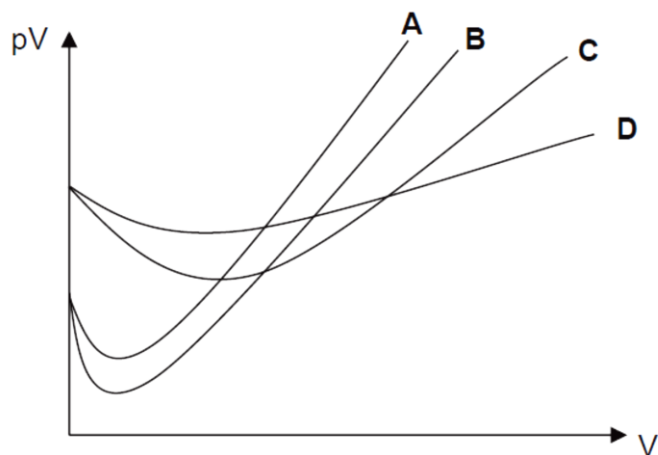
	cation	anion
A	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3 - \text{P}^+ - \text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	$\begin{array}{c} \text{O} \\ \\ ^-\text{O} - \text{S} - \text{O}^- \\ \\ \text{O} \end{array}$
B	$\begin{array}{c} \text{CH}_2\text{CH}_3 \\ \\ \text{CH}_3\text{CH}_2 - \text{P}^+ - \text{CH}_2\text{CH}_3 \\ \\ \text{CH}_2\text{CH}_3 \end{array}$	$\text{CH}_3 - \text{C}_6\text{H}_4 - \begin{array}{c} \text{O} \\ \\ \text{S} - \text{O}^- \\ \\ \text{O} \end{array}$
C	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3 - \text{P}^+ - \text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	$\text{CH}_3 - \text{C}_6\text{H}_4 - \begin{array}{c} \text{O} \\ \\ \text{S} - \text{O}^- \\ \\ \text{O} \end{array}$
D	$\begin{array}{c} \text{CH}_2\text{CH}_3 \\ \\ \text{CH}_3\text{CH}_2 - \text{P}^+ - \text{CH}_2\text{CH}_3 \\ \\ \text{CH}_2\text{CH}_3 \end{array}$	$\begin{array}{c} \text{O} \\ \\ ^-\text{O} - \text{S} - \text{O}^- \\ \\ \text{O} \end{array}$

- 6 When aqueous copper (II) sulfate is mixed with potassium iodide, a white precipitate in a brown solution is formed. The brown solution is decolorised when aqueous sodium thiosulfate is added to it.

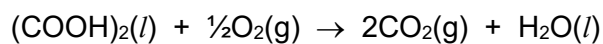
What is the formula and the electronic configuration of the copper cation in the white precipitate?

	formula of white precipitate	electronic configuration of the copper cation
A	CuI ₂	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 3d ⁹
B	CuI ₂	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 3d ⁷ 4s ²
C	CuI	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 3d ¹⁰
D	CuI	1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 3d ⁹ 4s ¹

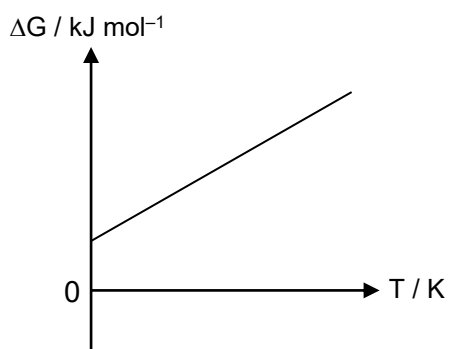
- 7 The volumes and pressures of equal masses of four gaseous compounds H_2O , CH_4 , $\text{C}_{16}\text{H}_{32}\text{O}_2$ and I_2 , are separately investigated, at constant temperature. The results are plotted on a graph of pV against V . Which of the following plot shows the result for CH_4 ?



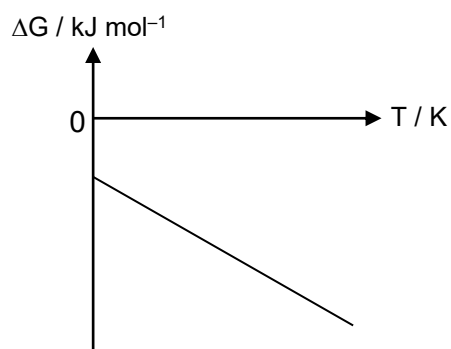
- 8 Which graph corresponds to the combustion of liquid ethanedioic acid, $(\text{COOH})_2$ at room temperature?



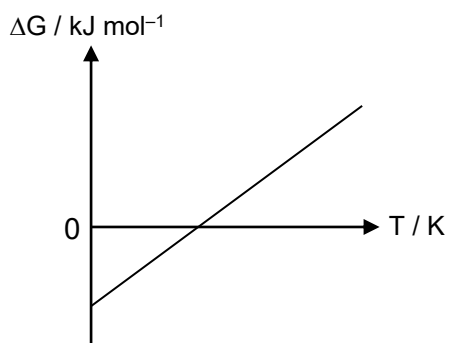
A



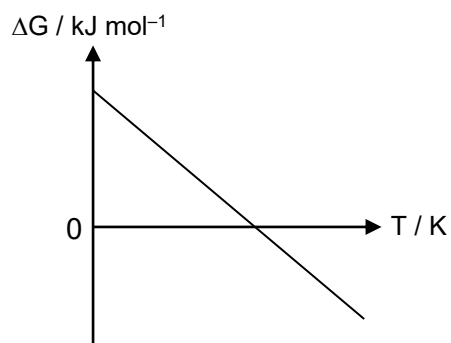
B



C



D

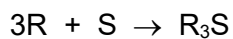


- 9 When equal volumes of 1.00 mol dm^{-3} hydrochloric acid and $v \text{ mol dm}^{-3}$ of sulfuric acid were separately neutralised by excess dilute sodium hydroxide, the heat liberated was $2a \text{ kJ}$ and $a \text{ kJ}$ respectively.

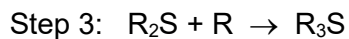
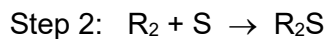
What is the concentration, v , of the sulfuric acid?

- A 0.25 mol dm^{-3}
- B 0.50 mol dm^{-3}
- C 1.00 mol dm^{-3}
- D 2.00 mol dm^{-3}

- 10 Consider the following reaction.



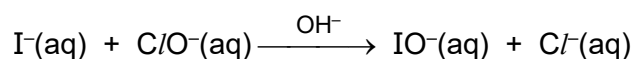
The mechanism involves the following steps:



The overall kinetics is found to be third order. Based on the information, which is the slow step in the mechanism?

- A Step 1
- B Step 2
- C Step 3
- D None of the above

- 11 The kinetics of the reaction below were studied using the initial rate method.



experiment	initial $[\text{I}^{-}]$ / mol dm^{-3}	initial $[\text{C/O}^{-}]$ / mol dm^{-3}	initial $[\text{OH}^{-}]$ / mol dm^{-3}	initial rate / $\text{mol dm}^{-3} \text{ s}^{-1}$
1	0.0013	0.012	0.100	9.4×10^{-3}
2	0.0026	0.012	0.100	18.7×10^{-3}
3	0.0013	0.018	0.100	14.0×10^{-3}
4	0.0026	0.018	0.050	c

The unit of k is found to be s^{-1} .

Which statements are correct?

- 1 The order of reaction with respect to $[\text{OH}^{-}]$ is -1 .
- 2 OH^{-} functions as a catalyst in this reaction.
- 3 The value of c is 56.0×10^{-3} .

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

- 12 Consider the equilibrium $3\text{P}_2(\text{g}) + 2\text{OP}(\text{g}) \rightleftharpoons 2\text{OP}_4(\text{g})$.

When 4 mol of OP_4 was put into a 2 dm^3 container and heated, the equilibrium mixture contained 0.8 mol of OP .

What is the numerical value of the equilibrium constant, K_c ?

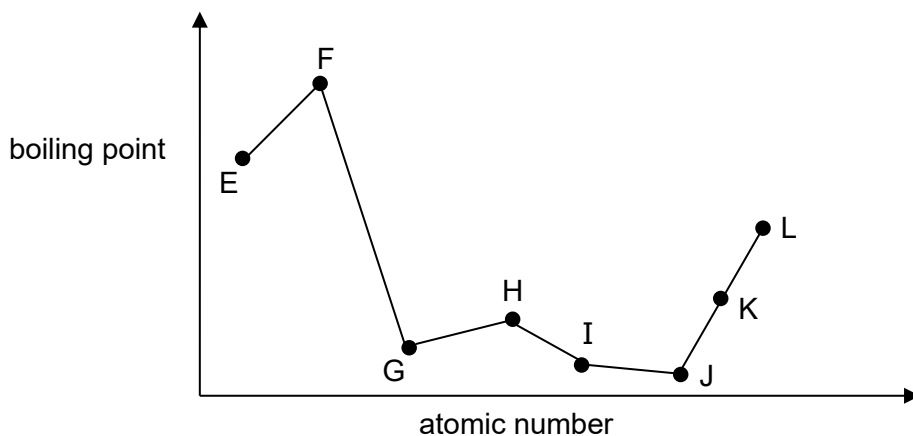
- A** 74.1
- B** 9.26
- C** 0.108
- D** 0.0135

- 13** Due to its radioactive nature, the properties of astatine, At, have to be predicted based on its position in the Periodic Table.

Which of the predictions concerning At or its compounds is correct?

- A** Hydrogen astatide has a higher decomposition temperature than hydrogen bromide.
- B** Astatine is a light coloured solid at room temperature.
- C** Silver astatide is soluble in $\text{NH}_3(\text{aq})$.
- D** Astatine is a weaker oxidising agent than iodine.

- 14** The graph below shows the variation in the boiling point for 8 consecutive elements in the Periodic Table, all with atomic number less than 21.



Which statements are correct?

- 1 The chloride of E reacts with aqueous sodium hydroxide to give a precipitate which is soluble in excess sodium hydroxide.
 - 2 The oxide of F is neutral in aqueous solution.
 - 3 The oxide of K dissolves readily in water to give a strongly alkaline solution.
- A** 1, 2 and 3
 - B** 1 and 2 only
 - C** 2 and 3 only
 - D** 1 only

- 15** The values of solubility products at 25 °C of three metal sulfides are shown in the table below. ΔH_{soln} of these metal sulfides is endothermic.

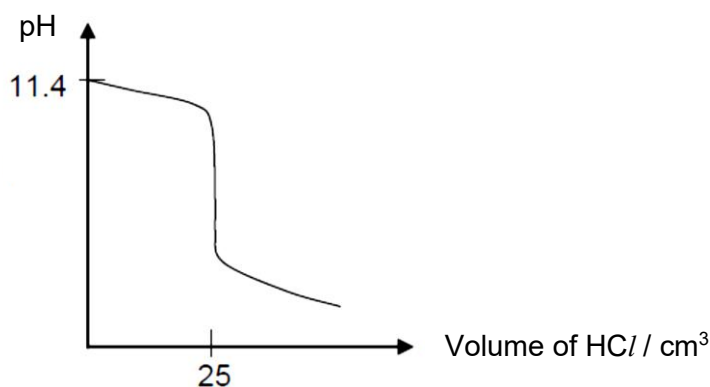
compound	value of K_{sp}
ZnS	1.1×10^{-21}
CuS	6.3×10^{-36}
Ag ₂ S	6.0×10^{-51}

Which statements are correct?

- 1 Addition of S^{2-} to the solution of Bi_2S_3 decreases the K_{sp} of Bi_2S_3 .
- 2 Ag₂S is more soluble than CuS.
- 3 Given a solution with $[\text{Cu}^{2+}] = [\text{Zn}^{2+}]$, CuS is precipitated out first on addition of S^{2-} .

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

- 16** 25.0 cm³ of a 0.1 mol dm⁻³ monoprotic base, U, was titrated with a 0.1 mol dm⁻³ HCl and the following titration graph was obtained.



Which statements about the above graph are correct?

- 1 When 25.0 cm³ of HCl is added, the pH of the resulting solution is < 7.
- 2 Methyl orange is a suitable indicator for the titration.
- 3 When 0.1 mol dm⁻³ NaOH is used in place of U, the titre value is 25.0 cm³.

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

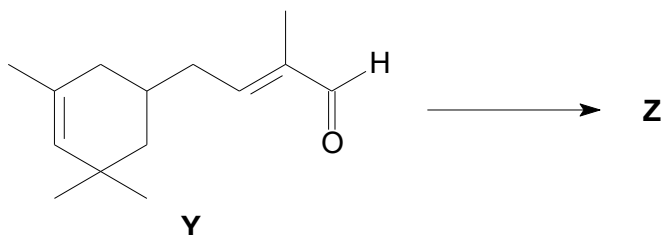
- 17** HF is a weak acid that dissociates partially in water.

When 50.0 cm³ of 0.100 mol dm⁻³ HF(aq) is added to 50.0 cm³ of 0.100 mol dm⁻³ KF(aq), the pH of the resulting solution formed is 3.20.

Calculate the pH of 0.100 mol dm⁻³ HF(aq) at 298 K.

- A** 1.00 **B** 2.10 **C** 3.20 **D** 10.8

- 18** Y can be reduced by LiAlH₄ in dry ether to form Z.



How many stereoisomers exist for Y and Z?

	Y	Z
A	4	4
B	4	8
C	8	8
D	16	16

- 19** G, H and J are three different organic compounds. H and G can react together to form an ester. J can also react with G to form an ester but much less readily than H. When G is added into water, white fumes are observed.

Which of the following could be J?

- A** butan-1-ol
B butan-2-ol
C phenol
D phenylamine

- 20** A few drops of ethanolic AgNO_3 were added separately to five test-tubes containing the following halogen derivatives.

halogen derivatives	structural formula
benzoyl bromide	$\text{C}_6\text{H}_5\text{COBr}$
2-chlorobutane	$\text{CH}_3\text{CH}(\text{Cl})\text{CH}_2\text{CH}_3$
2-iodobutane	$\text{CH}_3\text{CH}(\text{I})\text{CH}_2\text{CH}_3$
iodobenzene	$\text{C}_6\text{H}_5\text{I}$

Which statements are correct?

- 1 A white precipitate will be seen before the yellow precipitate because $\text{C}-\text{Cl}$ bond is more polar than $\text{C}-\text{I}$ bond
- 2 A cream precipitate of AgBr will take the shortest time to form.
- 3 No yellow precipitate will be observed for iodobenzene.

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

- 21** L reacts with excess hot concentrated acidified KMnO_4 to produce three different organic molecules, $\text{CH}_3\text{CO}_2\text{H}$, $(\text{CH}_3)_2\text{CO}$ and $\text{HO}_2\text{CCOCH}_3$. Which statements are correct?

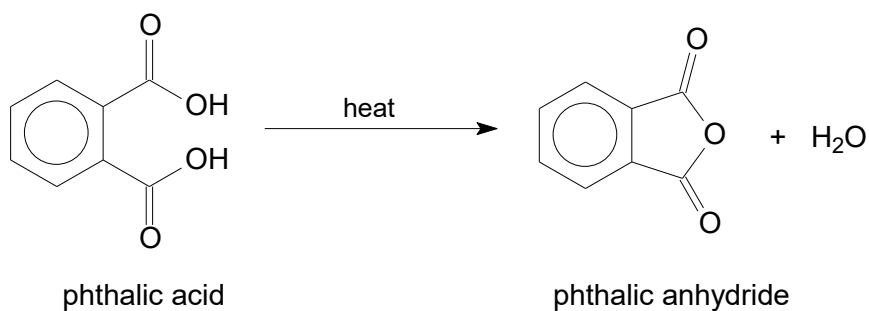
- 1 L can be 2,4-dimethylhexa-2,4-diene or 2,3-dimethylhexa-2,4-diene.
- 2 The three products formed can be distinguished from one another by using $\text{Na}_2\text{CO}_3(\text{s})$ followed by 2,4-DNPH.
- 3 L can also react with excess hot acidified $\text{K}_2\text{Cr}_2\text{O}_7$ to produce the same three organic molecules.

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

22 Which compound will give the lowest pH in aqueous solution?

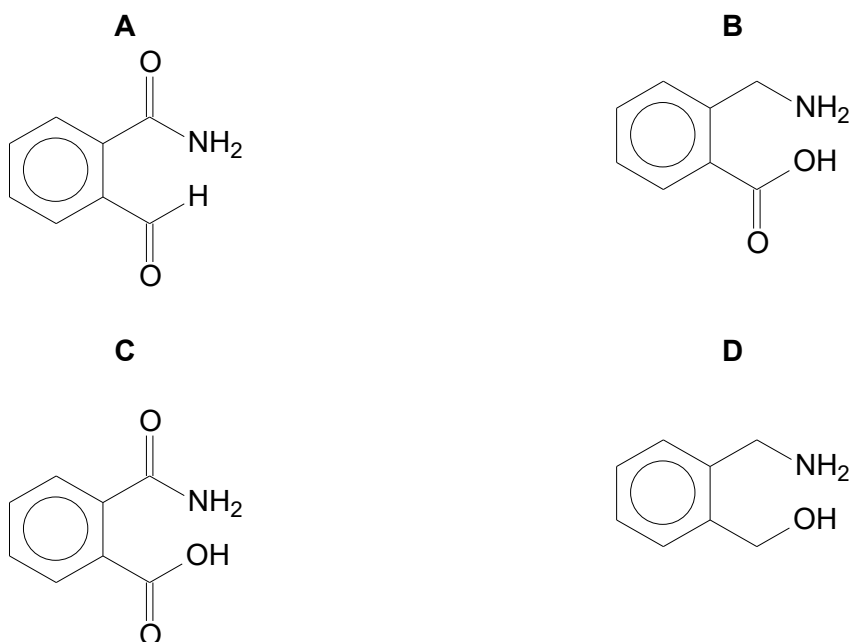
- A** $(\text{CH}_3)_2\text{NH}_2^+\text{Cl}^-$
B $\text{CH}_3\text{CONH}(\text{CH}_3)$
C NH_4^+Cl^-
D $\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2\text{H}_2^+\text{Cl}^-$

23 When heated strongly, phthalic acid undergoes condensation reaction to form phthalic anhydride.



On reaction with water, phthalic anhydride gives phthalic acid.

What would be formed when phthalic anhydride reacts with ammonia?

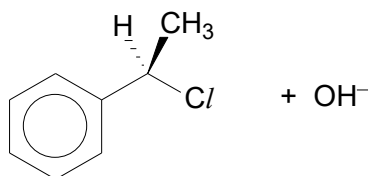


24 Which organic compound will give a positive test with warm aqueous alkaline iodine?

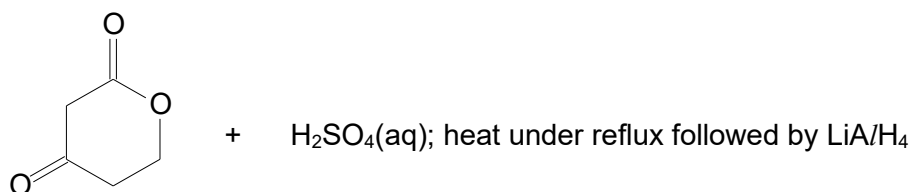
- A CH_3OH
 B CH_3CONH_2
 C $\text{C}_6\text{H}_5\text{COCH}_2\text{I}$
 D $\text{CH}_3\text{CH}_2\text{CHO}$

25 Which reaction will **not** produce a mixture of two enantiomers?

- A $\text{CH}_3\text{CH}=\text{CHCH}_3 + \text{HBr}$
 B $\text{CH}_3\text{COCH}_2\text{CH}_3 + \text{HCN}$ with trace amount of KOH at 10–20 °C
 C



D



26 Upon complete hydrolysis of a tetrapeptide, only the following amino acids were obtained.

$\text{NH}_2\text{CH}(\text{CH}_2\text{C}_6\text{H}_5)\text{CO}_2\text{H}$
 phenylalanine ($M_r = 165.0$)

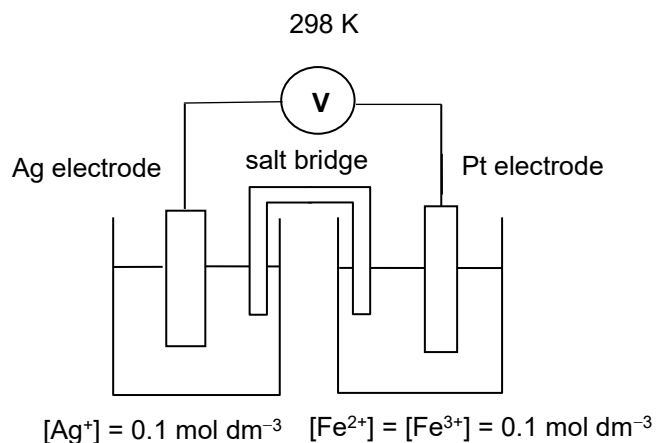
$\text{NH}_2\text{CH}(\text{CH}_2\text{CONH}_2)\text{CO}_2\text{H}$
 asparagine ($M_r = 132.0$)

$\text{NH}_2\text{CH}_2\text{CO}_2\text{H}$
 glycine ($M_r = 75.0$)

What is the mole ratio of phenylalanine : asparagine : glycine and the M_r of the tetrapeptide?

	ratio	M_r
A	1 : 1 : 1	372.0
B	1 : 1 : 2	447.0
C	1 : 2 : 1	450.0
D	2 : 1 : 1	537.0

27 Which statements about the electrochemical cell below are correct?



- 1 The e.m.f of the cell is +0.03 V.
- 2 Addition of water to the Fe³⁺ / Fe²⁺ half-cell increases the e.m.f of the cell.
- 3 Increasing the mass of the Ag electrode does not affect the e.m.f of the cell.
- 4 Addition of excess NaOH(aq) to the Fe³⁺ / Fe²⁺ half-cell increases the e.m.f of the cell.

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

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

A zinc-air battery uses oxygen gas in the air as an oxidising agent and zinc metal as a reducing agent. The electrolyte circulating through the battery is NaOH(aq).

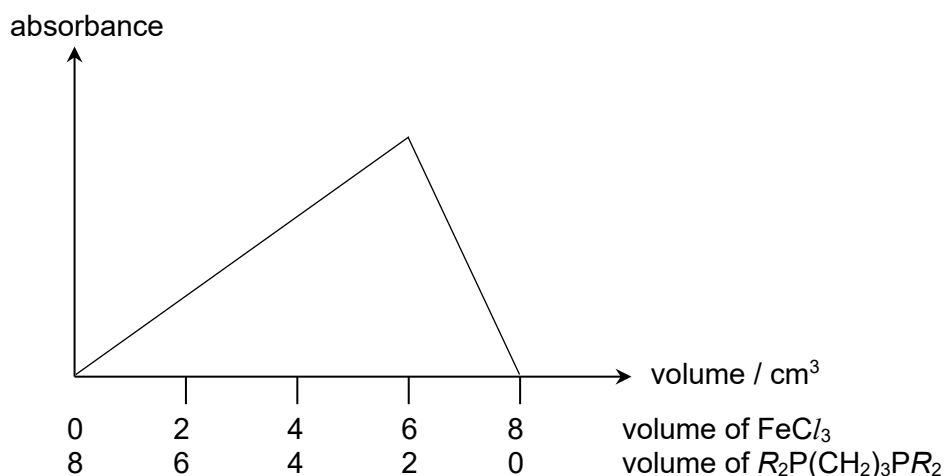
An experiment was conducted at room temperature to study the volume of oxygen consumed by the zinc-air battery. It was found that 0.12 cm³ of oxygen gas was consumed by the battery per minute. What is the E⁰ value for the cathode and the current, I?

	E ⁰ value for the cathode / V	current, I / A
A	+1.23	0.0322
B	+0.40	1.93
C	+1.23	1.93
D	+0.40	0.0322

29 In this question, R' represents a phenyl group.

2-bis(diphenylphosphino)propane, R₂P(CH₂)₃PR₂, is a commonly used ligand which forms a complex with many metal ions.

In the graph below, the intensity of visible light absorbance for different mixtures containing 1.00 × 10⁻³ mol dm⁻³ FeCl₃(aq) and 9.00 × 10⁻³ mol dm⁻³ R₂P(CH₂)₃PR₂ are shown.

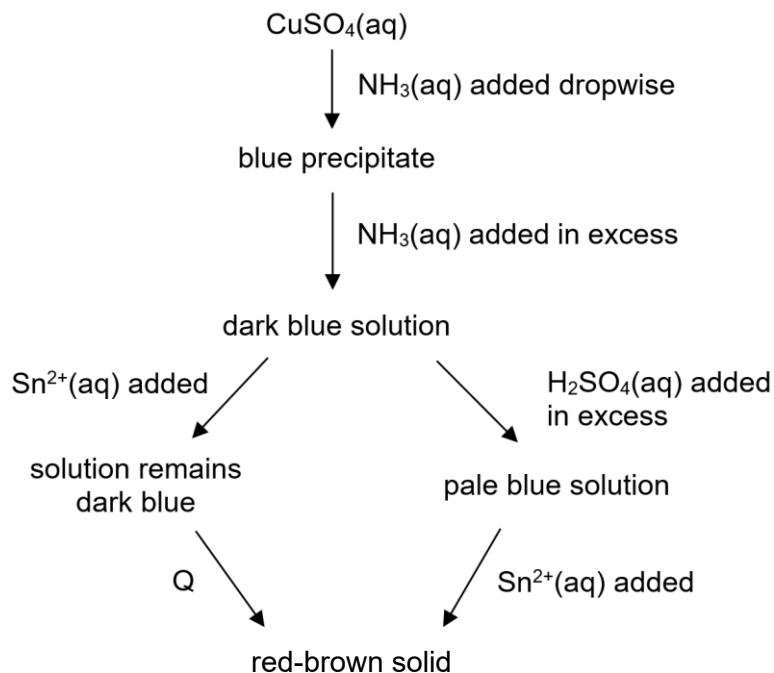


Which statement is incorrect?

- A When excess aqueous silver nitrate is added to the mixture with the highest absorbance, 1.8 × 10⁻⁵ mol of AgCl is formed.
- B H₂O molecule is a weaker ligand than R₂P(CH₂)₃PR₂.
- C The coordination number of the complex formed is 6.
- D The overall charge of the complex formed is 0.

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

A series of tests were performed on a sample of $\text{CuSO}_4(\text{aq})$ as shown below.



Which statement is incorrect?

- A Q could be silver metal.
- B The red-brown solid formed is copper metal.
- C Addition of limited $\text{NH}_3(\text{aq})$ to $\text{CuSO}_4(\text{aq})$ is an acid base reaction.
- D Addition of excess $\text{H}_2\text{SO}_4(\text{aq})$ causes the reformation of $\text{Cu}^{2+}(\text{aq})$.