Anglo-Chinese Junior College

JC2 Preliminary Examination
Higher 2

A Methodist Institution
(Founded 1886)

CHEMISTRY **9729/01**
Paper 1 Multiple Choice
9 September 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, Centre number and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on 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 incomplete combustion of a gaseous hydrocarbon produced 80 cm^3 of carbon dioxide, 40 cm^3 of carbon monoxide and 160 cm^3 of water vapour.

What volume of oxygen was used for combustion of the hydrocarbon?

A 40 cm^3

B 80 cm^3

C 160 cm^3

D 180 cm^3

2 0.01 mol of an unknown ion $\mathbf{G}^{2+}$ required 17.25 cm^3 of 0.23 mol dm^{-3} acidified $KMnO_4$ to reach the end-point.

What is the final oxidation state of element **G**?

A +3 **B** +4 **C** +5 **D** +6

3 Which ion will be deflected the most in an applied electric field?

A $^{79}Br^+$ **B** $^{81}Br^{2+}$ **C** $^{81}Br^+$ **D** $^{82}Br^{2+}$

4 An unstable ion has

- a nucleon number of 219,
- 51 more neutrons than electrons,
- an atomic number of 84, 85, 86, or 87,

What could this ion be?

A Po^{2+} **B** At^{3+} **C** Rn^{4+} **D** Fr^{5+}

5 Which species contains two π bonds?

1 BF_3NH_3

2 $CH_2CHCH_2CH_3$

3 CH_2CHCHO

4 $HCO_2CH_2COCH_3$

A 1 and 4 only

B 2 and 3 only

C 2 and 4 only

D 3 and 4 only

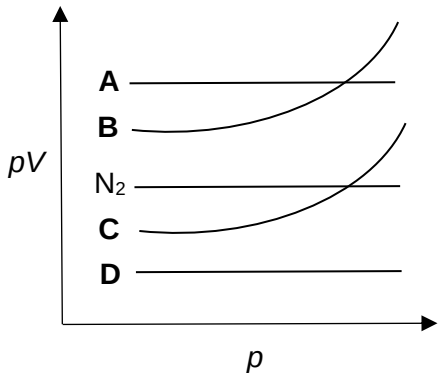
6 What is the strongest intermolecular force in ethanal, ethylamine and decan-1-ol?

	ethanal	ethylamine	decan-1-ol
A	hydrogen bonds	hydrogen bonds	induced dipoles
B	permanent dipoles	hydrogen bonds	induced dipoles
C	permanent dipoles	permanent dipoles	hydrogen bonds
D	hydrogen bonds	permanent dipoles	hydrogen bonds

7 The volumes and pressures of equal masses of two gases, N_2 and NH_3, are separately investigated at constant temperature.

The results are plotted on a graph of pV against p. Both gases behave as ideal gases under the conditions chosen. The result for N_2 is given.

Which plot shows the result for NH_3?



8 What can be added to a mixture of MgO and Al_2O_3 to separate them by filtration?

1 water

2 HC*l*(aq)

3 NaOH(aq)

A 1, 2 and 3

B 1 and 2 only

C 2 and 3 only

D 3 only

9 The following table shows the results of two experiments involving Group 17 halides, X^- and Y^-.

experiment	deduction
halogen Z_2 added to X^-	X_2 formed
halogen Z_2 added to Y^-	Y_2 not formed

Which row shows the halogens in decreasing order of oxidising strengths?

A Y_2, Z_2, X_2

B Y_2, X_2, Z_2

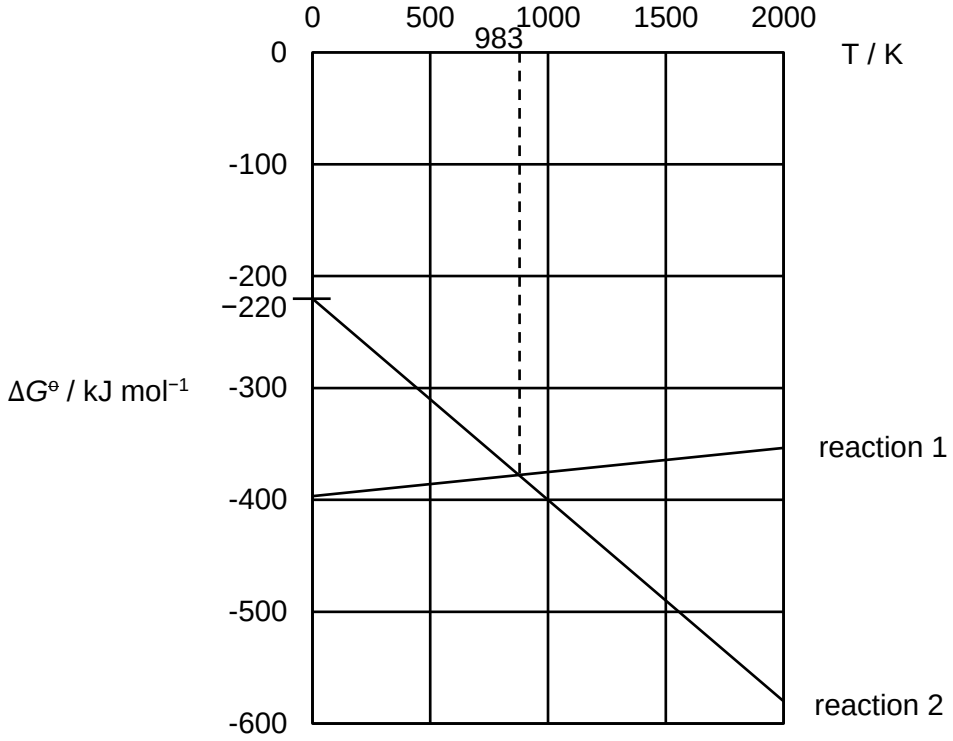
C X_2, Z_2, Y_2

D X_2, Y_2, Z_2

10 An Ellingham diagram is a plot of ΔG versus temperature and it can be used to show the stability of compounds at various temperatures.

The following Ellingham diagram is for reactions 1 and 2.

reaction 1 $W + X \rightarrow Y$
reaction 2 $2W + X \rightarrow 2Z$



Which statement is **incorrect**?

A Reaction 1 is favoured at lower temperatures.

B The entropy change of reaction 2 is negative.

C The enthalpy change of reaction 2 is −220 kJ mol^{-1}.

D At 983 K, ΔG of the reaction $2Z \rightarrow W + Y$ is zero.

11 When an instant cold pack is used, a vigorous reaction occurs, and the temperature falls from 25 °C to 5 °C.

What are the correct signs of Δ*G* and Δ*S* for this reaction?

	Δ*G*	Δ*S*
A	+	+
B	+	−
C	−	+
D	−	−

12 The Dushman reaction is represented by the following equation.

$$IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \rightarrow 3I_2(aq) + 3H_2O(l)$$

The rate equation for this reaction is as follows.

$$\text{rate} = k[IO_3^-][I^-]^2[H^+]^2$$

When the concentration of each reactant is *a* mol dm^{-3}, the initial rate was found to be *y* mol dm^{-3} s^{-1}.

What will be the initial rate of the reaction if $[IO_3^-]$ is 2*a*, $[I^-]$ is $\frac{1}{2}a$, and $[H^+]$ is 4*a*?

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

13 3.0 mol of Q, 1.5 mol of R and 0.2 mol of S are mixed in a 2.0 dm^3 flask and allowed to reach equilibrium.

$$4Q(g) + R(g) \rightleftharpoons S(g)$$

The equilibrium mixture contained 0.8 mol of S.

What is the equilibrium concentration of Q in the flask?

A 2.4 mol dm^{-3}

B 1.2 mol dm^{-3}

C 0.6 mol dm^{-3}

D 0.3 mol dm^{-3}

14 Water dissociates according to the equation:

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$$

The pH of water at different temperatures are shown below.

temperature / K	pH
298	7.0
333	6.5

Which statements are true?

1 The dissociation of water is endothermic.

2 The pK_a of water increases when the temperature increases.

3 Water becomes more acidic when the temperature increases.

A 1 only

B 1 and 2 only

C 2 and 3 only

D 1, 2 and 3

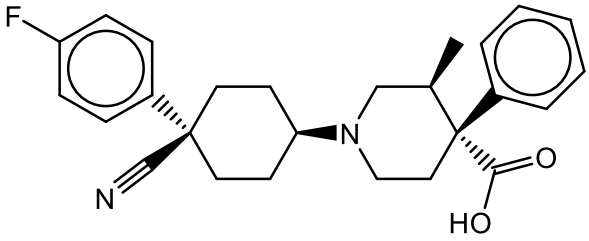
15 The table below describes some indicators.

indicator	colour in acid	colour in alkali	pK_a	range of pH for colour change
methyl orange	red	yellow	3.7	3.2 − 4.4
thymol blue	yellow	blue	8.9	8.0 − 9.6

For the titration of NaOH(aq) against HCOOH(aq), which row shows the most suitable indicator and the corresponding colour change?

	indicator	colour change
A	methyl orange	red to orange
B	methyl orange	yellow to orange
C	thymol blue	yellow to green
D	thymol blue	blue to green

16 Levocabastine is an antihistamine used in the treatment of sore eyes.



Levocabastine

Which functional group is **not** present in Levocabastine?

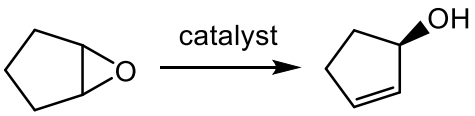
A alcohol

B amine

C aryl halide

D nitrile

17 1,2-epoxycyclopentane can be converted to cyclopent-2-en-1-ol in a single reaction.



1,2-epoxycyclopentane cyclopent-2-en-1-ol

Which statement about the reaction is correct?

A 1,2-epoxycyclopentane rotates plane-polarised light.

B A reducing agent is used for this reaction.

C Cyclopent-2-en-1-ol is more volatile than the 1,2-epoxycyclopentane.

D An isomerisation reaction has occurred.

18 Both benzene and propene react with bromine.

Which statement best explains the difference in the reactivity between these compounds?

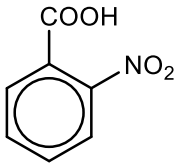
A Benzene is a planar molecule which allows ease of attack by bromine whereas propene is a non-planar molecule.

B The carbocation intermediate produced in the reaction of benzene with bromine is stabilised by resonance.

C The sideway overlap of p orbitals in benzene means the C−C bonds alternate between long, single bonds and short, double bonds.

D The delocalisation of electrons in benzene causes it to be more stable.

19 Benzene reacts in a three-stage process to produce 2-nitrobenzoic acid.



2-nitrobenzoic acid

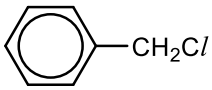
Which reagents could be used for the three-stage process?

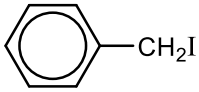
	first stage	second stage	third stage
A	CH_3Cl, $AlCl_3$	HNO_3(aq)	$KMnO_4$, dilute H_2SO_4, heat under reflux
B	conc HNO_3, conc H_2SO_4	CH_3Cl, $AlCl_3$	$KMnO_4$, dilute H_2SO_4, heat under reflux
C	CH_3Cl, $AlCl_3$	conc HNO_3, conc H_2SO_4	$KMnO_4$, dilute H_2SO_4, heat under reflux
D	CH_3Cl, $AlCl_3$	$KMnO_4$, dilute H_2SO_4, heat under reflux	conc HNO_3, conc H_2SO_4

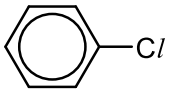
20 Compound **X** is boiled with aqueous sodium hydroxide, cooled and then acidified with dilute nitric acid. Aqueous silver nitrate was subsequently added to the mixture.

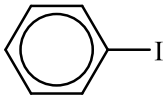
It was observed that a precipitate, which formed when aqueous silver nitrate was added, dissolved upon the addition of aqueous ammonia to the mixture.

What could be the structure of **X**?

A 

C 

B 

D 

21 The mechanism for the reaction between ethanal and hydrogen cyanide is given below.

step 1: $CH_3CHO + CN^- \rightarrow CH_3CHOCN^-$

step 2: $CH_3CHOCN^- + HCN \rightarrow CH_3CH(OH)(CN) + CN^-$

Which statement regarding the mechanism and the reaction is correct?

A The negative charge is on the nitrogen atom in the intermediate.

B There is one sp^2 hybridised carbon atom in the intermediate.

C The ethanal behaves as the nucleophile in step 1.

D The mixture does not rotate plane-polarised light after the reaction.

22 An unknown organic compound has the molecular formula $C_5H_{12}O$. It was subjected to the following chemical tests.

test	observations
alkaline aqueous iodine, warm	yellow precipitate is seen
hot acidified $KMnO_4$	purple solution decolourises

Two students saw the tests and each made a comment.

student E The compound is a secondary alcohol.

student F The compound is definitely pentan-2-ol.

Which students are correct?

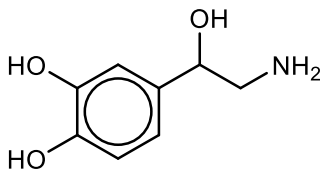
	student E	student F
A	✓	✓
B	✗	✓
C	✓	✗
D	✗	✗

key

✓ = correct

✗ = not correct

23 Noradrenaline functions in the brain as a neurotransmitter.



noradrenaline

How many moles of sodium hydroxide will react with one mole of noradrenaline?

A 1

B 2

C 3

D 4

24 Which statement regarding ethanoic acid is true?

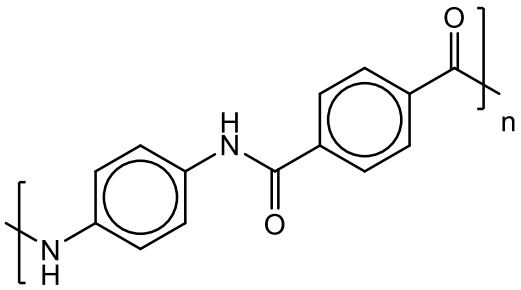
A It reacts with hydrogen chloride to form ethanoyl chloride.

B It can be reduced to ethanol with hydrogen gas in the presence of Pt.

C It does not form a yellow precipitate when warmed with alkaline aqueous iodine.

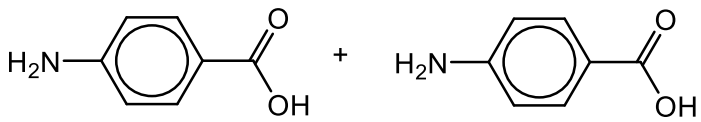
D It reacts with phenol in the presence of concentrated sulfuric acid to form phenyl ethanoate.

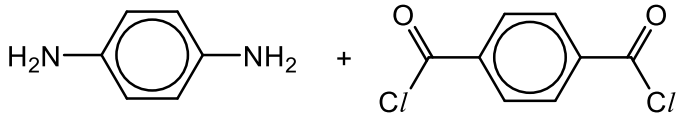
25 Kevlar is a lightweight and strong material, used to make tyres and bulletproof vests. Its structure is given below.

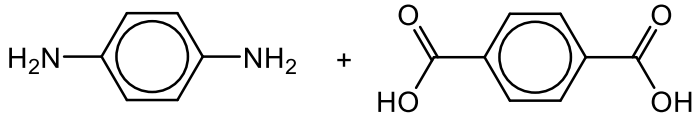


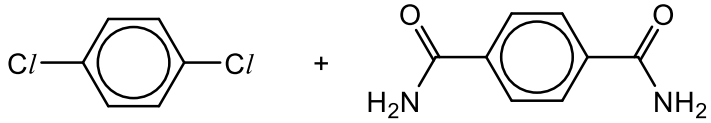
Kevlar

Which pair of monomers produces Kevlar in the greatest yield?

A 

B 

C 

D 

26 A peptide chain isolated from a protein in the medicinal mushroom *Lingzhi* is shown below.

ser-gly-arg-asn-leu-gly-val-lys-pro-ser

The enzyme trypsin will only hydrolyse a polypeptide chain at a peptide bond where the carboxyl group has been donated by either lysine (lys) or arginine (arg).

Which fragments could be made when trypsin acts on the peptide chain from *Lingzhi*?

1 ser-gly-arg

2 lys-pro-ser

3 asn-leu-gly-val-lys

4 arg-asn-leu-gly-val

A 1, 2, 3 and 4

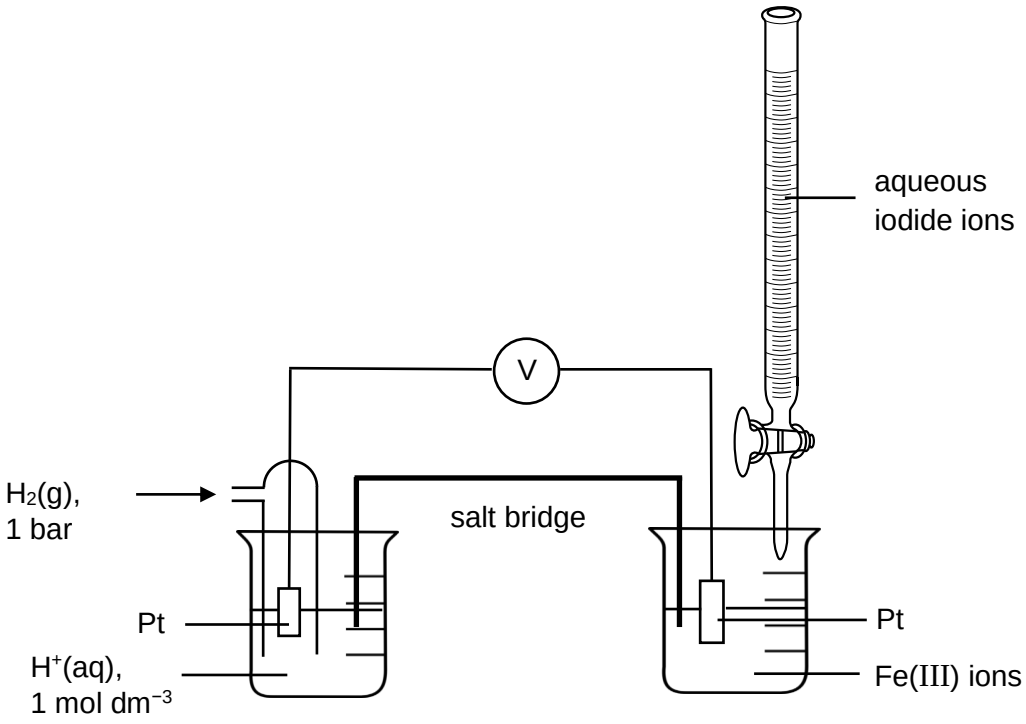
B 1 and 3 only

C 2 and 4 only

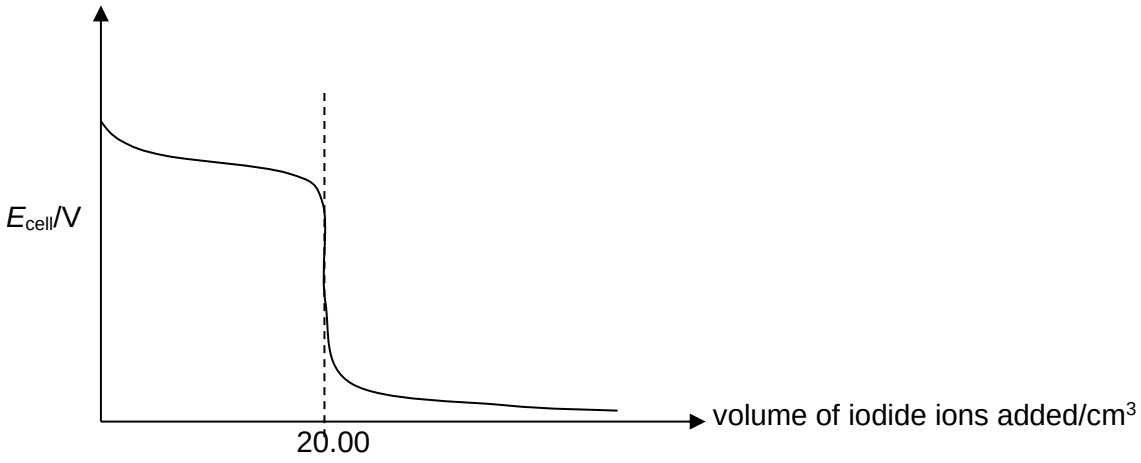
D 2 and 3 only

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

Aqueous iodide ions were added to an aqueous solution containing 50 cm^3 of iron(III) ions as shown below.



The titration curve obtained is shown below.



What is the volume of iodide ions added for the E_{cell} value to be +0.77 V?

A 0.00 cm^3 **B** 10.00 cm^3

C 20.00 cm^3 **D** 40.00 cm^3

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

By considering $E^{\ominus}$ values, which aqueous species will oxidise Sn^{2+} to Sn^{4+}?

1 H_2O_2, H^+

2 I_2

3 V^{3+}

A 1, 2 and 3 only

B 1 and 2 only

C 2 and 3 only

D 1 only

29 A complex of chromium with the general formula $CrCl_3 \cdot 6H_2O$ forms an aqueous solution.

When 0.01 mol of an aqueous solution of this compound was treated with an excess of aqueous silver nitrate, 2.87 g of precipitate was obtained.

What is the formula of the chromium complex?

A $[Cr(H_2O)_6]^{3+}$

B $[Cr(H_2O)_5Cl]^{2+}$

C $[Cr(H_2O)_4Cl_2]^{+}$

D $[Cr(H_2O)_3Cl_3]$

30 A student carried out two experiments on separate samples of aqueous $CuSO_4$.

Experiment 1

When aqueous potassium iodide was added to a sample of aqueous $CuSO_4$, a white precipitate in a brown solution was formed.

Experiment 2

When aqueous ammonia is added to another sample of aqueous $CuSO_4$, a pale blue precipitate is formed. The precipitate dissolves when an excess of aqueous ammonia is added, forming a deep blue solution.

Which statement about experiments 1 and 2 is **incorrect**?

A Ligand exchange occurred in experiment 2.

B The pale blue precipitate is $[Cu(OH)_2(H_2O)_4]$.

C Reduction of copper(II) ions occurred in experiment 1.

D The complex ion in the deep blue solution has a tetrahedral shape.

-End of paper-