EUNOIA JUNIOR COLLEGE
JC2 Preliminary Examination 2025
General Certificate of Education Advanced Level
Higher 2

CHEMISTRY

Paper 1 Multiple Choice

9729/01

19 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, civics group and registration number on the Answer Sheet in the spaces provided unless this has been done for you.

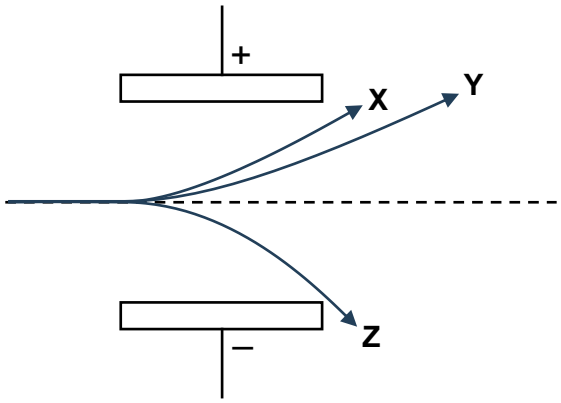
There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

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

This document consists of **13** printed pages and **3** blank pages.

1 Three particles approach an electric field at the same speed. They are deflected as they pass through the electric field.



What could be the identities of particles **X**, **Y** and **Z**?

	X	Y	Z
A	$^{35}_{17}Cl^-$	$^{37}_{17}Cl^-$	$^{23}_{11}Na^+$
B	$^{6}_{3}Li^+$	$^{7}_{3}Li^+$	$^{1}_{1}H^-$
C	$^{37}_{17}Cl^-$	$^{35}_{17}Cl^-$	$^{23}_{11}Na^+$
D	$^{7}_{3}Li^+$	$^{6}_{3}Li^+$	$^{1}_{1}H^-$

2 Which of the following about calcium and copper is correct?

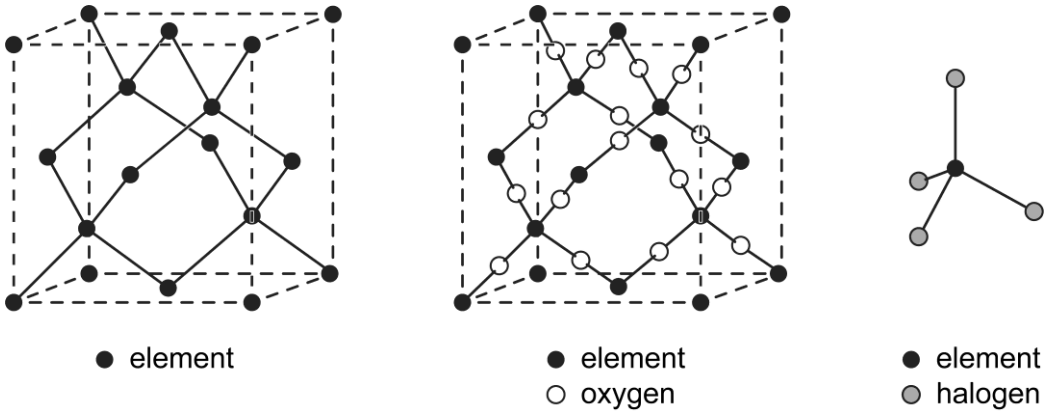
A The outermost orbital of the atoms of both elements has the same shape.

B Atom of both elements have orbitals of only 2 different shapes of various sizes.

C Atom of both elements have the same number of electrons in the outermost shell.

D Both elements form ions of 2+ charge with the electronic configuration of [Ar].

3 The following diagrams show the structures of an element, one of its oxides and its halides. What could the element be?



A aluminium **B** carbon **C** phosphorus **D** silicon

4 The boiling point of water (100 ºC) is greater than that of HF (20 ºC).
Which statement is a correct explanation of the above?

A Each hydrogen bond formed between water molecules is stronger than that formed between HF molecules.

B There are more atoms in a water molecule than there are in an HF molecule, resulting in stronger intermolecular forces in water.

C There are, on average, more hydrogen bonds between water molecules than there are between HF molecules.

D The water molecule has stronger permanent dipole–dipole interactions than the HF molecule.

5 For a fixed mass of an ideal gas, which of the following graphs does **not** have the same general shape as the rest?

(ρ = density of the gas; M = molar mass of gas)

A $\frac{p}{\rho}$ against T **B** pV against $\frac{M}{T}$

C p against ρT **D** $\frac{T}{p}$ against V

6 Which option correctly describes the species in terms of its behaviour as a Lewis base and as an Arrhenius acid?

	species	Lewis base	Arrhenius acid
A	HCl	no	yes
B	AlH_3	yes	no
C	NH_3	no	no
D	O^{2-}	yes	yes

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

Based on its position in the Periodic Table, which properties will indium, In, be expected to possess?

1 In the vapour state, the chloride dimerises to form In_2Cl_6.

2 Its oxide dissolves in both acids and alkalis.

3 Its ionic salts are typically coloured.

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

8 Metal peroxides decompose when heated to form metal oxides and oxygen gas. Which factor contributes to solid BaO_2 being more thermally stable than solid MgO_2?

A The hydration enthalpy of Mg^{2+} ion is more exothermic than that of Ba^{2+} ion.

B The lattice energy of BaO_2 is more negative than that of MgO_2.

C The charge density of Ba^{2+} ion is lower than that of Mg^{2+} ion.

D The O–O bond in O_2^{2-} is weaker than the O=O bond in O_2.

9 F_2 reacts with BrO_z^- ions in a 2 : 1 molar ratio to form F^- and BrO_4^- ions.

What is the value of ***z***?

A 1 **B** 2 **C** 3 **D** 5

10 Diamond is a pure form of carbon. The mass of a diamond can be measured in carats, where one carat is equivalent to 0.200 g of carbon.

How many carats is a diamond made up of 3.01×10^{23} carbon atoms?

A 0.4 **B** 2.5 **C** 30 **D** 60

11 The enthalpy change of formation of potassium bromide, KBr, can be calculated using a Born-Haber cycle.

The enthalpy changes related to potassium and bromine are shown in the table.

	enthalpy change /kJ mol^{-1}
$K(s) \rightarrow K(g)$	+90
$Br_2(g) \rightarrow 2Br(g)$	+193
$K(g) \rightarrow K^+(g) + e^-$	+418
$Br(g) + e^- \rightarrow Br^-(g)$	–325
$K^+(g) + Br^-(g) \rightarrow KBr(s)$	–678

What is the enthalpy change of formation of KBr?

A –302 kJ mol^{-1}

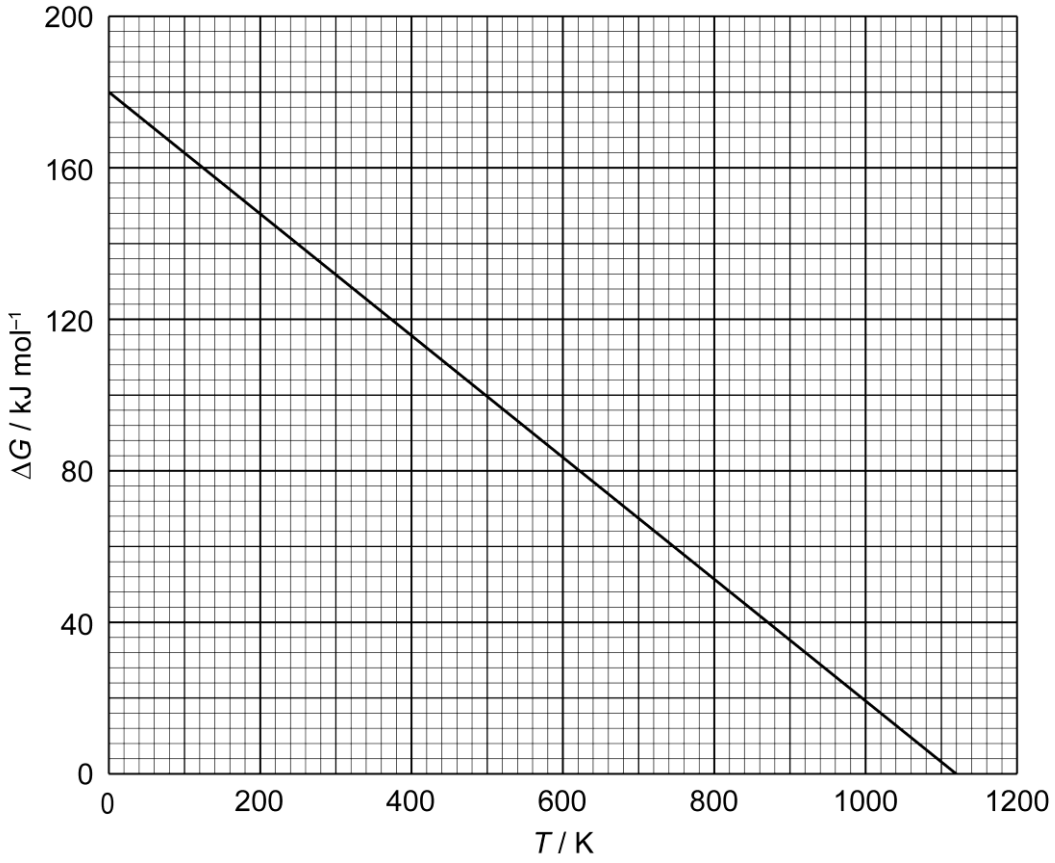
B –399 kJ mol^{-1}

C –958 kJ mol^{-1}

D –1054 kJ mol^{-1}

12 When heated, magnesium carbonate decomposes to form carbon dioxide and magnesium oxide.

A graphical plot of ΔG versus T, describing the change of the Gibbs free energy of the decomposition of magnesium carbonate with respect to temperature, is shown below.



Using the information from the graph, what is the value of $\Delta S^{\ominus}$ for the decomposition reaction?

A $+6.04 \times 10^2$ J mol^{-1} K^{-1} **B** -6.04×10^2 J mol^{-1} K^{-1}

C $+1.61 \times 10^2$ J mol^{-1} K^{-1} **D** -1.61×10^2 J mol^{-1} K^{-1}

13 Caesium-137 undergoes radioactive decay to form barium-137. This decay is a first-order reaction with a half-life of 30.2 years.

How long would it take for the molar proportion of caesium to barium to reach a ratio 1:3 from pure caesium-137?

A 30.2 years **B** 60.4 years **C** 90.6 years **D** 120.8 years

14 The reaction of hydrogen peroxide with iodide ions in an acidic solution can be monitored by an initial rates method.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \rightarrow 2H_2O(l) + I_2(aq)$$

The rate equation was found to be as follows:

$$\text{rate} = k\,[H_2O_2][I^-]$$

What of the following mechanism correctly describes this reaction?

A $H_2O_2 + I^- \rightarrow H_2O + IO^-$ (slow)
$IO^- + H^+ \rightarrow HIO$ (fast)
$HIO + H^+ + I^- \rightarrow H_2O + I_2$ (fast)

B $H_2O_2 + I^- \rightarrow H_2O + IO^-$ (slow)
$H_2O_2 + IO^- \rightarrow H_2O + IO_2^-$ (fast)
$IO_2^- + I^- + 4H^+ \rightarrow 2H_2O + I_2$ (fast)

C $2H^+ + 2I^- \rightarrow 2HI$ (fast)
$2HI + H_2O_2 \rightarrow 2H_2O + I_2$ (slow)

D $H_2O_2 + I^- + H^+ \rightarrow H_2O + HIO$ (fast)
$HIO + I^- \rightarrow OH^- + I_2$ (slow)
$OH^- + H^+ \rightarrow H_2O$ (fast)

15 When steam is passed over white hot coke, a mixture of combustible gases is obtained.

$$C(s) + H_2O(g) \underset{k_b}{\overset{k_f}{\rightleftharpoons}} H_2(g) + CO(g) \qquad \Delta H = +131 \text{ kJ mol}^{-1}$$

When equilibrium has been established, which of the following correctly describes what would happen if a proposed change is made to this system?

	proposed change	value of K_c	forward rate constant, k_f	backward rate constant, k_b
A	add catalyst	no change	increase	increase
B	add more C(s)	no change	increase	no change
C	increase volume	increase	decrease	decrease
D	increase temperature	increase	increase	decrease

16 Water dissociates into H^+ and OH^- as shown.

$$H_2O \rightleftharpoons H^+ + OH^-$$

The pH of water decreases at higher temperatures.

Which statements are correct?

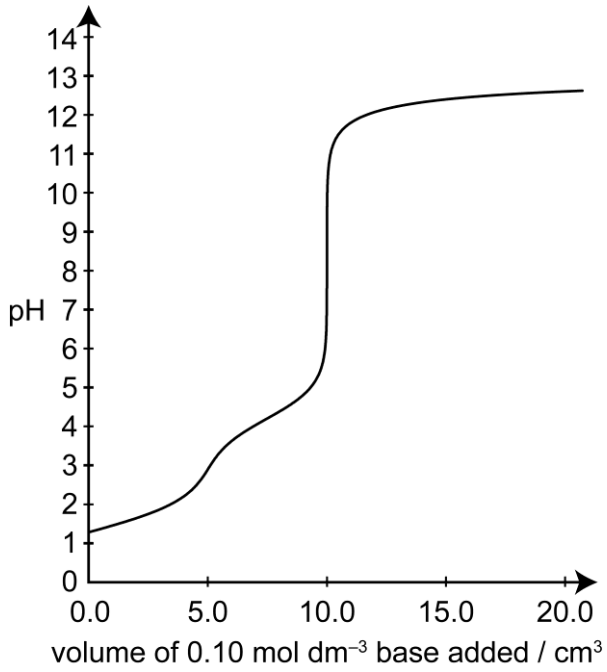
1 Water becomes acidic at higher temperatures.

2 The dissociation of water is endothermic.

3 The pOH decreases at higher temperatures.

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

17 The graph shows the changes in pH when excess 0.10 mol dm^{-3} base solution is added gradually to y cm^3 of 0.10 mol dm^{-3} acid solution.



Which combination could have given these results?

	acid	base	y / cm^3
A	H_2SO_4	NH_3	10
B	H_2SO_4	NH_3	5
C	$(COOH)_2$	KOH	10
D	$(COOH)_2$	KOH	5

18 Given the following solubility product, K_{sp}, which of the following statements is correct?

salt	K_{sp}
Ag_2SO_4	1.4×10^{-5}
$PbSO_4$	1.6×10^{-8}
PbI_2	7.1×10^{-9}

A All three K_{sp} values have the same unit.

B $PbSO_4$ has a lower solubility in pure water than PbI_2.

C Solubility product of Ag_2SO_4 decreases when added to sulfuric acid.

D When solid Na_2SO_4 is added to a solution containing 0.01 mol dm^{-3} of $Ag^+(aq)$ and $Pb^{2+}(aq)$, Ag_2SO_4 precipitates before $PbSO_4$.

19 One molecule of a non-cyclic organic compound contains only carbon atoms, hydrogen atoms and one oxygen atom. The compound is a ketone and contains a chiral carbon atom. One molecule of this compound contains *x* carbon atoms.

What could be the value of *x*?

1 $x = 5$

2 $x = 6$

3 $x = 7$

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

20 Propane undergoes free-radical substitution when mixed with chlorine and exposed to ultra-violet light.

Which compounds are possible products from this reaction?

1 $CH_3CH_2CH_2Cl$

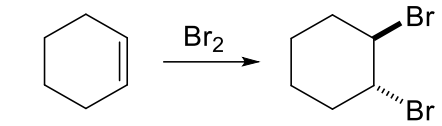
2 $CH_2ClCH_2CH_2Cl$

3 $CH_3CH_2CH_2CH_2CH_3$

4 $CH_3CH_2CH_2CH_2CH_2CH_3$

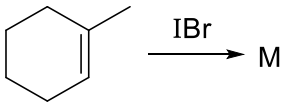
A 1, 2 and 3 **B** 1, 2 and 4 only **C** 1 and 2 only **D** 2 and 3 only

21 When cyclohexene reacts with bromine, only racemic *trans*-1,2-dibromocyclohexane is obtained. No *cis*-1,2-dibromocyclohexane is obtained.



cyclohexene — *trans*-1,2-dibromo-cyclohexane

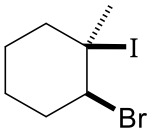
1-methylcyclohexene reacts with iodine monobromide, IBr, via the same mechanism giving the Markovnikov's product, M.



1-methylcyclohexene

Which of the following is likely to be the structure of M?

A



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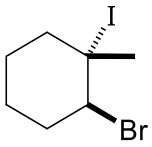
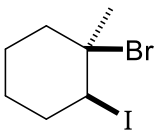
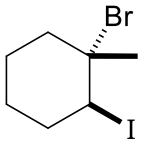


C



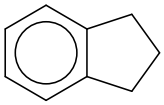
D



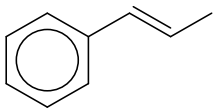
22 Compound **Y**, C_9H_{10}, reacts upon prolonged heating with acidified concentrated $KMnO_4$ to produce $C_8H_6O_4$ as the only organic product.

What is the structural formula of **Y**?

A



B



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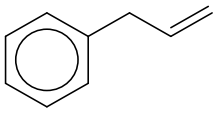
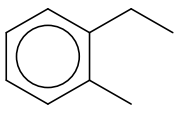
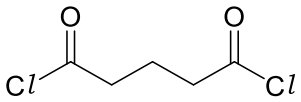


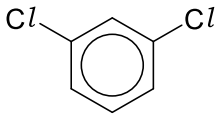
D

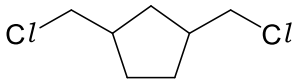


23 1.00 g of each of the following compounds was heated with NaOH(aq), and then dilute HNO_3(aq) and $AgNO_3$(aq) was added.

Which compound will produce the largest mass of AgC*l*(s)?

A  (M_r = 169.0)

B  (M_r = 147.0)

C  (M_r = 167.0)

D CH_3COCl (M_r = 78.5)

24 Which sets of reagents and conditions can be used to form the organic product $CH_3CH(OH)CH(CH_2NH_2)CO_2H$ from $CH_3COCH(CN)CO_2H$?

1 H_2, nickel catalyst, room temperature

2 $LiAlH_4$, dry ether as solvent, room temperature

3 $NaBH_4$, ethanol as solvent, room temperature

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

25 Propanone reacts with HCN at a slower rate compared to propanal.

Which statements are correct?

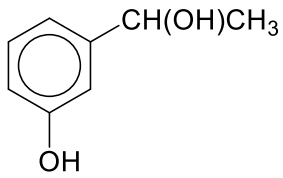
1 In both reactions, the carbonyl carbon reacts with a cyanide ion in the first step.

2 In propanone, the carbonyl carbon is more nucleophilic which repels the attacking cyanide ion.

3 A trace amount of NaC*l* is needed to catalyse the reaction.

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

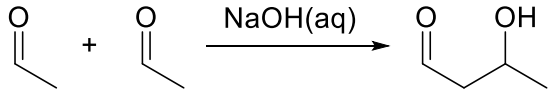
26 How many moles of $H_2(g)$ is produced when 1 mole of **Q** reacts with Na(s) and how many moles of $CO_2(g)$ is produced when 1 mole of **Q** reacts with $Na_2CO_3(aq)$?



Q

	$H_2(g)$ produced with Na(s)	$CO_2(g)$ produced with $Na_2CO_3(aq)$
A	0	1
B	1	2
C	1	0
D	2	1

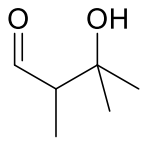
27 Aldol addition products are formed when a small amount of NaOH(aq) is added to carbonyl compounds at room temperature.



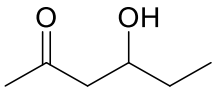
aldol addition product

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

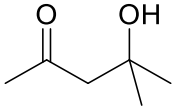
A



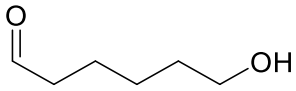
B



C



D



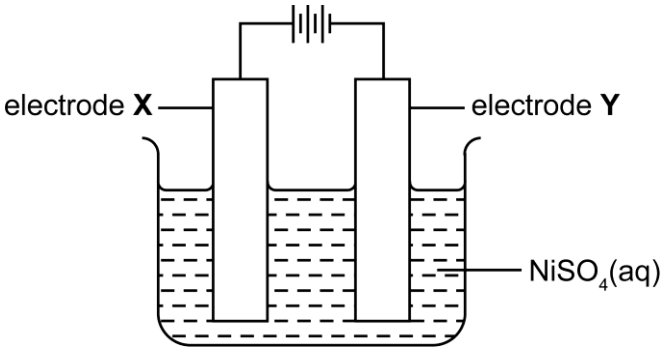
28 *Use of the Data Booklet is relevant to this question.*

An electrochemical cell is set up using a $Zn^{2+}(aq)|Zn(s)$ half-cell and a $MnO_4^-(aq)|Mn^{2+}(aq)$ half-cell in acidic solution.

Which of the following gives a correct effect on the E_{cell} when each of the changes is made to the corresponding half-cell separately?

	change	half-cell	effect on E_{cell}
A	addition of water	$MnO_4^-(aq)\|Mn^{2+}(aq)$	less positive
B	addition of $Mn(NO_3)_2(s)$	$MnO_4^-(aq)\|Mn^{2+}(aq)$	no change
C	addition of $Zn(NO_3)_2(s)$	$Zn^{2+}(aq)\|Zn(s)$	more positive
D	addition of $Na_2CO_3(s)$	$Zn^{2+}(aq)\|Zn(s)$	no change

29 In an experiment, a cell was set up to obtain pure nickel from a nickel-silver alloy.



Which of the following statements is correct?

A Electrode **Y** is the nickel-silver alloy.

B The concentration of the electrolyte must be 1 mol dm^{-3}.

C The electrolyte may be replaced with sodium sulfate solution.

D The mass of the cathode changes by the same mass as the anode.

30 Which of the following about period 4 transition elements is correct?

A The atomic radius decreases across the period.

B First ionisation energy remains relatively constant across the period.

C Period 4 transition elements have lower melting point than s block elements.

D The densities of period 4 transition elements are comparable to those of s block elements.

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