

EUNOIA JUNIOR COLLEGE JC2 Preliminary Examination 2024 General Certificate of Education Advanced Level Higher 2

CHEMISTRY

Paper 1 Multiple Choice

9729/01

18 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, 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.

1 A gravimetric analysis of a sample of an iron ore was carried out.

0.6 g of ore was dissolved in perchloric acid to oxidise the iron to Fe^{3+} . The resultant solution was filtered to remove solid impurities and made basic to precipitate the Fe^{3+} as the hydroxide. The precipitate was filtered and heated to produce 0.32 g of Fe_2O_3 .

What is the percentage by mass of iron in the ore?

A 18.6% **B** 37.3% **C** 53.0% **D** 69.9%

2 Ions of element Y can exist in variable oxidation states. 25.0 cm³ of 0.400 mol dm⁻³ Y²⁺ solution requires 40.00 cm³ of 0.100 mol dm⁻³ acidified KMnO₄ for a complete reaction.

What is the final oxidation state of Y?

A +4 B +3 C 0 D -1

- **3** Which of the following ions would experience the greatest angle of deflection in its path when passing through the same electric field?
 - A ²⁴Mg⁺ B ⁴⁸Ti³⁺ C ⁵⁹Co²⁺ D ¹⁰¹Ru⁴⁺
- 4 Which of the following shows the correct shape and bond angle of the molecule given?

	molecule	shape	bond angle	
Α	OF ₂	bent	117º	
в	BF_3	trigonal pyramidal	120º	
С	XeF ₄	tetrahedral	109.5°	
D	SF_6	octahedral	90°	

5 Ideal gases **K** and **L**, initially at different pressures and temperatures, are placed in different bulbs that are connected by a narrow tube of negligible volume as shown.



When the tap is opened, the gases mix. What is the final pressure of the mixture if both bulbs are maintained at 227 °C?

- A 28.0 kPa B 30.0 kPa C 36.6 kPa D 68.6 kPa
- **6** The enthalpy changes involved in the formation of KC*l*(aq) from K(s) and C*l*₂(g) are as follows:

$$\mathsf{K}(\mathsf{s}) + \frac{1}{2}\mathsf{C}l_2(\mathsf{g}) \xrightarrow{\Delta H_1} \mathsf{K}(\mathsf{g}) + \mathsf{C}l(\mathsf{g}) \xrightarrow{\Delta H_2} \mathsf{K}^+(\mathsf{g}) + \mathsf{C}l^-(\mathsf{g}) \xrightarrow{\Delta H_3} \mathsf{K}\mathsf{C}l(\mathsf{s}) \xrightarrow{\Delta H_4} \mathsf{K}^+(\mathsf{aq}) + \mathsf{C}l^-(\mathsf{aq})$$

Which of the following statements are correct?

- 1 The lattice energy of potassium chloride is ΔH_3 .
- 2 The enthalpy change of solution of potassium chloride is $(\Delta H_3 + \Delta H_4)$.
- 3 The enthalpy change of formation of solid potassium chloride is $(\Delta H_1 + \Delta H_2 + \Delta H_3)$.
- **A** 1 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

7 In this question, the symbol '<' means 'less positive than' or 'more negative than'.

Silver chloride dissolves in dilute $NH_3(aq)$ whereas silver bromide is only soluble in concentrated $NH_3(aq)$.

The following equations represent the equilibria involved.

$AgCl(s) \rightleftharpoons AgCl(aq)$	ΔG_1
$AgCl(aq) + 2NH_3(aq) \rightleftharpoons Ag(NH_3)_2Cl(aq)$	ΔG_2
$AgBr(s) \rightleftharpoons AgBr(aq)$	ΔG_3
$AgBr(aq) + 2NH_3(aq) \rightleftharpoons Ag(NH_3)_2Br(aq)$	ΔG_4

Some relationships between the free energies of these four reactions are as follows.

 $(\Delta G_1 + \Delta G_2) < (\Delta G_3 + \Delta G_4)$ $\Delta G_2 = \Delta G_4$ $\Delta G_2 < \Delta G_4$ $\Delta G_1 < \Delta G_3$

Which relationships are correct?

Α	1, 2 and 4 only	В	1 and 3 only	С	2 and 4 only	D	3 only
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8 Photochromic glass is used in transition lens. It quickly darkens when exposed to UV light and slowly becomes more transparent again when the intensity of UV light decreases. The depth of colour of the glass is proportional to the concentration of silver atoms present.

The following reactions are involved:

reaction 1	$Ag^+ + Cl^- \rightleftharpoons Ag + Cl$
reaction 2	$Cu^{\scriptscriptstyle +} + Cl \mathop{\rightarrow} Cu^{2 +} + Cl^{\scriptscriptstyle -}$
reaction 3	$Cu^{2+} + Ag \rightarrow Cu^{+} + Ag^{+}$

Which statement about these reactions is correct?

- A Since Cu⁺ and Cu²⁺ acts as catalysts, both reactions 2 and 3 are much faster than the forward reaction in Ag⁺ + C $l^- \rightleftharpoons$ Ag + Cl when intensity of UV light is high.
- **B** The forward reaction in $Ag^+ + Cl^- \rightleftharpoons Ag + Cl$ is non-spontaneous.
- **C** Reaction 3 is less spontaneous after glass darkens in UV light, as compared to the glass being clear.
- **D** The position of equilibrium of reaction 1 shifts to the left in strong UV light.

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9 The distribution of the number of molecules with energy *E* for an uncatalysed reaction with a given activation energy, E_a , is shown in the diagram below.



Which expression gives the fraction of the molecules that results in a reaction occurring when a catalyst is added at the start of the same reaction?

- $\textbf{A} \quad \frac{X+Y+Z}{W} \qquad \textbf{B} \quad \frac{Z}{W+X+Y} \qquad \textbf{C} \quad \frac{X+Y+Z}{W+X+Y+Z} \quad \textbf{D} \quad \frac{Z}{W+X+Y+Z}$
- **10** The K_c value of reaction **1** is 2.55×10^{65} at 373 K. Reaction **1** is catalysed by zirconium metal.

reaction 1: $Y(aq) \rightleftharpoons 2Z(aq)$ $\Delta H = +28 \text{ kJ mol}^{-1}$

Which of the following statements regarding reaction 1 are true?

- 1 The forward reaction proceeds very quickly because the K_c value is very large.
- 2 The K_c value will increase when boiling water is added and the mixture is kept at 373 K and 1 atm.
- 3 After the addition of a few granules of zirconium, the K_c value remains at 2.55×10^{65} .

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

11 Gas A decomposes to two other gases, B and C, according to the following equation:

$$\mathbf{A}(g) \rightleftharpoons 2\mathbf{B}(g) + \mathbf{C}(g)$$

The graph shows the decomposition of 2.0 mol of pure gas **A** in the presence of a catalyst at various temperatures.



Which one of the following statements about the above system is correct?

- **A** The decomposition of **A** is endothermic.
- **B** The K_p of the system decreases with increasing temperature.
- **C** The percentage of **A** decomposed is 40% when equilibrium is reached at 650 °C.
- **D** The amount of **C** at equilibrium is 0.8 mol at 650 °C.
- **12** What is the pH of the final solution formed when $V \text{ dm}^3$ of dilute hydrochloric acid of pH 2.0 is mixed with $V \text{ dm}^3$ of dilute sulfuric acid of pH 2.0, followed by the addition of $2V \text{ dm}^3$ of water?
 - **A** 1.33 **B** 2.00 **C** 2.30 **D** 4.00
- **13** A buffer solution consists of an aqueous solution of a weak acid and its sodium salt. Which of the following expressions gives the best estimate of the hydrogen ion concentration?

A
$$\begin{bmatrix} H^+ \end{bmatrix} = \sqrt{K_a [acid]}$$
B $\begin{bmatrix} H^+ \end{bmatrix} = \sqrt{K_a [salt]}$ C $\begin{bmatrix} H^+ \end{bmatrix} = K_a \frac{[acid]}{[salt]}$ D $\begin{bmatrix} H^+ \end{bmatrix} = K_a \frac{[salt]}{[acid]}$

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14 Calcium oxalate, CaC₂O₄, is a sparingly soluble salt and is added to a weakly acidic solution of oxalic acid, H₂C₂O₄. The pH of the solution is adjusted by adding NaOH.

Which diagram shows how the solubility of CaC_2O_4 will vary with the pH of the solution at constant temperature?



- **15** Which property of the first six elements of Period 3 (sodium to sulfur) continuously increases in magnitude?
 - A atomic radius
 - **B** first ionisation energy
 - **C** maximum oxidation number in oxide
 - **D** melting point of the highest chloride
- **16** Gallstones can form in the gall bladder and are very painful. The inorganic part of gallstones is calcium oxalate, CaC₂O₄, which is insoluble in water. The corresponding magnesium oxalate, MgC₂O₄, is soluble in water.

What factor accounts for the difference in solubility between CaC₂O₄ and MgC₂O₄?

- A The entropy change for dissolution of MgC₂O₄ is more negative than CaC₂O₄ due to the higher charge density of Mg²⁺.
- **B** Mg^{2+} ions have a more negative enthalpy change of hydration than Ca^{2+} ions.
- **C** MgC₂O₄ has a more negative lattice energy than CaC₂O₄.
- **D** Mg is more electronegative than Ca.

- 17 Which statements about the Group 17 elements (X₂) from chlorine to iodine are correct?
 - 1 The bond energy of X–X decreases down the group.
 - 2 The volatility of the elements decreases down the group.
 - 3 The elements become stronger oxidising agents down the group.
 - **A** 2 only **B** 1 and 2 only **C** 1 and 3 only **D** 1, 2 and 3
- 18 Consider compounds R and S below.



Which of the following statements regarding compounds R and S is correct?

- A Compound **R** can exist as a total of 16 stereoisomers.
- **B** Compounds **R** and **S** are constitutional isomers of each other.
- **C** At least one constitutional isomer of **S** cannot rotate polarised light.
- **D** At least one stereoisomer of compound **R** cannot rotate plane polarised light.
- **19** When dichlorodifluoromethane, CC*l*₂F₂, is released into the atmosphere, it accumulates in the upper part of the atmosphere where it reacts to form free radicals due to the action of ultraviolet light.

One of the chain reactions which can occur is shown, where X• represents the halogen radical.

$$X \bullet + O_3 \to XO \bullet + O_2$$
$$2XO \bullet + O_2 \to 2X \bullet + 2O_2$$

Which statement is correct?

- A F• and •CC1₂F are the major free radical products made during the initiation step.
- **B** The halogen radical acts as a catalyst in the breakdown of ozone.
- **C** The halogen radical is formed during the termination step.
- **D** F• is produced, but unlike C*l*•, does not react with ozone.

20 The oxo reaction is an important industrial process in which alkene combines directly with carbon monoxide and hydrogen under suitable conditions. The reaction with ethene is shown.

$$CH_2 = CH_2 + CO + H_2 \xrightarrow{\text{catalyst}} CH_3CH_2CHO$$

high temp and pressure

Which alkene undergoes the oxo reaction to give the product $CH_3CH_2C(CH_3)_2CHO?$



21 The Simmons-Smith reaction involves the formation of a cyclopropane ring from an alkene, using diiodomethane, a zinc-copper alloy, and diethyl ether as a solvent.



However, when the same reagents and conditions for the Simmons-Smith reaction are used on benzene, the cyclopropane ring is not formed.



Which of the following statements best explains this phenomenon?

- **A** The alkene is a weaker nucleophile than benzene.
- **B** Forming the cyclopropane ring will destroy the stable aromatic structure of benzene.
- **C** The C=C double bond in an alkene is weaker, hence it is more reactive.
- **D** The benzene ring lacks a directing alkyl group required to cause the cyclopropane ring to form.
- 22 Which sequence shows the correct order of increasing ease of hydrolysis?
 - **A** $CH_3CH_2Cl < CH_3CH_2Br < CH_3CH_2I$
 - **B** $(CH_3)_2CHCl < (CH_3)_2CHBr < (CH_3)_2CHF$
 - $\textbf{C} \quad C_6H_5CH_2I < C_6H_5CH_2Br < C_6H_5CH_2Cl$
 - $\textbf{D} \quad C_6H_5CH_2C\mathit{l} < C_6H_5CH_2Br < C_6H_5I$

23 One gram of each of the following compounds was heated with NaOH(aq), followed by addition of dilute HNO₃ and AgNO₃(aq).

Which compound will produce the largest mass of AgBr(s)?



24 Alcohol X with molecular formula C₄H₁₀O is oxidised by acidified potassium dichromate(VI) solution and produces a pale yellow precipitate with alkaline aqueous iodine.

Which compound could be X?

- A 2-methylpropan-1-ol
- B 2-methylpropan-2-ol
- **C** butan-1-ol
- D butan-2-ol
- 25 The structure of compound X is shown:



Which of the following statements will be observed with compound X?

- 1 Compound X decolourises hot acidified potassium manganate(VII).
- 2 1 mole of yellow precipitate is formed when 1 mole of compound **X** is warmed with alkaline iodine solution.
- 3 1 mole of compound **X** can only react with two moles of aqueous bromine.
- A 1 and 2 only B 1 and 3 only C 2 and 3 only D 1, 2 and 3

- **26** Which of the following reagents and conditions is the most suitable method to synthesise methanoic acid from methanol?
 - **A** $K_2Cr_2O_7(aq)$, dilute $H_2SO_4(aq)$, heat with distillation
 - **B** K₂Cr₂O₇(aq), dilute H₂SO₄(aq), heat under reflux
 - **C** KMnO₄(aq), dilute H₂SO₄(aq), heat with distillation
 - **D** KMnO₄(aq), dilute $H_2SO_4(aq)$, heat under reflux
- 27 Which mixture could be used to produce propyl methanoate?
 - A CH₃CH₂CO₂H and CH₃OH
 - **B** $CH_3CH_2CH_2CH_2OH$ and HCO_2H
 - C CH₃CH₂CH₂OH and HCO₂H
 - **D** $CH_3CH_2CH_2CO_2H$ and CH_3OH
- **28** The fully protonated form of glutamic acid is shown, and has pK_a values of 2.10, 4.07 and 9.47 at 25 °C.



Which structure is predominant in an aqueous solution at pH = 3.70?



29 Button batteries, often used in watches and calculators, typically contain zinc and silver oxide electrodes. The half-cells involved are:

 $Zn^{2+}(aq) + 2e^{-} \rightleftharpoons Zn(s) \qquad E^{\Theta} = -0.76 \text{ V}$ $Ag_2O(s) + H_2O(l) + 2e^{-} \rightleftharpoons 2Ag(s) + 2OH^{-}(aq) \qquad E^{\Theta} = +0.34 \text{ V}$

Which of the following statements about the button battery cell are correct?

- 1 Zinc is the negative electrode.
- 2 Electrons flow from $Zn^{2+}|Zn$ half-cell to $Ag_2O|Ag$ half-cell.
- 3 The ΔG^{Θ} of the reaction is -106 kJ mol⁻¹.
- **A** 3 only **B** 1 and 2 only **C** 1 and 3 only **D** 1, 2 and 3
- **30** When a solution containing 0.10 mol of the compound, $Cr(H_2O)_6Cl_3$, is treated with excess silver nitrate solution, 0.20 mol of silver chloride, AgCl, is immediately precipitated.

What is the formula of the complex ion in the compound?

A $[Cr(OH)_6]^{3-}$ **B** $[Cr(H_2O)_6]^{3+}$ **C** $[CrCl(H_2O)_5]^{2+}$ **D** $[CrCl_2(H_2O)_4]^{+}$