

EUNOIA JUNIOR COLLEGE JC2 Preliminary Examination 2023 General Certificate of Education Advanced Level Higher 2

CHEMISTRY

Paper 1 Multiple Choice

9729/01

21 September 2023 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 beam of particles contains D⁻ and ⁴He²⁺. All particles approach an electric field at the same speed. (D is deuterium, ²H)

2



Which row describes the behaviour of the species?

	D-	⁴ He ²⁺	relative extent of deflection
Α	deflect towards (–) plate	deflect towards (+) plate	⁴ He ²⁺ deflected more than D ⁻
В	deflect towards (–) plate	deflect towards (+) plate	⁴ He ²⁺ deflected less than D ⁻
С	deflect towards (+) plate	deflect towards (–) plate	⁴ He ²⁺ deflected more than D ⁻
D	deflect towards (+) plate	deflect towards (–) plate	⁴ He ²⁺ deflected to the same extent as D ⁻

2 The melting point of calcium, 839 °C, is much higher than the melting point of sodium, 98 °C.

Which statement is most relevant in explaining this difference?

- A The calcium atom is larger than the sodium atom.
- **B** The calcium atom is heavier than the sodium atom.
- **C** The calcium ion, Ca^{2+} , has a higher charge than the sodium ion, Na^+ .
- $\label{eq:D} \textbf{D} \quad \text{The calcium ion, Ca}^{2+}\text{, contains more electrons than the sodium ion, Na^+.}$
- 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; *T* = temperature in Kelvin)

A
$$pV$$
 against $\frac{M}{T}$ B p against ρT C $\frac{p}{\rho}$ against T D $\frac{T}{p}$ against V

4 The ammonia molecule can react in various ways: as an acid, as a base, as a nucleophile, as an oxidising agent and as a reducing agent.

In which of the following reactions is ammonia reacting as a Brønsted-Lowry acid?

- **A** $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$
- $\textbf{B} \quad NH_3 \ \textbf{+} \ NaH \ \rightarrow \ NaNH_2 \ \textbf{+} \ H_2$
- $\textbf{C} \quad NH_3 \ \textbf{+} \ HNO_2 \ \rightarrow \ N_2 \ \textbf{+} \ 2H_2O$
- $\textbf{D} \quad 2NH_3 \ + \ NaOCl \rightarrow \ N_2H_4 \ + \ NaCl \ + \ H_2O$
- 5 Which graph shows the correct trend of Period 3 elements and their compounds?



6 Sulfur is converted to SF_6 by fluorine, to SCl_2 by chlorine and to S_2Br_2 by bromine.

Which trend does this information best provide evidence for?

A electronegativity: F > Cl > Br

- **B** first ionisation energy: F > Cl > Br
- **C** bond energy: $Cl_2 > Br_2 > F_2$
- **D** oxidising ability: $F_2 > Cl_2 > Br_2$

3

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

Industrial welding commonly uses a mixture of gases. One such gas mixture composed of 25% argon and 75% of another gas by volume, has a density of 0.572 g dm⁻³ at standard temperature and pressure.

What is the identity of the other gas in the mixture?

- A oxygen, O₂
- **B** hydrogen, H₂
- C helium, He
- **D** carbon dioxide, CO₂
- **8** Ethanal (CH₃CHO) is a colourless gas that is a toxic by-product of ethanol consumption. It undergoes complete combustion as follows:

$$CH_3CHO~+~\frac{5}{2}O_2~\rightarrow~2CO_2~+~2H_2O$$

A sample of 20 cm³ of ethanal was completely combusted with 100 cm³ of oxygen.

What will be the final volume of the resultant mixture of gases at 150 °C?

A 130 cm³ **B** 90 cm³ **C** 80 cm³ **D** 40 cm³

9 Which of the following processes are always exothermic?

- 1 Formation of an ionic compound from its gaseous constituent ions
- 2 Formation of a covalent compound from its constituent elements
- 3 Dissolving of an ionic compound in water
- 4 Changing a covalent compound from liquid to solid state.
- **A** 1 and 4 only **B** 2 and 4 only **C** 1, 2 and 3 only **D** 1, 2, 3 and 4

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

A sample of propan-1-ol was burnt under laboratory conditions in an apparatus that trapped y% of the heat evolved by heating a container of water.

The burning of *m* g of propan-1-ol raised the temperature of 200 g of water by 30 °C.

Given that the enthalpy change of combustion of propan-1-ol is $-2020 \text{ kJ mol}^{-1}$, which of the following expressions gives the value of *y*?

- $\mathbf{A} \quad \frac{200 \times 4.18 \times 30 \times 100 \times 60.0}{m \times 2020 \times 1000}$
- $\mathbf{B} = \frac{200 \times 4.18 \times 30 \times 60.0}{m \times 2020 \times 1000 \times 100}$
- $\mathbf{C} = \frac{m \times 4.18 \times 30 \times 60.0}{200 \times 2020 \times 1000 \times 100}$
- $\mathbf{D} \quad \frac{200 \times 4.18 \times (30 + 273) \times 100 \times 60.0}{m \times 2020 \times 1000}$
- **11** Nitrogen monoxide, NO, reacts with chlorine, Cl₂, *via* the following mechanism to give nitrosyl chloride, NOC *l*.

Step 1: NO + $Cl_2 \rightarrow NOCl + Cl^{\bullet}$ Step 2: NO + $Cl^{\bullet} \rightarrow NOCl$

Which statement about this mechanism is correct?

- A NOC*l* is an intermediate.
- **B** The chlorine radical is acting as a catalyst.
- **C** Step 2 has a lower activation energy than step 1.
- **D** The rate equation derived from this mechanism is rate = $k[NO][Cl_{\cdot}]$.

12 The values of the equilibrium constant, K_{p} , for the reaction

$$Ag_2CO_3(s) \rightleftharpoons Ag_2O(s) + CO_2(g)$$

are 3.98 \times 10^{-4} atm and 1.41 \times 10^{-2} atm at 77 °C and 127 °C respectively.

What deduction can be made from the information given?

- A More CO₂ is formed at equilibrium if a suitable catalyst is used.
- **B** More CO₂ is formed at equilibrium if the reaction is allowed to take place in another container of a smaller volume.
- **C** More CO₂ is formed at equilibrium if some Ag₂CO₃ is added to a system that is already in equilibrium.
- **D** The activation energy of the forward reaction is higher than that of the reverse reaction.
- **13** The numerical values of K_a for two acids at 298 K are given.

acid	Ka
CH ₃ CO ₂ H	1.75 × 10 ^{−5}
$C_6H_5CO_2H$	$6.46 imes 10^{-5}$

Which statement is correct?

- **A** $C_6H_5CO_2^-$ is a stronger base than $CH_3CO_2^-$.
- **B** The K_a of CH_3O CO_2H is lower than that of $C_6H_5CO_2H$.
- **C** 1 mol dm⁻³ CH₃CO₂H(aq) has a lower pH than 1 mol dm⁻³ HOCH₂CO₂H(aq).
- **D** A smaller volume of HC*l* is required to neutralise 1 mol of $C_6H_5CO_2^-$ than 1 mol of $CH_3CO_2^-$.



The graph below shows the change in pH when aqueous sodium hydroxide is added to a solution containing 1 mole of aspartic acid.



Which statements about the reaction is correct?

- 1 At point W, the maximum concentration of the zwitterion is formed.
- 2 A solution of maximum buffering capacity is formed at both points X and Z.
- 3 Thymolphthalein (working range pH = 9.3-10.5) is a suitable indicator for equivalence point Y.

Α	1 and 2	В	1 and 3	С	2 only	D	3 only
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15 Hydroxyapatite, Ca(OH)₂·3Ca₃(PO₄)₂, is the inorganic mineral found in bone. In older people, calcium ions can be lost from hydroxyapatite, weakening their bone structure.

In some cases, strontium salts are administered to strengthen the bone, where the strontium ions will replace the lost calcium ions in the hydroxyapatite. [K_{sp} values for Ca(OH)₂ is 5.0×10^{-6} and for Sr(OH)₂ is 3.2×10^{-4}]

Which statements are **not** correct?

- 1 There is ionic, covalent and metallic bonding in hydroxyapatite.
- 2 When strontium ions replace calcium ions, bone density increases.
- 3 Sr(OH)₂ is less soluble than Ca(OH)₂ and will precipitate more easily to replace Ca(OH)₂ when administered into the bone structure.
- **A** 1 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3
- **16** Diazomethane (CH₂N₂) is a highly explosive yellow gas which is known to explode upon gentle impact or exposure to light.

Despite the risks associated with its use, it is well-known as an effective and efficient reagent in the preparation of methyl esters. The mechanism is shown below.



Which row best describes the type of reaction for the two steps?

	step 1	step 2
Α	acid-base reaction	elimination
в	acid-base reaction	nucleophilic substitution
С	nucleophilic substitution	elimination
D	nucleophilic substitution	nucleophilic substitution

17 Which structures represent the same stereoisomer?



18 When heated with bromine, hydrocarbon X undergoes free radical substitution. In the propagation step, the free radical Y• is formed by the loss of one hydrogen atom.

 $X + Br \bullet \rightarrow Y \bullet + HBr$

What is a possible structure of hydrocarbon X if there are 3 possible forms of Y•?



19 A hydrocarbon, which is a liquid at room temperature, decolourises aqueous bromine.

What could be the molecular formula of the compound?

- **A** C_2H_4 **B** C_6H_6O **C** C_7H_{16} **D** $C_{10}H_{20}$
- **20** Which of the following will **not** be formed when benzene reacts with $CHCl_3$ in the presence of $AlCl_3$?



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- **21** Which compound, when shaken with aqueous silver nitrate, will give a white precipitate in the shortest time?
 - A 2-chlorobut-1-ene
 - B chlorobenzene
 - **C** propanoyl chloride
 - D tetrachloromethane
- 22 Chlorofluorocarbons, CFCs, are chemicals that were commonly used in refrigeration and air conditioning. They are harmful to the ozone layer and many manufacturing companies are substituting CFCs with other compounds. Which of the following can be used as a substitute for CFCs?
 - 1 butane
 - 2 trichlorofluoromethane
 - 3 1,1,1,2-tetrafluoroethane
 - A 2 and 3 only B 1 and 2 only C 1 and 3 only D 1, 2 and 3
- **23** Compound **X** undergoes the following reactions:
 - 1 mol of **X** reacts completely with excess Na(s) to give 1 mol of H₂(g).
 - 1 mol of **X** reacts completely with 1 mol of $PCl_5(s)$.
 - 1 mol of **X** reacts completely with 1 mol of Br₂(aq).

Which of the following is compound **X**?



- 24 Fresh salads may contain the following compounds.
 - X $CH_3CH_2CH_2CH=CHCHO$, an aroma of tomatoes
 - Y CH₃CH₂CH₂CH₂CH=CHCOCH₃, a flavour of mushrooms
 - Z CH₃CH₂CH₂CH₂CH=CHCH=CHCHO, an aroma of cucumbers

If these compounds are present in the ratio X : Y : Z = 1 : 2 : 2, and are all reduced by excess hydrogen, how many hydrogen atoms would be incorporated on average per molecule?

A 2.0 **B** 2.8 **C** 4.0 **D** 4.8

25 Deuterium, D, is the ²H isotope of hydrogen.

Which reactions will give an organic product containing deuterium?



26 Pravastatin is used for prevention of cardiovascular diseases and treatment of abnormal lipid levels in the blood.



Which statement about pravastatin is correct?

- **A** It has a total of 2¹⁰ stereoisomers.
- **B** 1 mol of pravastatin reacts with 3 mol of HCl(g).
- **C** It gives an orange precipitate with 2,4-dinitrophenylhydrazine.
- **D** It reacts with cold alkaline KMnO₄ to give a compound with 6 secondary alcohol groups.
- 27 What is the correct order of basicity for the labelled nitrogen atoms in cyamemazine?



 $\label{eq:relation} \begin{array}{ccc} \mbox{\bf A} & N^1 > N^2 > N^3 & \mbox{\bf B} & N^1 > N^3 > N^2 & \mbox{\bf C} & N^2 > N^1 > N^3 & \mbox{\bf D} & N^3 > N^2 > N^1 \end{array}$

The E_{cell}^{Θ} of a galvanic cell is found to be +0.19 V. One of the half-cells contains 1 mol dm⁻³ each of K₂S₂O₈(aq) and K₂SO₄(aq). Which of the following reactions occurs in the other half-cell?

- **A** $\operatorname{Co}^{2+} \rightarrow \operatorname{Co}^{3+} + e^{-}$ **B** $\operatorname{Fe}^{2+} \rightarrow \operatorname{Fe}^{3+} + e^{-}$ **C** $\operatorname{Co}^{3+} + e^{-} \rightarrow \operatorname{Co}^{2+}$ **D** $\operatorname{Fe}^{3+} + e^{-} \rightarrow \operatorname{Fe}^{2+}$
- **29** The standard cell potentials for the redox equilibria of aqueous vanadium-containing ions and the colours of these ions are given below.

VO ₂ ⁺ + 2H ⁺ +	$e^{-} \rightleftharpoons H_2O + VO^{2+}$	<i>E</i> [⊖] = +1.00 V		
yellow	blue			
VO ²⁺ + 2H ⁺ +	$e^{-} \rightleftharpoons H_2O + V^{3+}$	$E^{\ominus} = +0.34 \text{ V}$		
blue	green			
V ³⁺ + e⁻ ⇒ '	V ²⁺	$E^{\ominus} = -0.26 \text{ V}$		
green pi	urple			

What is likely to be the final colour when metallic zinc is added to a solution containing VO^{2+} ?

	$Zn^{2+} + 2e^{-} \rightleftharpoons Zn$				$E^{\Theta} = -0.76 \text{ V}$		
col	ourless						
Α	yellow	в	blue	С	green	D	purple

30 Aqueous copper(II) sulfate forms a deep blue solution when aqueous ammonia is added. The colour intensity of the mixture can be analysed by measuring its absorbance using a colorimeter.

Given that the total volume of solution used is 1.0 cm^3 , which graph, **A**, **B**, **C** or **D**, correctly represents the absorbance against volume of solutions used when $0.2 \text{ mol dm}^{-3} \text{ CuSO}_4(\text{aq})$ is mixed with $0.4 \text{ mol dm}^{-3} \text{ NH}_3(\text{aq})$ in the given proportions?



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