

ST ANDREW'S JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATIONS

HIGHER 2

| CANDIDATE | | | | | | | |
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| NAME | | | | | | | |
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9729/01

1 hour

15 September 2023

CHEMISTRY

Paper 1 Multiple Choice

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 and class on the Answer Sheet in the spaces provided.

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.

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.

This document consists of <u>15</u> printed pages (including this cover page) and **1** blank page.

- 1 The relative atomic mass of boron, which consists of the isotopes ${}^{10}_{5}$ B and ${}^{11}_{5}$ B is 10.8. What is the percentage of ${}^{11}_{5}$ B atoms in the isotopic mixture? A 0.2 % B 0.8% C 20 % D 80 %
- 2 A mixture of sodium iodide, ²³Na¹²⁷I, and sodium bromide, ²³Na⁷⁹Br, were vapourised and the ions passed through an electric field.

Which statements about the results are correct?

- 1 There would be 4 angles of deflections observed.
- 2 The particle with the largest angle of deflection will be detected at the negative plate.
- 3 The positive plate will detect more particle types than the negative plate.
- **A** 1 only **B** 2 and 3 only **C** 1 and 2 only **D** 1,2 and 3
- 3 Which of the following statements about ice and its structure is correct?
 - **A** The bond angle around O in ice is 109.5°.
 - **B** Ice is more dense than water.
 - **C** 2 electrons on O in ice are involved in hydrogen bonding.
 - **D** Hydrogen bonds formed in ice are as strong as the O-H covalent bonds.
- **4** Benzylamine is commonly used in the industrial production of many pharmaceutical products and has the following structure.



Which bond angle is **not** present in benzylamine?A 105° B 107° C 109.5° D 120°

In a vessel, 5.0 dm³ of nitrogen gas at 20 °C and pressure of 200 kPa was compressed by a piston to 2.5 dm³ and heated to 60 °C.
What is the pressure in the heated vessel?

| A 90 kPa | B 455 kPa | C 715 kPa | D | 1200 kPa |
|-----------------|------------------|------------------|---|----------|
|-----------------|------------------|------------------|---|----------|

6 Magnesium, aluminium, silicon and phosphorus are consecutive elements in Period 3 of the Periodic Table.

Which of the following properties generally decreases from magnesium to phosphorus?

- 1 Electrical conductivity
- 2 Ionic radius
- 3 Melting point of their oxides
- 4 pH of their chlorides in water
- **A** 1 and 2 only **B** 1 and 3 only **C** 2 and 4 only **D** 3 and 4 only

| | size of the ions | magnitude of their lattice |
|---|------------------|----------------------------|
| | | energy |
| Α | small | small |
| В | small | large |
| С | large | small |
| D | large | large |

7 Which of the following properties of a salt will make it the most soluble in water?

A reaction involving 3 species, F, G and H have the following rate equation.
rate = k[G][H]²

Which of the following graphs will be obtained?



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

Hydrogen iodide decomposes according to the equation shown.

 $2HI \Longrightarrow H_2 + I_2$

The density of pure hydrogen iodide at 298 K is 2.85 g cm⁻³.

Which expression gives the concentration of hydrogen gas that are present in 1.00 dm³ of pure hydrogen iodide at 298 K?

A
$$\kappa_{c} \sqrt{\frac{2.85}{127.9}}$$
 B $\frac{2.85}{127.9} \sqrt{\kappa_{c}}$ **C** $\sqrt{\frac{2850}{127.9}} \kappa_{c}$ **D** $\frac{2850}{127.9} \sqrt{\kappa_{c}}$

10 A weak monoacidic base, **J**, has a p K_b value of 3.5.

25.0 cm³ of 0.08 mol dm⁻³ HCl is titrated against 0.10 mol dm⁻³ of J.

Which statements about the titration curve obtained are correct?

- 1 A suitable indicator for this titration is methyl orange.
- 2 The pH at maximum buffer capacity is 3.5.
- 3 The region of rapid pH change occurs at 20 cm³.
- 4 The volume at maximum buffer capacity is 10 cm³.
- **A** 1 and 3 only **B** 2 and 4 only **C** 1,2 and 3 only **D** 2,3 and 4 only
- **11** The K_{sp} of Mg(OH)₂ is 1.5×10^{-11} mol³ dm⁻⁹ and the K_b of aqueous CH₃CH₂NH₂ is 5.6×10^{-4} mol dm⁻³.

What is the solubility of $Mg(OH)_2$ in 1.0 mol dm⁻³ aqueous $CH_3CH_2NH_2$?

- **A** $1.64 \times 10^{-4} \text{ mol dm}^{-3}$ **B** $2.68 \times 10^{-8} \text{ mol dm}^{-3}$
- **C** 4.78 x 10⁻⁹ mol dm⁻³ **D** 6.34 x 10⁻¹⁰ mol dm⁻³

12 AgC*l* and AgBr are both partially soluble solids.

AgX (s) \longrightarrow Ag⁺ (aq) + X⁻ (aq), where X is C*l* or Br ------ equation 1 When aqueous NH₃ is added to separate solutions of each silver halide, only AgC*l* dissolves but not AgBr.

Which of the following statements that explains this observation is correct?

- **A** The K_{sp} value of AgCl is larger than that of AgBr.
- **B** The ionic product for AgC*l* decreases but not the ionic product of AgBr.
- **C** The addition of NH₃ resulted in the formation of the $Ag(NH_3)_2^+$ complex for only AgCl.
- D The concentration of Ag⁺(aq) decreases causing the position of equilibrium of equation 1 to shift to the left.
- **13** Which of the following statements explains the increase in reducing power of Group 2 element down the group?
 - **A** The increase in the nuclear charge down the group.
 - **B** The increase in the number of electron shells down the group.
 - **C** The melting point of Group 2 metals decreases down the group.
 - **D** The electronegativity of Group 2 metals decreases down the group.
- 14 A student added 2 cm³ of aqueous potassium iodide, KI, into a test tube, followed by bromine, Br₂, dissolved in an organic solvent of density 1.59 g cm⁻³. He then mixed the solution thoroughly before allowing it to settle.

Which of the following will be observed?

| | Observation of the | Final colour of the lower |
|---|----------------------|---------------------------|
| | organic solvent | layer in the test tube |
| Α | orange-red to purple | colourless |
| В | orange-red to purple | purple |
| С | remained orange-red | colourless |
| D | remained orange-red | orange-red |

15 Cephalotaxine is an alkaloid which has anti-leukemic activity.



| How many carbon atoms are sp ² hybridised? | | | | | | | | |
|---|---|---|---|---|---|----|--|--|
| A 7 | в | 8 | С | 9 | D | 10 | | |

16 How many constitutional isomers with molecular formula $C_6H_{12}O_2$ are esters that form ethanoic acid upon hydrolysis?

| Α | 2 | В | 3 | С | 4 | D | 5 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

17 Which could be the possible product from the termination step in the chain reaction when 2-methylbutane reacts with Br₂, in the presence of UV light?



18 When trichlorofluoromethane, CC*l*₃F, is released into the atmosphere, it accumulates in the upper part of the atmosphere when it reacts to form free radicals due to the action of the ultraviolet light.

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

$$Y \bullet + O_3 \longrightarrow Y O \bullet + O_2$$
$$2Y O \bullet + O_2 \longrightarrow 2Y \bullet + 2O_2$$

- 1 Both $Cl \bullet$ and $F \bullet$ are the free radicals that cause the breakdown of ozone.
- 2 The halogen radical acts as a catalyst in the breakdown of the ozone.
- 3 YOY is one possible product formed in the termination step.

Which statements are correct?

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

19 The following molecule, **T**, can be synthesised from benzene via several steps.



Which of the following synthesis routes would give the highest yield for T?

- A alkylation \rightarrow oxidation \rightarrow nitration \rightarrow reduction \rightarrow bromination
- **B** nitration \rightarrow alkylation \rightarrow oxidation \rightarrow reduction \rightarrow bromination
- **C** alkylation \rightarrow nitration \rightarrow oxidation \rightarrow bromination \rightarrow reduction
- **D** nitration \rightarrow alkylation \rightarrow oxidation \rightarrow bromination \rightarrow reduction
- 20 Equal amounts of compounds W, X, Y and Z are added separately to four test-tubes containing equal concentrations of ethanolic silver nitrate solution in a heated water bath. No precipitate forms in two of the tubes. In the two other tubes, precipitates form at different rates.



Which row is correct?

| | compounds which do not | colour of the precipitate |
|---|------------------------|---------------------------|
| | form a precipitate | which forms the slowest |
| Α | W and X | Cream |
| В | W and X | White |
| С | W and Y | Cream |
| D | W and Y | Yellow |

21 Compound **Q** is heated under reflux with an excess of acidified potassium dichromate (VI).



What could be the structure of the main organic product?



- **22** Compound **S** has the molecular formula $C_xH_yO_z$. It is tested with various reagents and gives the following results.
 - When S is treated with a reducing agent NaBH₄, it forms a product with the molecular formula C_xH_{y+2}O_z.
 - **S** can form a compound with molecular formula $C_xH_yO_{z+1}$ in a single reaction.
 - **S** gives a silver mirror with ammoniacal solution of silver nitrate.
 - **S** does not react with Na metal.

What conclusion can be drawn from these results?

- **A S** has a ketone functional group.
- **B S** has an aldehyde functional group.
- **C S** has a primary alcohol functional group.
- **D S** has both an aldehyde functional group and a ketone functional group.

23 Compound J reacts with alkaline aqueous iodine to form a yellow precipitate.Which is not a possible structure of Compound J?



24 What are the possible products that could be formed in the following reaction?



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

When an optically active sample of 2-chlorobutane is heated with aqueous KOH, the product, 2-butanol, is formed with an inversion of the chiral centre.



Which diagram represents the reaction profile for this mechanism?

26 Partial hydrolysis of insulin, the hormone essential for carbohydrate metabolism, gives the following tripeptide.

$$\begin{array}{c} \mathsf{CH}_2\mathsf{CH}_2\mathsf{CO}_2\mathsf{H}\\ \mathsf{I}\\ (\mathsf{CH}_3)_2\mathsf{CHCH}(\mathsf{NH}_2)\mathsf{CONHCHCONHCH}(\mathsf{CH}_3)\mathsf{CO}_2\mathsf{H} \end{array}$$

Which compound could be obtained by further hydrolysis of this tripeptide?

A $CH_3CH(CO_2H)_2$ B $(CH_3)_2CHCH(NH_2)CONH_2$ C $CH_2CH_2CO_2H$ D $CH_2(CO_2H)CH_2CH(NH_2)CONHCH(CH_3)CO_2H$ CID $CH_2(CO_2H)CH_2CH(NH_2)CONHCH(CH_3)CO_2H$

27 The amino acid phenylalanine exists as different ionic species depending on pH.



Which row could be correct?

| | рK _{а1} | pK _{a2} | Formula of phenylalanine ion at pH 7 |
|---|------------------|------------------|--------------------------------------|
| A | 2.2 | 9.3 | 0 +NH3 |
| в | 2.2 | 9.3 | O NH ₂ |
| с | 9.3 | 2.2 | O +NH ₃ OH |
| D | 9.3 | 2.2 | |

28 Use of the Data Booklet is relevant to this question.Which of the following are chemically stable when left to stand in the atmosphere?1 Bromine

- 2 A solution of tin(II) chloride, $SnCl_2$
- 3 A solution of vanadyl sulfate pentahydrate, VOSO₄.5H₂O
- 4 Zn metal
- A 1 and 2 only B 3 and 4 only C 1 and 3 only D 2 and 4 only
- **29** A hydrogen-oxygen fuel cell is constructed using 1.00 mol dm⁻³ sodium hydroxide as the electrolyte. What is the change in pH of the solution around each electrode when the current is flowing?



| | Cathode | Anode |
|---|----------|----------|
| Α | Increase | increase |
| В | Increase | decrease |
| С | Decrease | increase |
| D | Decrease | decrease |

porous electrodes

30 The following shows the relative wavelengths of some colours in the visible light spectrum.



When acidified hydrogen peroxide is added to a solution of $[Fe(CN)_6^{4-}]$, the colour of the solution changed from yellow to Prussian blue.

Given that wavelength and energy are inversely proportional, which of the following best accounts for what took place?

| | Number of d- | Energy gap between |
|---|-----------------|----------------------|
| | electrons in Fe | the d-orbitals in Fe |
| Α | change | decrease |
| В | change | increase |
| С | remain the same | decrease |
| D | remain the same | increase |

END OF PAPER