



ST. ANDREW'S JUNIOR COLLEGE  
JC2 PRELIMINARY EXAMINATIONS  
HIGHER 2

CANDIDATE

NAME

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CLASS

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**CHEMISTRY**

**9729/01**

Paper 1 Multiple Choice

**18 September 2025**

Candidate answer on the Optical Answer Sheet.

**1 hour**

Additional Materials: Data Booklet

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**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

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 Optical 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 **15** printed pages (including this cover page).

1 Which statement is correct?

**A** One mole of a compound is the amount that contains the same number of atoms as there are in 12.0 g of carbon-12.

**B** The relative isotopic mass of beryllium-9 is given by the following expression.

$$\frac{\text{average mass of all isotopes of beryllium}}{\frac{1}{12} \text{ the mass of one atom of } ^{12}\text{C}}$$

**C** The relative atomic mass of nitrogen is given by the following expression.

$$\frac{\text{average mass of one atom of nitrogen}}{\frac{1}{12} \text{ the mass of one atom of } ^{12}\text{C}}$$

**D** The relative molecular mass of Q is given by the following expression.

$$\frac{\text{average mass of one atom of Q}}{\frac{1}{12} \text{ the mass of one atom of } ^{12}\text{C}}$$

2 10 cm<sup>3</sup> of a gaseous hydrocarbon, C<sub>x</sub>H<sub>y</sub>, was exploded with an excess of oxygen. There was a contraction of 40 cm<sup>3</sup>. When the products were treated with aqueous sodium hydroxide, there was a further contraction of 50 cm<sup>3</sup>. All gas volumes were measured at room temperature and pressure.

What is the molecular formula of the hydrocarbon?

**A** C<sub>4</sub>H<sub>8</sub>

**B** C<sub>4</sub>H<sub>10</sub>

**C** C<sub>5</sub>H<sub>10</sub>

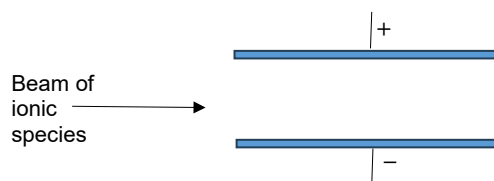
**D** C<sub>5</sub>H<sub>12</sub>

3 In which row are X and Y atoms or ions of different isotopes of the same element?

	X			Y		
	Number of electrons	Charge	Nucleon number	Number of electrons	Charge	Nucleon number
<b>A</b>	3	+3	12	9	−3	12
<b>B</b>	8	0	16	11	−1	19
<b>C</b>	10	+1	23	10	+1	24
<b>D</b>	18	−3	31	12	+3	31

Commented [SXF(1)]: Need table outline

- 4 Which particle will deflect the most when moving with the same speed through an electric field?



- A  ${}^7\text{Li}^+$       B  ${}^{11}\text{B}^{3+}$       C  ${}^{19}\text{F}^-$       D  ${}^{31}\text{P}^{3-}$
- 5 Which molecules are **not** polar?
- 1  $\text{H}_2\text{S}$       2  $\text{CS}_2$       3  $\text{SO}_2$       4  $\text{SF}_6$
- A 1 and 2  
B 2 and 4  
C 3 and 4  
D 4 only

- 6 A mixture consisting of gaseous compounds, S, T, U and V, is slowly cooled.

Gaseous Compound	$M_r$	Compound
S	72	$\text{CH}_3\text{CH}_2\text{COCH}_3$
T	74	$\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
U	72	$(\text{CH}_3)_4\text{C}$
V	72	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

In which order, from first to last, will the compounds condense to form their liquids?

- A  $\text{T} \rightarrow \text{S} \rightarrow \text{V} \rightarrow \text{U}$   
B  $\text{U} \rightarrow \text{V} \rightarrow \text{S} \rightarrow \text{T}$   
C  $\text{S} \rightarrow \text{T} \rightarrow \text{V} \rightarrow \text{U}$   
D  $\text{V} \rightarrow \text{U} \rightarrow \text{S} \rightarrow \text{T}$

Commented [SXF(2)]: I added comma

7 Which equation corresponds to the enthalpy change stated?

- |          |   |  |
|----------|---|--|
| <b>A</b> | $\text{S}_8(\text{s}) + 12\text{O}_2(\text{g}) \rightarrow 8\text{SO}_3(\text{l})$  | $\Delta H^\ominus_{\text{formation}}(\text{SO}_3(\text{l}))$         |
| <b>B</b> | $\text{CaCl}_2(\text{s}) + \text{aq} \rightarrow \text{Ca}^{2+}(\text{g}) + 2\text{Cl}^-(\text{g})$   | $\Delta H^\ominus_{\text{solution}}(\text{CaCl}_2(\text{s}))$        |
| <b>C</b> | $2\text{Fe}^{3+}(\text{g}) + 3\text{O}^{2-}(\text{g}) \rightarrow \text{Fe}_2\text{O}_3(\text{s})$  | $H^\ominus_{\text{lattice energy}}(\text{Fe}_2\text{O}_3(\text{s}))$ |
| <b>D</b> | $\text{H}_2\text{SO}_4(\text{aq}) + \text{Ca}(\text{OH})_2(\text{aq}) \rightarrow \text{CaSO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$ | $\Delta H^\ominus_{\text{neutralisation}}$                           |

Commented [SXF(3)]: Which equation corresponds to

Commented [SXF(4)]: Alignment

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

A student mixes  $20.0 \text{ cm}^3$  of  $5.00 \text{ mol dm}^{-3}$  sulfuric acid with an equal volume of  $6.00 \text{ mol dm}^{-3}$  sodium hydroxide. The initial temperature of both solutions is  $25.0^\circ\text{C}$ . The maximum temperature reached after the reaction is  $55.0^\circ\text{C}$ . Assume the density of both solutions is  $1 \text{ g cm}^{-3}$ .

What is the value of the enthalpy change of neutralisation, in  $\text{kJ mol}^{-1}$ , calculated using these values?

- A**  $-41.8$   
**B**  $-50.2$   
**C**  $-83.6$   
**D**  $-100.3$

Commented [SXF(5)]: Neutralisation and I included the units cos the A level qns has the units in the options

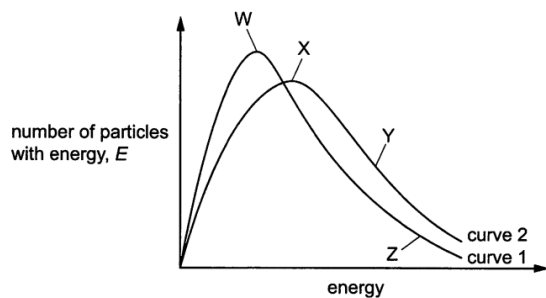
9 The half-life of the first-order gaseous reaction in which  $\text{M}_2$  molecules become converted into M atoms is 40 minutes. 1 mol of  $\text{M}_2$  is put into a sealed vessel at pressure  $p$ .

What will be true when 87.5% of  $\text{M}_2$  has been converted into M atoms?

- 1 80 minutes have elapsed.
- 2 1.5 mol of M have been formed.
- 3 The total pressure is  $\frac{15}{8}p$  (at constant pressure).

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

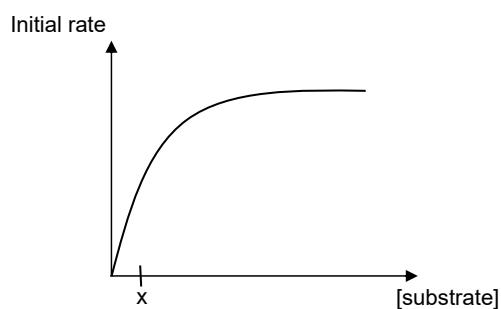
- 10 Curves 1 and 2 show the Boltzmann distributions for identical compositions of a reaction mixture which occur at different temperatures.



Which statement is correct?

- A Curve 1 applies to the faster reaction and point W indicates particles with lower energy than point Z.
- B Curve 1 applies to the faster reaction and point W indicates particles with higher energy than point Z.
- C Curve 2 applies to the faster reaction and point X indicates particles with lower energy than point Y.
- D Curve 2 applies to the faster reaction and point X indicates particles with higher energy than point Y.

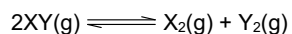
- 11 The graph shows how the initial rate of reaction varies for an enzyme catalysed reaction as the substrate concentration changes.



Which of the statements correctly describe the situation when  $[\text{substrate}] = x$ ?

- 1 The initial rate of reaction is affected by increasing  $[\text{substrate}]$ .
- 2 The order of reaction with respect to  $[\text{substrate}]$  is 1.
- 3 There are no more enzyme active sites available.

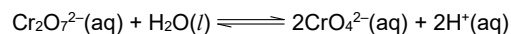
- A 1, 2 and 3  
 B 1 and 2 only  
 C 2 and 3 only  
 D 3 only
- 12 A sample of 1 mol of XY was placed in an empty  $1 \text{ dm}^3$  container and allowed to reach equilibrium with a total pressure,  $p$ , according to the following equation.



At equilibrium,  $x$  mol of XY had dissociated. What is the value of the equilibrium constant,  $K_p$ , at the temperature of the experiment?

- A  $\frac{x^2}{(1-x)^2}$   
 B  $\frac{(1-x)^2}{x^2}$   
 C  $\frac{4(1-x)^2}{x^2}$   
 D  $\frac{x^2}{4(1-x)^2}$

- 13 Orange dichromate(VI),  $\text{Cr}_2\text{O}_7^{2-}$ , and yellow chromate(VI) ions,  $\text{CrO}_4^{2-}$ , exist in equilibrium in aqueous solution.



Which statement about this equilibrium is correct?

- A Lowering the pH will increase concentration of  $\text{CrO}_4^{2-}$  ions.
- B Addition of a catalyst will shift the position of equilibrium to the left.
- C Addition of water will shift the position of equilibrium to the left.
- D In strong alkali, the solution appears yellow.

Commented [NHs(6): Changed this from full stop to question mark

- 14 The table shows the fifth ionisation energies of four consecutive elements in the Periodic Table.

Element	E	F	G	H
Fifth IE / $\text{kJmol}^{-1}$	37832	9445	10989	13327

What is the formula of the chloride of E?

- A  $\text{ECl}_2$
- B  $\text{ECl}_3$
- C  $\text{ECl}_4$
- D  $\text{ECl}_5$

- 15 Which pair contains an Arrhenius acid and Arrhenius base?

	Acid	Base
A	$\text{KCl}$	$\text{NaOH}$
B	$\text{HCl}$	$\text{KOH}$
C	$\text{CH}_3\text{COOH}$	$\text{NH}_3$
D	$\text{H}_2\text{SO}_4$	$\text{NH}_3$

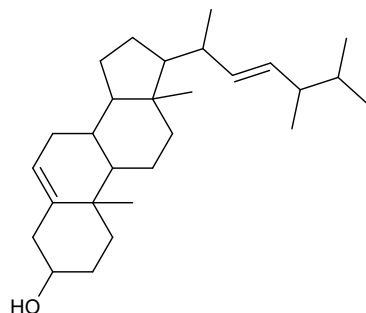
- 16 An excess of silver bromide is added to water and the mixture is shaken until equilibrium is reached.

How is the solubility of silver bromide, in this equilibrium mixture, affected by the addition of either

- aqueous ammonia or
- aqueous potassium bromide?

	addition of aqueous ammonia	addition of aqueous potassium bromide
<b>A</b>	decreases	decreases
<b>B</b>	decreases	increases
<b>C</b>	increases	increases
<b>D</b>	increases	decreases

- 17 Brassicasterol is a plant sterol found in sources like rapeseed oil and marine algae.



brassicasterol

How many stereoisomers does brassicasterol have?

- A**  $2^9$
- B**  $2^{10}$
- C**  $2^{11}$
- D**  $2^{12}$



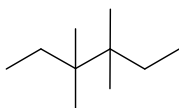
- 18 In the free radical substitution of 2-methylbutane with chlorine, a mixture of mono-chlorinated compounds was obtained.

Assuming the rate of reaction at all the carbon atoms are the same, which statements are correct?

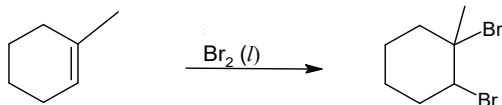
- 1 The ratio for the two compounds with the highest yields is 2:1.
- 2 Homolytic fission only occurs in the initiation step.

3

One of the products formed in this reaction is

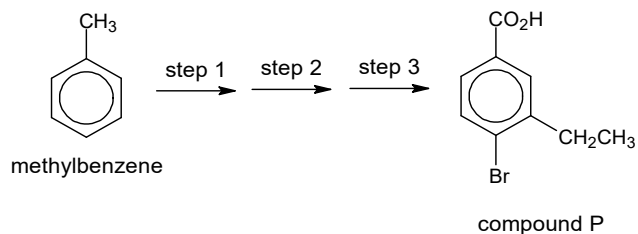


- A 1 and 2 only  
 B 1 and 3 only  
 C 2 and 3 only  
 D 1 only
- 19 Which statement about this reaction is correct?



- A The product as shown above is the major product when  $\text{Br}_2(\text{aq})$  is used instead.  
 B Electrons in the carbon-carbon  $\sigma$  bond are donated to an electrophile.  
 C The carbocation has the same hybridisation state as the C in the  $\text{C}=\text{C}$ .  
 D A primary carbocation is formed in this reaction.

- 20 Compound P can be synthesised from methylbenzene as shown below.



Which of the following could be a possible sequence for converting methylbenzene to compound P?

- |          | Step 1  | Step 2   | Step 3   |
|----------|---|--|--|
| <b>A</b> | $\text{CH}_3\text{CH}_2\text{Cl}$ , $\text{AlCl}_3$ | $\text{Br}_2$ , $\text{AlBr}_3$ , dark                     | Hot acidified $\text{KMnO}_4$                              |
| <b>B</b> | $\text{Br}_2$ , $\text{AlBr}_3$ , dark              | Hot acidified $\text{KMnO}_4$                              | $\text{CH}_3\text{CH}_2\text{Cl}$ , $\text{AlCl}_3$ , heat |
| <b>C</b> | $\text{Br}_2$ , $\text{AlBr}_3$ , dark              | $\text{CH}_3\text{CH}_2\text{Cl}$ , $\text{AlCl}_3$        | Hot acidified $\text{KMnO}_4$                              |
| <b>D</b> | Hot acidified $\text{KMnO}_4$                       | $\text{CH}_3\text{CH}_2\text{Cl}$ , $\text{AlCl}_3$ , heat | $\text{Br}_2$ , $\text{AlBr}_3$ , dark                     |
- 21 Equal amounts of compounds X, Y and Z were heated with ethanolic silver nitrate in three separate test-tubes. After some time, the precipitate formed in each test-tube, if any, was filtered, dried and weighed.

Compound X produced the largest mass of precipitate in the shortest time, while compound Z did not produce any precipitate.

Which of the following could be the identities of X, Y and Z?

- |          | X | Y | Z |
|----------|---|---|---|
| <b>A</b> |   |   |   |
| <b>B</b> |   |   |   |
| <b>C</b> |   |   |   |
| <b>D</b> |   |   |   |

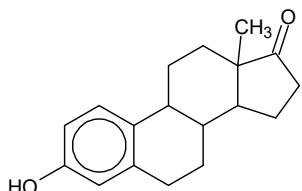
22 Compound W has the empirical formula  $\text{CH}_2\text{O}$  and has the following properties.

- It gives a yellow precipitate when warmed with alkaline aqueous iodine.
- White fumes are produced when it is heated with  $\text{PCl}_3$ .

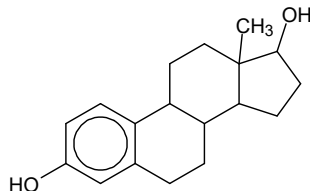
What could W be?

- A  $\text{CH}_3\text{CO}_2\text{H}$   
 B  $\text{CH}_3\text{CH}(\text{OH})\text{CO}_2\text{H}$   
 C  $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CO}_2\text{H}$   
 D  $\text{HO}_2\text{CCH}_2\text{CH}(\text{OH})\text{CH}_2\text{OH}$

23 Two female sex hormones are oestrone and oestradiol.



oestrone



oestradiol

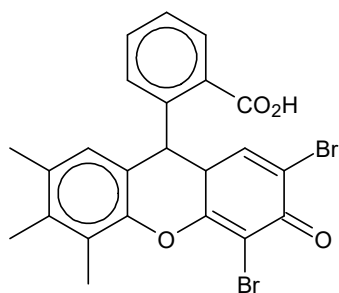
Which of the following reagents could be used to distinguish between the two hormones?

- 1 Acidified aqueous  $\text{K}_2\text{Cr}_2\text{O}_7$
- 2 Acidified aqueous  $\text{KMnO}_4$
- 3 Aqueous alkaline iodine

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

Commented [SXF(7): I don't think it is in the syllabus that they need to know  $\text{SOCl}_2$ . Change to  $\text{PCl}_5$

- 24 The classic red colour from many lipsticks are obtained from pigments and dyes, such as the compound, eosin. Eosin reacts with proteins of the skin to produce a deep red colour.



Eosin

Eosin was reduced separately by  $\text{NaBH}_4$  and by  $\text{H}_2$  with Pt.

What is the number of hydrogen atoms added to each molecule of eosin?

	$\text{NaBH}_4$	$\text{H}_2$ with Pt
<b>A</b>	2	4
<b>B</b>	2	6
<b>C</b>	4	4
<b>D</b>	4	6

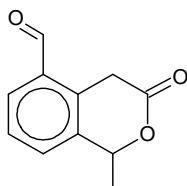
Commented [JY8]: Rephrase. Should not use + in prose.

- 25 Compound X reacts with  $[\text{Ag}(\text{NH}_3)_2]^+$ , but not with alkaline  $\text{Cu}^{2+}$ .

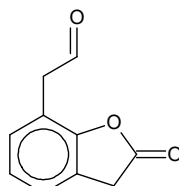
Upon warming X with alkaline aqueous iodine, a yellow precipitate is observed.

What could X be?

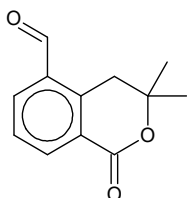
A



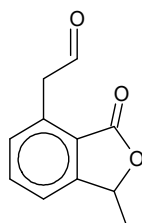
B



C

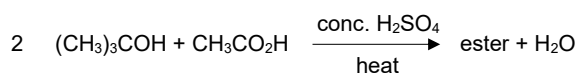
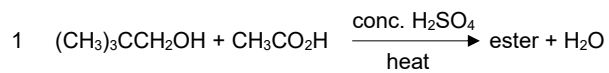


D



- 26 The ester 2,2-dimethylpropyl ethanoate is found in rare flowers and has a very strong scent.

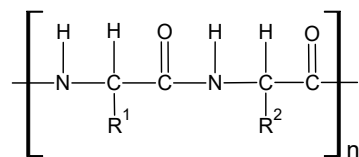
How may this ester be made in the laboratory?



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

[Turn Over

- 27 The diagram below shows the general structure of a protein.



Chymotrypsin is an enzyme that hydrolyses protein into smaller peptides and amino acids. It specifically hydrolyses the peptide bond on the carboxylic end of phenylalanine (Phe).

The structure of hexapeptide Y and the  $M_r$  of selected amino acids are given below.

Hexapeptide Y: Val–Ala–Lys–Phe–Ser–Arg

Amino acid	$M_r$
Valine (Val)	117
Alanine (Ala)	89
Lysine (Lys)	146
Phenylalanine (Phe)	165
Ser (Serine)	105
Arginine (Arg)	174

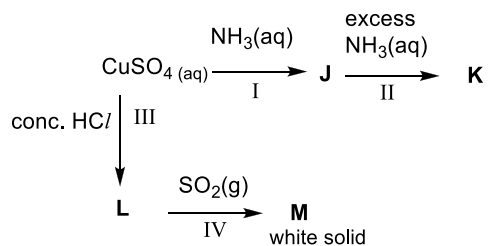
What are the  $M_r$  of the two fragments obtained when hexapeptide Y is hydrolysed by chymotrypsin?

	$M_r$ of fragment 1	$M_r$ of fragment 2
<b>A</b>	517	279
<b>B</b>	463	261
<b>C</b>	316	408
<b>D</b>	352	444

- 28 Which factors determine the number of atoms of nickel deposited on the cathode of an electrolytic cell?

	$[\text{Ni}^{2+}(\text{aq})]$	current	time
<b>A</b>	✓	✓	✓
<b>B</b>	✓	✓	x
<b>C</b>	x	✓	x
<b>D</b>	x	✓	✓

- 29 Copper(II) sulfate solution reacted as shown in the scheme below.



Which of the following statements is correct?

- A  $\text{NH}_3$  functions as a ligand in reaction I.
- B The coordination number of complex **L** is 6.
- C The oxidation number of Cu in **L** and **M** is the same.
- D Ligand exchange has taken place in reaction II.

- 30 Which of the following statements about manganese are correct?

- 1 Manganese have a greater number of oxidation states than titanium.
- 2 Aqueous solution of  $\text{Mn}^{3+}$  is acidic.
- 3  $\text{Mn}^{3+}$  can catalyse the reaction between  $\text{S}_2\text{O}_8^{2-}(\text{aq})$  and  $\text{I}^-(\text{aq})$ .

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

END OF PAPER