



NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE
NAME

SUBJECT
CLASS

REGISTRATION
NUMBER

CHEMISTRY

Paper 1 Multiple Choice

9729/01

23 September 2025
1 hour

Additional Materials: Optical Answer Sheet
 Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, subject class 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 booklet.

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

Instructions on how to fill in the Optical Mark Sheet

Shade the index number in a 5 digit format on the optical mark sheet:

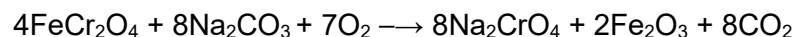
2nd digit and the last 4 digits of the Registration Number.

Example:

Student	Examples of Registration No.	Shade:
	<u>2405648</u>	45648

This document consists of **12** printed pages.

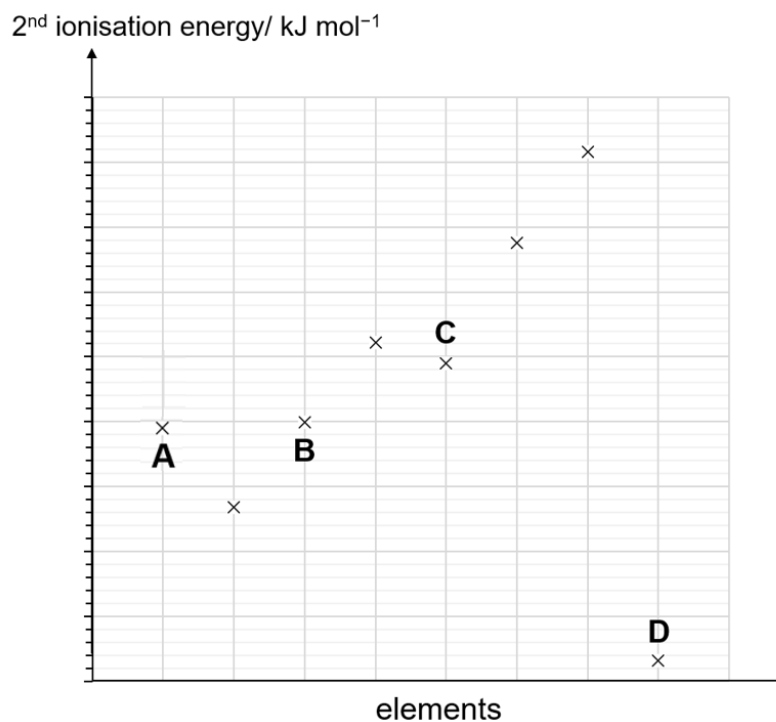
- 1 Sodium chromate(VI), Na_2CrO_4 , is manufactured by heating chromite, FeCr_2O_4 , with sodium carbonate in an oxidising atmosphere. Chromite contains $\text{Cr}_2\text{O}_4^{2-}$ ions.



What happens in this reaction?

- A Chromium and iron are the only elements oxidised.
- B Chromium, iron and carbon are oxidised.
- C Only chromium is oxidised.
- D Only iron is oxidised.
- 2 Which species has two unpaired electrons?
- A B^+ B Cu^+ C Mg D S
- 3 The variation in the second ionisation energy of eight consecutive elements in the Periodic Table with atomic numbers ≤ 20 is shown in the graph.

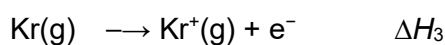
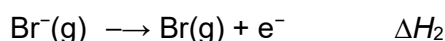
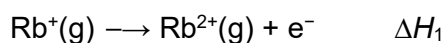
Which element is a Group 13 element?



4 What do the ions $^{15}\text{N}^{3-}$ and $^{14}\text{C}^{4-}$ have in common?

- A They have 10 neutrons in their nuclei.
- B They have more electrons than neutrons.
- C They have a valence electronic configuration of $3s^2 3p^6$.
- D They contain the same number of nucleons in their nuclei.

5 What is the order of decreasing enthalpy change for the three reactions shown?



- A $\Delta H_1 > \Delta H_2 > \Delta H_3$
- B $\Delta H_1 > \Delta H_3 > \Delta H_2$
- C $\Delta H_2 > \Delta H_1 > \Delta H_3$
- D $\Delta H_2 > \Delta H_3 > \Delta H_1$

6 Barium dithionate, $\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$, is soluble in water.

$\text{S}_2\text{O}_6^{2-}$ ions slowly decompose in acidic solution.



3.513 g of $\text{BaS}_2\text{O}_6 \cdot 2\text{H}_2\text{O}$ is dissolved in some water and the solution made up to the mark with $\text{HCl}(\text{aq})$ in a 100 cm^3 volumetric flask.

At time x min, a white precipitate of mass 0.661 g is present in the flask.

What is the concentration of BaS_2O_6 in the volumetric flask at time x min?

[A_r : Ba, 137.3; S, 32.1; O, 16.0; H, 1.0]

- A $0.0077 \text{ mol dm}^{-3}$
- B $0.0090 \text{ mol dm}^{-3}$
- C $0.077 \text{ mol dm}^{-3}$
- D $0.090 \text{ mol dm}^{-3}$

- 7 $\text{NH}_4\text{Fe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ is a hydrated 'double salt'. A student analyses this double salt using the following chemical tests.

Which row gives the correct result for the stated test?

	Test	Results
1	Reaction with cold $\text{NaOH}(\text{aq})$	Green ppt
2	Reaction with $\text{Ba}(\text{NO}_3)_2(\text{aq})$	White ppt
3	Reaction with warm $\text{NaOH}(\text{aq})$	Red-brown ppt and an alkaline gas

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

- 8 Which statements about BF_3 and NF_3 are correct?

- 1 The shape of BF_3 is trigonal planar while that of NF_3 is trigonal pyramidal.
- 2 Both BF_3 and NF_3 are polar molecules.
- 3 BF_3 can act as a Lewis acid because the boron atom has empty low-lying orbitals.

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

- 9 Silicon carbide has a similar structure to diamond.

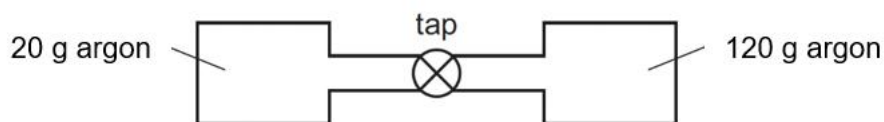
Silicon carbide can be used as

- A** a lubricant.
B a tip for cutting tools.
C a substitute for pencil 'lead'.
D an electrical conductor.

- 10 Which statement is **not** a basic assumption of the kinetic theory of gases?

- A** The atoms or molecules have negligible size in comparison with the space they occupy.
B There are negligible intermolecular forces between the gas particles.
C Collisions between the individual particles and the vessel are perfectly elastic.
D The particles of a given gas have the same kinetic energy at a given temperature.

- 11 The diagram below shows two containers of argon gas connected by a closed tap. Each container has a volume of 500 dm^3 .



The temperature of the system is changed to 250°C and the tap is opened.

What is the pressure of argon within the system at 250°C ?

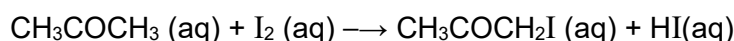
- A** 7.29 kPa **B** 14.6 kPa **C** 15.3 kPa **D** 30.5 kPa
- 12 The standard enthalpy change of combustion of but-1-ene, $\text{CH}_2=\text{CHCH}_2\text{CH}_3(\text{g})$, is $x \text{ kJ mol}^{-1}$.
The standard enthalpy change of the reaction $2\text{C}_2\text{H}_4(\text{g}) \longrightarrow \text{CH}_2=\text{CHCH}_2\text{CH}_3(\text{g})$ is $y \text{ kJ mol}^{-1}$.
What is the standard enthalpy change of combustion of ethene, $\text{C}_2\text{H}_4(\text{g})$?

- A** $\frac{x}{2} + y \text{ kJ mol}^{-1}$
- B** $x + \frac{y}{2} \text{ kJ mol}^{-1}$
- C** $\frac{x + y}{2} \text{ kJ mol}^{-1}$
- D** $\frac{x - y}{2} \text{ kJ mol}^{-1}$

- 13 Which suggested mechanism is consistent with the experimentally-obtained rate equation?

	rate equation	suggested mechanism
A	$\text{rate} = k[\text{N}_2\text{O}][\text{H}_2]$	$2\text{NO} + \text{H}_2 \longrightarrow \text{N}_2\text{O} + \text{H}_2\text{O}$ $\text{N}_2\text{O} + \text{H}_2 \xrightarrow{\text{slow}} \text{N}_2 + \text{H}_2\text{O}$
B	$\text{rate} = k[\text{NO}]^2[\text{H}_2]^2$	$2\text{NO} + \text{H}_2 \longrightarrow \text{N}_2\text{O} + \text{H}_2\text{O}$ $\text{N}_2\text{O} + \text{H}_2 \xrightarrow{\text{slow}} \text{N}_2 + \text{H}_2\text{O}$
C	$\text{rate} = k[\text{H}_2\text{O}_2][\text{I}^-]$	$\text{H}_2\text{O}_2 + \text{I}^- \longrightarrow \text{IO}^- + \text{H}_2\text{O}$ $\text{H}_2\text{O}_2 + \text{IO}^- \xrightarrow{\text{slow}} \text{I}^- + \text{H}_2\text{O} + \text{O}_2$
D	$\text{rate} = k[\text{H}_2\text{O}_2][\text{IO}^-]$	$\text{H}_2\text{O}_2 + \text{I}^- \longrightarrow \text{IO}^- + \text{H}_2\text{O}$ $\text{H}_2\text{O}_2 + \text{IO}^- \xrightarrow{\text{slow}} \text{I}^- + \text{H}_2\text{O} + \text{O}_2$

- 14 Propanone reacts with iodine in the presence of sulfuric acid.



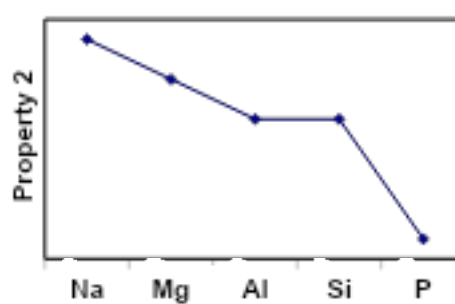
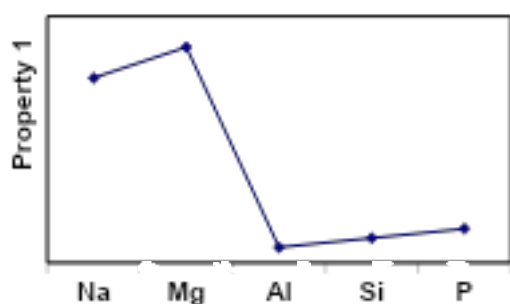
The rate equation for this reaction is: $\text{rate} = k[\text{H}^+][\text{CH}_3\text{COCH}_3]$.

Two experiments were carried out. In both experiments, the initial concentrations of propanone and iodine remained the same but the initial concentration of the sulfuric acid was changed. The initial rate in the first experiment was three times faster than the initial rate in the second experiment. In the first experiment the initial pH was 1.50.

What is the initial pH in the second experiment?

- A** 1.02 **B** 1.98 **C** 2.28 **D** 4.50
- 15 Which factor contributes to $\text{Ba}(\text{NO}_3)_2$ decomposing at a higher temperature than $\text{Mg}(\text{NO}_3)_2$?
- A** The charge density of the Ba^{2+} ion is lower than that of the Mg^{2+} ion.
- B** The standard enthalpy change of formation of BaO is more negative than that of MgO .
- C** The lattice energy of $\text{Ba}(\text{NO}_3)_2$ is less negative than that of $\text{Mg}(\text{NO}_3)_2$.
- D** The melting point of $\text{Ba}(\text{NO}_3)_2$ is higher than that of $\text{Mg}(\text{NO}_3)_2$.

- 16 Which statement explains the trend of decreasing volatility from HCl to HI ?
- A The electronegativity between the bonded atoms increases.
- B The molecules are polar and they have increasingly stronger permanent dipole-permanent dipoles.
- C There are more electrons in iodine atom than in chlorine atom.
- D The bond length decreases from H-Cl to H-I , hence thermal stability increases.
- 17 The graphs below show the variation of two properties of some Period 3 elements and/or their compounds.



Which option correctly describes properties 1 and 2?

	Property 1	Property 2
A	atomic radius of the elements	electrical conductivity of the elements
B	boiling point of the chlorides at the highest oxidation states	pH of the oxides when added to water
C	melting point of the oxides	first ionisation energies of the elements
D	electrical conductivity of elements	pH of the chlorides at the highest oxidation states when added to water

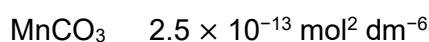
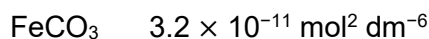
- 18 10.0 cm^3 of $0.100 \text{ mol dm}^{-3}$ of dilute sodium hydroxide was titrated against $0.100 \text{ mol dm}^{-3}$ of dilute ethanoic acid.

What is the volume of dilute ethanoic acid required to produce a buffer with maximum buffering capacity?

- A 5.00 cm^3 B 10.00 cm^3 C 15.00 cm^3 D 20.00 cm^3

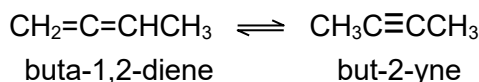
- 19 An acidified solution contains CaCl_2 , FeCl_2 and MnCl_2 , each of concentration 0.10 mol dm^{-3} . Carbon dioxide is blown through the solution until it is saturated with carbon dioxide at 25°C . The concentration of $\text{CO}_3^{2-}(\text{aq})$ in the saturated solution reaches $1 \times 10^{-9} \text{ mol dm}^{-3}$.

The value of the solubility product, K_{sp} , of each of the carbonates at 25°C is given below.



Which statement describes what happens in the solution?

- A Only CaCO_3 and FeCO_3 are precipitated.
 B Only CaCO_3 is precipitated.
 C Only MnCO_3 and FeCO_3 are precipitated.
 D Only MnCO_3 is precipitated.
- 20 Buta-1,2-diene and but-2-yne both have the same molecular formula, C_4H_6 . They exist in equilibrium as shown:



Which bond is present in buta-1,2-diene but **not** present in but-2-yne?

- A a σ bond formed by s – sp overlap
 B a π bond formed by p – p overlap
 C a σ bond formed by sp – sp^2 overlap
 D a σ bond formed by sp^2 – sp^2 overlap
- 21 The chlorofluorocarbon, CCl_2F_2 , can cause the breakdown of ozone in the upper atmosphere. Which initiation step could occur with ultraviolet radiation to catalyse this breakdown?

- A $\text{CCl}_2\text{F}_2 \rightarrow \cdot\text{C} + \cdot\text{Cl}_2\text{F}_2$
 B $\text{CCl}_2\text{F}_2 \rightarrow \cdot\text{F} + \cdot\text{CCl}_2\text{F}$
 C $\text{CCl}_2\text{F}_2 \rightarrow \cdot\text{Cl} + \cdot\text{CClF}_2$
 D $\text{CCl}_2\text{F}_2 \rightarrow \cdot\text{Cl}_2 + \cdot\text{CF}_2$

22 Which hydrocarbons undergo substitution reactions to form only one monochloro-derivative?

- 1 cyclobutane
- 2 2,2-dimethylpropane
- 3 2-methylpropane

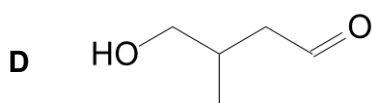
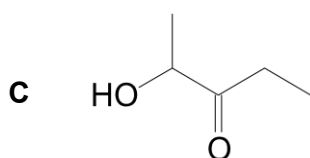
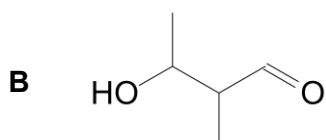
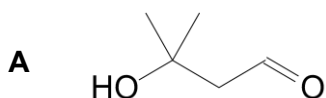
A 1 and 2 only **B** 2 and 3 only **C** 1 and 3 only **D** 1, 2 and 3

23 The alkene 2,4-dimethylpenta-1,3-diene reacts with two moles of HBr to give **X** as the major product.

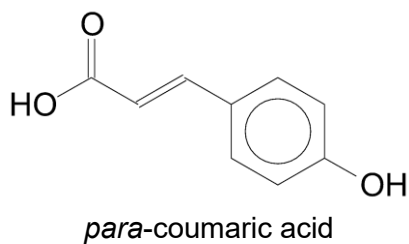
What is the structure of **X**?

- A** $\text{CH}_2\text{BrCH}(\text{CH}_3)\text{CH}_2\text{CBr}(\text{CH}_3)_2$
- B** $\text{CH}_2\text{BrCH}(\text{CH}_3)\text{CHBrCH}(\text{CH}_3)_2$
- C** $(\text{CH}_3)_2\text{CBrCHBrCH}(\text{CH}_3)_2$
- D** $(\text{CH}_3)_2\text{CBrCH}_2\text{CBr}(\text{CH}_3)_2$

24 Which compound can form an organic product with molecular formula $\text{C}_5\text{H}_8\text{O}_2$ when heated with excess acidified potassium dichromate(VI)?



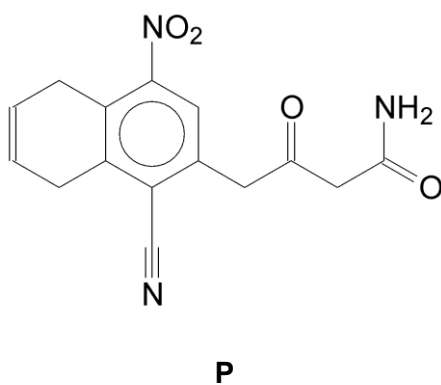
- 25 *Para*-coumaric acid is an antioxidant in coffee.



When treated with aqueous bromine, what is the maximum number of bromine atoms that can be incorporated into a molecule of *para*-coumaric acid?

- A** 2 **B** 3 **C** 4 **D** 5

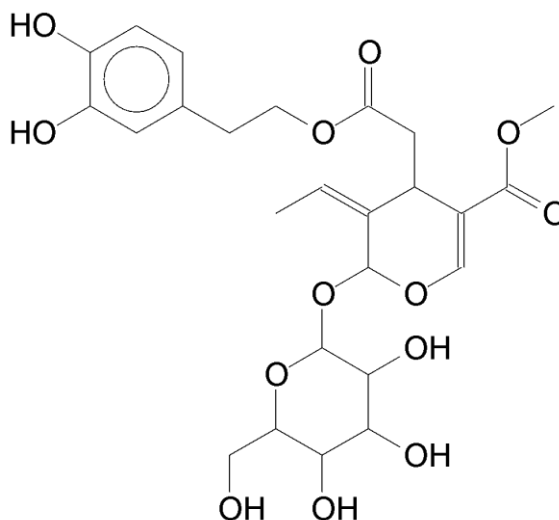
- 26



When treated with each of the respective reagents, what is the number of hydrogen atoms that can be incorporated into a molecule of **P**?

	H ₂ , Ni	LiAlH ₄ in dry ether	NaBH ₄ in ethanol
A	6	6	4
B	6	8	4
C	8	6	2
D	8	8	2

- 27** Biophenols derived from olives are used as traditional remedies for a variety of conditions, including inflammatory states and cardiovascular diseases. Oleuropein is the most well-known compound of this family and is present in olive tree leaves. Oleuropein has the following structure:



Which statement about oleuropein is correct?

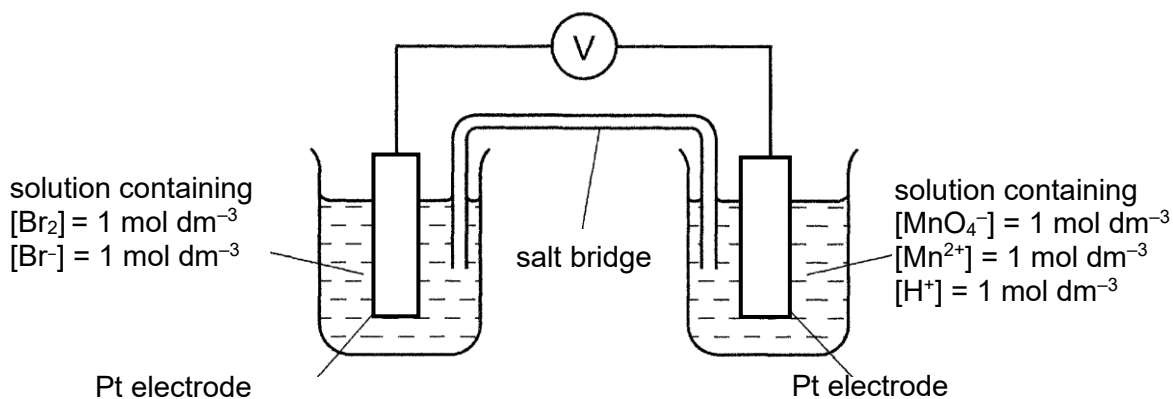
- A** It does not decolourise cold alkaline KMnO_4 .
- B** It reacts with Na_2CO_3 to liberate CO_2 gas.
- C** A product containing 9 chiral centers is formed when 1 mole of oleuropein reacts with excess H_2 gas in the presence of platinum.
- D** 6 moles of HCl are formed when 1 mole of oleuropein reacts with excess PCl_5 at room temperature.
- 28** Methyl ethanoate, $\text{CH}_3\text{OCOCH}_3$ undergoes acidic hydrolysis in the presence of H_2^{18}O .

Which products are formed?

- 1 $\text{CH}_3^{18}\text{OH}$
- 2 $\text{CH}_3\text{CO}^{18}\text{OH}$
- 3 CH_3OH

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

- 29 Use of the Data Booklet is relevant to this question.
The following electrochemical cell was set up at 25 °C.



Which of the following statements are true?

- 1 When silver nitrate crystals are added to the Br_2/Br^- half cell, E_{cell} becomes less positive.
- 2 The ΔG° of the above reaction is -434 kJ mol^{-1} .
- 3 Addition of water to the $\text{MnO}_4^-/\text{Mn}^{2+}$ half-cell has no effect on the E_{cell} of the cell.

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

- 30 When crystalline potassium chromate(VI), K_2CrO_4 , was dissolved in water, a yellow solution **P** was formed. The addition of dilute sulfuric acid to **P** gave an orange solution **Q**.

When hydrogen sulfide, H_2S , was bubbled through solution **Q**, the solution changed colour and gave a solution **R**, with a yellow solid.

Which process does **not** occur in this sequence?

- A** Ligand exchange reaction
- B** Acid-base reaction
- C** Redox reaction
- D** Precipitation reaction