

**RAFFLES INSTITUTION  
2025 YEAR 6 PRELIMINARY EXAMINATION**

**Higher 2**



**CHEMISTRY**

**Paper 1 Multiple Choice**

**9729/01**

**26 September 2025**

**1 hour**

Additional Materials:     Multiple Choice Answer Sheet  
                                     Data Booklet

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**READ THESE INSTRUCTIONS FIRST**

**Do not open this question booklet until you are told to do so.**

Write in soft pencil.

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

Write your name, class and index number in the spaces provided on the Answer Sheet.

There are **thirty** questions in 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 the question booklet.

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

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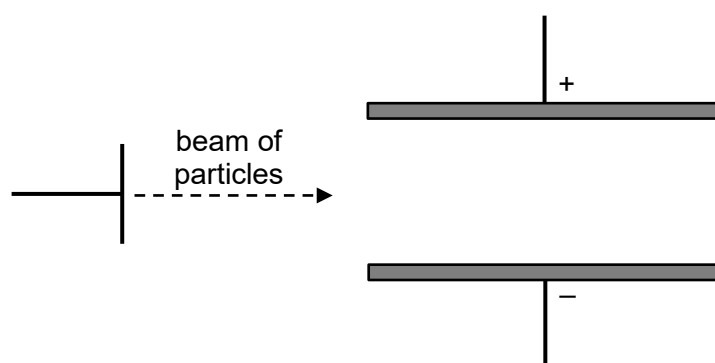
This document consists of **13** printed pages and **1** blank page.

- 1 *Use of the Data Booklet is relevant to this question.*

What are the numbers of electrons and neutrons in the  $^{37}\text{Cl}^+$  ion?

|          | electrons | neutrons |
|----------|-----------|----------|
| <b>A</b> | 16        | 20       |
| <b>B</b> | 16        | 37       |
| <b>C</b> | 17        | 20       |
| <b>D</b> | 17        | 37       |

- 2 In two separate experiments, a beam of  $^{17}\text{O}^+$  ions and a beam of  $[^{16}\text{O}^{18}\text{O}]^{2-}$  ions, travelling at the same velocity, pass through an electric field as shown.

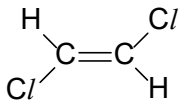
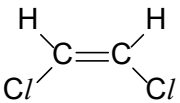


Which statements are correct?

- 1 The  $[^{16}\text{O}^{18}\text{O}]^{2-}$  ions are deflected to a larger extent than the  $^{17}\text{O}^+$  ions.
- 2 The  $[^{16}\text{O}^{18}\text{O}]^{2-}$  ions are deflected in the opposite direction to the  $^{17}\text{O}^+$  ions.
- 3 The beam of  $^{17}\text{O}^+$  ions travels in a straight path towards the negatively charged plate.

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

- 3 The table shows the structural formulae of three compounds.

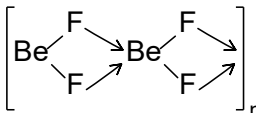
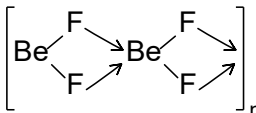
| compound            | P                                                                                 | Q                                                                                  | R                                                               |
|---------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| structural formulae |  |  | CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub> |

What is the correct order of **increasing** boiling point of these compounds?

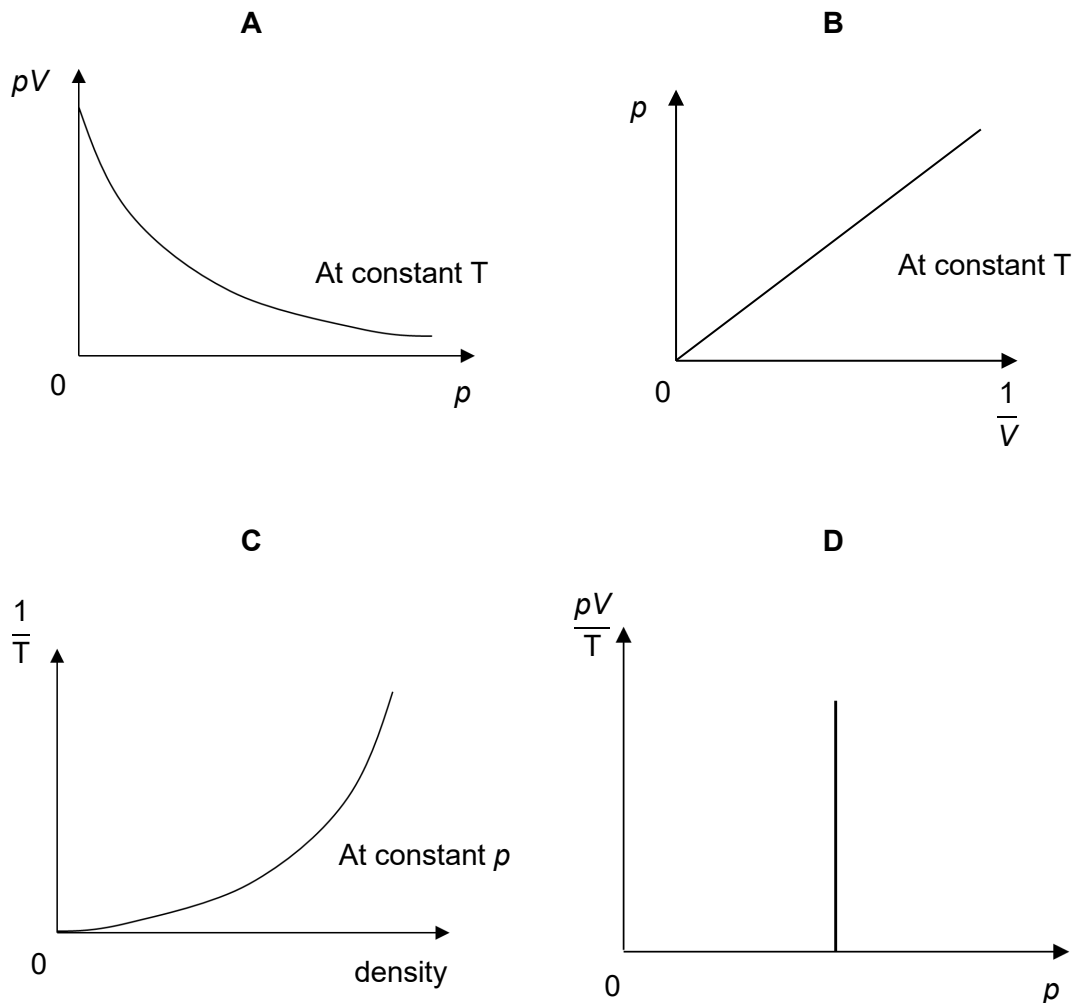
- A** P → Q → R  
**B** P → R → Q  
**C** R → P → Q  
**D** R → Q → P
- 4 Beryllium is the first member of Group 2 and forms covalent compounds which are said to be electron deficient. In many ways, beryllium resembles aluminium.

Which statement regarding compounds of beryllium is correct?

- A** BeF<sub>2</sub> acts as a Lewis base when it reacts with NH<sub>3</sub> to form the BeF<sub>2</sub>•NH<sub>3</sub> adduct.  
**B** BeF<sub>2</sub>•NH<sub>3</sub> is a planar molecule.  
**C** BeF<sub>4</sub><sup>2-</sup> contains two co-ordinate bonds.

- D**

 The  polymer cannot form hydrogen bonds with H<sub>2</sub>O.

- 5 Which graph correctly describes the behaviour of a fixed mass of an ideal gas?  
[T is measured in K.]



- 6 Elements X, Y and Z are in Period 3 of the Periodic Table.

- X has the highest melting point among all the Period 3 elements.
- The chloride of Y has the highest pH among all the Period 3 chlorides when dissolved in water.
- Z has the largest ionic radius among all the Period 3 elements.

Which statement is correct?

- A** Y has a smaller atomic radius than Z.
- B** Y has a lower electrical conductivity than X.
- C** X has a higher first ionisation energy than Z.
- D** X has a higher electronegativity value than Y.

- 7 Which statement about the behaviour of the Group 2 elements from magnesium to barium is correct?

**A** The reducing power decreases.  
**B** The reactivity with cold water decreases.  
**C** The thermal stability of the metal carbonate increases.  
**D** The magnitude of the enthalpy of hydration of the metal ion increases.

- 8 0.015 mol of  $\text{NO}_2$  reacts completely with  $\text{H}_2\text{O}$  to form 0.010 mol of  $\text{HNO}_3$  and a nitrogen-containing compound.

What could be the identity of the nitrogen-containing compound?

**A**  $\text{NH}_3$                       **B**  $\text{NO}$                       **C**  $\text{HNO}_2$                       **D**  $\text{N}_2\text{O}_3$

- 9 The relative abundances of the isotopes of chromium are given below.

| $^{50}\text{Cr}$ | $^{52}\text{Cr}$ | $^{53}\text{Cr}$ | $^{54}\text{Cr}$ |
|------------------|------------------|------------------|------------------|
| 4.3%             | 83.8%            | 9.5%             | 2.4%             |

What is the relative atomic mass of chromium calculated from these data?

**A** 51.9                      **B** 52.1                      **C** 52.2                      **D** 52.4

- 10 Which process is always endothermic?

- 1 the sublimation of a solid
- 2 the combustion of a fuel
- 3 the hydration of a gaseous ion

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

- 11 The following table shows the lattice energies for two silver halides.

| compound | theoretical lattice energy /<br>kJ mol <sup>-1</sup> | experimental lattice energy /<br>kJ mol <sup>-1</sup> |
|----------|------------------------------------------------------|-------------------------------------------------------|
| AgBr     | -759                                                 | -877                                                  |
| AgI      | -736                                                 | -867                                                  |

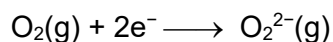
Which statement best explains the difference in the deviation of the experimental lattice energy from the theoretical lattice energy?

- A** The difference in electronegativity between Ag and the halogen is greater in AgBr than in AgI.
- B** The interionic distance in AgBr is smaller than that in AgI.
- C** The relative formula mass of AgBr is smaller than that of AgI.
- D** The I<sup>-</sup> ion is more polarisable than the Br<sup>-</sup> ion.
- 12 When heated with oxygen, barium forms barium peroxide, BaO<sub>2</sub>.

The relevant enthalpy changes are shown in the table.

|                                                                                | enthalpy change / kJ mol <sup>-1</sup> |
|--------------------------------------------------------------------------------|----------------------------------------|
| Ba(g) → Ba <sup>2+</sup> (g) + 2e <sup>-</sup>                                 | p                                      |
| Ba <sup>2+</sup> (g) + O <sub>2</sub> <sup>2-</sup> (g) → BaO <sub>2</sub> (s) | q                                      |
| Ba(s) → Ba(g)                                                                  | r                                      |
| Ba(s) + O <sub>2</sub> (g) → BaO <sub>2</sub> (s)                              | s                                      |

What is the enthalpy change of the following reaction?



- A** s - q + p - r
- B** s - q - p - r
- C** r - s + p + q
- D** r - s + p - q

- 13** The rates of chemical reactions can often be increased by catalytic action.

Which statement about catalysts is correct?

- A** A catalysed reaction has a higher rate constant than the uncatalysed reaction.
- B** In an autocatalytic reaction, the rate of the reaction increases continuously as the reaction progresses.
- C** In a reaction catalysed by a heterogeneous catalyst, the reactant molecules are in the same phase as the catalyst.
- D** In a reaction catalysed by an enzyme, increasing the concentration of the substrate will always result in an increase in the rate of the reaction.

- 14** The decomposition of a gas, A, undergoes a 3-step mechanism. The rate constants of the three steps are given by  $k_1$ ,  $k_2$ , and  $k_3$  respectively.

The overall rate equation for the reaction is given by

$$\text{rate} = \frac{k_1 k_3 [A]^2}{k_3 + k_2 [A]}$$

Consider the two statements about the order of reaction for the decomposition of A at constant temperature.

- 1 At very low pressures of A, the reaction is second order with respect to A.
- 2 At very high pressures of A, the reaction is first order with respect to A.

Which statements are correct?

- A** Both statements are correct.
- B** Neither statement is correct.
- C** Statement 1 only is correct.
- D** Statement 2 only is correct.

- 15** In a titration experiment,  $25.0 \text{ cm}^3$  of a solution of a weak acid, HA, required  $V \text{ cm}^3$  of NaOH solution to neutralise completely.

In a separate titration,  $\frac{1}{2}V \text{ cm}^3$  of the same NaOH solution was added to  $25.0 \text{ cm}^3$  of the same solution of HA. The pH was measured at this point.

How are the value of  $V$  and the pH at  $\frac{1}{2}V$  affected when the experiment was repeated at a higher temperature?

|          | value of $V$     | pH at $\frac{1}{2}V$ |
|----------|------------------|----------------------|
| <b>A</b> | decreases        | decreases            |
| <b>B</b> | decreases        | remains the same     |
| <b>C</b> | remains the same | decreases            |
| <b>D</b> | remains the same | remains the same     |

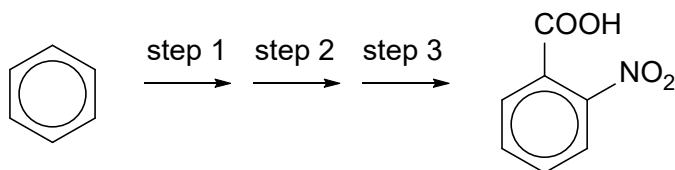
- 16** A small amount of solid  $\text{CuSO}_4$  was added to a saturated solution of  $\text{PbSO}_4$ .

Which observation is correct?

The  $K_{\text{sp}}$  of  $\text{PbSO}_4 = 1.8 \times 10^{-8} \text{ mol}^2 \text{ dm}^{-6}$ .

- A** No precipitate will form.
- B** A blue precipitate of  $\text{CuSO}_4$  will form.
- C** A white precipitate of  $\text{PbSO}_4$  will form.
- D** Both  $\text{CuSO}_4$  and  $\text{PbSO}_4$  will precipitate.

- 17 Which set of reagents and conditions gives the highest yield of the product?



|          | step 1                                                         | step 2                                                         | step 3                                                         |
|----------|----------------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------------------|
| <b>A</b> | $\text{CH}_3\text{Cl}$ , $\text{AlCl}_3$ catalyst              | hot acidified $\text{KMnO}_4$                                  | conc. $\text{H}_2\text{SO}_4$ ,<br>conc. $\text{HNO}_3$ , heat |
| <b>B</b> | $\text{CH}_3\text{Cl}$ , $\text{AlCl}_3$ catalyst              | conc. $\text{H}_2\text{SO}_4$ ,<br>conc. $\text{HNO}_3$ , heat | hot acidified $\text{KMnO}_4$                                  |
| <b>C</b> | conc. $\text{H}_2\text{SO}_4$ ,<br>conc. $\text{HNO}_3$ , heat | $\text{CH}_3\text{Cl}$ , $\text{AlCl}_3$ catalyst              | hot acidified $\text{KMnO}_4$                                  |
| <b>D</b> | conc. $\text{H}_2\text{SO}_4$ ,<br>conc. $\text{HNO}_3$ , heat | hot acidified $\text{KMnO}_4$                                  | $\text{CH}_3\text{Cl}$ , $\text{AlCl}_3$ catalyst              |

- 18 How many isomers, including stereoisomers, are there with the formula  $\text{C}_4\text{H}_8$ ?

**A** 4

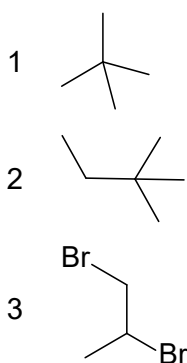
**B** 5

**C** 6

**D** 7

- 19 Propane undergoes free-radical substitution when mixed with bromine and exposed to ultra-violet light.

Which compounds are possible products from this reaction?



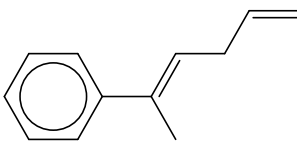
**A** 1 only

**B** 3 only

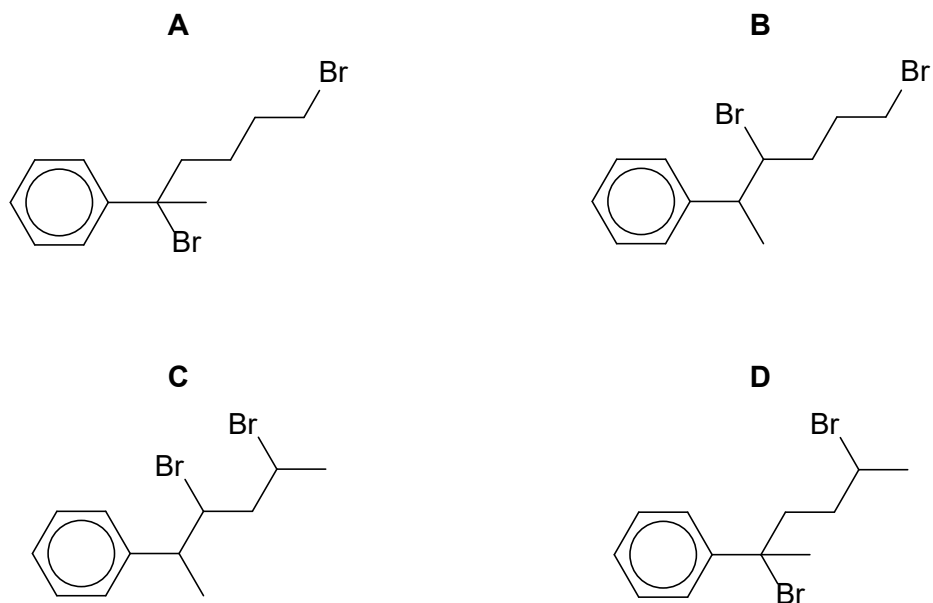
**C** 1 and 2

**D** 2 and 3

- 20 The following alkene reacts with two moles of HBr to give J as the major product.



What is the structure of J?

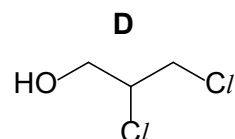
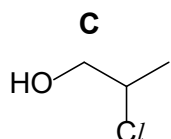
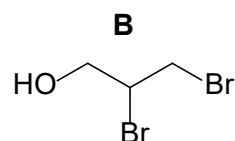
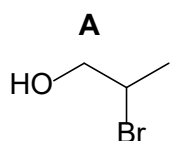


- 21 Consider the two statements.

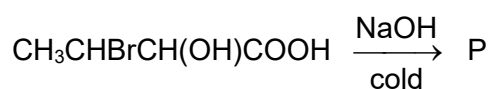
- 1 An optically active sample rotates plane-polarised light and contains chiral molecules.
- 2 A racemic mixture contains chiral molecules.

- A** Neither statement is correct.  
**B** Both statements are correct.  
**C** Statement 1 only is correct.  
**D** Statement 2 only is correct.

22 Which alcohol is the most acidic?



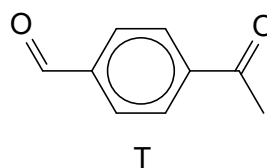
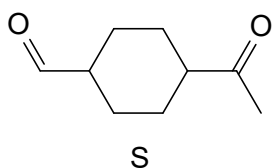
23 3-Bromo-2-hydroxybutanoic acid is reacted with an excess of cold aqueous NaOH to give compound P.



What could P be?

- A**  $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{OH})\text{COOH}$
- B**  $\text{CH}_3\text{CHBrCH}(\text{OH})\text{COO}^-\text{Na}^+$
- C**  $\text{CH}_3\text{CHBrCH}(\text{O}^-\text{Na}^+)\text{COO}^-\text{Na}^+$
- D**  $\text{CH}_3\text{CH}(\text{O}^-\text{Na}^+)\text{CH}(\text{O}^-\text{Na}^+)\text{COO}^-\text{Na}^+$

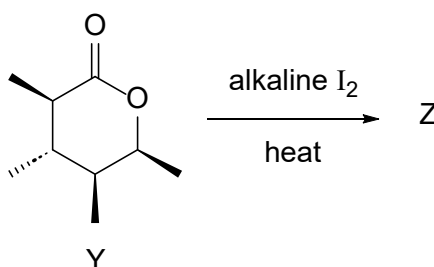
24 The structures of compounds S and T are shown.



Which reagents and conditions can be used to distinguish between S and T?

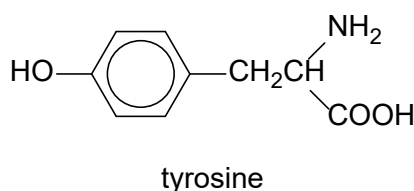
- A**  $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$ ,  $\text{H}_2\text{SO}_4(\text{aq})$ , heat
- B** 2,4-dinitrophenylhydrazine
- C** Fehling's solution, heat
- D** Tollens' reagent, heat

- 25 A sample that contains one enantiomer of compound Y reacts completely with warm alkaline aqueous iodine to give Z, which contains more than one carbon atom.



Which statement about Z is correct?

- A Z is a meso compound.  
 B Z contains three oxygen atoms.  
 C Effervescence is observed when sodium metal is added to Z.  
 D Z can form hydrogen bonds with another particle of Z.
- 26 Tyrosine is dissolved in heavy water,  $D_2O$ . It contains a number of hydrogen atoms which can be replaced by deuterium, D.  
 [D =  ${}^2_1H$ ]



What is the maximum number of hydrogen atoms which could be replaced by deuterium atoms in each molecule of tyrosine?

- A 2                      B 3                      C 4                      D 7
- 27 Which statement is correct about the standard hydrogen electrode?
- A The standard hydrogen electrode contains 1 atm of  $H_2$  gas.  
 B The standard hydrogen electrode contains  $1 \text{ mol dm}^{-3}$  of  $H_2SO_4(aq)$ .  
 C The standard hydrogen electrode is measured at s.t.p.  
 D The standard hydrogen electrode is measured at 298 K.

- 28 *Use of the Data Booklet is relevant to this question.*

An electrolysis cell was set up to purify copper and it consists of an impure copper electrode, a pure copper electrode and copper(II) sulfate solution as the electrolyte. The impure copper electrode has silver and nickel as minor impurities.

Which statement is correct?

- A The concentration of  $\text{Cu}^{2+}$  in the electrolyte decreases during the purification process.
- B Both silver and nickel are oxidised during the purification process.
- C The same number of moles of copper was oxidised and reduced.
- D The impure copper is the cathode while the pure copper is at the anode.

- 29 *Use of the Data Booklet is relevant to this question.*

Titanium is a transition metal.

Which titanium compound is **unlikely** to exist?

- A  $\text{TiO}$                       B  $\text{TiCl}_3$                       C  $\text{K}_3\text{TiF}_6$                       D  $\text{K}_2\text{TiO}_4$

- 30 Which statement best explains the difference in physical properties between magnesium and iron?

- A Iron has a higher melting point than magnesium because it forms stronger metallic bonds.
- B Magnesium is denser than iron because it has a smaller atomic radius and a larger atomic mass.
- C Iron has a higher first ionisation energy than magnesium because the increase in shielding effect outweighs the increase in nuclear charge.
- D Magnesium conducts electricity better than iron because it loses electrons more easily.

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