# NATIONAL JUNIOR COLLEGE SH2 PRELIMINARY EXAMINATION

Higher 2

CANDIDATE	
NAME	

SUBJECT	REGISTRATION	
CLASS	NUMBER	

# CHEMISTRY

Paper 1 Multiple Choice

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:
	2 <u>3</u> 0 <u>5648</u>	35648

This document consists of 13 printed pages and 3 blank page.

9729/01

1 hour

19 September 2024

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

A sample of 35.6 g of hydrated sodium carbonate contains 25.84% sodium ions by mass. When this sample is heated, anhydrous sodium carbonate and water vapour are formed.

What is the mass lost?

**A** 7.2 g **B** 10.6 g **C** 14.4 g **D** 21.2 g

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

Sodium and fluorine are both reactive elements.

Which statements are correct?

- 1 One Na atom has two more protons than one  $F^-$  ion.
- 2 One Na atom has two more neutrons than one F atom.
- 3 One Na<sup>+</sup> ion has the same number of electrons as one  $F^-$  ion.
- **A** 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 1 only
- **3** When iodine is oxidized by nitric acid, a white crystalline solid oxide can be isolated from the mixture.

0.001 mole of this oxide reacts with 0.01 mole of acidified potassium iodide to give 0.006 mole of iodine, I<sub>2</sub>.

What is the oxidation number of iodine in the oxide?

**A** +1 **B** +5 **C** +6 **D** +10

- 4 Which pair of compounds meets the criteria below?
  - The first compound has a larger bond angle than the second compound.
  - The second compound is more polar than the first compound.
  - **A** CO<sub>2</sub>, BC*l*<sub>3</sub> **B** IF<sub>3</sub>, H<sub>2</sub>O **C** HCN, SO<sub>3</sub> **D** CO<sub>2</sub>, NC*l*<sub>3</sub>

5 Hydrogen peroxide solution decomposes. The equation for this reaction is shown.

 $2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$ 

A 300 cm<sup>3</sup> sample of hydrogen peroxide solution is warmed. After 150 minutes, 10.00 dm<sup>3</sup> of oxygen gas, measured at r.t.p., is collected. Under these conditions, the reaction has a constant half-life of 50 minutes.

What is the initial concentration of the hydrogen peroxide solution?

- A 0.79 mol dm<sup>-3</sup>
- **B** 1.6 mol dm<sup>-3</sup>
- **C** 2.8 mol dm<sup>-3</sup>
- **D** 3.2 mol dm<sup>-3</sup>
- 6 In order to determine the enthalpy of neutralisation of a strong acid and a strong alkali, 25.0 cm<sup>3</sup> of 2.00 mol dm<sup>-3</sup> sodium hydroxide is added to 25.0 cm<sup>3</sup> of 2.00 mol dm<sup>-3</sup> hydrochloric acid. The increase in temperature is 12°C.

In a second experiment, the same method is used, but 50.0 cm<sup>3</sup> of 2.00 mol dm<sup>-3</sup> sodium hydroxide is added to 50.0 cm<sup>3</sup> of 2.00 mol dm<sup>-3</sup> hydrochloric acid.

What is the increase in temperature in the second experiment?

**A** 6°C **B** 12°C **C** 24°C **D** 48°C

7 X and Y react together to form Z in a reversible reaction.

The equilibrium yield of Z at different conditions are shown in the following table.

Conditions	Equilibrium yield of Z
High Temperature	Decreased
High Pressure	Increased

Which equation could represent this reaction?

Α	X(g) + Y(g)	$\Rightarrow$ Z(g)	$\Delta H = -100 \text{ kJ mol}^{-1}$
В	X(g) + Y(g)	≓Z(g)	$\Delta H$ = +100 kJ mol <sup>-1</sup>
С	X(s) + Y(g)	⇒2Z(g)	$\Delta H = -100 \text{ kJ mol}^{-1}$
D	X(s) + Y(g)	⇒ 2Z(g)	$\Delta H$ = +100 kJ mol <sup>-1</sup>

8 PC*l*<sup>5</sup> decomposes as shown.

 $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ 

1.0 mole of  $PCl_5(g)$ , 1.0 mole of  $PCl_3(g)$  and 1.0 mole of  $Cl_2(g)$  are placed in a container of volume 2 dm<sup>3</sup> at 250 °C and allowed to reach equilibrium.

At this temperature, the equilibrium mixture contains 1.8 moles of PCl<sub>3</sub>.

What is the value of  $K_c$  at 250 °C?

**A** 0.12 **B** 1.8 **C** 8.1 **D** 16.2

**9** Ammonium carbonate is a crystalline solid. On gentle warming a reaction occurs, forming ammonia as one product.

How are the carbonate ions behaving during this reaction?

- A Brønsted-Lowry acid
- **B** Brønsted-Lowry base
- **C** oxidising agent
- **D** reducing agent
- **10** The dissociation constant,  $K_w$ , for the ionisation of water,  $H_2O \Longrightarrow H^+ + OH^-$ , at different temperatures is given below.

Temperature / °C	<i>K</i> <sub>w</sub> / mol <sup>2</sup> dm⁻ <sup>6</sup>
0	1.15 x 10 <sup>-15</sup>
25	1.00 x 10 <sup>-14</sup>
50	5.50 x 10 <sup>-14</sup>

Which statement is correct?

- A Only at  $25 \,^{\circ}$ C are [H<sup>+</sup>] and [OH<sup>-</sup>] equal.
- **B** The equilibrium lies furthest to the right at 0 °C.
- **C** The forward reaction is exothermic.
- **D** The pH of water decreases with temperature.

**11** The indicator bromophenol blue, HIn, changes colour from yellow to blue over a pH range of 3.0 to 4.6.

Which statements are correct?

- 1 When bromophenol blue is added to water at 25 °C, [HIn] < [In<sup>-</sup>].
- **2** Bromophenol blue would be a suitable indicator for the titration of a strong base and a weak acid.
- 3 The  $In^-$  ions are yellow.
- **A** 1,2 and 3 **B** 1 and 3 only **C** 1 only **D** 2 and 3 only
- **12** Phosphoric acid is a tribasic acid.

$$H_{3}PO_{4} \stackrel{K_{a1}}{\rightleftharpoons} H_{2}PO_{4}^{-} + H^{+}$$

$$H_{2}PO_{4}^{-} \stackrel{K_{a2}}{\Longrightarrow} HPO_{4}^{2-} + H^{+}$$

$$HPO_{4}^{2-} \stackrel{K_{a3}}{\Longrightarrow} PO_{4}^{3-} + H^{+}$$

The graph shows the fraction of each species at different pH.



What is the numerical value of  $K_{a2}$ ?

**A** 
$$2.0 \times 10^{-10}$$
 **B**  $7.9 \times 10^{-8}$  **C**  $2.0 \times 10^{-5}$  **D**  $6.3 \times 10^{-3}$ 

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[Turn over

**13** An acidified solution contains 0.10 mol dm<sup>-3</sup> of ZnSO<sub>4</sub> and 0.10 mol dm<sup>-3</sup> of CuSO<sub>4</sub>. Hydrogen sulfide gas, H<sub>2</sub>S, is bubbled through the solution until it is saturated with H<sub>2</sub>S at 15 °C. The concentration of S<sup>2–</sup>(aq) in the solution reaches  $1 \times 10^{-35}$  mol dm<sup>-3</sup>.

The solubility product of ZnS at 15 °C is  $1 \times 10^{-24}$  mol<sup>2</sup> dm<sup>-6</sup> and that of CuS is  $1 \times 10^{-40}$  mol<sup>2</sup> dm<sup>-6</sup>.

Which statement is correct?

- A No precipitate is formed.
- **B** ZnS only is precipitated.
- **C** CuS only is precipitated.
- **D** Both ZnS and CuS are precipitated.
- 14 In this question the symbol '<' means 'less positive than' or 'more negative than'.

Silver chloride dissolves in dilute  $NH_3(aq)$  whereas silver bromide is only soluble in concentrated  $NH_3$ .

The following equations represent the equilibria involved.

$AgCl(s) \iff AgCl (aq)$	$\Delta G_1$
$AgCl(aq) + 2NH_3(aq) \longrightarrow Ag(NH_3)_2Cl(aq)$	$\Delta G_2$
AgBr(s) === AgBr(aq)	$\Delta G_3$
AgBr(aq) + 2NH <sub>3</sub> (aq) = Ag(NH <sub>3</sub> ) <sub>2</sub> Br(aq)	$\Delta G_4$

Some relationship between the free energies of these four reactions are as follows.

$$1 \qquad (\Delta G_1 + \Delta G_2) < (\Delta G_3 + \Delta G_4)$$

$$2 \qquad \Delta G_2 = \Delta G_4$$

- $\mathbf{3} \qquad \Delta \mathbf{G}_2 \leq \Delta \mathbf{G}_4$
- $4 \qquad \Delta G_1 < \Delta G_3$

Which relationships are correct?

Α	1, 2 and 4	В	1 and 3	С	2 and 4	D 3 only
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**15 X**, **Y** and **Z** are elements all found within Groups 13, 14 and 15 of the Periodic Table.

**X** is in the same group in the Periodic Table as **Y**.

Y and Z are in Period 3.

The first ionisation energy of X is greater than the first ionisation energy of Y. The melting point of Z is less than the melting point of Y.

Which row shows the possible identities of X and Y?

	Х	Y
Α	В	Al
В	Ge	Si
С	As	Р
D	Ν	Р

**16** The solids sodium bromide and sodium iodide both react with concentrated sulfuric acid at room temperature.

With NaBr, the products formed are S and Br<sub>2</sub>.

With NaI, the products formed are  $H_2S$  and  $I_2$ .

Which statement can be deduced from the above information?

- A lodine will displace the bromide ions from the solution.
- **B** Sodium bromide is more volatile than sodium iodide.
- **C** lodide ions are stronger reducing agents than bromide ions.
- **D** Sulfuric acid act as a dehydrating agent with NaI.

17 Equal amount of two Period 3 oxides were added to water. The resultant solution has a pH below 7.

What are the identities of the two oxides?

- A  $Al_2O_3$  and MgO
- B Na<sub>2</sub>O and MgO
- **C** SiO<sub>2</sub> and  $Al_2O_3$
- D Na<sub>2</sub>O and P<sub>4</sub>O<sub>10</sub>
- 18 Which statements are correct?
  - 1 Magnesium carbonate decomposes at a lower temperature than calcium carbonate.
  - 2 Calcium chloride has a higher boiling point than magnesium chloride.
  - 3 Calcium is a stronger reducing agent than magnesium.
  - A
     1 and 2
     B
     1 and 3
     C
     2 and 3
     D
     3 only
- **19** A yellow solution is formed when concentrated hydrochloric acid is added to blue aqueous copper(II) chloride solution. Addition of potassium iodide to the mixture results in the formation of a brown solution and a white solid.

What type of reaction occurred in this sequence?

- 1 Redox reaction
- 2 Ligand exchange
- **3** Precipitation of copper(II) compound
- A 1 and 2 B 1 and 3 C 2 and 3 D 1, 2 and 3
- **20** Platinum(IV) chloride reacts with ammonia to form a compound in which the coordination number of platinum is 6. When dissolved in water, 1 mole of this compound gave 3 moles of ions.

What could be the formula of this compound?

- **C**  $Pt(NH_3)_4Cl_4$  **D**  $Pt(NH_3)_4Cl_2$

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

Which statement is not true about the first-row transition metals and their compounds?

- **A**  $[Fe(CN)_6]^{3-}$  does not oxidise I<sup>-</sup>.
- **B**  $Fe_2(CO_3)_3$  can be prepared by reacting  $FeCl_3(aq)$  with  $Na_2CO_3(aq)$ .
- **C** On addition of acidified KMnO<sub>4</sub>(aq) to  $Fe^{2+}(aq)$ , a yellow solution is formed.
- **D** On addition of  $NH_3(aq)$  to  $FeCl_2$  a green precipitate is formed which turns brown on standing.
- 22 An electrochemical cell consisting of a Ni<sup>2+</sup>/Ni half-cell and a Fe<sup>3+</sup>/Fe<sup>2+</sup> half-cell was set up as shown below:



What change to the cell conditions leads to a higher cell potential?

- A Add nickel (II) chloride to the Ni<sup>2+</sup>/Ni half-cell.
- **B** Add aqueous cyanide ions to the  $Fe^{3+}/Fe^{2+}$  half-cell.
- **C** Add water to the Ni<sup>2+</sup>/Ni half-cell.
- **D** Increases the surface area of iron immersed in the solution.

an alloy of copper and tin dilute sulfuric acid

23 The circuit shown in the diagram was set up.

Which reactions will occur at the electrodes at the start of electrolysis?

	anode reaction	cathode reaction
Α	Oxygen gas is evolved.	Hydrogen gas is evolved.
в	Tin dissolves preferentially.	Hydrogen gas is evolved.
С	Copper dissolves preferentially.	Copper is deposited.
D	Copper and tin both dissolve.	Sulfur dioxide gas is evolved

24 Excess aqueous sodium hydroxide was added into a test tube containing 1 mole of each of the compounds below at room temperature. After 10 minutes, excess HNO<sub>3</sub> was added. Excess aqueous silver nitrate was then added to the mixture.

Which compound will produce the largest mass of silver halide precipitate?



**25** Which reaction has the correct reagents and conditions for forming the respective organic compounds?



26 Aldehydes can undergo a reaction with HCN to form a halohydrin.



Which statements are true?

- 1 The reaction will proceed with the addition of NaCN to the aldehyde, followed by dropwise addition of aqueous sulfuric acid at room temperature.
- 2 The reaction proceeds via nucleophilic addition, followed by reduction.
- 3 The resultant solution from the reaction is optically active.
- **A** 1 only **B** 1 and 2 **C** 1 and 3 **D** 2 and 3
- 27 The following molecule is reacted with hot acidified KMnO<sub>4</sub>.



What is the possible number of stereoisomers that the product molecule can have?

- **A**  $2^3$  **B**  $2^4$  **C**  $2^5$  **D**  $2^6$
- **28** Compound **P**, C<sub>5</sub>H<sub>8</sub>O<sub>2</sub> is optically active and produces a yellow precipitate when heated with aqueous alkaline iodine. Brick-red precipitate is formed when **P** is warmed with alkaline solution of copper(II) tartrate.

What could be the identity of **P**?

- A CH<sub>3</sub>COCH<sub>2</sub>CH<sub>2</sub>CHO
- B CH<sub>3</sub>COCH(CH<sub>3</sub>)CHO
- C CH<sub>3</sub>COOCH<sub>2</sub>CH=CH<sub>2</sub>
- D CH<sub>3</sub>CH(OH)COCH=CH<sub>2</sub>

**29** Deuterium, D, is a heavy isotope of hydrogen that can be used for molecular labelling in mechanistic studies.

When compound **T** was completely reacted with bromomethane and  $\text{FeBr}_3$ , a mixture of products was formed.

Assuming that the carbon-deuterium bond is broken as easily as a carbon-hydrogen bond, what is the expected proportion of compound U in the mixture?



**30** Ethylbenzene when heated with liquid bromine produced a mixture of products.

Which molecules are possible products from the reaction?

