

Anglo-Chinese Junior College

JC2 Preliminary Examination Higher 1



A Methodist Institution (Founded 1886)

CHEMISTRY

Paper 1 Multiple Choice

8873/01 9 September 2024 1 hour

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, Centre number and index 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.

Carbon sulfide, CS₂, is a volatile flammable liquid used in the manufacture of cellophane.
 On combustion, CS₂ is oxidised as follows.

 $CS_2(g) + 3O_2(g) \longrightarrow CO_2(g) + 2SO_2(g)$

A 20 cm³ sample of carbon disulfide vapour is ignited with 100 cm³ of oxygen. The final volume of gas after burning is treated with an excess of aqueous alkali.

What percentage of this final volume dissolves in the alkali?

[All volumes are measured at the same temperature and pressure.]

A 20% **B** 40% **C** 60% **D** 80%

2 2 mol of nitric acid, HNO₃, a powerful oxidising agent, reacts with 3 mol of hydrogen sulfide, H₂S, to form three products, one of which is water.

In this reaction, the oxidation number of nitrogen decreases by 3.

What are the other two products of this reaction?

- **A** N_2O_2 and H_2SO_4 **C** NO and SO_2
- $\label{eq:bound} \textbf{B} \quad \text{NO and } \textbf{S} \qquad \qquad \textbf{D} \quad N_2O_2 \text{ and } H_2SO_3$

3 Consider the following half-equations.

$$MnO_{4^{-}} + 8H^{+} + 5e^{-} \longrightarrow Mn^{2+} + 4H_{2}O$$

$$Fe^{2+} \longrightarrow Fe^{3+} + e^{-}$$

$$C_{2}O_{4}^{2-} \longrightarrow 2CO_{2} + 2e^{-}$$

What volume of 0.01 mol dm⁻³ KMnO₄ is required to oxidise 15 cm³ of an acidified solution of 0.01 mol dm⁻³ FeC₂O₄?

A 3 cm³ **B** 6 cm³ **C** 9 cm³ **D** 15 cm³

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

The table shows statements made by three students about the s, p and d electrons in the atoms of the element with atomic number 30.

student	statement
X	There are s electrons in 4 different quantum shells.
Y	There are p electrons in 2 different quantum shells.
Z	The d electrons have the same principal quantum number as the outermost s electrons.

Which students are correct?

Α	X, Y and Z	В	X and Y	С	Y and Z	D	X and Z
		_		•			

Alpha particles, He²⁺, are commonly emitted by larger radioactive nuclei. The path of a 5 mixture of an unknown ion, \mathbf{A} , O^{2+} and alpha particles after passing through an electric field is as shown below.



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7 Some car paints contain small flakes of silica, SiO₂.

In the structure of solid SiO₂

- each silicon atom is bonded to **x** oxygen atoms,
- each oxygen atom is bonded to **y** silicon atoms,
- each bond is a **z** type bond.

What is the correct combination of **x**, **y** and **z** in these statements?

	x	У	Z
Α	2	1	covalent
В	2	1	ionic
С	4	2	covalent
D	4	2	ionic

- 8 What is the order of increasing volatility at room temperature?
 - 1 2,3-dimethylbut-2-ene
 - 2 cis-hex-3-ene
 - 3 trans-hex-3-ene

Α	2, 3, 1	С	3, 2, 1
В	1, 2, 3	D	1, 3, 2

- 9 Which statement can be explained in terms of hydrogen bonding?
 - 1 The apparent relative molecular mass of ethanoic acid in benzene is 120.
 - 2 HF_2^- is formed when HF is dissolved in molten NaF.
 - 3 The boiling point of propanoic acid is higher than ethanoic acid.
 - 4 Ice is less dense than water.

Α	1, 2 and 3	С	2, 3 and 4
В	1, 3 and 4	D	1, 2 and 4

10 Elements A and B are both in Period 3. Element A has the smallest atomic radius in Period 3. There are only two elements in Period 3 which have a higher melting point than element B. Elements A and B react together to form compound C.

Which compound could be C?

A Al_2S_3 B $MgCl_2$ C Na_2S D	PCl_5
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11 Use of the Data Booklet is relevant to this question.

The properties of chlorine, bromine (denoted as X_2 in their elemental state) and their compounds are compared.

Which property is smaller for bromine than for chlorine?

- 1 pressure to liquefy $X_2(g)$ at the same temperature
- 2 oxidising power of X_2
- 3 first ionisation energy of X(g)

Α	1 and 2	С	2 and 3
В	1 and 3	D	1, 2 and 3

12 An element in the Period 2 of the Periodic Table often shows similar properties to the element a group higher in the Period 3. This is known as a diagonal relationship between the elements and their compounds.

An example of a diagonal relationship is between beryllium and aluminium.

Which statement about BeO and BeCl₂ is incorrect?

- A BeO is amphoteric in nature but BeCl₂ is acidic in nature.
- **B** BeO is predominantly covalent but BeCl₂ is predominantly ionic.
- **C** BeO is insoluble in water but BeCl₂ partially hydrolyses in water.
- **D** BeO has a giant lattice structure but $BeCl_2$ has a simple lattice structure.
- **13** Nitromethane can be used as a fuel additive for motor racing and rockets.

 $4CH_3NO_2(g) + 3O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(l) + 2N_2(g)$

Values of standard enthalpy changes of formation are in the table.

compound	Δ <i>H</i> _f / kJ mol⁻¹
CH ₃ NO ₂ (g)	–113
CO ₂ (g)	-394
H ₂ O(<i>l</i>)	-286

What is the enthalpy change of this reaction?

- **A** -3744 kJ mol⁻¹ **C** -2840 kJ mol⁻¹
- **B** +3744 kJ mol⁻¹ **D** +2840 kJ mol⁻¹

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

Butane is used as a fuel for cooking.

When 0.025 mol of butane was burnt under a vessel containing 250 g of water, it was found that the temperature of the water rose by 50 °C.

Which value for the enthalpy change of combustion of butane is given by these results?

Α	–2090 kJ mol ^{–1}	С	–13 500 kJ mol ^{–1}

- **B** –2100 kJ mol⁻¹ **D** –13 580 kJ mol⁻¹
- **15** The lattice energies of the caesium chloride, caesium fluoride, sodium chloride and sodium fluoride are given below in the options, not necessarily in this order.

Which value corresponds to the lattice energy of caesium chloride?

Α	–661 kJ mol ^{–1}	C	–780 kJ mol ^{–1}

- **B** -740 kJ mol⁻¹ **D** -918 kJ mol⁻¹
- **16** For a reaction $2\mathbf{U}(aq) + 3\mathbf{V}(aq) \longrightarrow 2\mathbf{W}(aq)$, the rate equation is rate = $k[\mathbf{U}]^2[\mathbf{V}]$.

reaction	temperature / °C	initial [U] / mol dm⁻³	initial [V] / mol dm⁻³	initial rate / mol dm ⁻³ s ⁻¹
1	25	1.0	1.0	r
2	55	0.5	0.5	q

It is also given that the rate doubles for every 10 °C rise in temperature.

What is the initial rate of reaction 2, q?

A 0.5 <i>r</i> B <i>r</i> C 2 <i>r</i>	D 4 <i>r</i>
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17 A radioactive element has two isotopes, **X** and **Y**, with half–lives of 2 min and 6 min respectively.

An experiment starts with *z* times as many atoms of **X** than **Y**. After 6 min, the number of atoms of **X** and **Y** are both equal.

Given that radioactive decay is a first order reaction, what is the value of *z*?

A 0.5 **B** 2 **C** 4 **D** 8

18 The gas-phase reaction of hydrogen and nitrogen monoxide produces nitrogen and water.

 $2NO(g) + 2H_2(g) \longrightarrow N_2(g) + 2H_2O(g)$

A series of experiments was carried out in a reaction vessel at constant pressure and the results obtained are given in the table.

[NO] / mol dm ⁻³	[H ₂] / mol dm ⁻³	initial rate / mol dm ⁻³ s ⁻¹
0.250	0.250	0.212
0.250	0.125	0.106
0.125	0.125	0.027

Which statement about this reaction is correct?

- A The overall order of the reaction is 3.
- **B** The reaction is second order with respect to [H₂].
- **C** The reaction is first order with respect to [NO].
- **D** The theoretical rate equation for this reaction is rate = $[H_2]^m[NO]^n$.
- **19** The gas-phase reaction of carbon monoxide with hydrogen forming methanol is an example of an equilibrium. The reaction was investigated by mixing 2.0 mol of $H_2(g)$ with 1.0 mol of CO(g) in a 0.4 dm³ flask and allowing equilibrium to be established at 300 K.

 $2H_2(g) + CO(g) \iff CH_3OH(g)$ initial amount 2.0 1.0 0

At equilibrium, 0.2 mol of H₂ had reacted with CO.

What is the value of the equilibrium constant, K_c at 300 K?

A 1.2 × 10⁻²

- **B** 1.5 × 10⁻²
- **C** 3.4×10^{-2}
- **D** 5.5×10^{-3}

20 The Haber process involves a reversible reaction between hydrogen and nitrogen to achieve large scale production of ammonia.

 $3H_2(g) + N_2(g) \implies 2NH_3(g) \quad \Delta H < 0$

Which statements about the Haber process is correct?

- 1 Addition of iron catalyst speeds up the reaction and increases the yield of ammonia.
- 2 The pressure used should be as high as possible to increase the yield of ammonia.
- 3 Increasing the temperature speeds up the reaction but lowers the yield of ammonia.
- A 3 only
- **B** 1 and 2 only
- **C** 1 and 3 only
- **D** all of the above
- 21 The concentration-time graph of a reversible reaction is shown below.



What is a possible change made to the reaction at time t?

- A concentration of reactant was changed
- **B** volume of the reaction vessel was changed
- C temperature of the system was changed
- **D** catalyst was added

22 Three unknown solutions **P**, **Q** and **R** contain a strong monobasic acid, a weak monobasic acid and a strong monoprotic base, but not necessarily in the same order. The concentration and pH of each solution are shown below.

Р	Q	R
1.00 mol dm ⁻³	0.01 mol dm ⁻³	0.001 mol dm ⁻³
pH = 1.8	pH = 12.0	pH = 3.0

Which statement is incorrect?

- **A P** contains the strong acid.
- **B Q** contains the strong base.
- **C** Mixing equal volumes of **P** and **Q** will produce a buffer solution.
- **D** Mixing 10 cm³ of **Q** and 100 cm³ of **R** will produce a solution of pH 7.
- **23** The value of the ionic product of water, K_{w} , varies with temperature.

 $H_2O(I) \Longrightarrow OH^-(aq) + H^+(aq)$

temperature / °C	K _w / mol² dm⁻ ⁶	рН
0	0.1 × 10 ⁻¹⁴	7.5
10	0.3 × 10 ⁻¹⁴	7.3
25	1.0 × 10 ⁻¹⁴	7.0
35	2.1 × 10 ⁻¹⁴	6.8

Which statements about the ionisation of water are correct?

- 1 The reaction is endothermic.
- 2 At 10 °C, [H⁺] is less than 1.0×10^{-7} mol dm⁻³.
- 3 Water is more acidic at 35 °C than at 25 °C as pH is less than 7.0.
- A 1 only
- B 1 and 2 only
- C 3 only
- **D** all of the above

- 24 Which of the following underlined species is **not** acting as a Brønsted-Lowry acid?
 - Α <u>H₂O(I)</u> + NH₃(aq) \rightarrow NH₄⁺(aq) + OH⁻(aq)
 - В <u>HCl(g)</u> + NH₃(g) \rightarrow NH₄Cl(g)
 - С <u>HNO₃(I) + H₂SO₄(I) \rightarrow H₂NO₃⁺(I) + HSO₄⁻(I)</u>
 - D $CH_3COO^{-}(aq) + \underline{H}_2O(l) \rightleftharpoons CH_3COOH(aq) + OH^{-}(aq)$
- 25 Which of the following does not explain the wall climbing ability of geckos?
 - Α Strong covalent bonds form between the geckos' feet and ceilings.
 - В Geckos' feet contain nanostructures that have high surface area to volume ratio.
 - С Instantaneous dipole-induced dipole interactions support the geckos' body weight.
 - D Geckos can move along walls simply by pulling their feet at different angles.
- 26 Graphene and poly(ethyne) are represented by the following structures.



graphene

Which statement about graphene and poly(ethyne) is correct?

- Graphene can conduct electricity but poly(ethyne) cannot. Α
- В The carbon atoms in graphene are sp³ hybridised while the carbon atoms in poly(ethyne) are sp² hybridised.
- С Both have similar melting points.
- D Both layers of graphene and layers of poly(ethyne) are held together by weak forces of attraction.

27 When 1 mol of cocamide DEA is heated with excess aqueous sodium hydroxide, a product mixture was obtained.



cocamide DEA

Which statement about the product mixture is correct?

- A The product mixture exists as an organic layer and an aqueous layer.
- **B** The organic products are $CH_3(CH_2)_nCOOH$ and $HOCH_2CH_2NHCH_2CH_2OH$.
- **C** The organic products react completely with 1 mol of dilute sulfuric acid.
- **D** The product mixture cannot be separated by heating.
- 28 Cyclohexene can form a polymer.



cyclohexene

Which of the following shows a section of the polymer?



29 A section of nylon-6,6 is shown below.

-CO(CH₂)₄CONH(CH₂)₆NHCO(CH₂)₄CONH(CH₂)₆NH-

Which deductions can be made about nylon-6,6?

- 1 It is a polyamide.
- 2 It can be made from monomers HO₂C(CH₂)₆NH₂ and HO₂C(CH₂)₄NH₂
- 3 Hydrogen bonding forms between two polymer chains.
- A 1 only
- **B** 1 and 3 only
- **C** 2 and 3 only
- **D** all of the above
- **30** Poly(vinyl chloride) (PVC) and poly(vinyl alcohol) (PVA) are represented by the following structures.



Which statement is incorrect?

- A PVC and PVA are both addition polymers.
- **B** PVA is water-soluble and is found in eye drops.
- **C** PVC is tough and flexible and can be used to make water pipes.
- **D** PVC is water-soluble and can be used to make glues.

End of Paper