

RAFFLES INSTITUTION 2024 YEAR 6 PRELIMINARY EXAMINATION



8873 / 01

Higher 1

CHEMISTRY

Paper 1 Multiple Choice

19 September 2024 1 hour

Additional Materials: Multiple Choice Answer Sheet Data Booklet

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, highlighters, glue or correction fluid. Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions in this section. 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.

This document consists of 12 printed pages.

For each question, there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 Which statement about one mole of ethanal, CH₃CHO, is correct?

- **A** It contains 6.02×10^{23} atoms.
- **B** It contains 6.02×10^{23} carbon atoms.
- **C** It contains 1.81 x 10²⁴ hydrogen atoms.
- D It contains 6.02 x 10²³ molecules.
- 2 The charge on an electron is -1.60×10^{-19} coulombs.

Aluminium reacts with fluorine to form aluminium fluoride, A/F₃.

Calculate the charge removed from one mole of aluminium atoms as they form one mole of aluminium fluoride, A/F_3 .

Α	−2.89 x 10 ⁵ C	С	−4.80 x 10 ⁻¹⁹ C
в	−9.63 x 10 ⁴ C	D	−1.81 x 10 ²⁴ C

3 The manganate(VII) ion, MnO₄⁻, is a strong oxidising agent in acidic solution. It oxidises iodide ions, copper(I) ions and sulfite ions, SO₃²⁻. The relevant half-equations are given.

$$\begin{split} \mathsf{MnO_4^-} + 8\mathsf{H}^+ + 5\mathsf{e}^- &\rightleftharpoons \mathsf{Mn^{2+}} + 4\mathsf{H_2O} \\ \\ I_2 + 2\mathsf{e}^- &\rightleftharpoons 2I^- \\ \\ \mathsf{Cu^{2+}} + \mathsf{e}^- &\rightleftharpoons \mathsf{Cu^+} \\ \\ \mathsf{SO_4^{2^-}} + 2\mathsf{H}^+ + 2\mathsf{e}^- &\rightleftharpoons \mathsf{SO_3^{2^-}} + \mathsf{H_2O} \end{split}$$

Which statements about the reactions of 1 mole of MnO₄-(aq) are correct?

- 1 It reacts with 5 moles of copper(I) ions, producing 5 moles of copper(II) ions.
- 2 It reacts with an excess of iodide ions, producing 5 moles of iodine molecules.
- 3 It reacts with 2.5 moles of sulfate ions, producing 2.5 moles of sulfite ions.

Α	1 only	С	1 and 3 only
в	1 and 2 only	D	1, 2 and 3

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

The table shows the number of subatomic particles in different atoms or ions.

	number of	number of	number of
	neutrons	protons	electrons
W	12	12	10
Х	13	12	12
Y	16	15	18
Ζ	18	17	18

Which statement about W, X, Y and Z is correct?

- A W has a charge of 2-.
- **B** Z is an isotope of Y.
- \mathbf{C} W and Y form W₂Y₃.
- **D** WZ₂ has a giant ionic lattice structure.
- 5 The ninth to thirteenth ionisation energies of an element, G, in kJ mol⁻¹ are shown. The atomic number of G is less than 20.

ionisation energies / kJ mol ⁻¹				
9th	13th			
33 878	38 726	42 321	46 485	148 231

Which statement about G is correct?

- A G is a Period 2 element.
- **B** G is likely to form a chloride with the formula GCl₂.
- **C** G is likely to form a chloride with the formula GCl₄.
- **D** G forms a chloride with a giant molecular structure.
- 6 Which molecule is non-polar?

Α	SF ₄	в	CH ₂ Br ₂	С	NF ₃	D	SiCl ₄
					-		

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- 7 Which equation shows a reaction in which a co-ordinate (dative covalent) bond is formed, resulting in a trigonal pyramidal shape about the central atom(s)?
 - $\textbf{A} \quad H_2 O \textbf{+} H^+ \longrightarrow H_3 O^+$
 - $\textbf{B} \quad NH_3 + BF_3 \longrightarrow NH_3 \bullet BF_3$
 - **C** $Al_2Cl_6 \longrightarrow 2AlCl_3$
 - $\textbf{D} \quad N_2 + 3H_2 \longrightarrow 2NH_3$
- 8 The table shows the boiling points of various substances.

substance	boiling point / °C
Br ₂	59
NH ₃	-33
H ₂ O	100

Which statements explain the differences in the boiling points?

- 1 Br₂ has a larger electron cloud size than NH₃.
- 2 H₂O has a larger electron cloud size than NH₃.
- 3 The hydrogen bonds in H₂O are more extensive than in NH₃.
- A 1 and 2 only C 1 and 3 only
- B
 2 and 3 only
 D
 1, 2 and 3
- 9 AIBN is a common reagent used for the initiation of radical reactions.



AIBN

Which statement about AIBN is correct?

- A It is linear about both N atoms in the N=N bond.
- **B** It contains 4 lone pairs of electrons.
- C It is tetrahedral about all carbons in AIBN.
- **D** It contains 5 π bonds and 11 σ bonds.

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10 Which change is endothermic?

- **A** $H_2O(I) \longrightarrow H_2O(g)$
- **B** $H_2O(I) \longrightarrow H_2O(s)$
- $\label{eq:constraint} \boldsymbol{\mathsf{C}} \quad 2H(g) + O(g) \longrightarrow H_2O(g)$
- $\textbf{D} \quad 2C_2H_6(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(g)$
- 11 When 50.0 cm³ of 2.0 mol dm⁻³ sulfuric acid was added to 100.0 cm³ of 1.5 mol dm⁻³ sodium hydroxide solution, the temperature rose by 12.6 °C.

Assume that the density and the specific heat capacity of the final mixture are 1.0 g cm⁻³ and 4.2 J g⁻¹ K⁻¹ respectively.

What is the enthalpy change of neutralisation for the above reaction?

A -1200 kJ mol⁻¹ **B** -79.4 kJ mol⁻¹ **C** -52.9 kJ mol⁻¹ **D** -17.6 kJ mol⁻¹

12 The table shows the enthalpy changes of formation, $\Delta H_{\rm f}^{\ominus}$, of some compounds.

compound	$\Delta H_{\rm f}^{\oplus}$ / kJ mol ⁻¹
SO ₂ (g)	-297
H ₂ S(g)	-20
H ₂ O(I)	-286

 H_2S undergoes combustion according to the following equation.

 $2H_2S(g) + 3O_2(g) \longrightarrow 2SO_2(g) + 2H_2O(I)$

What is the standard enthalpy change of combustion of H₂S?

A +563 kJ mol⁻¹ B +1126 kJ mol⁻¹ C -563 kJ mol⁻¹ D -1126 kJ mol⁻¹

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5

13 A compound, P, decomposes by a first order reaction.

At the start of the reaction, the concentration of P is 0.300 mol dm⁻³. After 900 s, the concentration of P falls to 0.0375 mol dm⁻³.

What is the total time taken for the concentration of P to fall to 0.01875 mol dm⁻³?

- A 1200 s
- **B** 1350 s
- **C** 1500 s
- **D** 1800 s
- 14 X and Y were reacted in two separate experiments, where the concentration of Y was varied from 1.0 mol dm⁻³ to 2.0 mol dm⁻³. The following graph was obtained.



What is the rate equation for the reaction?

- A rate = $k [X]^2$
- B rate = k [Y]
- **C** rate = k [Y]²
- **D** rate = $k [X][Y]^2$

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15 Nitrogen monoxide is oxidised to form nitrogen dioxide.

 $O_2 + 2NO \longrightarrow 2NO_2$

The following results were obtained from the investigation of the kinetics of the reaction.

experiment	initial [O ₂] / mol dm ⁻³	initial [NO] / mol dm ⁻³	initial rate / mol dm ⁻³ min ⁻¹
1	1.2	0.6	8.0
2	0.6	0.6	4.0
3	2.4	1.2	64.0

What is the rate equation for the reaction?

- A rate = k [O₂][NO]
- **B** rate = k [O₂][NO]²
- **C** rate = $k [O_2]^2[NO]$
- **D** rate = $k [O_2][NO]^4$

16 Which statement is always correct when the system is at equilibrium?

 $P + Q \rightleftharpoons R + S$

- A The rate of the forward and reverse reactions are equal.
- **B** The concentration of the reactants and products are equal.
- **C** The rate constant of the forward and reverse reactions are equal.
- D The rate of both the forward and the reverse reactions are equal to zero.

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Commented [JTW1]: Added "always"

- 8
- 17 2.0 mol of H₂(g) was mixed with 1.0 mol of CO(g) and equilibrium was established at a given temperature.

$$2H_2(g) + CO(g) \rightleftharpoons CH_3OH(g)$$
 initial amount / mol 2.0 1.0 0

At equilibrium, x mol of H_2 had reacted with CO.

What is the amount, in mol, of each component in the equilibrium mixture?

	H ₂ (g)	CO(g)	CH₃OH(g)
Α	$2.0 - \frac{1}{2}x$	1.0 – x	$\frac{1}{2}$ X
в	$2.0 - \frac{1}{2}x$	1.0 – 2x	х
С	2.0 – x	$1.0 - \frac{1}{2}x$	$\frac{1}{2}$ X
D	2.0 – x	1.0 – x	$\frac{1}{2}$ X

18 The ionic product of water, K_{w} , at two different temperatures is given.

temperature / °C	$K_{\rm w}$ / mol ² dm ⁻⁶
25	1.00 x 10 ⁻¹⁴
30	1.44 x 10 ⁻¹⁴

Which is correct for pure water at 30 °C?

- $\mathbf{A} \quad [\mathsf{H}^{\scriptscriptstyle +}] > [\mathsf{O}\mathsf{H}^{\scriptscriptstyle -}]$
- **B** $[H^+] = 1.44 \text{ x } 10^{-7} \text{ mol } dm^{-3}$
- **C** pH < 7
- **D** pH = 7

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19 Phosphoric acid, H₃PO₄, and sodium dihydrogen phosphate, NaH₂PO₄ are commonly used additives in food and drinks. They act as a buffer, helping to maintain a relatively constant pH when small amounts of either H⁺ or OH⁻ ions are added.

Which reaction occurs when either H^+ or OH^- ions are added to the buffer?

- **A** $H_3PO_4 + H^+ \longrightarrow H_2O + H_2PO_4^-$
- **B** $H_3PO_4 + OH^- \longrightarrow H_2O + H_2PO_4^-$
- **C** NaH₂PO₄ + H⁺ \longrightarrow NaH + H₂PO₄⁻
- **D** NaH₂PO₄ + OH⁻ \longrightarrow NaOH + H₂PO₄⁻

20 Which reaction involves both Arrhenius acid and Arrhenius base behaviour?

- **A** $NH_3 + CH_3Cl \longrightarrow CH_3NH_3^+ + Cl^-$
- **B** $CH_3OH + HClO_4 \longrightarrow CH_3OH_2^+ + ClO_4^-$
- **C** $CH_3COOH + NH_3 \longrightarrow CH_3COO^- + NH_4^+$
- **D** HNO₃ + NaOH \longrightarrow NaNO₃ + H₂O
- 21 Which property always decreases across the third period of the Periodic Table, from Na to C/?
 - A electrical conductivity
 - **B** ionisation energy
 - C melting point
 - D radius of the atom
- **22** Pure germanium, an important element in the electronics industry, can be extracted from GeC*l*₄.

GeCl₄ is a liquid at room temperature and has similar properties to SiCl₄.

Which statement about germanium tetrachloride is correct?

- A Germanium tetrachloride is an ionic compound.
- B Germanium tetrachloride is hydrolysed by water.
- **C** Germanium tetrachloride conducts electricity.
- **D** The bond angle in germanium tetrachloride is 120°.

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Commented [JTW2]: Changed phrasing from consistently to always. Jackson said "consistently" could be interpreted as same amount of decrease

Commented [JTW3R2]: Ref h2 2014 paper 1 Q18

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

Indium, ⁴⁹In, is used in solar cells and transistors, and to coat high-speed bearings.

From its position in the Periodic Table, which properties will indium be expected to possess?

- 1 Its chloride has the formula In_2Cl_6 in the vapour phase.
- 2 Its oxide dissolves in water to form an alkaline solution.
- 3 Its chloride dissolves in water to form an acidic solution.
- A
 1 and 2 only
 C
 2 and 3 only

 B
 1 and 3 only
 D
 1, 2 and 3

24 HCl is stable to heat, but HI decomposes into its elements when heated.

Which statement is responsible for this difference?

- A HI is a stronger reducing agent than HCl.
- **B** The H–I bond is weaker than the H–C*l* bond.
- **C** The I–I bond is weaker than the C*l*–C*l* bond.
- D HI has weaker intermolecular forces of attraction than HCl.
- 25 Which statement about ethene and benzene is incorrect?
 - A All bond angles in both molecules are 120°.
 - **B** All atoms in both molecules are in the same plane.
 - **C** Each carbon atom in ethene and benzene forms three σ bonds.
 - **D** The shape about each carbon atom in both ethene and benzene is tetrahedral.
- **26** How many different alkenes, including *cis-trans* isomers, are produced when 2-methylpentan-3-ol is heated with excess concentrated sulfuric acid?

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

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27 An amide has the structure shown.



11

Which two compounds will react to form this amide?

- 1 2-methylbutanoic acid
- 2 butylamine
- 3 3-methylbutanoic acid
- 4 propylamine

Α	1 and 4	C	2 and 3

B 1 and 2 **D** 3 and 4

28 A polyamide A is hydrolysed as shown.



Another polyamide ${\bf X}$ is hydrolysed using the method above and the equation is shown below.

$$X \longrightarrow 10 \text{ H}_2\text{N}(\text{CH}_2)_6\text{NH}_2 + 10 \text{ HOOC}(\text{CH}_2)_4\text{COOH}$$
$$(M_t = 116) \qquad (M_t = 146)$$

What is the M_r of **X**?

A 2260 **B** 2278 **C** 2440 **D** 2620

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- **29** Which statement regarding the properties of high density polyethene (HDPE) and low density polyethene (LDPE) is **incorrect**?
 - A HDPE has less branching than LDPE.
 - **B** HDPE is a harder material than LDPE.
 - **C** HDPE has a higher melting point than LDPE.
 - D HDPE is more suitable for making plastic bags than LDPE.
- **30** Platinum is one of the catalysts used in a catalytic converter.

Which statements about the platinum catalyst are correct?

- 1 Platinum nanoparticles are used since they have large surface area to volume ratio.
- 2 Platinum nanoparticles react with nitrogen oxide to form nitrogen and platinum oxide.
- 3 Platinum nanoparticles remove carbon monoxide from exhaust fumes by reduction.
- 4 Platinum nanoparticles remove unburnt hydrocarbons from exhaust fumes by oxidation.

Α	1 and 4 only	С	1, 3 and 4
в	1 and 2 only	D	2, 3 and 4

END OF PAPER

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