

DUNMAN HIGH SCHOOL Preliminary Examination Year 6

H2 CHEMISTRY

Paper 1 Multiple Choice

9729/01 23 September 2022 1 hour

Additional Materials: Multiple Choice Answer Sheet Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your centre number, index number, name and class at the top of this page.

Write in soft pencil.

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

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.

1 Beams of charged particles are deflected by an electric field. Under identical conditions, the angle of deflection of a particle is proportional to its charge/mass ratio.

In an experiment, protons are deflected by an angle of $+15^{\circ}$ by an electric field. In another experiment under identical conditions, particle Y is deflected by an angle of -5° .

What could be the composition of particle Y?

	protons	neutrons	electrons
Α	1	2	1
В	3	3	5
С	4	5	1
D	4	5	3

2 The first ionisation energies of four elements with consecutive atomic numbers below 20 are shown on the graph.

One of the elements reacts with hydrogen to form a covalent compound with formula HX.

Which element could be X?



- 3 Which molecule does **not** have any 90° or 180° bond angles?
 - 1 O₃
 - 2 PF5
 - 3 [PCl₄]⁺
 - 4 SF₆

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

4 Which molecule has the largest overall dipole moment?



5 The value of pV is plotted against p for two gases, an ideal gas and a non-ideal gas, where p is the pressure and V is the volume of the gas.



Which gas shows the greatest deviation from ideal gas behaviour at 273 °C?

Α	CO ₂	В	Cl_2
С	CH₃OH	D	N_2H_4

6 X and Y are oxides of different elements in Period 3.

If one mole of X is added to water, the solution formed is neutralised by exactly one mole of Y.

	Х	Y
Α	P ₄ O ₁₀	Al ₂ O ₃
в	SO ₃	Al_2O_3
С	P ₄ O ₁₀	Na ₂ O
D	SO ₃	Na ₂ O

What could be the identities of X and Y?

- 7 Which factor contributes to the difference in thermal stability between CaCO₃ and BaCO₃?
 - A The polarisability of the ions present in CaCO₃ is greater than that of BaCO₃.
 - **B** The melting point of CaCO₃ is lower than that of BaCO₃.
 - **C** The charge density of Ca^{2+} is higher than that of Ba^{2+} .
 - **D** The lattice energy of CaCO₃ is more negative than that of BaCO₃.
- 8 The volatility of the Group 17 elements, chlorine, bromine and iodine, decreases down the group.

Which of the following is responsible for this trend?

- 1 bond length in the halogen molecule
- 2 bond strength in the halogen molecule
- 3 electronegativity of the halogen atom
- 4 number of electrons in the halogen atom

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

9 30 cm³ of 0.1 mol dm⁻³ sulfuric acid and 40 cm³ of 0.2 mol dm⁻³ sodium hydroxide were mixed in a Styrofoam cup.

Assume that the density and 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 temperature change of the solution given that the standard enthalpy change of neutralisation is $-57.3 \text{ kJ mol}^{-1}$?

A -1.6 °C **B** -1.2 °C **C** +1.2 °C **D** +1.6 °C

10 Which statement is correct to describe the spontaneity of reaction I?

reaction I $T(aq) + U(s) \rightarrow V(aq) + W(g)$

- A Reaction I is only spontaneous at low temperatures if the reaction is endothermic.
- **B** Reaction **I** is only spontaneous at low temperatures if the reaction is exothermic.
- **C** Reaction **I** is spontaneous at all temperatures if the reaction is endothermic.
- **D** Reaction **I** is spontaneous at all temperatures if the reaction is exothermic.

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

Which statements are correct?

- H_2O_2 acts as both the oxidising agent and reducing agent in its decomposition.
- 2 MnO_4^- reacts with Fe³⁺ in a 1 : 5 ratio under acidic conditions to give Fe²⁺ and Mn²⁺.
- In an iodometric titration, I_2 is the reducing agent while $S_2O_3^{2-}$ is the oxidising agent.
- 4 Each carbon atom in the ion, $HC_2O_4^-$, has an oxidation state of +3.

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

12 Nitric oxide, NO, reacts with hydrogen gas to give nitrogen and water only.

Given that rate = $k[NO]^{2}[H_{2}]$, which reaction mechanism best agrees with the experimentally determined rate law?

- A NO + NO \rightleftharpoons N₂O₂ (slow) N₂O₂ + H₂ \rightarrow N₂O + H₂O (fast)
- **B** NO + H₂ \rightarrow HNO + H• (slow) HNO + H• $\rightarrow \frac{1}{2}N_2$ + H₂O (fast)

13 The initial rate method was used to investigate the reaction between compounds K and L which is catalysed by reagent M.

	experiment	initial [K] / mol dm ⁻³	initial [L] / mol dm ⁻³	initial [M] / mol dm ⁻³	relative rate / s ⁻¹
	1	0.0025	0.08	0.80	0.50
	2	0.0010	0.08	0.80	0.20
	3	0.0050	0.08	0.40	0.25
Γ	4	0.0050	0.04	0.80	0.50

The results obtained are shown below.

What is the rate equation for this reaction?

Α	rate = <i>k</i> [K][L][M]	В	rate = <i>k</i> [K][L] ² [M]
С	rate = <i>k</i> [K][L][M] ²	D	rate = <i>k</i> [K][L] ² [M] ²

14 Nitrogen dioxide can decompose to form nitrogen monoxide and oxygen.

$$2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$$

When 2.50 mol of nitrogen dioxide was allowed to undergo decomposition in a 0.8 dm³ container, 0.528 mol of oxygen was present at equilibrium.

What is the numerical value of the equilibrium constant, K_c , for this reaction?

Α	0.282	В	0.353
С	2.83	D	3.54

15 The formation of sulfur trioxide from sulfur dioxide and oxygen is a reversible reaction.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$
 $\Delta H = -197 \text{ kJ mol}^{-1}$

Which statements about this equilibrium are correct?

- 1 The K_c value will be halved if the stoichiometric coefficients in the equation are halved.
- 2 At dynamic equilibrium, the rates of the forward and backward reactions are equal to zero.
- 3 An increase in pressure of the system will result in a greater yield of SO_3 at equilibrium.
- 4 When temperature is reduced, the rate constant of the forward reaction, $k_{\rm f}$, decreases to a smaller extent than that of the backward reaction, $k_{\rm b}$.

Α	3 and 4 only	В	1 and 2 only

 C
 2, 3 and 4 only
 D
 1 and 3 only

16 The pH change when 1.00 mol dm⁻³ hydrochloric acid was added dropwise to 25 cm³ of 1.00 mol dm⁻³ piperazine ($C_4H_{10}N_2$) is shown below.



From the table below, which pair of indicators can be used consecutively to detect the end-points of the titration?

indicator	range
bromothymol blue	6.0 – 7.6
ethyl orange	3.4 - 4.8
methyl red	4.8 - 6.0
thymolphthalein	9.4 - 10.6

- A Bromothymol blue followed by ethyl orange
- **B** Bromothymol blue followed by methyl red
- **C** Thymolphthalein followed by ethyl orange
- **D** Thymolphthalein followed by methyl red

17 A student added aqueous silver nitrate, with stirring, to three different mixtures.

beaker	mixture
1	sodium chloride and sodium bromide
2	sodium chloride and sodium iodide
3	sodium bromide and sodium iodide

The student then added an excess of concentrated aqueous ammonia to each beaker with stirring.

Which observation is correct?

	beaker 1	beaker 2	beaker 3
Α	colourless solution	yellow precipitate	yellow precipitate
В	cream precipitate	yellow precipitate	cream and yellow precipitate
С	colourless solution	cream precipitate	cream precipitate
D	yellow precipitate	cream precipitate	cream and yellow precipitate

18 Which equation has the movement of electrons correctly shown using curly arrows?



19 Which statement correctly describes enantiomers?

- **A** A racemic mixture is optically active.
- **B** Enantiomers have different melting points.
- **C** Enantiomers exhibit the same biological behaviour in the human body.
- **D** Enantiomers have the same solubility in the same solvent.

20 2-methylpentane can undergo free radical substitution with chlorine in the presence of ultraviolet light.



2-methylpentane

Assume that the rate of abstraction of hydrogen atom from each carbon is the same.

Which statements are correct?

- 1 There are four equivalent secondary hydrogen atoms in 2-methylpentane.
- 2 The relative proportion of the tertiary monochloroalkane product will be the smallest.
- 3 There are three isomeric primary monochloroalkane products.
- 4 The propagation step of the reaction mechanism involves H• radicals.

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

21 Which statement is true about the reaction between but–1–ene and aqueous bromine?

- 1 The reaction is an overall first order reaction.
- 2 Water acts as an electrophile in this reaction.
- 3 The reaction involves a trigonal planar intermediate.
- 4 1–bromobutan–2–ol will be the product with the highest yield.
- A
 3 only
 B
 2 and 3 only

 C
 1 and 4 only
 D
 3 and 4 only

22 Pyridine is analogous to benzene, and they share very similar chemical properties.



Pyridine undergoes electrophilic substitution with bromine. Which of the following accurately describes the catalyst required and the intermediate formed in this reaction?

	required catalyst	intermediate formed
A	Lewis base	H Br
В	Lewis base	H Br
С	Lewis acid	H Br
D	Lewis acid	H Br

23 Which chemical test will **not** allow for the following two compounds to be distinguished?



- **A** Add Br_2 in CCl_4
- **B** Add neutral $FeCl_3(aq)$
- $\label{eq:constraint} \textbf{C} \qquad \text{Warm with } K_2 Cr_2 O_7(aq) \text{ and } H_2 SO_4(aq)$
- **D** Warm with KOH(aq), then add excess HNO₃(aq) followed by AgNO₃(aq)

24 Compound X does not give a reddish-brown precipitate with Fehling's solution but produces a pale yellow precipitate with hot alkaline aqueous iodine. What could be the structure of compound X?



The structure of chlorogenic acid is relevant to Questions 25 and 26.



- 25 Which statement is true about chlorogenic acid?
 - A 1 mol of chlorogenic acid gives 2 mol of organic products when heated with excess acidified K₂Cr₂O₇(aq).
 - **B** 1 mol of chlorogenic acid produces 1 mol of CO_2 gas when reacted with excess $Na_2CO_3(aq)$.
 - **C** 1 mol of chlorogenic acid will react with 6 mol of NaOH(aq) at room temperature.
 - **D** 1 mol of chlorogenic acid will react with 6 mol of ethanoyl chloride.

26 Which compound below can be used to synthesise chlorogenic acid in either one or two steps?



C 2 and 3 only

- **3** 1 and 2 only
- **D** 1, 2 and 3

27 Methotrexate is an immunosuppressant used to treat some forms of cancer.



You may assume that the R group is unreactive.

Which statement is true about methotrexate?

- A N₁ can react with ethanoyl chloride to give an amide.
- **B** Both N_1 and N_2 have lone pair of electrons that are available for donation.
- **C** The heating of methotrexate with $H_2SO_4(aq)$ does not produce any zwitterions.
- **D** The treatment of methotrexate with $LiAlH_4$ will result in the removal of 2 oxygen atoms from methotrexate.
- 28 Consider the galvanic cell below.



Excess NaCN(s) was added into half-cell 2.

Which is true about the galvanic cell above after the addition of NaCN(s)?

- A Electrons flow out of half–cell 1 and into half–cell 2.
- **B** The cell potential becomes more positive.
- **C** The polarity of both electrode changes.
- **D** The cathode reduces in mass.

29 An impure piece of copper contained silver and zinc as minor impurities. It contained no other metal. In order to purify it, the impure copper was made the anode of an electrolytic cell, with a pure copper cathode and aqueous CuSO₄ as electrolyte.

15

Which statement is true regarding this purification of copper?

- 1 Cu²⁺ is preferentially reduced at the cathode.
- 2 At the anode, zinc and copper are oxidised.
- 3 The cell voltage must be adjusted such that only copper and metals with more positive E^{\ominus} than $E^{\ominus}_{Cu^{2+}/Cu}$ are preferentially oxidised.
- A 1 only B 2 only
- C
 1 and 2 only
 D
 1, 2 and 3
- **30** Which cation contains exactly two unpaired electrons?
 - A
 Fe³⁺
 B
 Cu²⁺

 C
 Cr³⁺
 D
 Ni²⁺

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