

CANDIDATE NAME		
CG	INDEX NO	
CHEMISTRY		9729/01
Paper 1 Multiple Choid		13 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, highlighters, glue or correction fluid/tape.

Write your name and class 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.

1 A sample of calcium contains three naturally occurring isotopes, ⁴⁰Ca, ⁴²Ca and ⁴⁴Ca.

The sample is made up of 96.64% of ⁴⁰Ca and the relative atomic mass of calcium in this sample is 40.11.

What is the percentage of the isotope ⁴²Ca in the sample?

- **A** 0.44% **B** 0.67% **C** 1.22% **D** 2.09%
- **2** Aluminium chloride dimerises to give Al_2Cl_6 .

Which statement about aluminium chloride and its dimer is correct?

- A A/Cl_3 has a high melting and boiling point due to strong electrostatic forces of attraction between Al^{3+} and Cl^{-} .
- **B** Each aluminium atom is surrounded by four chlorine atoms in the dimer, Al_2Cl_6 .
- **C** Some of the bond angles decrease while some remains the same when $AlCl_3$ dimerises to form Al_2Cl_6 .
- **D** The geometry around each aluminium atom in Al_2Cl_6 is trigonal planar.
- **3** The graph shows the behaviour of one mole of an ideal gas.



Which of the following will produce the graph shown?

	y-axis	x-axis	condition
Α	ρV	р	at constant temperature
В	p	V	at constant temperature
С	р	1/V	at constant temperature
D	T (in K)	V	at constant pressure

4 Sodium, magnesium, aluminium, silicon and phosphorus are all elements in Period 3 of the Periodic Table.

Three statements about the oxides and chlorides of these elements are given.

Which statements are correct?

- 1 The ionically bonded oxides all react with dilute hydrochloric acid.
- 2 All metal chlorides produced neutral solutions when added to water.
- 3 The two most electronegative elements both form covalently bonded chlorides.
- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only
- 5 The table shows the trend in the stated properties from magnesium to barium in Group 2.

Which row is correct?

	decomposition temperature of the carbonate	reducing power
Α	increases	increases
В	increases	decreases
С	decreases	increases
D	decreases	decreases

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

The element astatine, At, is in Group 17 of the Periodic Table.

Which statements about At will be true?

- 1 It is a coloured solid at room temperature.
- 2 Its hydride is thermally more stable than the hydride of iodine.
- 3 It is more electronegative than iodine.
- A 1, 2 and 3 B 1 and 2 only C 2 and 3 only D 1 only

7 When 30 cm³ of a hydrocarbon was burnt in excess oxygen, there was a contraction of 105 cm³. On treating the cooled resulting mixture with excess potassium hydroxide, a further contraction of 150 cm³ occurred. All volumes were measured at r.t.p.

What is the formula of the hydrocarbon?

- $\label{eq:2.1} {f A} \quad C_3 H_6 \qquad \ \ {f B} \quad C_3 H_8 \qquad \ \ {f C} \quad C_5 H_{10} \qquad \ \ {f D} \quad C_5 H_{12}$
- 8 Iron metal and VO₂⁺ were reacted together in a 1 : 1 ratio until all the iron metal was oxidised to Fe²⁺ ions.

What is the oxidation state of vanadium in the product?

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

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

Butanal can be synthesised from propene, C_3H_6 .

 $CH_3CH=CH_2(g) + CO(g) + H_2(g) \rightleftharpoons CH_3CH_2CH_2CHO(g)$

What is the value of the enthalpy change of the reaction?

- A +47 kJ mol⁻¹
- **B** -47 kJ mol⁻¹
- C +137 kJ mol⁻¹
- **D** -137 kJ mol⁻¹

10 Ammonia gas and hydrogen chloride gas react to form ammonium chloride.

 $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$ $\Delta H^{\circ} = -176 \text{ kJ mol}^{-1}$

The magnitude of standard entropy change of this reaction is 284 J K⁻¹ mol⁻¹.

Which statements are correct?

- 1 ΔG° is -261 kJ mol⁻¹ for the above reaction.
- 2 There is a decrease in disorder as the particles in NH₄C*l* are held close to each other in fixed positions.
- 3 The reaction becomes non-spontaneous at high temperature.
- **A** 1 only **B** 1 and 2 only **C** 2 only **D** 2 and 3 only
- **11** A first-order decomposition reaction is shown below.

$$2XY(g) \rightarrow X_2Y_2(g)$$

The half-life of the reaction was found to be 3.46 s.

What is the time taken for $X_2Y_2(g)$ to reach 99% of its final concentration?

A 21.0 s **B** 22.0 s **C** 23.0 s **D** 24.0 s

12 Nitric oxide, NO, reacts with oxygen to form nitrogen dioxide.

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

The reaction is thought to involve the following steps.

NO + O_2	\rightleftharpoons	NO ₃	(fast)
$NO_3 + NO$	\rightarrow	$NO_2 + NO_2$	(slow)

Which conclusions can be drawn from this information?

- 1 O_2 is acting as a catalyst.
- 2 NO_3 is an intermediate in this reaction.
- 3 The reaction is first order with respect to NO.
- 4 The reaction is first order with respect to O₂.

Α	1 and 2	В	2 and 3	С	2 and 4	D	2, 3 and 4
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13 The graph below shows how the number of moles of CH_4 varies with temperature at two different pressures of P_1 and P_2 respectively for the following equilibrium.



Which statements are correct?

- 1 The forward reaction is exothermic.
- 2 The magnitude of P_1 is greater than the magnitude of P_2 .
- 3 Adding catalyst increases the amount of CH₄ formed.
- **A** 1 only **B** 2 only **C** 1 and 2 only **D** 1, 2 and 3
- 12.50 cm³ of 0.100 mol dm⁻³ sodium hydroxide was added to 25.0 cm³ of 0.100 mol dm⁻³ hydrochloric acid.

What is the pH of the resulting solution?

- **A** 1.00
- **B** 1.48
- **C** 2.60
- **D** 2.90

- **15** What is a suitable indicator for the titration between 0.10 mol dm⁻³ nitric acid and 0.10 mol dm⁻³ aqueous ammonia?
 - A bromothymol blue (pH range 6.0–7.6)
 - **B** methyl orange (pH range 3.1–4.4)
 - **C** phenolphthalein (pH range 8.3–10.0)
 - D There is no suitable indicator
- **16** The ionic product of water, K_{w} , is affected by temperature.

temperature / °C	\mathcal{K}_{w} / mol 2 dm $^{-6}$
0	1.0 × 10 ^{−15}
50	5.5 × 10 ⁻¹⁴

Which statement describes what happens as the temperature of water is increased from 0 °C to 50 °C?

- A pH of water increases and $[H^+] = [OH^-]$
- **B** pH of water increases and $[H^+] < [OH^-]$
- **C** pH of water decreases and $[H^+] > [OH^-]$
- **D** pH of water decreases and $[H^+] = [OH^-]$
- **17** An aqueous solution containing both potassium chloride and potassium iodide is treated with an excess of aqueous silver nitrate.

The precipitate formed is filtered off and washed with deionised water. The precipitate is then shaken with aqueous ammonia and filtered off again.

Which ion is present in the final filtrate?

- A chloride
- B iodide
- C potassium
- **D** silver

- 18 Which molecule contains a total of two sp hybridised atoms?
 - A $H_2C=CH-CH=CH_2$
 - B HC≡C−C≡CH
 - \mathbf{C} H₂C=CH₂
 - **D** HC=CCH₃

19 Which row is correct?

	2-methylbutan-2-ol	$C_2H_5CO_2C_2H_5$
Α	secondary alcohol	propyl ethanoate
В	secondary alcohol	ethyl propanoate
С	tertiary alcohol	propyl ethanoate
D	tertiary alcohol	ethyl propanoate

20 A straight chain organic compound has a molecular formula of C₄H₅NO. It contains a nitrile, −CN, functional group.

Which other functional groups could be present?

- 1 aldehyde
- 2 alkene
- 3 amide
- **A** 1, 2 and 3 **B** 1 and 2 only **C** 1 only **D** 3 only
- 21 Which reaction is a termination step in the chain reaction between chlorine and methane, in the presence of ultraviolet light?
 - $A \quad \bullet CH_3 + \bullet CH_3 \rightarrow CH_3CH_3$
 - $\mathbf{B} \quad \bullet \mathbf{CH}_3 \ + \ \mathbf{Cl}_2 \ \rightarrow \ \mathbf{CH}_3\mathbf{Cl} \ + \ \mathbf{Cl} \bullet$
 - $\label{eq:constraint} \textbf{C} \quad \bullet CH_3 \ \textbf{+} \ H \bullet \ \rightarrow \ CH_4$
 - $\textbf{D} \quad \textbf{H}\bullet \ + \ \textbf{C}l\bullet \ \rightarrow \ \textbf{H}\textbf{C}l$

22 The diagram shows the structure of three halogenoalkanes.



Q, R and S can be hydrolysed.

Which row is correct?

	relative speed	l of hydrolysis	mechanism of hydrolysis		
	R	S	Q	R	
Α	fast	slow	S _N 1	S _N 2	
В	fast	slow	S _N 2	S _N 1	
С	slow	fast	S _N 1	S _N 2	
D	slow	fast	S _N 2	S _N 1	

23 Compound T, C₇H₁₃Br, reacts with hot alcoholic NaOH to produce two compounds, U and V.

On reaction with Br_2 , U gives a product, $C_7H_{12}Br_2$, which exists as a mixture of four enantiomers. On reaction with Br_2 , V gives a product, $C_7H_{12}Br_2$, which is non-chiral.

What could T be?



Compound W has molecular formula C₅H₁₀O.
W gives an orange precipitate with 2,4-dinitrophenylhydrazine and gives a silver mirror with Tollens' reagent.

How many isomers, including stereoisomers, does W have?

- **A** 4 **B** 5 **C** 6 **D** 7
- 25 Which row describes the order of decreasing acid strengths of the four compounds?
 - A ethanoic acid > fluoroethanoic acid > phenol > ethanol
 - **B** fluoroethanoic acid > ethanoic acid > phenol > ethanol
 - C ethanol > phenol > fluoroethanoic acid > ethanoic acid
 - D fluoroethanoic acid > ethanoic acid > ethanol > phenol
- 26 The structure of compound X is shown.



One mole of compound X reacts with two moles of substance Y.

What could be substance Y?

- 1 anhydrous PCl₅
- 2 sodium
- 3 sodium carbonate

A 1 only B 1 and 2 C 1 a	and 3 D 2 and 3
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27 Compound Z has been used as a painkiller.



What are the products when Z is hydrolysed by heating with NaOH(aq)?



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

The diagram shows apparatus that can be used to measure the standard electrode potential between the NO_3^{-}/NO_2 half-cell and the $S_4O_6^{2-}/S_2O_3^{2-}$ half-cell.



Which statement is correct?

- A The cell potential is 0.90 V.
- **B** Adding sodium hydroxide to the NO_3^{-}/NO_2 half-cell would increase the cell potential.
- **C** Adding iodine crystals to the $S_4O_6^{2-}/S_2O_3^{2-}$ half-cell would decrease the cell potential.
- **D** The direction of electron flow will reverse when the NO_3^-/NO_2 half-cell is replaced with a Cl_2/Cl^- half-cell.

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

Gold medals awarded in the Olympic Games have a silver core and a pure gold coating of mass 6.0 g. The core of the medal was immersed in a solution of 0.10 mol dm^{-3} gold(III) chloride for 1.5 hours.

What is the current used to achieve an electroplated coating weighing 6.0 g?

- **A** 0.2 A
- **B** 0.5 A
- **C** 1.6 A
- **D** 5.4 A

When copper(II) nitrate is dissolved in water, it gives a blue solution.When the blue solution is treated with an excess of aqueous ammonia it turns dark blue.When the blue solution is treated with an excess of concentrated hydrochloric acid it turns yellow.

What are the formulae of the copper species in the dark blue and yellow solutions?

	dark blue	yellow
Α	[Cu(NH ₃) ₆] ²⁺	[CuC <i>l</i> ₆] ^{2–}
В	[Cu(NH ₃) ₄ (H ₂ O) ₂] ²⁺	[CuC <i>l</i> 4] ^{2–}
С	[Cu(NH ₃) ₄ (H ₂ O) ₂] ²⁺	[CuCl ₆] ²⁻
D	[Cu(NH ₃) ₆] ²⁺	[CuCl ₄] ²⁻

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