Candidate Name:



2024 Mid-Year Examination Pre-University 3

H2 CHEMISTRY	9729/01
Paper 1 Multiple Choice	8 Jul 2024
	1 hour
Additional materials: Multiple Choice Answer Sheet	
Data Booklet	

READ THESE INSTRUCTIONS FIRST

Do not turn over this question paper until you are told to do so

Write in soft pencil.

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

Write your name, class and admission number in the spaces provided at the top of this page and on the Multiple Choice Answer Sheet provided.

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 Multiple Choice Answer Sheet provided.

Read the instructions on the Multiple Choice 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 question paper.

The use of an approved scientific calculator is expected, where appropriate.

FOR EXAMINER'S	S USE
TOTAL (30 marks)	

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

Which of the following options contain the same number of molecules as one another?

- 1 750 cm³ of carbon dioxide gas (measured at r.t.p.)
- 2 1.00 g of oxygen gas
- 3 1.90 cm³ of ethanol where the density of ethanol is 0.80 g cm⁻³
- **A** 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

2 10 cm³ of a hydrocarbon was burnt in 150 cm³ of oxygen. The resultant gaseous mixture contracted by 30 cm³ when passed through a solution of aqueous sodium hydroxide.

The remaining gas was just sufficient to burn exactly 20 cm³ of the same hydrocarbon.

Given that all gas volumes were measured at room temperature and pressure, what is the formula of the hydrocarbon?

3 Which of the following statements describe the reaction below correctly?

 $2PCl_5 \rightleftharpoons PCl_4^+ + PCl_6^-$

- 1 PCl_4^+/PCl_6^- is a conjugate acid-base pair.
- 2 PCl_5 is both a Lewis acid and Lewis base.
- 3 PCl_5 is both an Arrhenius acid and Arrhenius base.
- A
 2 only
 B
 3 only
 C
 1 and 2 only
 D
 1 and 3 only
- 4 The table belows shows the fifth, sixth, seventh and eighth ionisation energies of an element in the third period.

	5th	6th	7th	8th
ionisation energy / kJ mol ⁻¹	7000	8500	27110	31720

Which is the identity of the element?

A P **B** S **C** C*l* **D** Ar

5 Which of the following options are correct?

	molecule	shape	polarity
1	$BeCl_2$	bent	non-polar
2	NO ₂	bent	polar
3	SO ₃	trigonal planar	non-polar

- **A** 1 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3
- **6** Which of the following compounds is expected to have the greatest degree of covalent character?

A (CaO	В	CaS	С	MgO	D	MgS
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7 10 cm³ of a volatile liquid **E** turns into 0.050 dm³ of vapour at 50 °C and 1 bar. **E** is known to have an M_r of y.

What is the density of liquid **E**, in g cm⁻³?

- $\mathbf{A} \qquad \frac{100000 \times 0.050 \times 10^{-3} \times y}{8.31 \times 323 \times 10}$
- $\mathbf{B} \qquad \frac{100000 \times 0.050 \times 10^{-3}}{8.31 \times 323 \times 10 \times y}$
- $c \qquad \underline{100000 \times 0.050 \times 10^{-6} \times y}_{8.31 \times 323 \times 10}$
- $\mathbf{D} \qquad \frac{100000 \times 0.050 \times 10^{-6} \times 10}{8.31 \times 273 \times y}$

8 Three identical flasks each contain the same mass of gases G_1 , G_2 and G_3 respectively. The temperature and pressure of each flask are as follows:

	G ₁	G ₂	G ₃
temperature / K	Т	Т	2T
pressure / Pa	р	2р	р

Assuming ideal gas behaviour, which of the following is a correct representation of the relative molecular masses of the three gases?

 $\mathbf{A} \qquad \mathbf{G}_1 < \mathbf{G}_3 < \mathbf{G}_2$

B $G_2 < G_1 < G_3$

 $G_2 < G_3 < G_1$

- $D = G_3 < G_1 < G_2$
- 9 Which of the following reactions is non-spontaneous at all temperatures?

 - $\mathbf{C} \qquad \mathbf{P}(g) \to 2\mathbf{Q}(g) \qquad \qquad \Delta H < 0$
 - $$\label{eq:relation} \begin{split} \mathbf{D} \qquad \mathbf{R}(g) + \mathbf{S}(g) \to \mathbf{T}(g) \qquad \qquad \Delta H > 0 \end{split}$$
- **10** Hess' Law can be used to determine the average C-H bond energy in $CH_4(g)$.

What information is necessary to perform the calculation?

- **A** $\Delta H_{\text{formation}}(CH_4(g))$ only
- **B** $\Delta H_{\text{formation}}(CH_4(g)), \Delta H_{\text{atomisation}}(H_2(g)), \Delta H_{\text{atomisation}}(C(s))$
- **C** $\Delta H_{\text{formation}}(CH_4(g)), \Delta H_{\text{atomisation}}(H_2(g)), \text{Bond Energy (C-C)}$
- **D** $\Delta H_{\text{combustion}}(CH_4(g)), \Delta H_{\text{combustion}}(C(s)), \Delta H_{\text{combustion}}(H_2(g))$

11 Nepetalactone is the active ingredient found in catnip.



Which product is formed from an electrophilic addition reaction with nepetalactone?



12 Vasopressin is a mammalian hormone released from the pituitary gland of the body. It is a protein made up of many amino acids, two of which have formed a S–S covalent bond.



Which statements about vasopressin are correct?

- 1 Vasopressin is made of 9 amino acid subunits.
- 2 There are eight chiral carbons in vasopressin.
- 3 Only two of the amino acids that make up vasopressin have side-chains containing O.
- **A** 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

13 Which set of reagents will produce phenyl propanoate under suitable conditions?



14 Gel electrophoresis is a technique used to identify amino acids obtained from peptide hydrolysis. The sample is loaded onto the middle of the gel and placed across a potential difference.

The following tripeptide, Lys-Gly-Asp, was completely hydrolysed using acid, then buffered to pH 7 at 25 °C.



The following results were obtained:



At which position on the gel would the spot for Lys be formed?

15 Which of the following molecules can exhibit cis-trans isomerism?



16 Compounds **U** and **V** have the following structures.



Which reagents and conditions can be used to distinguish them?

- 1 ethanolic AgNO₃, warm
- 2 $K_2Cr_2O_7$, warm
- 3 Fehling's reagent, warm
- **A** 2 only **B** 3 only **C** 1 and 2 only **D** 2 and 3 only

17 The kinetics of a reaction was investigated, and the following results obtained:

run	[W] / mol dm ⁻³	[X] / mol dm ⁻³	initial rate / mol dm ⁻³ s ⁻¹
1	0.020	0.015	6.40 × 10 ⁻³
2	0.020	0.030	2.56 × 10 ⁻²
3	0.030	0.030	3.84×10^{-2}

 $2\mathbf{W} + \mathbf{X} \rightarrow \mathbf{Y} + 2\mathbf{Z}$

What is the numerical value of the rate constant for this reaction?

Α	0.213	В	0.320	С	21.3	D	1420
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18 A solution of acidified potassium manganate(VII) was added to ethanedioate ions, $C_2O_4^{2-}$, and the reaction is as follows:

 $2MnO_4^{-}(aq) + 5C_2O_4^{2-}(aq) + 16H^{+}(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$

It is known that Mn²⁺ catalyses the above reaction.

Which of the following graphs best describes the reaction?



19 The Haber process is used in the industrial production of ammonia.

 $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$

Which of the following options show a correct operating condition with its rationale?

	operating condition			rationale			
1	450 °C	high temperature increases rate of reaction			of reaction		
2	450 atm		high pressure shifts position of equilibrium to the right				
3	finely-divided Fe		lowers activation energy to increase rate of reaction				ate of reaction
Α	3 only B	1 ar	nd 2 only	С	1 and 3 only	D	1, 2 and 3

20 Sulfuric acid can be produced from the Contact process, which involves an equilibrium reaction to produce sulfur trioxide, SO₃.

 $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $K_c = 280 \text{ mol}^{-1} \text{ dm}^3$

What is the amount of O_2 used to react with 0.80 mol of SO_2 initially, given that 0.60 mol of SO_3 is obtained at equilibrium in a 1 dm³ vessel?

A 0.31 mol B 0.33 mol C 0.61 mol D 0.	.63 mol
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21 Which of the following conjugate acid-base pairs give a pH of 4.70 (at 25 °C) when at maximum buffer capacity?

Α	HOCN / -OCN	p <i>K</i> _b of ⁻OCN = 10.54
В	CH ₃ COOH / CH ₃ COO ⁻	pK_b of $CH_3COO^- = 9.30$
С	$H_2PO_4^- / HPO_4^{2-}$	pK_b of HPO ₄ ²⁻ = 6.79
D	HCN / CN⁻	p <i>K</i> ₀ of CN⁻ = 4.70

22 The pH curve below shows how pH changes when 20.0 cm³ of 0.20 mol dm⁻³ base is titrated against a 0.10 mol dm⁻³ acid.



Which of the following statements regarding this titration is incorrect?

- **A** This is a weak base–strong acid titration.
- **B** The solution at equivalence point is acidic.
- **C** The base is monoprotic and the acid is diprotic.
- **D** A buffer solution is formed when 30 cm³ of the acid is added.
- 23 The table below gives the pK_w values of pure water at different temperatures:

temperature / °C	р <i>К</i> _w
25	14.0
50	13.3

Four solutions of nitric acid at various concentrations were prepared separately, and their pH or pOH values measured at different temperatures.

Which of the following solutions of nitric acid has the greatest [H⁺]?

	pH or pOH	measured at
Α	pH = 2	25 °C
В	pH = 2	50 °C
С	pOH = 12	25 °C
D	pOH = 12	50 °C

24 40 cm³ of 0.60 mol dm⁻³ lead(II) nitrate solution was added into a 20 cm³ solution containing a mixture of Cl⁻, Br⁻, and I⁻ ions, each with the same concentration of 0.01 mol dm⁻³.

salt	K _{sp} value at 25 °C
lead(II) chloride	1.7 × 10⁻⁵
lead(II) bromide	$6.6 imes 10^{-6}$
lead(II) iodide	9.8 × 10⁻ ⁹

Which one of the following statements is correct?

- A No precipitate will form.
- **B** Only PbI₂ precipitate will form.
- **C** A mixture of PbI₂ and PbBr₂ precipitates will form.
- **D** All three precipitates, PbI_2 , $PbBr_2$, and $PbCl_2$ will form.
- 25 Which of the following statements about Group 2 elements is incorrect?
 - 1 BeC*l*₂ is able to act as a Lewis acid because Be has energetically-accessible vacant orbitals
 - 2 Be has a lower melting point than Mg as it has fewer valence electrons delocalised.
 - 3 Mg loses its electrons more readily than Ca.
 - 4 MgCO₃ decomposes at a lower temperature compared to CaCO₃.
 - **A** 1 and 2 only **B** 1 and 4 only **C** 2 and 3 only **D** 2 and 4 only

element	pH of solution when oxide is added to water	pH of solution when chloride is added to water			
E > 7		= 7			
F	= 7	< 7			
G	< 7	< 7			

26 E, **F** and **G** are elements from Period 3. The following observations are made when their respective oxides and chlorides are added to water at 25 °C.

What could be the identities of E, F and G?

	E	F	G
Α	Na	Al	Р
В	Na	Р	Al
С	Si	Р	Al
D	Р	Na	Si

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

Vanadium ions of different oxidation states exhibit a range of different colours in water:

ion	VO ₂ +	VO ²⁺	V ³⁺	V ²⁺
oxidation state	+5	+4	+3	+2
colour	yellow	blue	green	violet

When excess of a metal was added to an aqueous solution of VO_2^+ , the yellow solution turned green.

What is the identity of the metal?

A Mg **B** Zn **C** Sn **D** Ag

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

An electrolytic cell was set up with an anode made of Sn, a cathode made of Ni, and an aqueous solution of SnSO₄.

A current of 2.4 A is passed through the cell for 4.2 hours.

What is the change in mass of the cathode?

Α	-22.3 g	В	0 g	C +11.0 g	D	+22.3 g
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29 Use of the Data Booklet is relevant to this question.

Which of the following is the strongest reducing agent?

- A Cu⁺
- B Pb
- **C** V³⁺
- D [Fe(CN)₆]³⁻
- 30 Which of the following titanium compounds is **not** likely to exist?
 - A TiO₂
 - B K₃TiF₆
 - C Ti₂O₃
 - D K₂TiO₄

END OF PAPER 1

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