VICTORIA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CHEMISTRY 9729/01

Paper 1 Multiple Choice **22 September 2023**

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 index number, name and CT group on the Answer Sheet.

There are **thirty** questions. 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.
A Data Booklet is provided.

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.

This document consists of **11** printed pages.

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

1 In which species are the numbers of protons, neutrons and electrons all different?

A $^{27}_{13}Al$ **B** $^{35}_{17}Cl^-$ **C** $^{32}_{16}S^{2-}$ **D** $^{39}_{19}K^+$

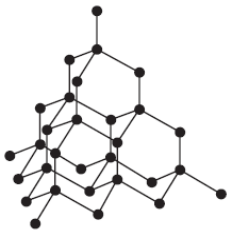
2 Dicarbon monoxide, C_2O, is found in dust clouds in space. Analysis of it shows that the central carbon atom is sp hybridised and there are no unpaired electrons.

How many lone pairs of electrons are present in a molecule of C_2O?

A 1 **B** 2 **C** 3 **D** 6

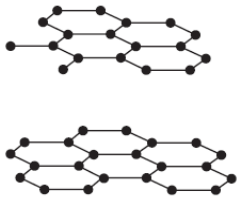
3 Which diagrams represent part of a giant molecular structure?

1



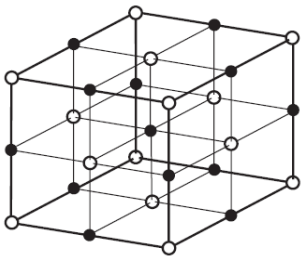
● = C

2



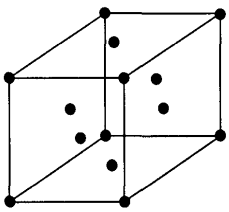
● = C

3



● = Na
○ = C*l*

4



● = I_2

A **1**, **2** and **3** only

B **1** and **2** only

C **2, 3** and **4** only

D **3** and **4** only

4 Three identical flasks each contains the same mass of gases **E**, **F** and **G** respectively. The temperature and pressure of each flask are indicated below.

Gas	**E**	**F**	**G**
Temperature / K	t	t	2t
Pressure / Pa	p	2p	p

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

A M_r(**G**) > M_r(**F**) > M_r(**E**)

B M_r(**E**) > M_r(**F**) > M_r(**G**)

C M_r(**G**) > M_r(**E**) > M_r(**F**)

D M_r(**F**) > M_r(**E**) > M_r(**G**)

5 Which of the following explains the non-ideal behaviour of the gases present in the reaction chamber in the Haber process?

A the high pressure of 150 atm

B the high temperature of 450°C

C the presence of a catalyst

D the strong bonds between the atoms in the nitrogen molecules

6 Elements **X**, **Y** and **Z** are in Period 3 of the Periodic Table.

Element **X** has a chloride and an oxide where each reacts vigorously with water to form a highly acidic solution.

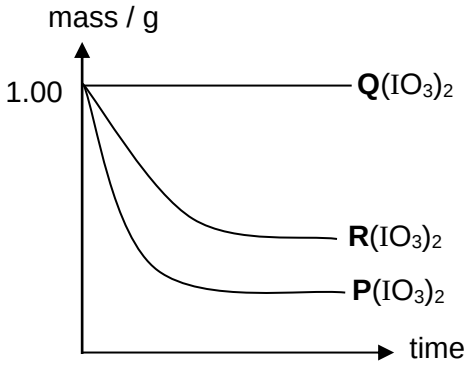
Element **Y** has a low conductivity at room temperature. It forms only one chloride that hydrolyses in water forming a white solid and an acidic solution.

Both the chloride and oxide of **Z** have high melting points. The oxide reacts readily with water. The chloride dissolves in water to form a neutral solution.

What are their identities?

	X	**Y**	**Z**
A	A*l*	S	Na
B	A*l*	S	Mg
C	P	Si	Mg
D	P	Si	Na

7 **P**, **Q** and **R** are Group 2 elements. The three graphs below show the change in mass when 1.00 g each of **P**$(IO_3)_2$, **Q**$(IO_3)_2$ and **R**$(IO_3)_2$ were heated separately at a temperature of T ^oC.



Which of the following statements about the elements **P**, **Q**, **R** and their compounds is correct?

A The first ionisation energy of **P** is the most endothermic.

B **R** reacts the most readily with water to give hydrogen gas.

C **Q**$(IO_3)_2$ has the highest melting point.

D Only oxide of **P** reacts with acids to form salts.

8 Due to its radioactive nature, the properties of astatine, At, has to be estimated based on its position in the Periodic Table.

Which of the predictions concerning At or its compounds can be correct?

A Hydrogen astatide has a higher decomposition temperature than hydrogen bromide.

B When astatine reacts with sodium iodide, a brown solution will form.

C Silver astatide is soluble in NH_3(aq).

D Astatine exists as a solid at room temperature.

9 When Tl^+(aq) ions are reacted with VO_3^-(aq) ions, Tl^{3+}(aq) ions and V^{2+}(aq) ions are formed.

Assuming the reaction goes to completion, how many moles of Tl^+(aq) and VO_3^-(aq) would result in a mixture containing equal number of moles of VO_3^-(aq) and V^{2+}(aq) once the reaction had taken place?

	moles of Tl^+(aq)	moles of VO_3^-(aq)
A	1	2
B	1	3
C	3	2
D	3	4

10 Equations involving four enthalpy changes are shown.

$Na(g) \rightarrow Na^+(g) + e^-$ $\Delta H = w$

$Na(g) \rightarrow Na^{2+}(g) + 2e^-$ $\Delta H = x$

$Na(s) \rightarrow Na(g)$ $\Delta H = y$

$Na(s) \rightarrow Na^{2+}(g) + 2e^-$ $\Delta H = z$

What is the second ionisation energy of sodium?

A x **B** $x - w$ **C** $y - w$ **D** $z - y$

11 Which of the following changes will result in a decrease in entropy?

A forward reaction of $[Fe(H_2O)_6]^{2+}(aq) + edta^{4-}(aq) \rightleftharpoons [Fe(edta)]^{2-}(aq) + 6H_2O(l)$

B mixing of 1 mol of N_2 with 1 mol of Ar at constant pressure

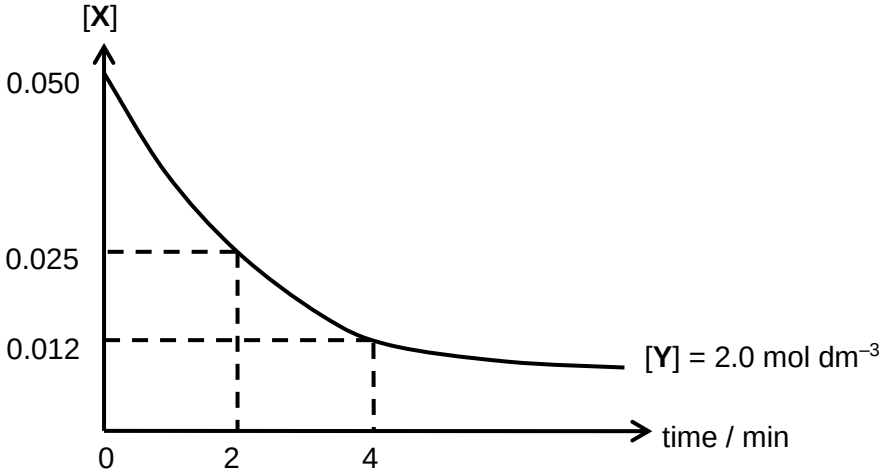
C cooling of liquid ethanol from 50 °C to 20 °C

D sublimation of iodine crystal

12 A student performed an experiment to investigate a hypothetical reaction.

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

The graph of [**X**] against time for the experiment is shown below.



When the initial [**Y**] doubles in another experiment, the gradient of tangent at t = 0 min increases by two times.

Which of the following statements about this reaction is correct?

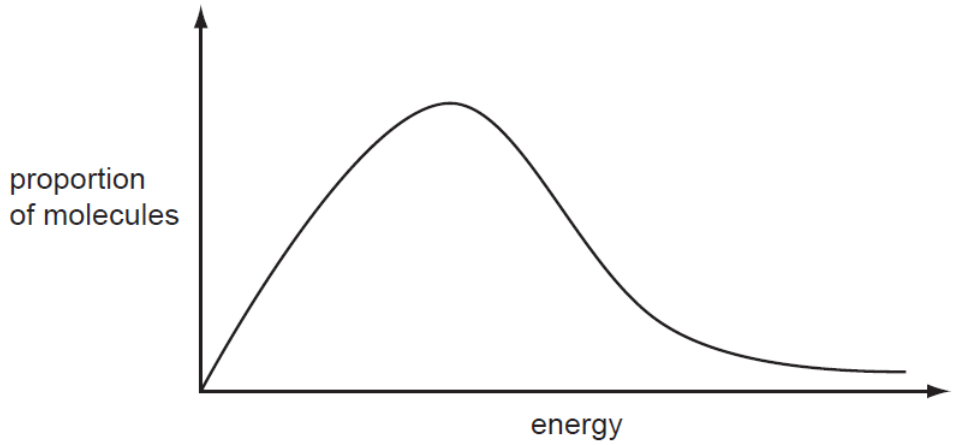
A The unit of the rate constant is min^{-1}.

B It is a single-step reaction.

C The half-life of the reaction remains unchanged when [**Y**] doubles.

D The half-life of the reaction remains unchanged when [**X**] doubles.

13 The diagram represents the Maxwell-Boltzmann energy distribution of molecular energies at a given temperature.



As temperature increases, which of the following statements are correct?

1 The proportion of molecules with energies above activation energy increases.

2 The maximum of the curve is displaced to the right.

3 At all energies, the proportion of molecules of a particular energy increases.

A **1**, **2** and **3**

B **1** and **2** only

C **2 and 3** only

D **3** only

14 An equilibrium can be represented by the equation below.

$$2\mathbf{W}(aq) + \mathbf{X}(aq) \rightleftharpoons \mathbf{Y}(aq)$$

The equilibrium concentrations of different substances in a 0.50 dm^3 mixture are shown below.

species	**W**	**X**	**Y**
concentration / mol dm^{-3}	2.00	1.00	2.00

A certain amount of **Y** was later added to this equilibrium mixture. When equilibrium is reached again, the equilibrium concentration of **X** is found to be 1.20 mol dm^{-3}.

You should assume that the temperature of the mixture remained constant throughout.

What is the number of moles of **Y** added to the mixture?

A 0.26 **B** 0.83 **C** 1.05 **D** 1.66

15 Given that the K_a of ethanoic acid is 1.80×10^{-5} mol dm^{-3}, what is the volume of water that needs to be added to a 10 cm^3 of 0.100 mol dm^{-3} ethanoic acid to increase its pH to 3.20?

A 11.2 cm^3 **B** 21.2 cm^3 **C** 35.2 cm^3 **D** 45.2 cm^3

16 Which of the following mixtures would constitute a buffer solution?

A 1 mol of HC*l* and 1 mol of NaC*l*

B 1 mol of $H_2PO_4^-$ and 1 mol of HPO_4^{2-}

C 1 mol of NaOH and 1 mol NaC*l*

D 1 mol of $H_2PO_4^-$ and 1 mol of NaOH

17 Values of two solubility products are given as follows:

$K_{sp}(ZnF_2) = 3.20 \times 10^{-2}$ mol^3 dm^{-9}
$K_{sp}(BaF_2) = 1.60 \times 10^{-7}$ mol^3 dm^{-9}

Solid zinc fluoride is shaken with water. The remaining solid is filtered off, leaving a saturated solution *L*.

Drops of dilute aqueous barium chloride are added to *L* until barium fluoride just precipitates.

Which row of the table is correct?

	$[F^-]$ in *L* / mol dm^{-3}	$[Ba^{2+}(aq)]$ when BaF_2 just precipitates
A	2.00×10^{-1}	4.00×10^{-7}
B	2.00×10^{-1}	8.00×10^{-7}
C	4.00×10^{-1}	1.00×10^{-6}
D	4.00×10^{-1}	4.00×10^{-6}

18 A mixture of propyne and propadiene is produced as side products during the cracking of propane. Propyne exists in equilibrium with propadiene.

$$\underset{\text{propyne}}{H{-}C{\equiv}C{-}CH_3} \rightleftharpoons \underset{\text{propadiene}}{H_2C{=}C{=}CH_2}$$

Which of the following statements is **incorrect**?

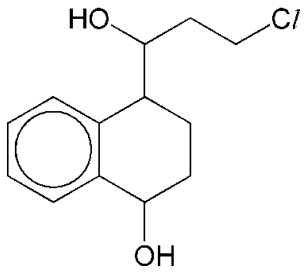
A Propyne contains a σ bond formed by 1s–2sp overlap.

B Propadiene contains a π bond formed by 2p–2p overlap.

C Both propyne and propadiene contain sp hydridised carbons.

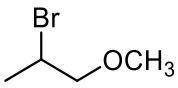
D Propyne has a longer C–C single bond compared to propane.

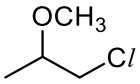
19 What is the total number of possible stereoisomers exhibited by the following compound?

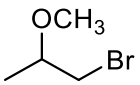


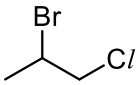
A 2 **B** 4 **C** 6 **D** 8

20 Which of the following is the major product formed when prop–1–ene reacts with BrC*l* in pure methanol?

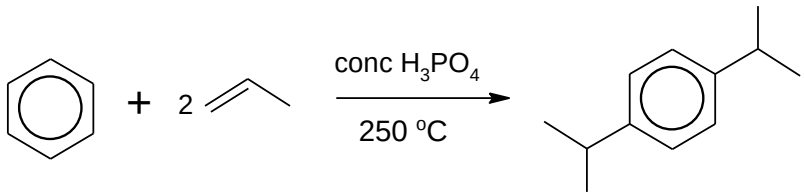
A 

B 

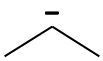
C 

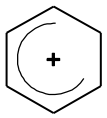
D 

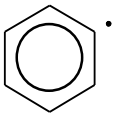
21 The following industrial reaction involves benzene and propene.

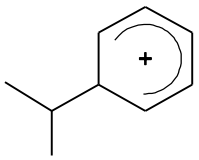


Which of the following intermediate is likely formed in this reaction?

A 

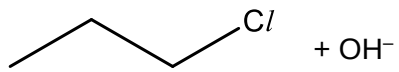
B 

C 

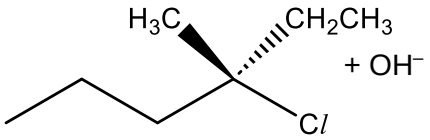
D 

22 Which reaction will **not** produce a mixture of two enantiomers in aqueous solution?

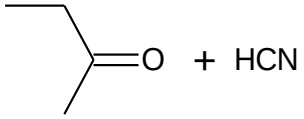
A



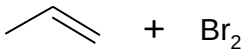
B



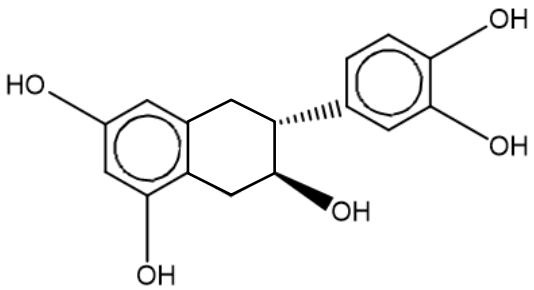
C



D



23 Which statement about the compound **Z** is correct?



compound **Z**

A 1 mol of **Z** reacts with 5 mol of aqueous sodium hydroxide.

B 1 mol of **Z** reacts with sodium to produce 5 mol of hydrogen gas.

C 1 mol of **Z** reacts with 5 mol of aqueous bromine.

D 1 mol of **Z** reacts with phosphorus pentachloride to form 5 mol of hydrogen chloride gas.

24 Which reaction yields a carbon containing compound incorporating deuterium, D? [D = $^{2}_{1}H$]

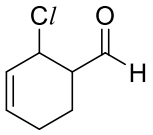
A $CH_3CHO \xrightarrow[\text{dry ether}]{LiAlD_4}$

B $CH_3CH_2CN \xrightarrow[D_2O]{NaOD}$

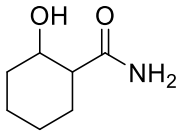
C $(CH_3)_3COH \xrightarrow[\text{heat}]{\text{conc. } D_2SO_4}$

D $CH_3CD(OD)CH_3 \xrightarrow[\text{heat}]{\text{acidified } KMnO_4}$

25 Which reagents can be used to distinguish between compounds **Y** and **Z**?



Y



Z

1 2,4-dinitrophenylhydrazine

2 hot acidified potassium dichromate

3 hot aqueous sodium hydroxide

A **1** and **2** only

B **1** and **3** only

C **2** and **3** only

D **2** only

26 Which of the following trends are **correct**?

1 The boiling points of alcohols with the same molecular formula increase from primary to secondary to tertiary alcohols.

2 The pH values of the aqueous solutions increase in the order of CH_3CH_2COCl, $CH_3CH_2CO_2H$, $CH_3CH_2CONH_2$, $CH_3CHClCH_2NH_2$.

3 The ease of hydrolysis decreases in the order of chlorobenzene, chloroethane, ethanoyl chloride.

4 The pK_b values decrease in the order of CH_3CO_2Na, C_6H_5ONa, C_2H_5ONa.

A **1**, **2** and **3** only

B **2** and **4** only

C **3** and **4** only

D **2** only

27 A small peptide **X** is hydrolysed according to the following reaction.

$$\mathbf{X} \xrightarrow{\text{hydrolysis}} 2NH_2CH_2CO_2H + NH_2CH(CH_3)CO_2H + 2NH_2CH(CH_2OH)CO_2H$$

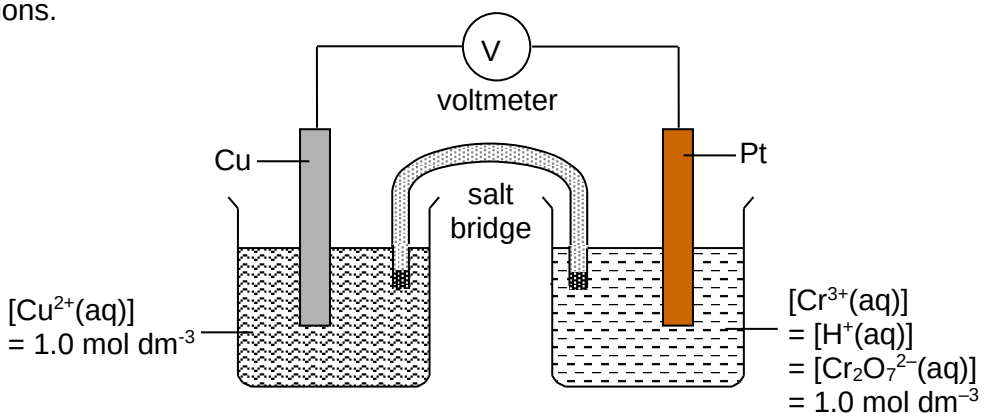
(M_r = 75) (M_r = 89) (M_r = 105)

What is the M_r of **X**?

A 359 **B** 377 **C** 431 **D** 449

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

A cell is set up by connecting a Cu^{2+}/Cu half-cell and an acidified $Cr_2O_7^{2-}/Cr^{3+}$ half-cell under conditions.



Which of the following correctly state the effect on the e.m.f of the cell when the respective change is made?

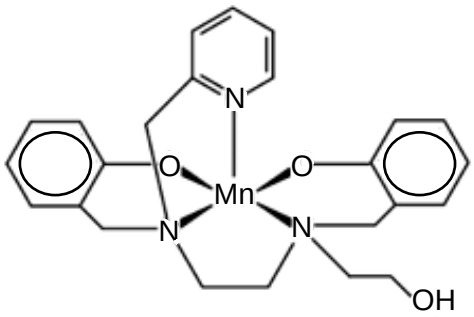
	Change	Effect on e.m.f of cell
1	Using a larger copper electrode	Decreases
2	Addition of excess aqueous NH_3 into oxidation half-cell	Increases
3	Addition of dilute H_2SO_4 into reduction half-cell	Increases

A **1**, **2** and **3**
B **1** and **3** only
C **2** and **3** only
D **1** only

29 Which species does **not** act as a ligand in the formation of complexes?

A NH_4^+ **B** Cl^- **C** CH_3NH_2 **D** OH^-

30 *Use of the Data Booklet is relevant to this question.*



Which one of the following statements about the above complex is **incorrect**?

A This complex contains five ligands.
B The oxidation number of manganese in this complex is +2.
C The coordination number of this complex is 5.
D There are 5 unpaired 3d electrons in manganese in this complex.