NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
SUBJECT CLASS		REGISTRATION NUMBER	

CHEMISTRY **9729/01**
Paper 1 Multiple Choice **14 September 2023**
1 hour

Additional Materials: Optical Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, subject class and registration number 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.
A Data Booklet is provided.

Instructions on how to fill in the Optical Mark Sheet
Shade the index number in a 5 digit format on the optical mark sheet:
2nd digit and the last 4 digits of the Registration Number.

Example:

Student	Examples of Registration No.	Shade:
	2205648	**25648**

This document consists of **8** printed pages.

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

Which particle has more protons than electrons and more protons than neutrons? (D = $^{2}_{1}H$)

A D_3O^+ **B** H_3O^+ **C** NH_2^- **D** OD^-

2 Cl_2 reacts with hot dilute NaOH to give Cl^- and ClO_x^- in a 5:1 ratio.

What is the value of x in ClO_x^-?

A 1 **B** 2 **C** 3 **D** 5

3 The boiling point of water (100 °C) is greater than that of HF (20 °C).

Which statement is a correct explanation of this?

A Each hydrogen bond formed between water molecules is stronger than that formed between HF molecules.

B There are more atoms in a water molecule than there are in an HF molecule, resulting in stronger intermolecular forces in water.

C There are on average, more hydrogen bonds between water molecules than there are between HF molecules.

D The water molecule has stronger permanent dipole-permanent dipole interactions than the HF molecule.

4 When the carbon-oxygen bonds in methanol, CH_3OH, methanal, HCHO, and methanoate, HCO_2^- are arranged in order of increasing length, what is the correct order?

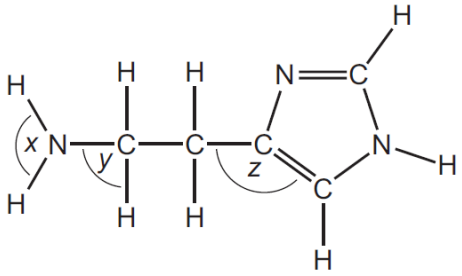
A CH_3OH, HCO_2^-, HCHO

B HCO_2^-, CH_3OH, HCHO

C HCHO, HCO_2^-, CH_3OH

D HCO_2^-, HCHO, CH_3OH

5 Histamine is produced in the body to help fight infection. Its shape allows it to fit into receptors which expand blood vessels.



histamine

What are the bond angles x, y and z in histamine, from the smallest to the largest?

	smallest bond angle	⟶	largest bond angle
A	x	y	z
B	y	x	z
C	y	z	x
D	z	y	x

6 When a sample of a gas is compressed at constant temperature from 1500 kPa to 6000 kPa, its volume changes from 76.0 cm^3 to 20.5 cm^3.

Which statements are possible explanations for this behaviour?

1 The gas behaves non-ideally.

2 The gas partially liquefies.

3 The gas molecules have undergone dimerisation.

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

7 The table below describes some of the chemistry and thermodynamic properties of the halogens.

process	name and symbol of quantity
$2HX(g) \longrightarrow H_2(g) + X_2(g)$	enthalpy change of reaction, $\Delta H^{\ominus}$
$H_2(g) + X_2(g) \rightleftharpoons 2HX(g)$	equilibrium constant, K_p
$X(g) \longrightarrow X^+(g) + e^-$	ionisation energy, I.E.

Which statements are correct?

1 $|\Delta H^{\ominus}|$ for HC*l* > $|\Delta H^{\ominus}|$ for HBr

2 K_p for HBr > K_p for HI

3 I.E. for I > I.E. for C*l*

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

8 In a calorimetric experiment 1.60 g of a fuel are burnt. 45.0 % of the energy released is absorbed by 200 g of water. The temperature of the water rises from 18 °C to 66 °C.

What is the total energy released per gram of fuel burnt (to 3 significant figures)?

A 25 100 J **B** 55 700 J **C** 89 200 J **D** 373 000 J

9 Consider this gas phase reaction.

$Cl_2(g) + CHCl_3(g) \longrightarrow HCl(g) + CCl_4(g)$

The rate equation for the above reaction is given below.

rate = $k\,[CHCl_3]\,[Cl_2]^{1/2}$

Based on this information, what conclusions can be drawn about this proposed mechanism?

Step **1** $Cl_2(g) \rightleftharpoons 2Cl(g)$

Step **2** $Cl(g) + CHCl_3(g) \longrightarrow HCl(g) + CCl_3(g)$

Step **3** $Cl(g) + CCl_3(g) \longrightarrow CCl_4(g)$

A Step **1** is the rate-determining step.

B Step **2** is the rate-determining step.

C Step **3** is the rate-determining step.

D The rate-determining step cannot be identified.

10 Ethyl ethanoate undergoes acid-catalysed hydrolysis in water where the concentration of acid in the solution remains constant.

$$CH_3CO_2CH_2CH_3 + H_2O \xrightarrow{H^+} CH_3CO_2H + CH_3CH_2OH$$

The rate equation is found to be rate = $k[CH_3CO_2CH_2CH_3][H^+]$

In an experiment, when 1.0 mol dm^{-3} HC*l* was reacted with 0.20 mol dm^{-3} ethyl ethanoate, the half-life was found to be 42 min.

In a second experiment, 1.0 mol dm^{-3} HC*l* was reacted with 0.10 mol dm^{-3} ethyl ethanoate.

What is the half-life of the second experiment?

A 10.5 min **B** 21 min **C** 42 min **D** 84 min

11 The equation below shows the reaction of ethanoic acid with ethanol.

$$CH_3CO_2H(l) + CH_3CH_2OH(l) \rightleftharpoons \underset{\text{ethyl ethanoate}}{CH_3CO_2CH_2CH_3}\ (l) + H_2O(l)$$

Which statement is true when the above reaction has attained equilibrium?

A The equilibrium constant, *K*, is equal to 1.

B The reaction between the acid and the alcohol has stopped.

C The concentrations of the products and reactants are the same.

D The rate of formation and the rate of hydrolysis of ethyl ethanoate are the same.

12 Which statements regarding acids and bases are correct?

1 Water can act as either an acid or a base.

2 When A*l*C*l*$_3$ reacts with C*l*$_2$, the A*l*C*l*$_3$ acts as a Lewis acid.

3 The ammonium ion acts as a base when reacted with hydroxide ions.

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

13 A 1 dm^3 solution was made by mixing 4.0×10^{-8} mol of HC*l*(aq) and 2.5×10^{-8} mol of NaOH(aq).

What is the pH of the resulting solution?

A 0.18 **B** 6.94 **C** 7.00 **D** 7.82

14 A mixture consists of 0.10 mol dm^{-3} $MgSO_4$ and 0.10 mol dm^{-3} $FeSO_4$. It is suggested that the metal ions can be separated as their hydroxides by adding solid NaOH to the mixture.

At 298 K, the solubility product of $Mg(OH)_2$ is 7.1×10^{-12} mol^3 dm^{-9} and that of $Fe(OH)_2$ is 4.1×10^{-15} mol^3 dm^{-9}.

What would be the pH of the resultant solution when maximum separation has occurred?

A 5.07 **B** 7.30 **C** 8.93 **D** 10.10

15 **W**, **X** and **Y** are elements in Period 3 of the Periodic Table.

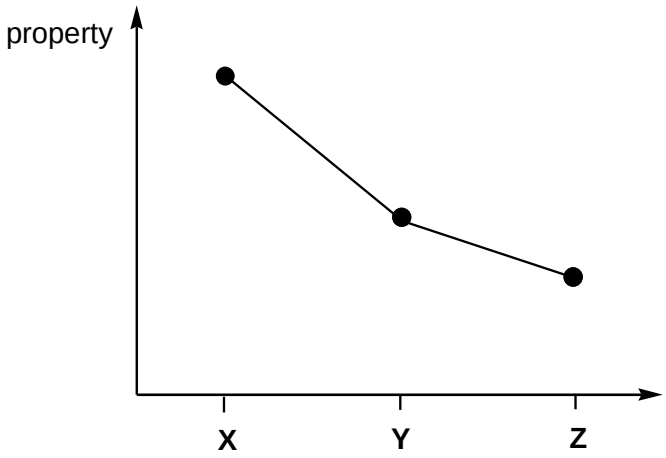
A mixture containing the oxides of **W**, **X** and **Y** was dissolved in excess dilute sulfuric acid and filtered. The oxide of **Y** was collected as a residue.

When excess dilute sodium hydroxide was added to the filtrate, only a white precipitate of the hydroxide of **X** was formed.

What are the possible identities of **W**, **X** and **Y**?

	W	**X**	**Y**
A	Mg	A*l*	P
B	A*l*	Mg	P
C	Mg	A*l*	Si
D	A*l*	Mg	Si

16 The graph below shows the trend for a property of **X**, **Y** and **Z**.



Which property about **X**, **Y** and **Z** will give the trend shown above?

	Property	**X**	**Y**	**Z**
A	pH of the resultant solution when added to water	$MgCl_2$	$AlCl_3$	$SiCl_4$
B	Decomposition temperature	$MgCO_3$	$CaCO_3$	$SrCO_3$
C	Boiling point	HCl	HBr	HI
D	First ionization energy	Mg	Al	Si

17 An element **X** and compound **YZ** react separately with acid as shown.

$$\mathbf{X}(s) + 2H^+(aq) \longrightarrow \mathbf{X}^{2+}(aq) + H_2(g)$$

$$\mathbf{YZ}(s) + 2H^+(aq) \longrightarrow \mathbf{Y}^{2+}(aq) + H_2\mathbf{Z}(g)$$

When 1.0 g of either **X** or **YZ** is reacted with an excess of acid, the total volume of gas formed is the same.

Which statements are correct?

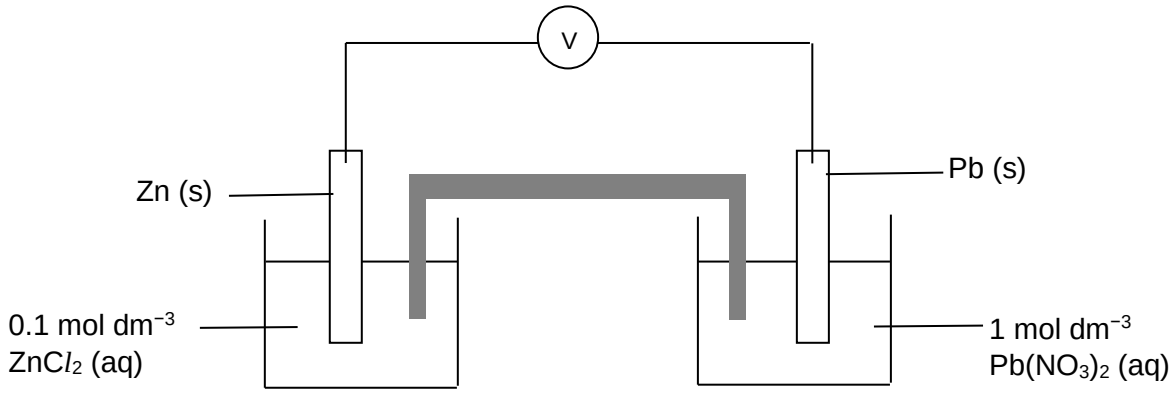
1 A_r(**X**) = M_r(**YZ**)

2 **X** and **Y** are metals.

3 **X** and **Y** must both be in the same Group of the Periodic Table.

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

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



The following conclusions were made based on the set up as shown above.

Which statement is correct?

A Zn is the positive electrode while Pb is the negative electrode.

B Chlorine gas is produced at the Zn electrode.

C The voltmeter will show a reading of 0.63V.

D When H_2SO_4(aq) is added to the beaker containing $Pb(NO_3)_2$, the voltmeter reading becomes smaller.

19 *The use of Data Booklet is relevant to this question.*

A piece of copper, containing impurities of zinc and silver metal, was purified via electrolysis.

Which statement is correct about the process?

A The concentration of Cu^{2+} in the electrolyte has to be at 1 mol dm^{-3}.

B The impure copper is placed at the positive terminal.

C Silver metal is oxidized at the anode.

D Zn^{2+} is reduced at the cathode.

20 Which statement about the reaction below is true?

$$[Fe(EDTA)]^- + 3C_2O_4^{2-} \rightleftharpoons [Fe(C_2O_4)_3]^{3-} + EDTA^{4-} \qquad K_c \text{ value} = 3 \times 10^{-21}$$

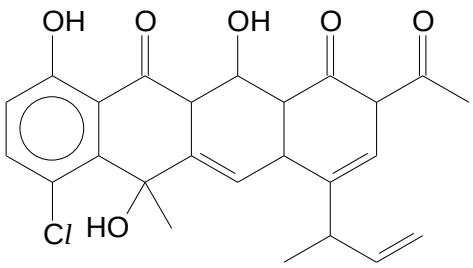
A It is a redox reaction.

B The $C_2O_4^{2-}$ ligand has a greater binding affinity than $EDTA^{4-}$ ligand to the iron ion.

C The reaction is less feasible at high temperatures.

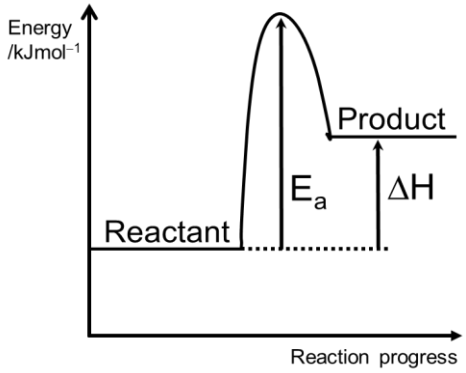
D The coordination numbers of $[Fe(EDTA)]^-$ and $[Fe(C_2O_4)_3]^{3-}$ are 6 and 3 respectively.

21 How many stereoisomers are possible for the following compound?



A 2^6 **B** 2^7 **C** 2^8 **D** 2^{10}

22 The energy profile diagram shown below corresponds to one of the steps in the reaction mechanism of ethane with bromine in the presence of UV light.



To which step does this diagram apply?

A $CH_3\dot{C}H_2 + CH_3\dot{C}H_2 \longrightarrow CH_3CH_2CH_2CH_3$

B $CH_3\dot{C}H_2 + Br_2 \longrightarrow CH_3CH_2Br + Br\bullet$

C $CH_3\dot{C}H_2 + Br\bullet \longrightarrow CH_3CH_2Br$

D $Br_2 \longrightarrow Br\bullet + Br\bullet$

23 Some dichlorobutanes were separately treated with hot ethanolic sodium hydroxide. The formula of the hydrocarbon formed is C_4H_6.

Which pair of dichlorobutane can form the same hydrocarbon, C_4H_6?

1 $CH_2ClC(CH_3)_2Cl$

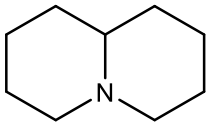
2 $CH_3CHClCHClCH_3$

3 $CH_2ClCH_2CH_2CH_2Cl$

4 $CH_3CH_2CH_2CHCl_2$

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

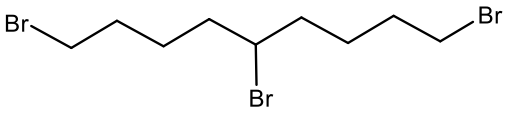
24 Compound **X** has the following structure.



compound **X**

It can be synthesised by reacting ammonia with a halogenoalkane.

Which statements are correct?

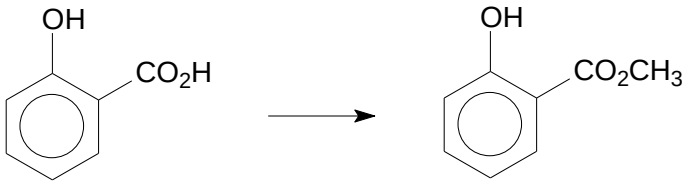
1 The halogenoalkane is 

2 Synthesis of Compound **X** involves intramolecular nucleophilic substitution.

3 Compound **X** is formed at the same rate regardless of the halogen present in the halogenoalkane.

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

25 A manufacturer wishes to make methyl salicylate, the aromatic liniment of oil of wintergreen, from salicylic acid.



How is this esterification of salicylic acid best achieved?

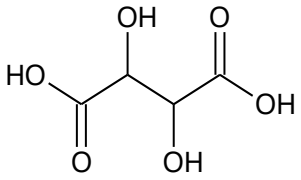
A Addition of cold ethanoyl chloride.

B Heat with methanol.

C Heat with methanol and sulfuric acid.

D Heat with ethanoic acid and sulfuric acid.

26 Tartaric acid, a common acid, has the following structure below.



Which reagent reacts in stoichiometric ratio with 1 mol of tartaric acid in a complete reaction?

A 4 mol of Na

B 2 mol of Na_2CO_3

C 2 mol of $SOCl_2$

D 4 mol of aqueous KOH

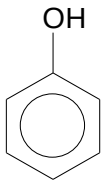
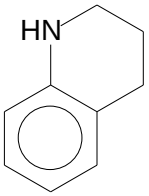
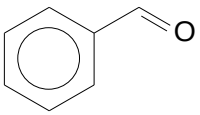
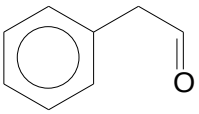
27 Compound **X** has molecular formula $C_4H_{10}O$. Separate samples of **X** are tested with three different reagents.

Which results could **not** be obtained?

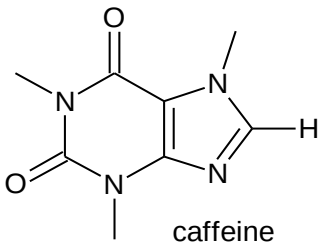
	Tollens' reagent	2, 4-dinitrophenylhydrazine reagent	warm acidified potassium dichromate (VI) solution
1	silver mirror forms	orange precipitate forms	orange to green
2	no change	no change	no change
3	no change	no change	orange to green

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

28 Which reagents and conditions can be used to distinguish the compounds in each pair?

	compound **1**	compound **2**	Reagents and conditions
A			Br_2(aq), room temperature
B	$CH_3CH_2COCI_3$	$CH_3CH(OH)CH_2CH_3$	I_2(aq), NaOH(aq), warm
C			alkaline Cu^{2+} complex, warm
D	$C_6H_5CH_2CH_3$	$C_6H_5CH=CH_2$	$KMnO_4$(aq), dilute H_2SO_4, heat

29 The structure of caffeine is shown below.



caffeine

Which statement is correct?

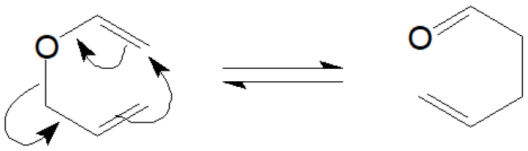
A Caffeine is soluble in ethanol.

B Caffeine is neutral.

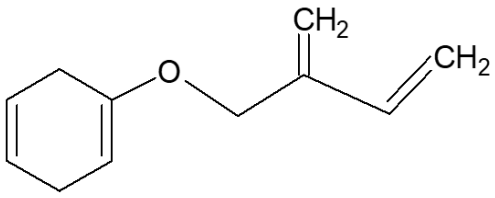
C Caffeine exists as a zwitterion.

D Caffeine reacts with Li$Al$$H_4$ to give a product containing secondary alcohol.

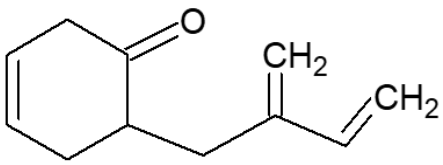
30 The Claisen rearrangement is a powerful carbon–carbon bond-forming chemical reaction. An example of the mechanism is shown below.



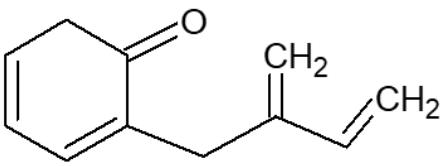
What could be the identity of the product formed when the following compound undergoes Claisen rearrangement?



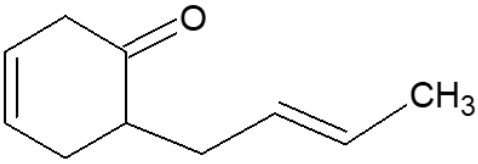
A



B



C



D