VICTORIA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CHEMISTRY 9729/01

Paper 1 Multiple Choice **22 September 2022**

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.
Write your name, CT group and exam number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

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 choices in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. No mark will 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 **14** printed pages.

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

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

A compound is made from two elements, **X** and **Y**. Each separate atom of **X** and of **Y** has exactly one unpaired electron in their ground states.

What could the compound be?

1 Al_2O_3

2 BH_3

3 CuI

4 $FeCl_3$

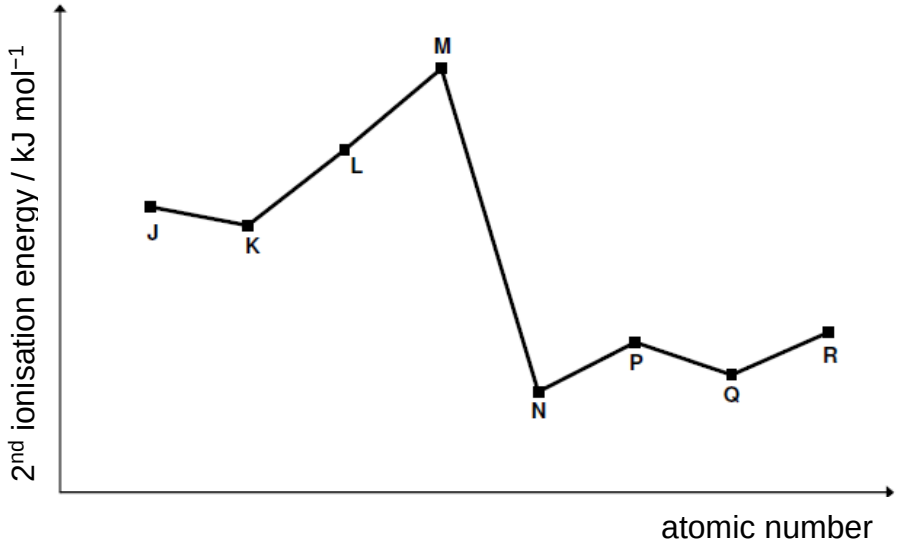
A 1 and 2 only

B 2 and 3 only

C 2 and 4 only

D 3 and 4 only

2 The following graph shows the second ionisation energies of eight consecutive elements **J** to **R**, which have atomic numbers between 3 to 20 in the Periodic Table.



Which one of the following statements about the elements is false?

A **L** does not form an oxide.

B **Q** has the highest melting point.

C The atomic radius of **J** is larger than the atomic radius of **K**.

D The oxide of **N** has a lower melting point than the oxide of **R**.

3 Which one of the following pairs of molecules has the same bond angle about the central atom?

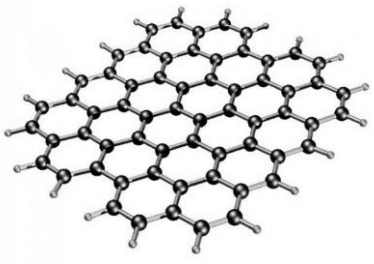
A SO_2 and OF_2

B OCS and HCN

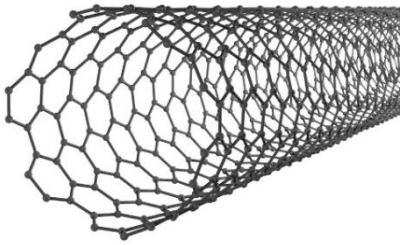
C CCl_4 and XeF_4

D CS_2 and H_2S

4 Two allotropes of carbon are shown below.



graphene



carbon nanotube

Similar to graphite, graphene and carbon nanotubes consist of rings of six covalently bonded carbon atoms. Unlike graphite, graphene is made up of only a single layer of carbon atoms.

Which of the following statements correctly describe the properties of graphene and carbon nanotube?

1 Both allotropes are good electrical conductors.

2 Both allotropes can be used as lubricants.

3 Both allotropes are soluble in water.

A 1 only

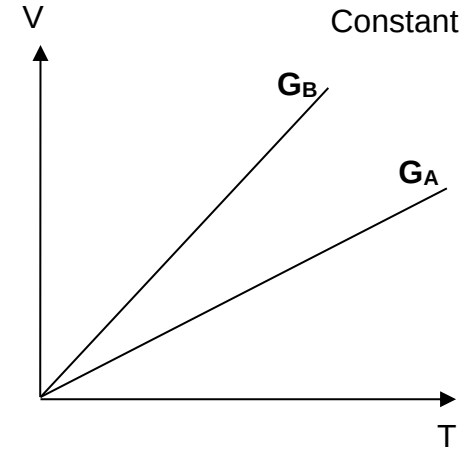
B 2 only

C 1 and 2 only

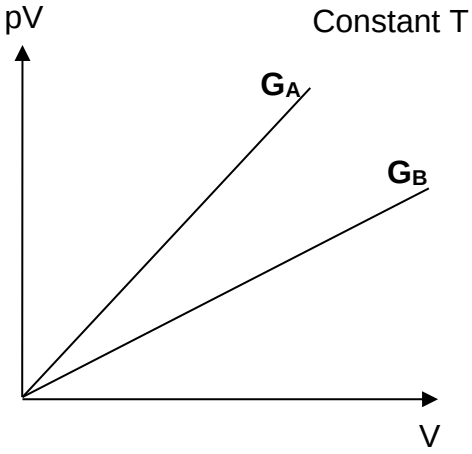
D 2 and 3 only

5 Which graph correctly describes the behaviour of the same fixed masses of two ideal gases $\mathbf{G_A}$ and $\mathbf{G_B}$, whereby $\mathbf{G_A}$ has a higher M_r than $\mathbf{G_B}$?

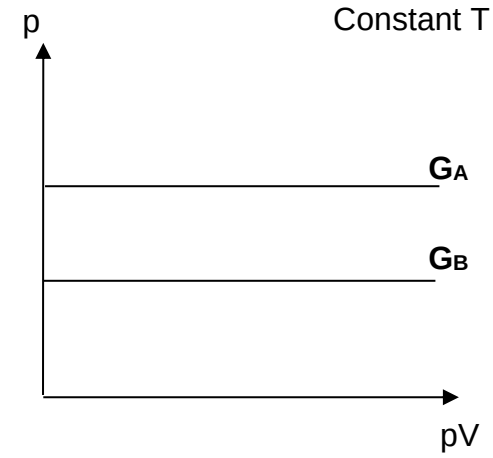
A



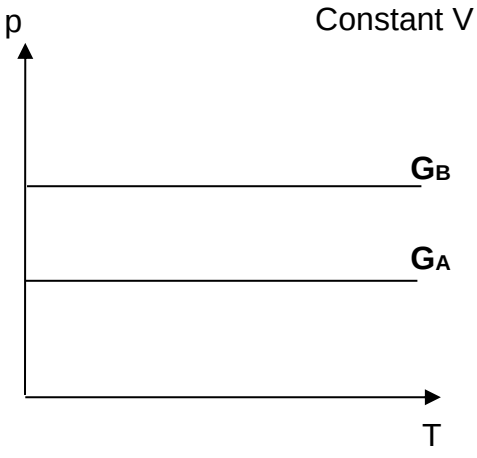
B



C



D



6 Which statement about Group 2 elements and their compounds is incorrect?

A Beryllium chloride can behave as a lewis acid because there are only four valence electrons on beryllium.

B Barium has lower melting point than strontium as the metallic bonds in barium are weaker than those in strontium.

C Barium loses its valence electrons more easily than calcium.

D Magnesium carbonate decomposes at a higher temperature than calcium carbonate.

7 The position of equilibrium lies to the right in each of these reactions.

Reaction 1: $N_2H_4 + HClO \rightleftharpoons N_2H_5^+ + ClO^-$
Reaction 2: $N_2H_5^+ + NH_3 \rightleftharpoons NH_4^+ + N_2H_4$

Based on this information, which one of the following statements is correct?

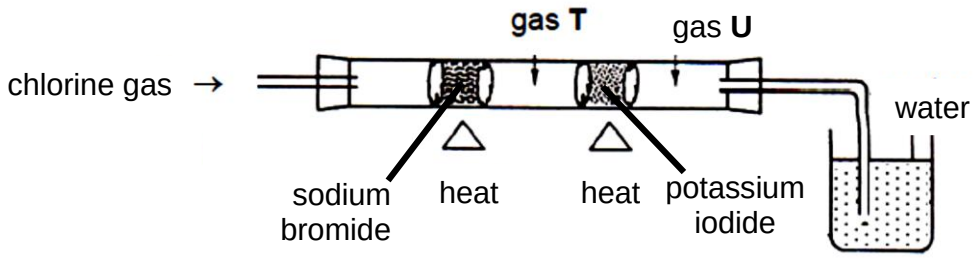
A N_2H_4 is the Bronsted−Lowry acid in Reaction 1.

B $N_2H_5^+$ and NH_3 are a conjugate acid−base pair in Reaction 2.

C The order of acid strength is $HClO > N_2H_5^+ > NH_4^+$.

D N_2H_4 is a stronger base than NH_3.

8 As shown in the apparatus below, chlorine gas was passed through the tube. After a short time, some observable changes were seen during the experiment.



What are the colours observed for gas **T,** gas **U** and water during the experiment?

	gas **T**	gas **U**	water
A	reddish−brown	purple	brown
B	reddish−brown	brown	purple
C	colourless	purple	colourless
D	brown	brown	orange

9 10 cm^3 of a gaseous hydrocarbon was completely burnt in 90 cm^3 of oxygen. The volume of the gas remaining at the end of the combustion was 70 cm^3. After passing over sodium hydroxide, this volume was reduced to 40 cm^3. All gases were measured at 298 K and at the same pressure.

Which of the following could be the formula of the gaseous hydrocarbon?

A C_2H_6

B C_3H_6

C C_3H_8

D C_4H_8

10 *Use of Data Booklet is relevant to this question.*

Tellurite is a rare oxide mineral consisting of tellurium dioxide, TeO_2 (M_r = 159.6). Its name comes from the word Tellus, the Latin name for planet Earth.

In one experiment, it was found that 1.01 g of TeO_2 reacted with exactly 30 cm^3 of 0.070 mol dm^{-3} acidified $K_2Cr_2O_7$ for complete reaction. The orange solution turned green in this reaction.

What is the oxidation state of Te in the Tellurite-containing product?

A +2 **B** +3 **C** +5 **D** +6

11 The enthalpy change of reaction between calcium and water, ΔH_r, can be measured in the laboratory.

$$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + H_2(g) \qquad \Delta H_r$$

In addition to ΔH_r, what other data is needed to calculate the enthalpy change of formation of $Ca(OH)_2(s)$?

A Enthalpy change of atomisation of calcium
B Enthalpy change of combustion of hydrogen
C First and second ionisation energies of calcium
D Lattice energy of calcium hydroxide

12 Which one of the following equations represents a reaction that is spontaneous at all temperatures?

A $\mathbf{W}(s) \rightarrow \mathbf{X}(s) + \mathbf{Y}(g) \qquad \Delta H > 0$

B $2\mathbf{T}(g) + 3\mathbf{U}(g) \rightarrow 4\mathbf{V}(g) \qquad \Delta H < 0$

C $\mathbf{R}(g) \rightarrow 2\mathbf{Q}(g) \qquad \Delta H < 0$

D $\mathbf{K}(g) + \mathbf{L}(g) \rightarrow \mathbf{M}(g) \qquad \Delta H > 0$

13 Ozone in the earth's atmosphere decomposes according to the equation:

$$2O_3(g) \rightarrow 3O_2(g)$$

This reaction is thought to occur via a two–step mechanism:

Step 1	$O_3(g) \rightleftharpoons O_2(g) + O(g)$	fast, reversible
Step 2	$O_3(g) + O(g) \rightarrow \cdot 2O_2(g)$	slow

What rate law is consistent with this mechanism?

A Rate = $k\dfrac{[O_3]^2}{[O_2]}$ **B** Rate = $k\dfrac{[O_3]^2}{[O_2]^3}$

C Rate = $k[O_3]$ **D** Rate = $k[O_3]^2$

14 Ammonium hydrogen sulfide dissociates as follows:

$$NH_4HS(s) \rightleftharpoons H_2S(g) + NH_3(g)$$

When excess solid NH_4HS is placed in an evacuated flask at a certain temperature, it dissociates. When equilibrium is established, the total gas pressure is 66.4 kPa.

Which of the following statements are correct about the above system?

1 K_p of the system is 1.10×10^3 $(kPa)^2$.

2 Some H_2S is removed from the system. When equilibrium is established again, the new total pressure is more than 66.4 kPa.

3 Addition of solid NH_4HS would cause the position of equilibrium to shift right.

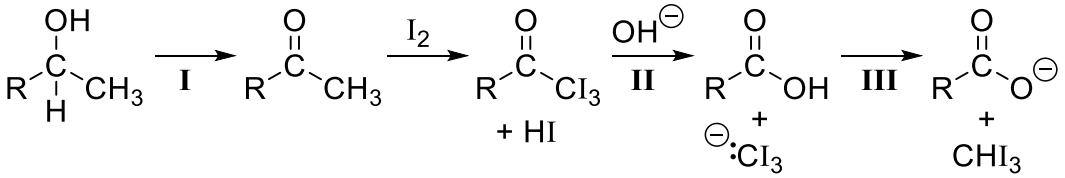
A 1 only **B** 1 and 2 only

C 2 and 3 only **D** 1 and 3 only

15 Which of the following conjugate acid−base pairs can be used to prepare a buffer of pH 6.38 that has maximum buffering capacity?

A	NH_4^+ / NH_3	pK_b of NH_3 = 4.75
B	H_2CO_3 / HCO_3^-	pK_b of HCO_3^- = 7.62
C	H_3PO_4 / $H_2PO_4^-$	pK_b of $H_2PO_4^-$ = 11.9
D	CH_3CO_2H / $CH_3CO_2^-$	pK_b of $CH_3CO_2^-$ = 9.24

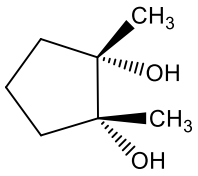
16 The mechanism for the iodoform reaction is summarised as follows :



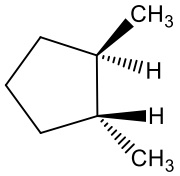
Which of the following correctly represents the type of reaction occurring in each of the three stages?

	I	II	III
A	reduction	nucleophilic addition	redox
B	reduction	nucleophilic substitution	acid−base
C	oxidation	nucleophilic substitution	acid−base
D	oxidation	nucleophilic addition	redox

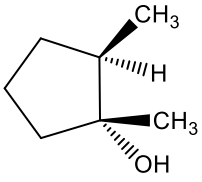
17 Which of the following molecules can rotate plane−polarised light?



1



2



3

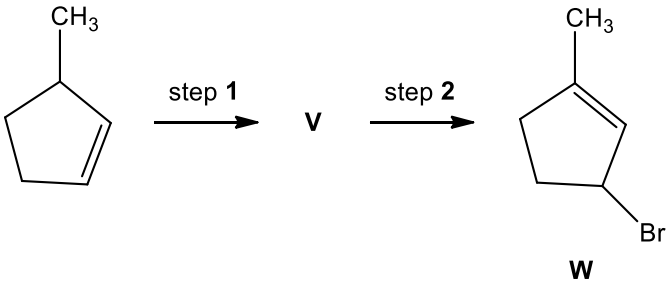
A **3** only

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

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

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

18 Consider the following reaction sequence.



W

Which of the following reagents will not produce **W**?

	step **1**	step **2**
A	Br_2 in CCl_4	ethanolic NaOH
B	Br_2 in CCl_4	excess concentrated H_2SO_4
C	Br_2(aq)	ethanolic NaOH
D	Br_2(aq)	excess concentrated H_2SO_4

19 Which one of the following sequences involving nitration, alkylation and bromination is expected to give the best yield for the synthesis of 2−bromo−4−nitromethylbenzene from benzene?

A alkylation, bromination, nitration

B alkylation, nitration, bromination

C nitration, alkylation, bromination

D nitration, bromination, alkylation

20 0.5 g of each of the following compounds was heated with excess NaOH(aq).

CH_2=CH*Cl* CH_3CH_2I CH_3COCl C_6H_5Br

Each of the mixtures was then acidified with dilute nitric acid, followed by the subsequent addition of aqueous silver nitrate solution.

Which of the following statement is correct?

A The reaction with C_6H_5Br gave a cream precipitate.

B The reaction with CH_3CH_2I gave a precipitate that dissolved completely in dilute aqueous ammonia.

C The reaction with CH_2=CH*Cl* gave a white ppt.

D The reaction with CH_3COCl gave the largest mass of precipitate.

21 Several alcohols with the formula $C_4H_{10}O$ were separately oxidised using acidified potassium dichromate(VI). 65.0 g of the alcohol was used to achieve a 55% yield of the organic product.

What of the following can be obtained?

1 42.5 g of butanoic acid

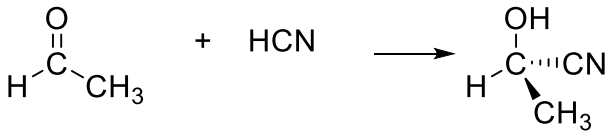
2 42.5 g of 2−methylpropanoic acid

3 34.8 g of butanone

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

C 2 and 3 only **D** 1 only

22 Ethanal reacts with CN^- from HCN in the presence of a weak base as shown below.



$^-CH_2COCH_3$ ion is generated when CH_3COCH_3 reacts with a strong base and $^-CH_2COCH_3$ can then react with ethanal in a similar way.

Which one of following compounds is the product when $^-CH_2COCH_3$ reacts with ethanal followed by acidification?

A $CH_3CH(OH)CH_2COCH_3$

B $(CH_3)_2C(OH)CH_2CHO$

C $(CH_3)_2C(CHO)CH_2OH$

D $(CH_3)_2C(OH)COCH_3$

23 Compound **X**, $C_5H_{12}O$, is oxidised by acidified potassium dichromate(VI) to compound **Y**. Compound **Y** reacts with butan−2−ol in the presence of hot concentrated sulfuric acid to give liquid **Z**.

What is the formula of liquid **Z**?

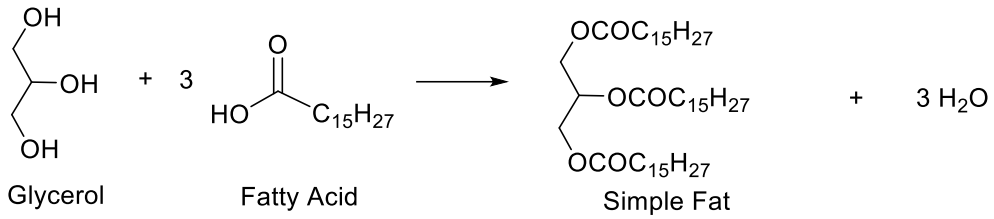
A $(CH_3)_2CHCH_2CO_2C(CH_3)_3$

B $CH_3(CH_2)_3CO_2(CH_2)_3CH_3$

C $CH_3(CH_2)_3CO_2CH(CH_3)CH_2CH_3$

D $CH_3(CH_2)_2CO_2CH_2CH_2CH(CH_3)_2$

24 A simple fat is formed from three carboxylic acids (also known as fatty acids) and one glycerol.



Which of the following statements about simple fat are correct?

1 The alkyl chains of simple fat are saturated.

2 It is formed via a condensation reaction.

3 When the simple fat is heated with acidified potassium dichromate(VI), a mixture of products was formed. One of the products formed has five oxygen atoms in its molecule.

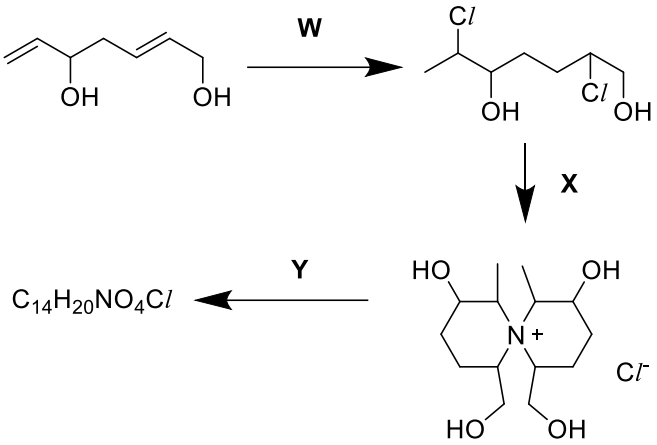
A 1, 2, and 3

B 1 and 2 only

C 2 and 3 only

D 2 only

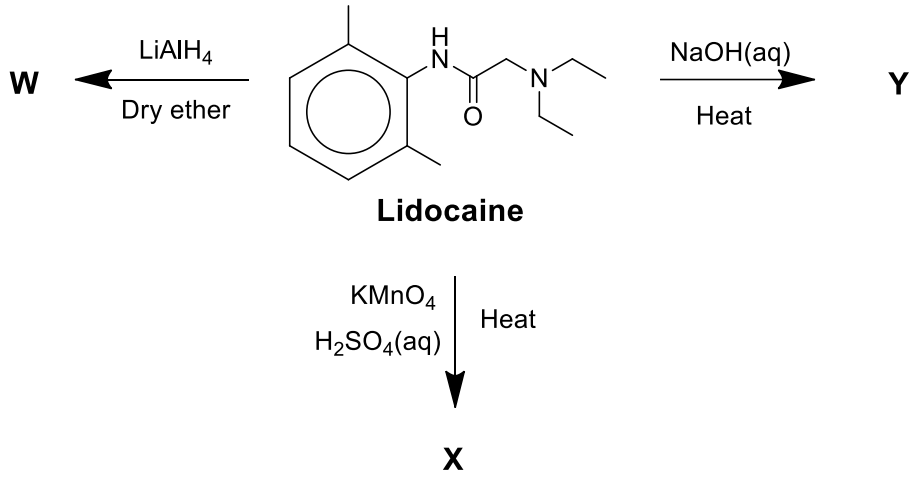
25 The amine salt $C_{14}H_{20}NO_4Cl$ can be synthesised via a sequence of reactions as follows:



What could be the reagents and conditions for steps **W**, **X** and **Y**?

	W	X	Y
A	HC*l*(aq)	excess alcoholic NH_3	acidified $K_2Cr_2O_7$ heat under reflux
B	HC*l*(g)	excess alcoholic NH_3	acidified $K_2Cr_2O_7$ heat with immediate distillation
C	HC*l*(aq)	limited alcoholic NH_3	acidified $K_2Cr_2O_7$ heat under reflux
D	HC*l*(g)	limited alcoholic NH_3	acidified $K_2Cr_2O_7$ heat with immediate distillation

26 Lidocaine belongs to a family of medicines called local anaesthetics, where it prevents pain by blocking the signals at the nerve endings in the skin. Using specific reagents and conditions, it can be converted to other organic substances.

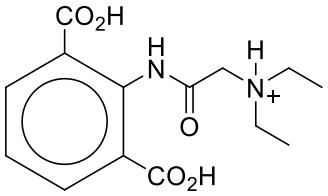


Which one of the following statements about lidocaine and the above reactions is correct?

A **W** has four more hydrogen atoms than lidocaine.

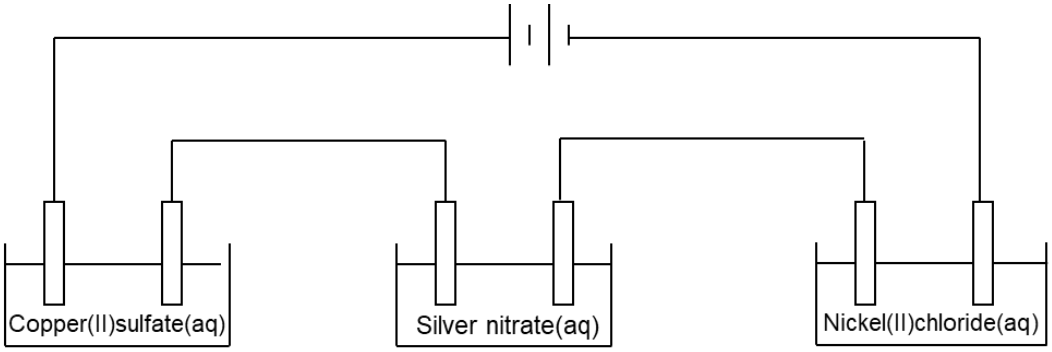
B **Y** is a mixture of amine and carboxylic acid.

C The structure of the cation in **X** is



D Lidocaine is a base and it reacts with HC*l*(aq) to form an ionic salt.

27 Three cells are connected in series for the electrolysis of aqueous solutions involving copper(II) sulfate, silver nitrate and nickel(II)chloride.



What is the ratio of the mass of the metals formed at the respective cathodes, after 193 A of current is passed through for the cell for 200 seconds?

	Copper	**Silver**	**Nickel**
A	1	1	1
B	1	2	1
C	1.08	1.84	1
D	1.08	3.68	1

28 Hydrogen peroxide is a commonly used household chemical to eliminate mold and mildew in dishwashers. A student added a few drops of acidified hydrogen peroxide to an excess of aqueous potassium iodide.

Based on equations given below, which of the following best describe the observation?

Half equations	***E*°/V**
$I_2(aq) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$2H^+(aq) + O_2(g) + 2e^- \rightleftharpoons H_2O_2(aq)$	+0.68
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O$	+1.77

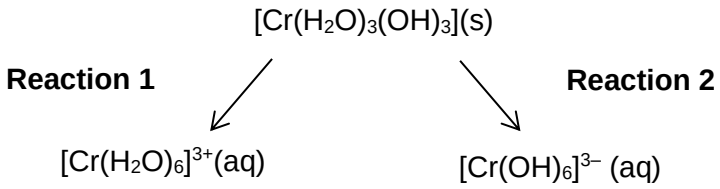
A Solution changes from colourless to brown with effervescence.

B Solution remains colourless with effervescence.

C Solution changes from colourless to brown without effervescence.

D No observable change was observed.

29 Two-reactions of hydrated chromium(III) hydroxide are shown below.



Which one of the following statements about the two reactions is correct?

A Hydrated chromium(III) hydroxide is acting as a Bronsted−Lowry acid in reaction 1.

B Reactions 1 and 2 are ligand exchange reactions.

C Reactions 1 and 2 are displaying the amphoteric nature of hydrated chromium(III) hydroxide.

D There is a change in oxidation number of chromium in reactions 1 and 2.

30 A compound of cobalt with the general formula $CoCl_3(H_2O)_6$ forms an aqueous solution containing octahedral complex ions. When excess $AgNO_3(aq)$ was added to 1 mol of aqueous $CoCl_3(H_2O)_6$, 2 mol of $AgCl$ was precipitated.

What is the likely identity of this cobalt-containing compound?

A $[Co(H_2O)_6]Cl_3$

B $[Co(H_2O)_5Cl]Cl_2.H_2O$

C $[Co(H_2O)_4Cl_2]Cl.2H_2O$

D $[Co(H_2O)_3Cl_3].3H_2O$