RIVER VALLEY HIGH SCHOOL
JC 2 PRELIMINARY EXAMINATION

CANDIDATE NAME								
CLASS	2	2	J					
CENTRE NUMBER	S					INDEX NUMBER		

H2 CHEMISTRY 9729/01

Paper 1 Multiple Choice **25 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 name, class, centre number and index number on the Answer Sheet in the spaces 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 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.

This document consists of **15** printed pages and **1** blank page.

1 Why is the third ionisation energy of magnesium much higher than that of aluminium?

A Aluminium has more protons than magnesium.

B Magnesium has a complete octet, but aluminium does not.

C The ionic radius of Al^{2+} ion is larger than that of Mg^{2+} ion.

D The electron to be removed from magnesium is closer to the nucleus.

2 When a beam of protons is passed through an electric field, the angle of deflection towards the negatively-charged plate is 12.0 °.

Which particle will undergo a deflection of 8.0 ° in the opposite direction?

A $^{12}C^{3-}$ **B** $^{10}B^{2-}$ **C** $^{6}Li^{4-}$ **D** $^{3}He^{-}$

3 Tritium, $^{3}_{1}H$, is a radioactive isotope of hydrogen. It slowly turns into a helium isotope $^{3}_{2}He$.

Which statements about the two isotopes are **incorrect**?

1 Both isotopes have more neutrons than electrons.

2 Both isotopes have the same number of protons in their nuclei.

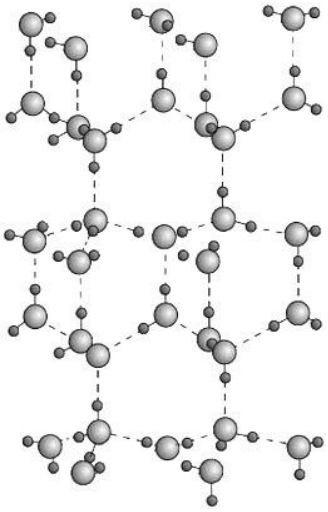
3 Both isotopes have the same number of charged sub-atomic particles.

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

4 Which compound does **not** have a co-ordinate bond?

A CO **B** CS_2 **C** NO_3^- **D** NH_4^+

5 Ice is the crystalline form of water. The diagram below shows part of the structure of ice.



- - - - - - Hydrogen bond
——— Covalent bond

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

A Ice is not a conductor of electricity.

B Ice has a giant covalent structure.

C The bond angle about oxygen in ice is 109.5 °.

D It has a lower density than water at 0 °C due to its open structure.

6 A gas at a pressure of 4.50 atm is heated from 25.0 °C to 480 °C and simultaneously compressed to one-third of its original volume.

What is the final pressure of the gas?

A 3.79 atm **B** 34.1 atm **C** 86.4 atm **D** 259 atm

7 The table below shows the values of the ionic product of water, K_w, at two different temperatures.

Temperature / °C	K_w / mol^2 dm^{-6}
25	1.00×10^{-14}
62	1.00×10^{-13}

Which of the following statements is correct for pure water?

A At 62 °C, pH = 14 − pOH.

B At 62 °C, pH > 7.

C At 62 °C, pOH < 7.

D At 62 °C, pH < pOH.

8 Some ΔH_f, values are given below.

compound	ΔH_f, / kJ mol^{-1}
SO_2	–297
SO_3	–396

The contact process involves the oxidation of sulfur dioxide using vanadium(V) oxide catalyst. The overall equation can be represented by the following equation.

$$SO_2(g) + \frac{1}{2}O_2(g) = SO_3(g)$$

Which row correctly describes the sign of ΔH, and ΔS, for this reaction?

	ΔH,	ΔS,
A	–	–
B	–	+
C	+	–
D	+	+

9 The enthalpy change of solution of ammonium chloride in +14.8 kJ mol^{-1} under standard conditions.

Which of the following statement is true?

A The energy level of products is lower than that of reactants.

B The lattice energy of ammonium chloride is numerically larger than the sum of hydration energies of ammonium and chloride ions.

C When 1 mole of ammonium chloride dissolves, 14.8 kJ of heat is released.

D When 1 mole of ammonia dissolves in hydrochloric acid, 14.8 kJ of heat is taken in from the surrounding.

10 When steam condenses, 44.0 kJ mol^{-1} of heat is evolved.

Which statements about the condensation of 12.0 g of steam at 100 °C are correct?

1 The enthalpy change of reaction is – 29.3 kJ mol^{-1}.

2 The Gibbs free energy change is negative.

3 The entropy change is –78.6 J K^{-1}.

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

11 A sample of gaseous methanal was contaminated with methane gas in the laboratory.

10 cm^3 of the sample of the gaseous mixture was combusted in the presence of 20 cm^3 excess pure oxygen. The final total volume decreases to 18 cm^3 at room conditions.

What is the molar ratio of methanal : methane?

A 2:1 **B** 4:1 **C** 8:1 **D** 10:9

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

Solution containing 0.5 % by mass of sodium hypochlorite, NaC*l*O can be used as a disinfectant effective against a wide range of bacteria.

Sodium hypochlorite reacts with acid to generate toxic chlorine gas according to the following equation.

$$NaClO + 2HCl = Cl_2 + H_2O + NaCl$$

What is the volume of 0.5 % sodium hypochlorite solution required to produce 90 cm^3 of chlorine gas upon reacting with excess acid at room conditions?

You may assume the density of solution is 1.0 g cm^{-3}.

A 0.0101 cm^3 **B** 0.559 cm^3 **C** 55.9 cm^3 **D** 111.8 cm^3

13 The equation for the oxidation of nitrogen monoxide is shown below.

$$NO + O_2 \rightarrow 2NO_2$$

From the initial rates experiments, the following rate equations were derived.

$$\text{rate} = k\,[O_2]\,[NO_2]^2$$

The results of the initial rates experiments are shown below.

Initial $[O_2]$ / mol dm^{-3}	Initial $[NO_2]$ / mol dm^{-3}	Initial rate / mol dm^{-3} min^{-1}
0.1	0.1	0.1
0.2	0.2	x
0.3	0.4	y
0.4	z	6.4

What are the values of x, y and z?

	x	y	z
A	0.4	1.2	1.6
B	0.8	3.6	0.4
C	0.8	4.8	0.16
D	0.8	4.8	0.4

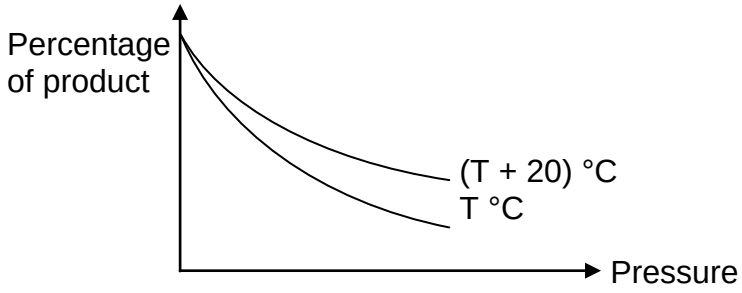
14 The decomposition of dinitrogen pentoxide is a first order reaction with a rate constant of $5.00 \times 10^{-4}\ s^{-1}$ at 45.0 °C.

How long would it take for a sample of dinitrogen pentoxide to decompose 60% of its initial amount at 45.0 °C?

A 17.0 min **B** 30.5 min

C 1020 min **D** 1830 min

15 The graph below shows how the percentage of product present at equilibrium varies with temperature and pressure for a reaction.



Which reaction could the graph represent?

A $4Fe\ (s) + 3O_2\ (g) = 2Fe_2O_3\ (s)$ $\Delta H = -1644\ kJ\ mol^{-1}$

B $2C\ (s) + O_2\ (g) = 2CO\ (g)$ $\Delta H = -222\ kJ\ mol^{-1}$

C $N_2O_4(g) = 2NO_2(g)$ $\Delta H = +57\ kJ\ mol^{-1}$

D $CO(g) + Cl_2(g) = COCl_2(s)$ $\Delta H = +86\ kJ\ mol^{-1}$

16 The solubility of $Mn(OH)_2$ in water at 25 °C is 3.60×10^{-5} mol dm^{-3}.

What is the solubility of $Mn(OH)_2$ in mol dm^{-3} in a buffer solution of pH 12.0 at the same temperature?

A 1.87×10^{-9} **B** 1.87×10^{-1} **C** 4.67×10^{-2} **D** 4.67×10^{-10}

17 The numerical values of the solubility product of calcium carbonate and calcium fluoride at 25.0 °C are 8.7×10^{-9} and 4.0×10^{-11} respectively.

Which of the following statements is correct?

1 Calcium carbonate has a lower solubility than calcium fluoride.

2 Addition of solid sodium fluoride to a saturated solution of calcium fluoride increases the ionic product of calcium fluoride.

3 Addition of sodium carbonate to a solution containing calcium carbonate decreases the solubility product of calcium carbonate.

4 Addition of solid calcium nitrate to a solution containing 1 mol dm^{-3} each of carbonate and fluoride ions causes calcium carbonate to precipitate out first.

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

18 $$H_2PO_4^- + HBO_3^{2-} = HPO_4^{2-} + H_2BO_3^-$$

The above reversible reaction has an equilibrium constant much greater than 1.

Which of the following options correctly shows the relative strengths of acids and bases?

	Acids	Bases
A	$H_2PO_4^- > H_2BO_3^-$	$HPO_4^{2-} > HBO_3^{2-}$
B	$H_2BO_3^- > H_2PO_4^-$	$HBO_3^{2-} > HPO_4^{2-}$
C	$H_2PO_4^- > H_2BO_3^-$	$HBO_3^{2-} > HPO_4^{2-}$
D	$H_2BO_3^- > H_2PO_4^-$	$HPO_4^{2-} > HBO_3^{2-}$

19 Soft drinks often have sodium citrate added to them to form a buffer solution.

Which of the following statements is correct?

A Ionic product of water, K_w, is the product of K_a of citric acid and K_b of sodium hydroxide.

B The pH of a buffer solution decreases when water is added to it.

C The pH of a buffer solution remains unchanged when small amount of acid or base is added to it.

D The pH of a buffer solution increases slightly when a small amount of base is added to it.

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

In the commercial electrolysis of concentrated sodium chloride, the products are chlorine, hydrogen and sodium hydroxide.

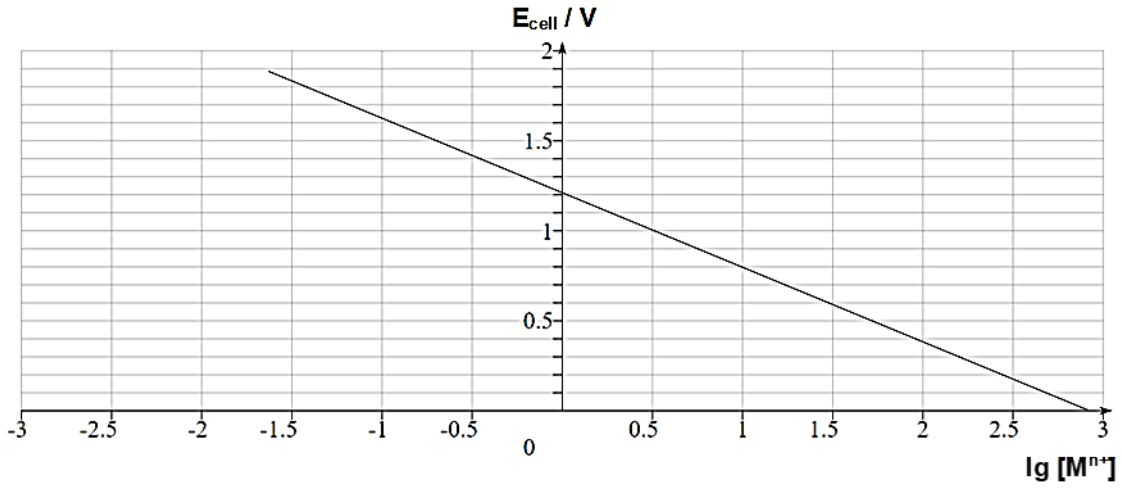
What is the maximum yield of each of these products when 58.5 kg of sodium chloride was electrolysed?

	Mass of H_2/ kg	Mass of Cl_2/ kg	Mass of NaOH/ kg
A	1	35.5	40
B	2	35.5	80
C	1	71	40
D	2	71	80

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

A galvanic cell is made up of half–cell A and half–cell B.

The cell potential, E_{cell}, of this galvanic cell was measured at various concentrations of $M^{n+}(aq)$ and the results of E_{cell} against $\log[M^{n+}]$ in half–cell A are as shown below. It was found that size of metal M decreased after some time.



Half–cell B contained 1 mol dm^{-3} of Cl^- and 1 mol dm^{-3} of ClO^- in alkaline conditions.

What is the standard electrode potential of the metal $E^{\ominus}(M^{n+}/M)$ in V?

A 2.01 **B** 1.61 **C** 0.01 **D** –0.39

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

On the basis of bond energies, what could be the products of the following reaction?

$$CH_3^{\bullet} + CH_3CH_2Cl \rightarrow$$

A $CH_4 + CH_3CH^{\bullet}Cl$

B $CH_3CH_2CH_2^{\bullet} + HCl$

C $CH_3CH_2CH_3 + Cl^{\bullet}$

D $CH_3CH_2CH_2Cl + H^{\bullet}$

23 A catalytic converter is part of the exhaust system of many modern cars.

Which reactions occur in a catalytic converter?

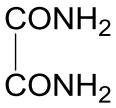
1 Carbon monoxide reacts with nitrogen monoxide to give carbon dioxide and nitrogen gas.

2 Carbon dioxide reacts with nitrogen monoxide to give carbon monoxide and nitrogen dioxide.

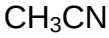
3 Sulfur dioxide reacts with nitrogen monoxide to give sulfur trioxide and nitrogen gas.

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

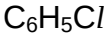
24 Experiments are carried out on three compounds **W**, **X** and **Y**.



W



X



Y

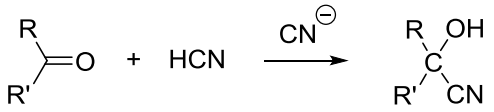
A sample of 0.0100 mol of each compound is boiled under reflux with 50.0 cm^3 of 1.00 mol dm^{-3} NaOH (an excess) until hydrolysis is complete and any ammonia produced is expelled from solution. The excess NaOH is titrated in each case and is found to require 30.0 cm^3, 40.0 cm^3 and 50.0 cm^3 of 0.500 mol dm^{-3} H_2SO_4 for neutralisation.

Which sequence of compounds matches these results?

	30 cm^3	40 cm^3	50 cm^3
A	**W**	**Y**	**X**
B	**X**	**W**	**Y**
C	**Y**	**W**	**X**
D	**W**	**X**	**Y**

25 Cyanohydrins can be made from carbonyl compounds by generating CN^- ions from

HCN in the presence of a weak base.



In a similar reaction, $^{-}CH_2CO_2CH_3$ are generated from $CH_3CO_2CH_3$ by strong bases.

Which compound can be made from an aldehyde and $CH_3CO_2CH_3$?

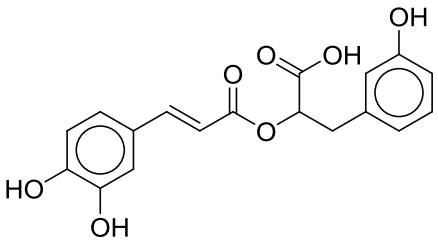
A $CH_3CH(OH)CO_2CH_3$

B $CH_3CO_2CH_2CH(OH)CH_3$

C $CH_3CH_2CH(OH)CH_2CO_2CH_3$

D $(CH_3)_2C(OH)CH_2CO_2CH_3$

26 Rosmarinic acid occurs in culinary herbs such as rosemary, sage and thyme.



Which statements are correct?

1 When treated with excess of $Br_2(aq)$, one mole of rosmarinic acid reacts with 3.5 moles of $Br_2(aq)$ to give the major product.

2 When treated with an excess of Na, one mole of rosmarinic acid forms 2 moles of H_2 gas.

3 When treated with a solution of 2,4-dinitrophenylhydrazine, an orange precipitate is formed.

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

27 Compound **T** has the molecular formula $C_xH_yCIO_z$ and contains two functional groups. It is tested with various reagents and gives the following results.

- When **T** is treated with a reducing agent $NaBH_4$, it forms only one organic product. The product has a molecular formula $C_xH_{y+2}CIO_z$.
- When **T** is treated with warm aqueous alkaline iodine, $C_{x-1}H_{y-3}O_{z+2}^{2-}$ ions are formed.
- **T** does not react with dry $SOCI_2$.

Which conclusions can be drawn from these results?

A **T** contains ketone and acyl chloride.

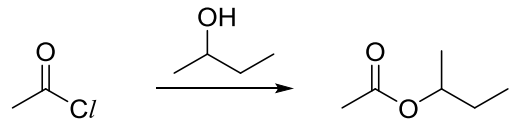
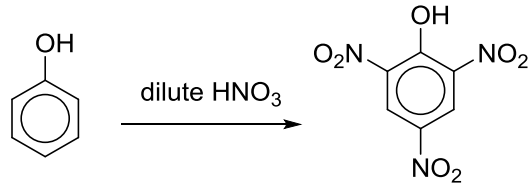
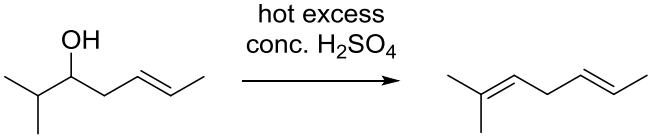
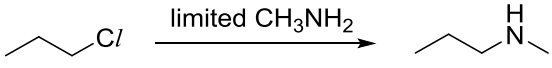
B **T** contains aldehyde and alkyl chloride.

C **T** contains alcohol and acyl chloride.

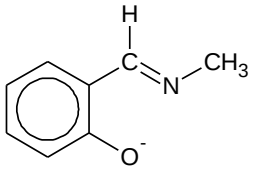
D **T** contains carboxylic acid and alkyl chloride.

28 The reaction conditions for four different transformations are given below.

Which transformation has a set of conditions and type of reaction that is correct?

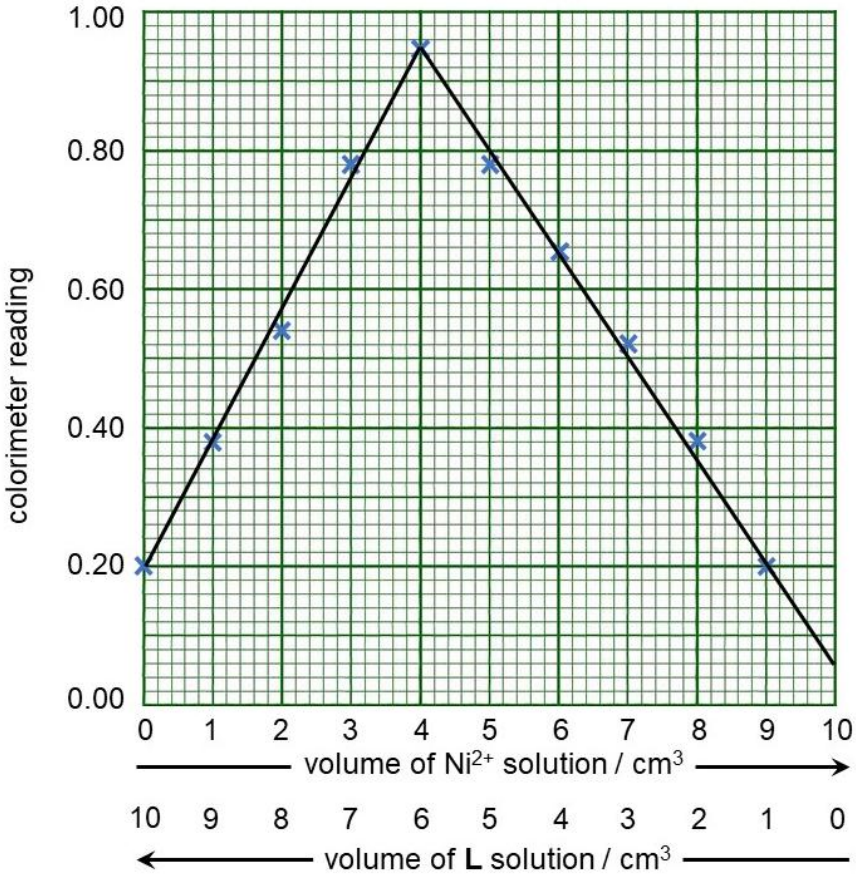
	Conditions	Reaction
A		condensation
B		electrophilic substitution
C		condensation
D		nucleophilic substitution

29 Nickel(II) ion forms a red complex with ligand **L** at room temperature.



L

The graph below was obtained when the colour intensities of mixtures of a 4×10^{-3} mol dm^{-3} solution of **L** and a 3×10^{-3} mol dm^{-3} solution of nickel(II) chloride were measured using a colorimeter at room temperature.



Which one of the following statements regarding the ligand **L** or the nickel(II) complex is correct?

A **L** is a monodentate ligand.

B The nickel(II) complex is negatively charged.

C The nickel(II) complex absorbs red light strongly.

D The ratio of nickel(II) to ligand **L** is 1:2.

30 Transition metals such as iron are often used as a catalyst in reactions such as the Haber process. Which of the following statements best explains the role of transition metals in this use?

A Transition metals have good electrical conductivity as both 4s and 3d electrons are involved in metallic bonding.

B Transition metals have available and partially filled 3d orbitals for adsorption of reactant molecules.

C Transition metals form coloured ions due to the absorption of energy in the visible light region to promote an electron from a lower to a higher energy 3d orbital.

D Transition metals can exhibit variable oxidation states due to the close proximity in energy between the 3d and 4s electrons.

Blank Page