

**JURONG PIONEER JUNIOR COLLEGE**
JC2 PRELIMINARY EXAMINATION 2022**CHEMISTRY****9729/01****Higher 2****22 September 2022**

Paper 1 Multiple Choice

1 hour

Candidates answer on separate paper.

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 and exam index 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** or **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 **13** printed pages.

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

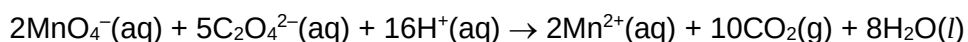
The table shows the forth, fifth, sixth, seventh, eighth and ninth ionisation energies of an element.

Which element has these ionisation energies values?

	4 th	5 th	6 th	7 th	8 th	9 th
Ionisation Energy / kJ mol⁻¹	5900	7100	8700	11000	13500	42000

- | | | | |
|----------|----|----------|----|
| A | Si | B | P |
| C | Cl | D | Ar |

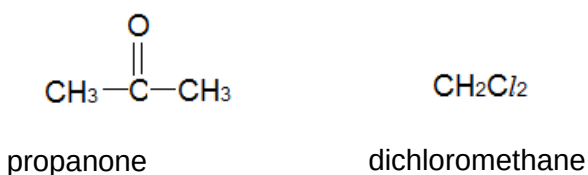
2 Ethanedioate ions, $\text{C}_2\text{O}_4^{2-}$, are oxidised by hot acidified, aqueous potassium manganate(VII) according to the following equation.



What volume of $0.020 \text{ mol dm}^{-3}$ potassium manganate(VII) is required to oxidise completely $1.0 \times 10^{-3} \text{ mol}$ of the salt $\text{K}_2\text{C}_2\text{O}_4$?

- A** 20 cm³
B 40 cm³
C 50 cm³
D 125 cm³

3 Propanone and dichloromethane are common organic solvents used in the laboratory. Propanone is soluble in water but dichloromethane is not.



Which of the following statements best accounts for this?

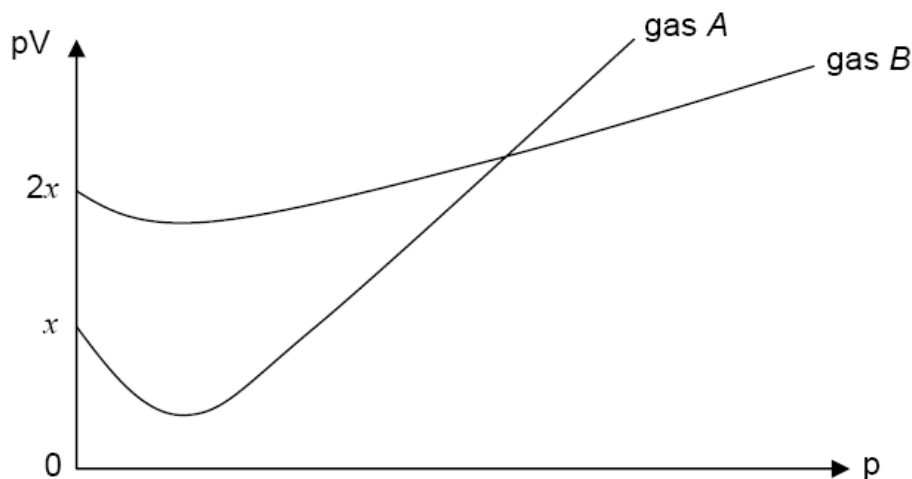
- A** Propanone is a polar molecule but dichloromethane is non-polar.
- B** A hydrogen bond forms between the hydrogen in propanone and the oxygen of a water molecule.
- C** A hydrogen bond forms between the oxygen in propanone and the hydrogen of a water molecule.
- D** Propanone has a smaller relative molecular mass than dichloromethane.

- 4 Nitrogen oxides (NO_x) can be formed from the reaction of nitrogen with oxygen in car engines. It can dissolve in water to form nitric acid which causes acid rain. Which of the following statements are correct?

- 1 N atom in NO_3^- is sp^2 hybridised.
- 2 NO and NO_2 contain an unpaired electron.
- 3 NO and NO_2 have no net dipole moment.

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

- 5 The value of pV is plotted against p for 2 gases, **A** and **B**, where p is the pressure and V is the volume of the gas.



Which of the following could be identities of the gases?

- | gas A | gas B |
|--|---|
| A 0.5 mol of CH_4 at 25°C | 0.5 mol of CH_4 at 50°C |
| B 0.5 mol of NH_3 at 25°C | 0.5 mol of NH_3 at 323°C |
| C 0.5 mol of CH_4 at 25°C | 1 mol of NH_3 at 25°C |
| D 1 mol of NH_3 at 25°C | 0.5 mol of CH_4 at 25°C |

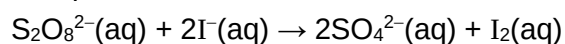
- 6 Travellers to countries with cold climate may sometimes use heat packs to keep warm. One example is the sodium ethanoate heat pack. This consists of a supersaturated solution of sodium ethanoate and a small metal disc containing very small crystals of sodium ethanoate.

When the disc is broken, the small crystals of sodium ethanoate are released into the solution and act as nucleation sites to catalyse the crystallisation reaction of sodium ethanoate.

Which line gives the signs of ΔH , ΔS and ΔG for the overall process?

	ΔH	ΔS	ΔG
A	-	-	-
B	-	-	+
C	+	+	-
D	+	+	+

- 7 A student investigated the kinetics of the reaction between 1.00 mol dm^{-3} potassium iodide and $0.0500 \text{ mol dm}^{-3}$ sodium peroxodisulfate.



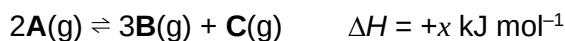
The two reactants were mixed in the presence of a known amount of sodium thiosulfate and a few drops of starch. The time taken for an intense blue colour to be observed was recorded.

Experiment number	Volume used / cm^3			Time / s
	KI	$\text{Na}_2\text{S}_2\text{O}_8$	H_2O	
1	10.0	5.0	25.0	170
2	15.0	5.0	20.0	113
3	15.0	10.0	15.0	56.5
4	20.0	20.0	0.0	z

What is the value of z?

- A 11 B 21 C 85 D 1360

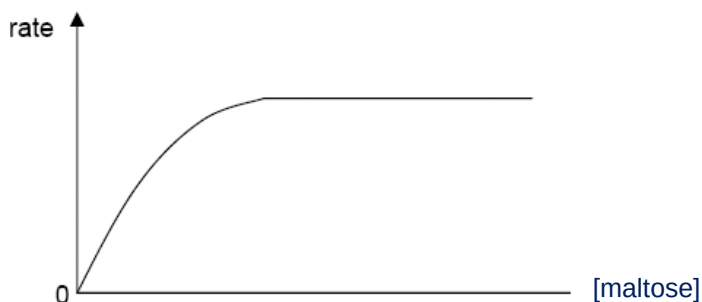
- 8 Gas **A** decomposes to two other gases, **B** and **C**, according to the equation:



Which of the following correctly describes what will happen if a proposed change is made to this system at equilibrium?

	proposed change	value of K_c	position of equilibrium
A	add inert solid	no change	shift left
B	increase pressure	no change	shift right
C	increase temperature	increase	shift right
D	add catalyst	increase	no change

- 9 The graph shows the result of an investigation of the initial rate of hydrolysis of maltose by the enzyme amylase. In the experiments, the initial concentration of maltose was varied, but that of amylase was kept constant.



Which conclusions can be deduced from these results?

- 1 When [maltose] is low, the rate is first order with respect to [maltose].
- 2 When [maltose] is high, the rate is independent of [maltose].
- 3 When [maltose] is high, the rate is independent of [amylase].

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

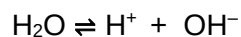
- 10 Aqueous solutions of aluminium salts are acidic. They contain $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ ions.

$$K_a \text{ for } [\text{Al}(\text{H}_2\text{O})_6]^{3+} = 1.0 \times 10^{-5} \text{ mol dm}^{-3}$$

What is the pH of $0.01 \text{ mol dm}^{-3} \text{ AlCl}_3$?

- A** 2.5 **B** 3.5 **C** 5.0 **D** 6.0

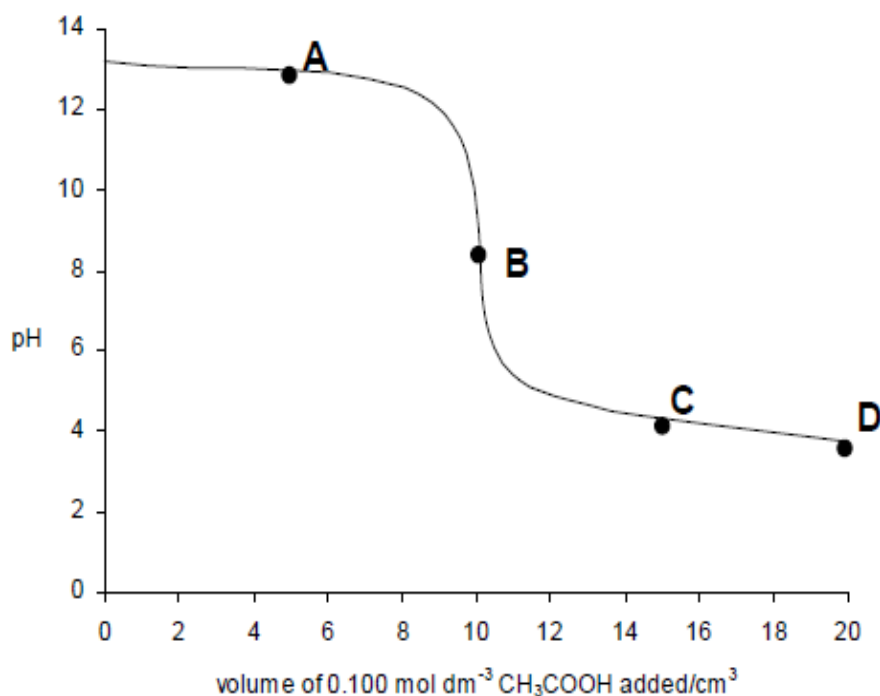
- 11 Pure water undergoes dissociation as shown in the equation below.



At 40°C, the $[\text{H}^+]$ is found to be $10^{-6.8} \text{ mol dm}^{-3}$.

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

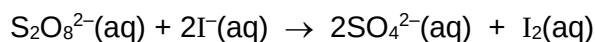
- A The dissociation of water is an endothermic process.
- B Water is acidic at 40°C.
- C At 40°C, the value of $\text{p}K_w$ is 13.6.
- D Both H^+ and OH^- ions are of the same concentration for pure water at 40°C.
- 12 The pH change when $0.100 \text{ mol dm}^{-3} \text{ CH}_3\text{CO}_2\text{H}$ is added dropwise to 10.0 cm^3 of $0.100 \text{ mol dm}^{-3} \text{ KOH(aq)}$ is given in the graph below.



At which point on the graph does $\text{pH} = \text{p}K_a$, where K_a is the acid dissociation constant of the weak acid?

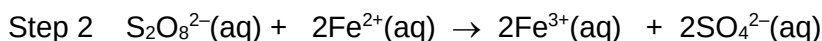
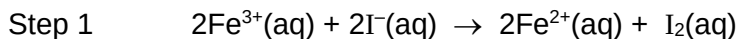
13 The use of Data Booklet is relevant to this question.

Peroxodisulfate ions convert iodide ions into iodine slowly.



The rate of the reaction can be increased by adding catalysts such as aqueous iron(III) ions.

A possible pathway of a catalyst reaction involves the following steps:

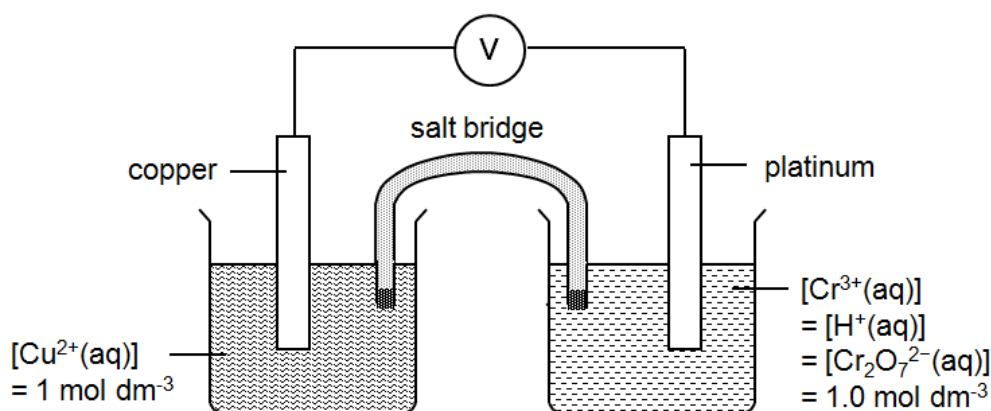


Which statement about the reaction is **incorrect**?

- A $\text{S}_2\text{O}_8^{2-}$ is a stronger oxidising agent than Fe^{3+} .
- B The reaction between $\text{S}_2\text{O}_8^{2-}$ and I^- is slow because the $E^\ominus_{\text{cell}}$ value is small.
- C The $E^\ominus_{\text{cell}}$ for step 2 is more positive than step 1.
- D Aqueous cobalt(II) ions can be used as a catalyst for this reaction.

14 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 $\text{Cr}_2\text{O}_7^{2-}/\text{Cr}^{3+}$ half-cell under standard conditions.

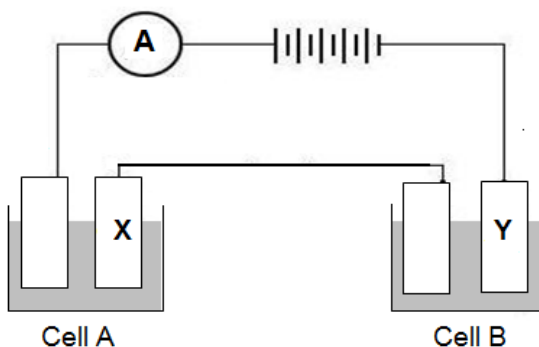


Which of the following correctly describes the effect on the e.m.f of the cell when the respective change is made?

- | change | effect on e.m.f of cell |
|--|-------------------------|
| A using a larger copper electrode | Become more positive |
| B addition of concentrated H_2SO_4 into reduction half-cell | Become less positive |
| C addition of dilute NaOH into oxidation half-cell | Become less positive |
| D addition of water into oxidation half-cell | Become more positive |

- 15 Use of the Data Booklet is relevant to this question.

A student carried out an experiment involving the electrolysis of aqueous copper(II) sulfate in cell A and aqueous chromium(III) sulfate in cell B.



Given that 6.35 g of copper was deposited at electrode X at the end of the experiment, what is the mass of chromium deposited at electrode Y?

- A 0.87 g B 1.74 g C 3.47 g D 10.4 g

- 16 The solubility product of a substance is S . If the concentration of the cation in a saturated solution is found to be $(\frac{9S}{4})^{\frac{1}{5}}$, what could be the substance?

- A CaCl_2
 B $\text{Ca}_3(\text{PO}_4)_2$
 C $\text{Al}(\text{OH})_3$
 D $\text{Al}_2(\text{SO}_4)_3$

- 17 Adding concentrated HCl to $\text{CuSO}_4(\text{aq})$ causes the colour of the solution to change from blue to green.

Which of the following best explains this observation?

- 1 number of d-electrons in copper changes
- 2 energy gap between the d-orbitals changes
- 3 oxidation state of copper changes.

- A Only 1 is correct.
 B Only 2 is correct.
 C 1 and 2 are correct.
 D 1 and 3 are correct.

- 18** The three minerals below are obtained from mines around the world. Each one behaves as a mixture of two carbonate compounds. They can be used as fire retardants because they decompose in the heat, producing CO_2 . This gas smothers the fire.

barytocite	$\text{BaCa}(\text{CO}_3)_2$
dolomite	$\text{CaMg}(\text{CO}_3)_2$
huntite	$\text{Mg}_3\text{Ca}(\text{CO}_3)_4$

What is the order of effectiveness as fire retardant, from best to worst?

	best	—————→	worst
A	dolomite	barytocite	huntite
B	dolomite	huntite	barytocite
C	huntite	dolomite	barytocite
D	huntite	barytocite	dolomite

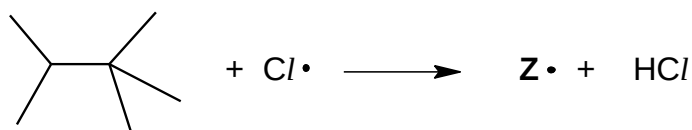
- 19** When aqueous potassium fluoride is added to an aqueous solution of iron(III) chloride, the yellow solution decolourises. No colour change is observed when aqueous ammonium thiocyanate is added to the resulting solution. However, when aqueous sodium cyanide is added, the colourless solution turns red.

complex	$[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$	$[\text{Fe}(\text{H}_2\text{O})_5\text{F}]^{2+}$	$[\text{Fe}(\text{H}_2\text{O})_5\text{SCN}]^{2+}$	$[\text{Fe}(\text{CN})_6]^{3-}$
colour	yellow	colourless	blood red	red

In which sequence are the ligands listed in order of increasing ligand strength?

- A** $\text{F}^- < \text{SCN}^- < \text{CN}^-$
- B** $\text{SCN}^- < \text{F}^- < \text{CN}^-$
- C** $\text{F}^- < \text{CN}^- < \text{SCN}^-$
- D** $\text{CN}^- < \text{F}^- < \text{SCN}^-$
- 20** What is the total number of different isomers that can be produced when 2-methylpentan-3-ol is heated with an excess of concentrated sulfuric acid?
- A** 1
- B** 2
- C** 3
- D** 4

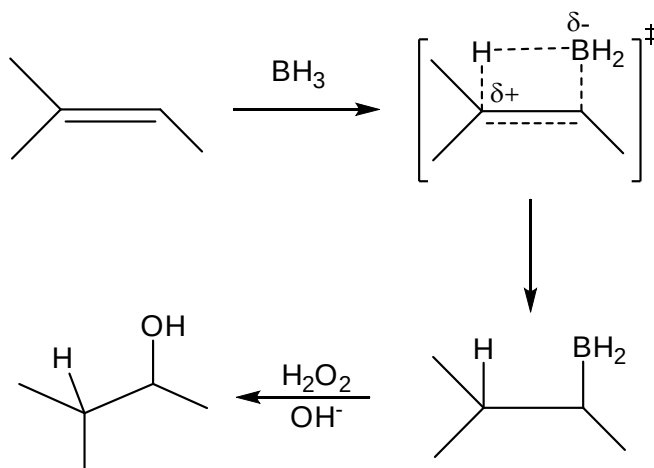
- 21 Compound **W** undergoes free radical substitution with chlorine. The equation below represents one of the propagation steps, where the free radical **Z•** is formed by the loss of a hydrogen atom.



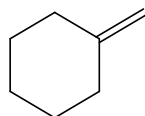
compound **W**

What is the total number of different mono-substituted radicals **Z•** that can be formed?

- A 2
B 3
C 4
D 5
- 22 Hydroboration is a method of preparing alcohols from alkenes in an anti-Markovnikov manner. The reaction involves the formation of a four-membered cyclic transition state, where the partial positive charge is carried on the more highly substituted carbon. The alkylborane undergoes redox reaction with hydrogen peroxide to form an alcohol.



Which of the following will be obtained if the following compound **Y** is subjected to hydroboration using BD_3 followed by H_2O_2 and OH^- ? ($\text{D} = {}^2_1\text{H}$)

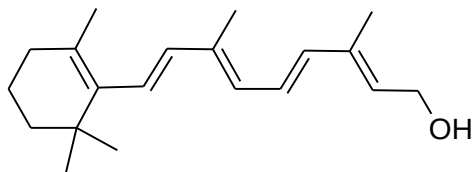


Compound **Y**

- A
- B
- C
- D

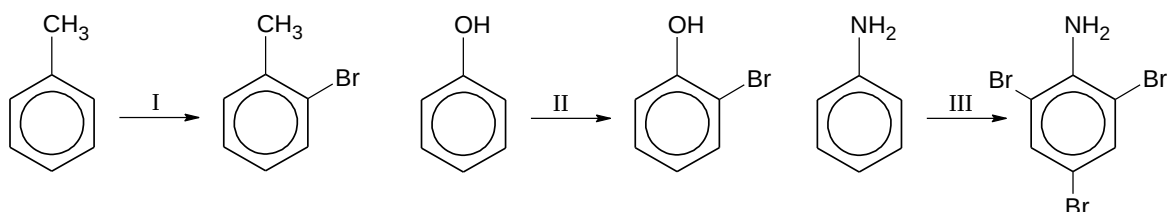
- 23** Vitamin A₁ is a fat-soluble vitamin that can be found in food. It is used as a supplement to treat and prevent vitamin A deficiency, and to reduce the risk of complications in measles patients.

The structure of Vitamin A₁ is given below:



Which statements regarding Vitamin A₁ is/are correct?

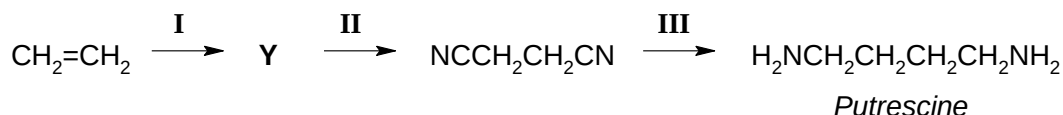
- 1** When Vitamin A₁ is treated with cold alkaline KMnO₄, the product has a total of 2¹⁰ isomers.
 - 2** 3 different organic compounds are formed when Vitamin A₁ is treated with hot acidified KMnO₄.
 - 3** 2 mol of CO₂ gas is produced when Vitamin A₁ is treated with hot acidified KMnO₄.
- A** Only 1
B Only 2
C 1 and 2
D 1, 2 and 3
- 24** Methylbenzene, phenol and phenylamine all undergo electrophilic substitution with suitable reagents.



Which of the following gives the correct reagent and condition for reactions **I**, **II** and **III**?

	I	II	III
A	Br ₂ , Fe	Br ₂ in CCl ₄	Br ₂ (aq)
B	Br ₂ , FeBr ₃	Br ₂ (aq)	Br ₂ in CCl ₄
C	Br ₂ (aq)	Br ₂ in CCl ₄	Br ₂ , Fe
D	Br ₂ in CCl ₄	Br ₂ , FeBr ₃	Br ₂ (aq)

- 25 *Putrescine* is used in the production of *Nylon-4,6*. It can be synthesised from ethene by the following reactions.

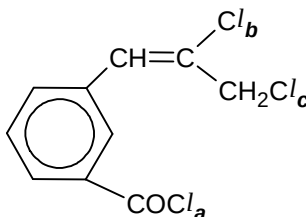


Which of the following gives the correct reagents and conditions for steps I to III?

- | | I | II | III |
|----------|----------------------------------|-----------------------|--------------------------------|
| A | Br_2 | KCN in ethanol, heat | H_2 , Ni, heat |
| B | Br_2 | HCN, trace NaCN, cold | LiAlH ₄ , dry ether |
| C | cold, alkaline KMnO ₄ | KCN in ethanol, heat | LiAlH ₄ , dry ether |
| D | cold, alkaline KMnO ₄ | HCN, trace NaCN, cold | H_2 , Ni, heat |
- 26 Compound **P**, C₃H₈O₂, is an alcohol containing two –OH groups per molecule. It can be oxidised in stages to compound **Q**, C₃H₆O₂, which reacts with 2,4-dinitrophenylhydrazine but **not** with Fehling's solution. Compound **Q** is then further oxidised to **R**, C₃H₄O₃ which reacts with aqueous sodium carbonate.

Which of the following about the properties of **P**, **Q** and **R** is correct?

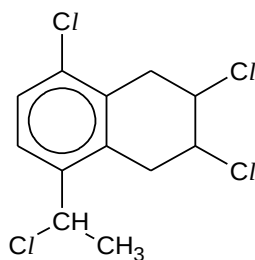
- | | contains at least one chiral centre | gives positive iodoform test |
|----------|-------------------------------------|----------------------------------|
| A | P , Q and R | P only |
| B | Q only | P and Q |
| C | P only | P , Q and R |
| D | P and Q | Q and R |
- 27 The diagram below shows an aromatic organic compound that contains 3 chlorine atoms labelled **a**, **b**, and **c** respectively.



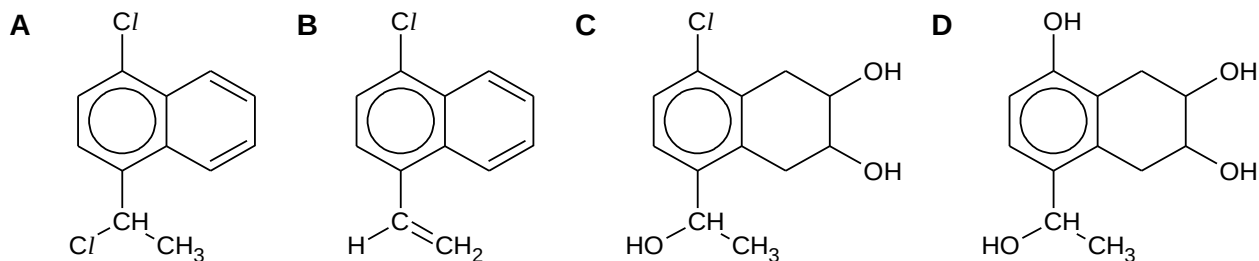
Which gives the correct order of the Cl atoms based on their decreasing ease of hydrolysis?

- A** a, b, c
- B** a, c, b
- C** b, a, c
- D** b, c, a

- 28 Which of the following represents the structure of the organic product when compound Y is heated with ethanolic NaOH?



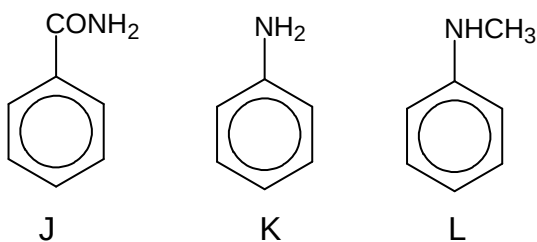
Compound Y



- 29 Which of the following will produce solutions of increasing pH when equimolar quantities of the organic compounds are separately dissolved in water?

- A ethanamide, ethanoic acid, ethanoyl chloride
- B ethanamide, ethanoyl chloride, ethanoic acid
- C ethanoic acid, ethanoyl chloride, ethanamide
- D ethanoyl chloride, ethanoic acid, ethanamide

- 30 The diagram below shows 3 common organic nitrogen compounds.



Which of the following shows the correct order of increasing basicity of these compounds?

- A J, K, L
- B J, L, K
- C K, L, J
- D K, J, L

End of paper

1	D	11	B	21	B
2	A	12	D	22	C
3	C	13	B	23	A
4	B	14	D	24	A
5	B	15	C	25	A
6	A	16	B	26	C
7	B	17	B	27	B
8	C	18	C	28	B
9	B	19	B	29	D
10	B	20	C	30	A