



CATHOLIC JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS
Higher 2

CHEMISTRY

Paper 1 Multiple Choice

9647/01

3 September 2013

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 and/or shade your name, NRIC / FIN number and HT group on the Multiple Choice Answer Sheet in the spaces provided.

There are **forty** questions in 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 Multiple Choice Answer Sheet.

Read the instructions on the Multiple Choice 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.

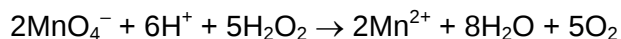
Calculators may be used.

This document consists of **18** printed pages and **0** blank page.

[Turn over

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

- 1** Sodium carbonate peroxyhydrate with the formula $(\text{Na}_2\text{CO}_3)_x \cdot y\text{H}_2\text{O}_2$ is used in some eco-friendly cleaning products and as a laboratory source of anhydrous hydrogen peroxide.



When 20.0 cm^3 of $0.100 \text{ mol dm}^{-3}$ sodium carbonate peroxyhydrate is titrated with $0.200 \text{ mol dm}^{-3}$ acidified KMnO_4 , it requires 12.0 cm^3 of acidified KMnO_4 before the first pink colour appears.

When an identical sample is acidified, it releases 96.0 cm^3 of carbon dioxide at room conditions.

What is the ratio of $x:y$?

- A** 1 : 3 **B** 2 : 3 **C** 2 : 1 **D** 3 : 1

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

Species containing one or more unpaired electrons and can be attracted by an external magnetic field are said to be paramagnetic.

Which of the following species is **not** paramagnetic?

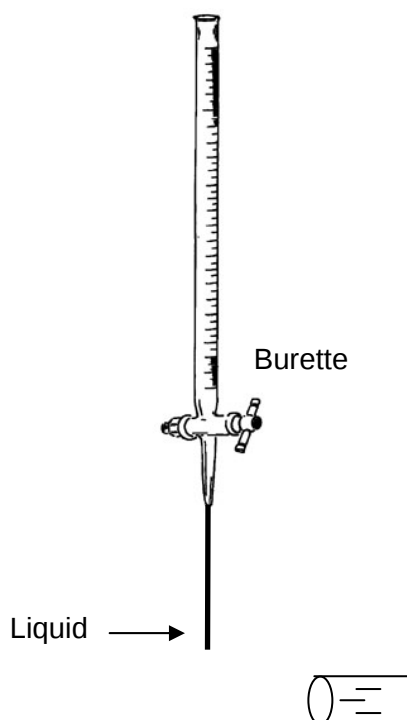
- A** Cr^{3+} **B** Cu^+ **C** Ni^{2+} **D** V^{3+}

- 3** Elemental oxygen exists in the atmosphere in two forms, O_2 and O_3 . Even though O_2 and O_3 are both made up of oxygen atoms, they have different physical and chemical properties.

Which of the following best explains why O_3 is more soluble in water compared to O_2 ?

- A** O_3 is more stable than O_2 and thus O_3 is able to react more readily with water.
B O_3 is able to form more extensive van der Waals' forces with water molecules as compared to O_2 .
C O_3 is able to form permanent dipole-permanent dipole interaction with water but O_2 is not able to do so.
D O_3 has more lone electrons than O_2 and therefore forms stronger ion-dipole interaction with water.

- 4 The diagram shows a liquid flowing from a burette and a negatively charged rod being brought near the flow.

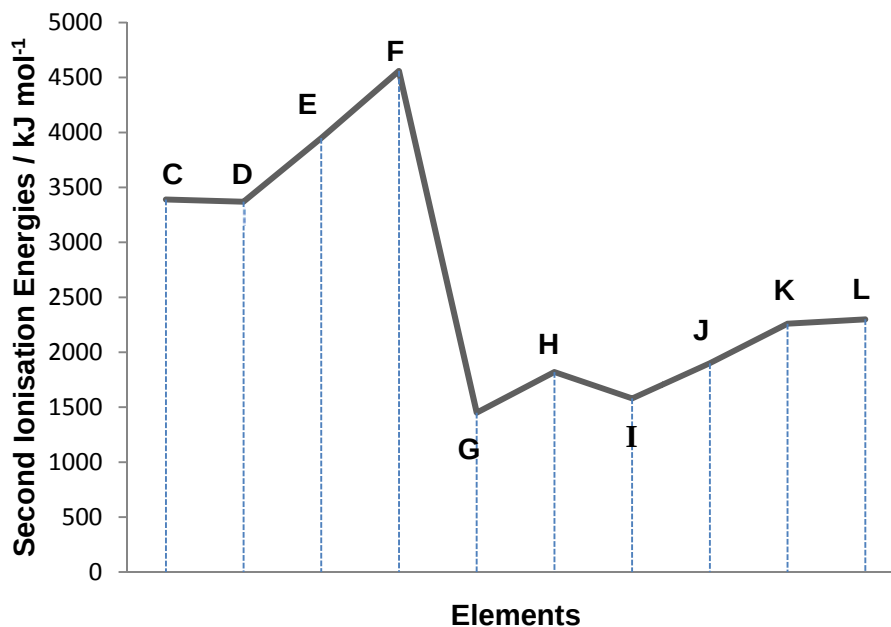


What would happen to the flow of the liquid if the liquid were methanol and carbon tetrachloride respectively?

	methanol	carbon tetrachloride
A	Deflected towards the rod, larger deflection angle	Deflected towards the rod, smaller deflection angle
B	Deflected towards the rod, smaller deflection angle	Deflected towards the rod, larger deflection angle
C	Not deflected	Deflected towards the rod
D	Deflected towards the rod	Not deflected

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

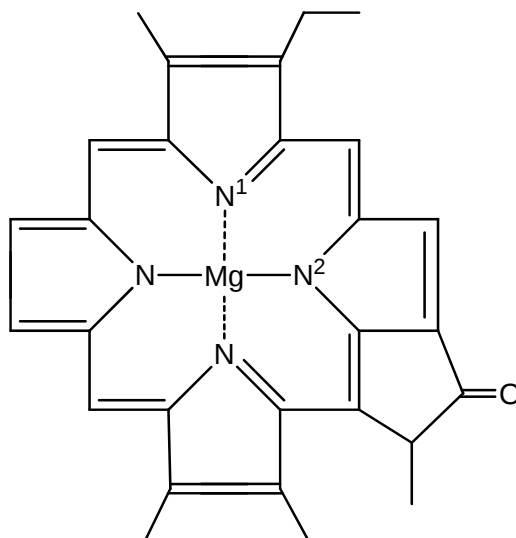
The second ionisation energies of successive elements with atomic numbers between 7 to 19 in the Periodic Table are represented in the graph.



Which of the following statements about elements **C** to **L** is **incorrect**?

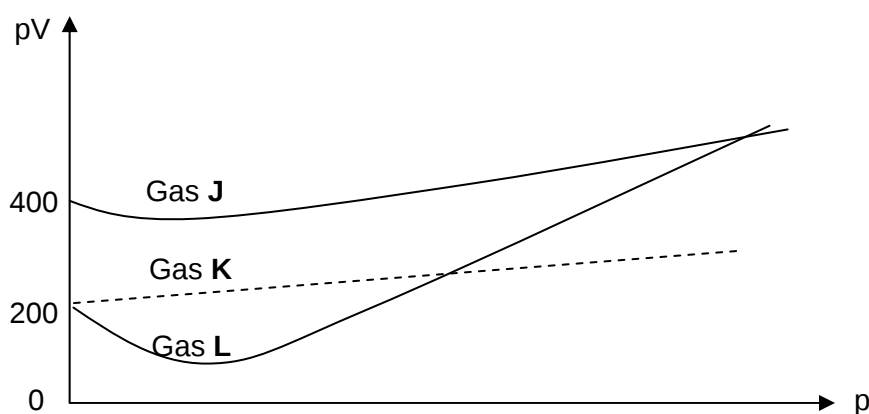
- A L has a larger atomic radius than D.
- B E and L^- have fully filled p-orbitals.
- C H has higher first ionisation energy than G.
- D C and K form compounds with the formula KC_2 and KC_3 .

- 6 A simplified structure of a molecule of chlorophyll is shown. Mg is situated in the centre of a planar arrangement of the four N atoms.



Which of the following is **not** true?

- A The hybridisation about N^1 is sp^2 .
 B The hybridisation about Mg is sp^3 .
 C The bonding between Mg and N^2 is ionic.
 D The bonding between Mg and N^1 is dative covalent.
- 7 The graph below shows how pV changes with p for the three gases, **J**, **K** and **L**, at a fixed temperature (where p = pressure, V = volume).



Which of the following correctly identifies the gases?

	Gas J	Gas K	Gas L
A	1 mol of NH_3	1 mol of H_2	1 mol of N_2
B	1 mol of N_2	1 mol of H_2	1 mol of NH_3

C	2 mol of N ₂	1 mol of H ₂	1 mol of NH ₃
D	2 mol of H ₂	1 mol of NH ₃	1 mol of N ₂

- 8** Solutes dissolve in solvents to form solutions. If a semi-permeable membrane that allows solvent molecules to pass through it, is placed between a pure solvent and a solution containing a solute in that solvent, pure solvent only will go through the membrane into the solution. This process is called osmosis.

Which statement regarding ΔS is correct for the following processes?

- A** Dissolving the solute in the solvent results in a negative ΔS .
- B** Evaporation of the solvent from the solution results in a negative ΔS .
- C** Cooling the solution will not change ΔS since the number of particles in the system is unchanged.
- D** Movement of solvent molecules through the semi-permeable membrane during osmosis results in a positive ΔS .
- 9** The ionic product of water at 10 °C is $2.93 \times 10^{-15} \text{ mol}^2 \text{ dm}^{-6}$.

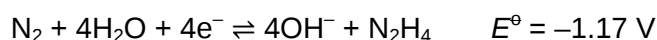
What is the pH of a solution containing 0.02 mol dm^{-3} of Ba(OH)₂ at 10 °C?

- A** 12.6 **B** 12.9 **C** 13.1 **D** 13.3
- 10** The pH of human blood is constant at about 7.4.
- Which species present in the human body removes excess H⁺(aq) to help keep the blood pH constant?

- A** CO₂ **B** CO₃²⁻ **C** HCO₃⁻ **D** H₂CO₃

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

Hydrazine (N₂H₄) can be used to reduce metal ions to their elemental forms in the treatment of wastewater. An important half-equation involving hydrazine is shown.



Which of the following substances **cannot** be removed from a wastewater source by hydrazine?

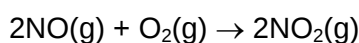
- A** Pb⁴⁺ **B** Fe³⁺ **C** Zn²⁺ **D** V³⁺

- 12** The last stage in the production of aluminium involves the electrolysis of refined aluminium oxide (Al_2O_3) dissolved in molten cryolite (Na_3AlF_6) using graphite electrodes. A typical cell operates at 3.0×10^5 A. Oxygen gas produced at the anode reacts with graphite forming carbon dioxide gas. The electrodes are replaced when 50 % of the graphite is used up.

If the mass of the electrode used is 5000 kg, what is the time taken, in minutes, before replacement of the electrode is necessary?

- A** 1.34×10^5 **B** 2.68×10^5 **C** 4.47×10^3 **D** 8.94×10^3

- 13** One of the reactions that occurs in a sample of polluted air containing oxides of nitrogen is the oxidation of nitrogen monoxide to nitrogen dioxide.

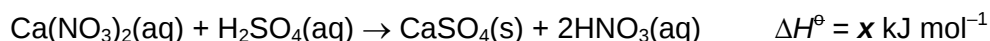


The table shows some data obtained in experiments carried out at 25°C to determine the rate equation for this reaction.

Experiment	Initial concentration / mol dm^{-3}		Rate of formation of NO_2 / $\text{mol dm}^{-3} \text{s}^{-1}$
	$\text{NO}(\text{g})$	$\text{O}_2(\text{g})$	
1	0.025	0.020	8.75×10^{-2}
2	0.050	0.020	3.50×10^{-1}
3	0.025	0.040	1.75×10^{-1}

Which of the following statement is correct?

- A** The half-life of O_2 is not affected by a decrease in initial concentration of NO .
B The graph of $[\text{O}_2]$ versus time is a straight-line graph passing through origin.
C A decrease in $[\text{NO}]$ increases the rate constant.
D The units of the rate constant is $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$.
- 14** The standard enthalpy change of the reaction below can be calculated using the data shown in the table.



	$\Delta H^\circ / \text{kJ mol}^{-1}$
$\frac{1}{2} \text{N}_2(\text{g}) + \frac{3}{2} \text{O}_2(\text{g}) + \text{aq} + \text{e}^- \rightarrow \text{NO}_3^-(\text{aq})$	-206
$\text{Ca}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Ca}(\text{s})$	-347
$\text{Ca}(\text{s}) + \text{S}(\text{s}) + 2\text{O}_2(\text{g}) \rightarrow \text{CaSO}_4(\text{s})$	-1435
$2\text{S}(\text{s}) + 4\text{O}_2(\text{g}) + 4\text{e}^- \rightarrow 2\text{SO}_4^{2-}(\text{aq})$	-1814

What is the value of x in kJ mol^{-1} ?

- A** -1081 **B** -875 **C** -181 **D** +32

- The enthalpy changes of fusion of four successive elements, W to Z , in the third period (sodium to argon) of the Periodic Table is given in the table.

element	<i>W</i>	<i>X</i>	<i>Y</i>	<i>Z</i>
enthalpy change of fusion / kJ mol ⁻¹	10.8	46.4	0.6	1.4

	<i>W</i>	<i>X</i>	<i>Y</i>	<i>Z</i>
A	Mg	Al	Si	P
B	Al	Si	P	S
C	Si	P	S	Cl
D	P	S	Cl	Ar

- | | | | |
|----------|--|----------|--|
| A | aragonite, CaCO_3 | B | dolomite, $\text{CaCO}_3 \cdot \text{MgCO}_3$ |
| C | artinite, $\text{MgCO}_3 \cdot \text{Mg}(\text{OH})_2 \cdot 3\text{H}_2\text{O}$ | D | barytocalcite, $\text{BaCO}_3 \cdot \text{CaCO}_3$ |

- Experiment II:** Potassium chloride was dissolved in aqueous ammonia and then silver nitrate was added to the resultant mixture.

What was observed in each experiment?

	Experiment I	Experiment II
A	brown solution	white precipitate
B	colourless solution	white precipitate
C	brown solution	colourless solution
D	colourless solution	colourless solution

- 18 Mohr's salt, a pale green crystalline solid soluble in water, is a 'double sulfate' containing two cations, one of which is Fe^{2+} .

To determine the identity of the second cation, a sample of solid Mohr's salt is heated with solid sodium hydroxide. A colourless gas was evolved, which readily dissolved in water to give an alkaline solution. The residue is a grey-green solid insoluble in water.

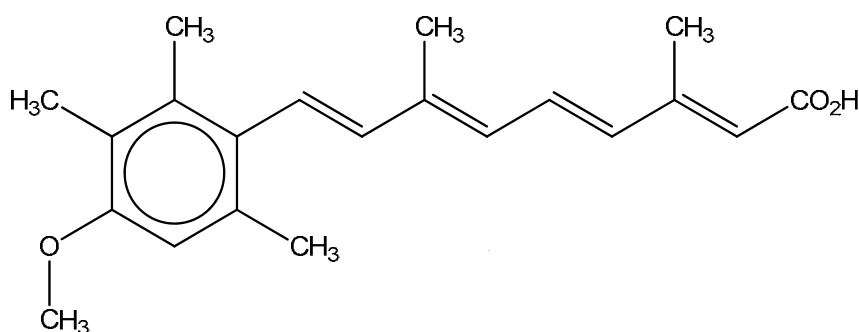
Which set gives the identity of the gas and the solid residue?

	gas	residue
A	H_2	FeSO_4
B	NH_3	Na_2SO_4
C	NH_3	$\text{Fe}(\text{OH})_2$
D	SO_2	$\text{Fe}(\text{OH})_2$

- 19 Covalent bonds are formed by orbital overlap. The shape of unsaturated hydrocarbon molecules can be explained in terms of hybridisation of orbitals.

Which bond is **not** present in $\text{H}_2\text{C}=\text{C}=\text{CHCH}_2\text{CH}_3$?

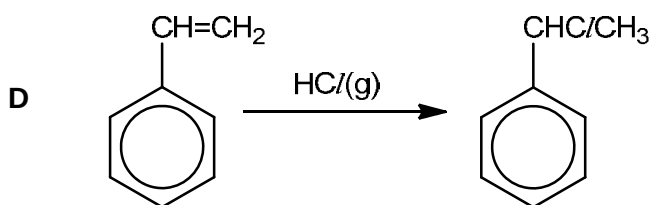
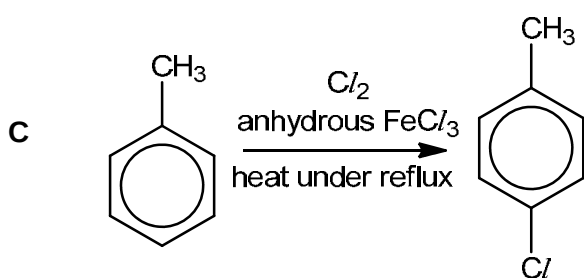
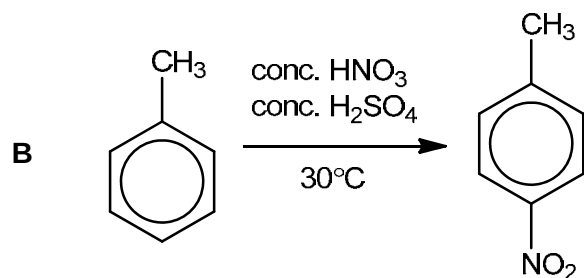
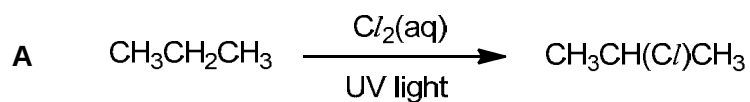
- A a π bond formed by $2\text{sp} - 2\text{sp}^2$ overlap
 B a σ bond formed by $2\text{sp}^3 - 2\text{sp}^2$ overlap
 C a σ bond formed by $1\text{s} - 2\text{sp}^3$ overlap
 D a σ bond formed by $2\text{sp}^3 - 2\text{sp}^3$ overlap
- 20 Acetretin is a retinoid that is used to treat skin diseases.



Assuming that $-\text{OCH}_3$ is inert, what is the total number of different **organic** products that can be formed when acetretin is treated with hot acidified potassium manganate(VII)?

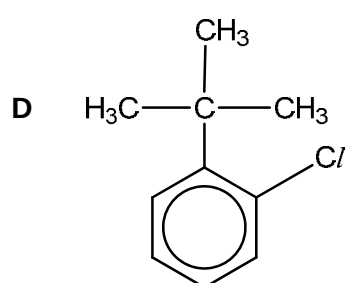
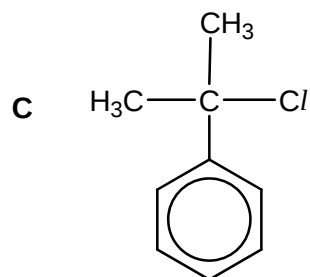
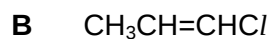
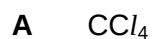
- A 2 B 3 C 4 D 5

- 21 The reaction conditions for four different transformations are given below. Which transformation has a set of conditions that is **not** correct?



- 22 When a halogen compound **S** was boiled under reflux for some time with aqueous silver nitrate, a precipitate was seen.

Which formula could represent **S**?



23 An organic compound **X** undergoes the following reactions:

- (i) It decolourises a solution of bromine in tetrachloromethane.
- (ii) It reacts with phosphorus pentachloride giving copious white fumes of HCl .
- (iii) It reacts with hot alkali to give a compound with two alcohol functional groups.

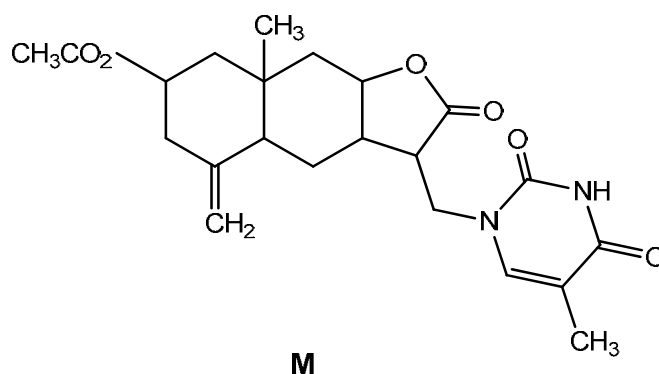
Which compound could be **X**?

- A $\text{HOH}_2\text{CCH}=\text{CHCH}=\text{CHCH}_2\text{Cl}$
- B $\text{Cl}_2\text{CHCH}=\text{CHCH}_2\text{CO}_2\text{H}$
- C $\text{BrCH}_2\text{CH}_2\text{CHClCH}_2\text{COCl}$
- D $\text{ClCH}_2\text{CH}_2\text{CH}=\text{CHCH}(\text{Cl})\text{CH}_2\text{OH}$

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

- A $\text{CH}_3\text{CH}_2\text{CN} \xrightarrow[\text{D}_2\text{O}]{\text{NaOD}}$
- B $\text{CH}_3\text{CD}_2\text{OH} \xrightarrow[\text{heat}]{\text{acidified KMnO}_4}$
- C $\text{CH}_3\text{COCH}_3 \xrightarrow[\text{dry ether}]{\text{LiAlD}_4}$
- D $(\text{CH}_3)_3\text{COH} \xrightarrow[\text{heat}]{\text{conc. D}_2\text{SO}_4}$

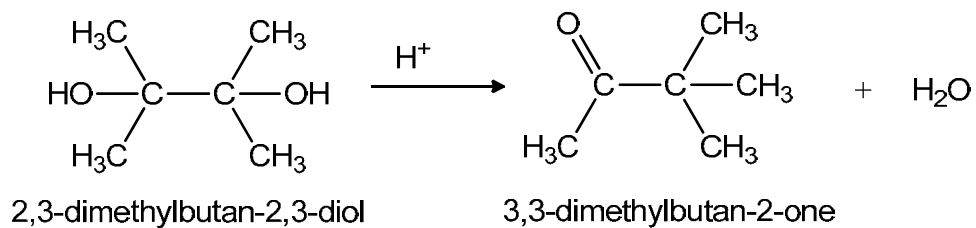
25 The sesquiterpene lactone, **M**, extracted from sunflowers, was studied to determine its anti-tumour potency.



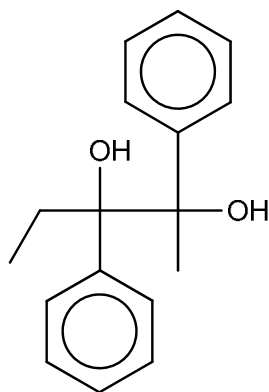
How many moles of dilute NaOH are required to completely hydrolyse 1 mol of **M**?

- A 3
- B 4
- C 5
- D 6

- 26 The pinacol rearrangement involves the reaction of a diol in acidic conditions to form a carbonyl compound as shown below.

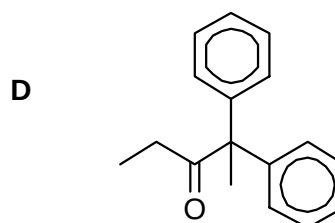
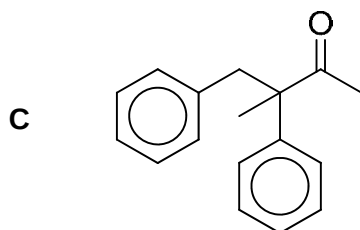
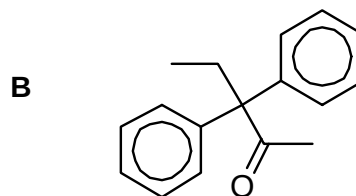
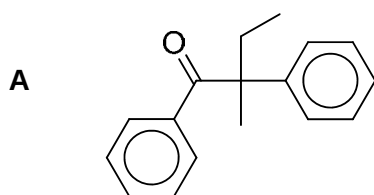


2,3-diphenylpentan-2,3-diol has the structure shown below.

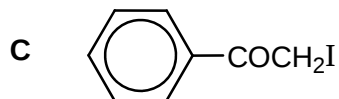
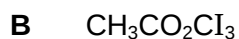
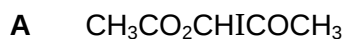


2,3-diphenylpentan-2,3-diol

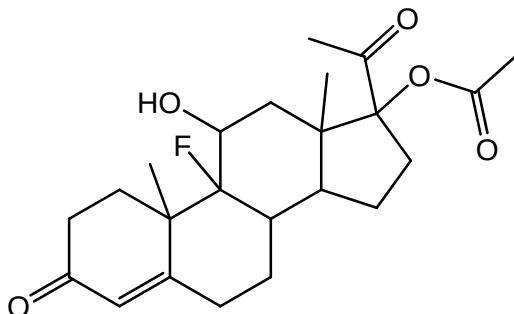
Which structural formulae is **not** a product of the pinacol rearrangement of 2,3-diphenylpentan-2,3-diol?



27 Which compounds will **not** produce CHI_3 on warming with alkaline $\text{I}_2(\text{aq})$?



28 Flurogestone acetate is a synthetic steroid that can be used as a hormone.



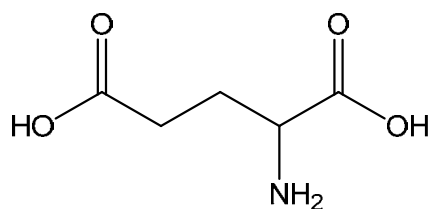
Which of the following is true about Flurogestone acetate?

- A It reacts with H_2 to form a product with 3 new chiral centres.
- B It reacts with $\text{Br}_2(\text{aq})$ to incorporate up to 3 atoms of bromine in each molecule.
- C 1 mole of Flurogestone acetate reacts with 3 moles of 2,4-dinitrophenylhydrazine.
- D 1 mole of Flurogestone acetate reacts with aqueous alkaline iodine to give 2 moles of CHI_3 .

29 Which statement about amino acids found in the body is always true?

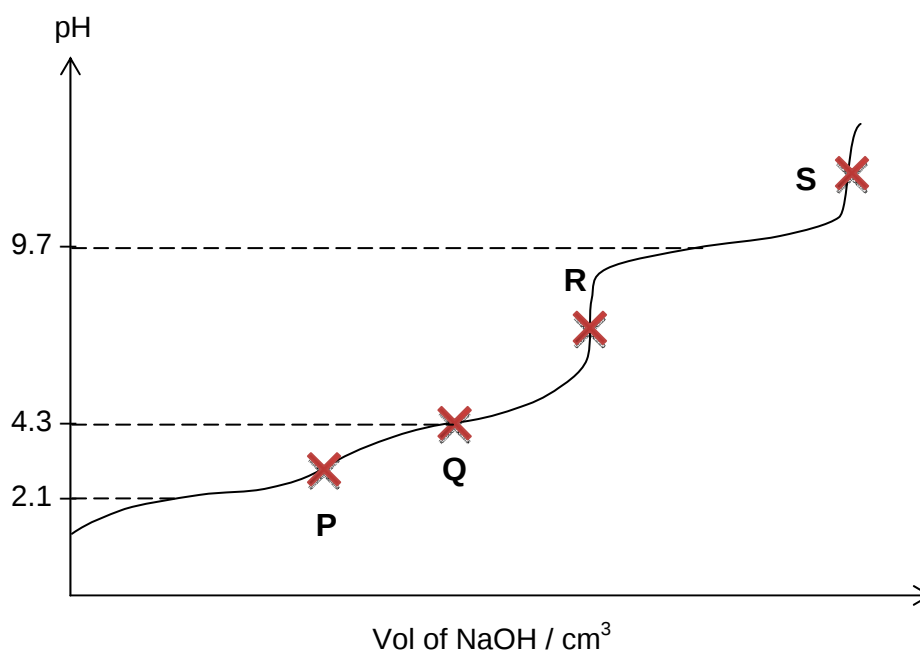
- A They are chiral compounds.
- B They exist as zwitterions at pH 7.
- C They exist as crystalline solids at room temperature.
- D They are soluble in water due to the formation of hydrogen bonding.

- 30 The structure of glutamic acid is shown below.



It has pK_a values of 2.1, 4.3 and 9.7.

A solution of glutamic acid was titrated against aqueous sodium hydroxide and the following graph is obtained.



What deduction can be drawn from the titration curve above?

- A Maximum buffering capacity occurs at point P.

- B is the predominant species at point Q.

- C Point R corresponds to the isoelectric point of glutamic acid.

- D A doubly charged anion is the predominant species at point S.

For each of the following questions, one or more of the three numbered statements **1** to **3** may be correct. Decide whether each of the statements is or is not correct. The responses **A** to **D** should be selected on the basis of:

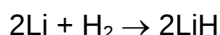
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

No other combination of statements is used as a correct response.

31 Which statements about relative formula mass are correct?

- 1** It is the ratio of the sum of the average mass of the formula unit to 1/12 of the mass of a ^{12}C atom.
- 2** It is the sum of the relative atomic masses of the atoms within the formula unit.
- 3** It is the ratio of the mass of 1 mol of the formula unit to the mass of 1 mol of ^1H atom.

32 Lithium hydride is used as a reagent for the synthesis of organic reducing agents such as lithium aluminium hydride (LiAlH_4) and lithium borohydride (LiBH_4). Lithium hydride is produced by reacting lithium metal with hydrogen gas:

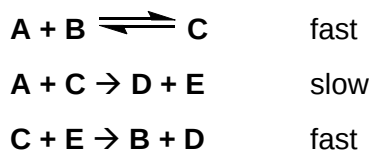


The standard enthalpy change of formation of LiH can be measured in the laboratory and the atomisation energies of Li and H are given as x and $y \text{ kJ mol}^{-1}$ respectively.

What further information is required to calculate the lattice energy of LiH ?

- 1** The hydrogen-hydrogen bond energy.
- 2** The electron affinity of hydrogen.
- 3** The first ionisation energy of lithium.

33 Consider the following mechanism.



What can be deduced from the mechanism?

- 1** The rate equation is $\text{rate} = k[\text{A}]^2[\text{B}]^2$.
- 2** The overall equation is $2\text{A} + \text{C} \rightarrow 2\text{D}$.
- 3** **B** is a catalyst and **E** is an intermediate.

The responses **A** to **D** should be selected on the basis of:

A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

No other combination of statements is used as a correct response.

34 **X, Y and Z** are Period 3 elements.

Element **X** has high thermal conductivity at room temperature. It forms a chloride that hydrolyses in water forming an acidic solution, and an oxide that reacts very slowly with aqueous acids.

Element **Y** and its oxide have high melting points. The chloride of **Y** reacts with water to form steamy fumes and an acidic solution.

Element **Z** has a chloride that forms an acid in water, and an oxide which reacts vigorously with water to form solutions containing strong acids.

Which of the following statements about **X, Y** and **Z** is true?

- 1** The chloride of **X** sublimes when heated.
- 2** A chloride of **Z** reacts with carboxylic acids.
- 3** The oxides of **X** and **Y** readily dissolve in water.

35 A student set up four standard half-cells each containing one of the metals, **W, X, Y** and **Z**, immersed in a solution of its metallic salts. These were then used to make different electrochemical cells. The table below shows the standard cell potential, E°_{cell} and the negative terminal of each electrochemical cell.

Cell	Metals used	$E^\circ_{\text{cell}} / \text{V}$	Negative terminal
A	W and X	+1.10	X
B	X and Y	+0.46	Y
C	X and Z	+0.47	X

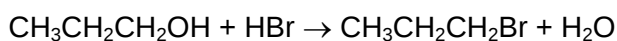
Which one of the following statement is correct?

- 1** **W** can oxidise **X, Y** and **Z**.
- 2** **Y** has a stronger reducing power than **Z**.
- 3** **W** and **Z** form a cell represented as $\text{W(s)} / \text{W}^{n+}(\text{aq}) // \text{Z}^{m+}(\text{aq}) / \text{Z(s)}$.

- 36** 1,1-dichloro-1-fluoroethane is known to cause the depletion of ozone in the upper atmosphere.

Which of the following are **not** involved in the destruction of ozone by 1,1-dichloro-1-fluoroethane?

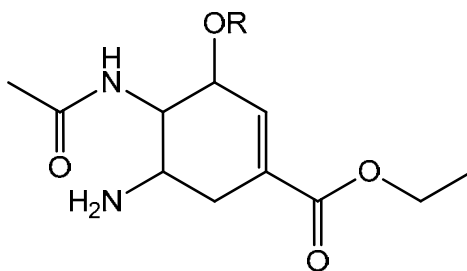
- 1 $\text{CH}_3\text{CCl}_2\text{F}(\text{g}) \rightarrow \text{CH}_3\dot{\text{C}}\text{Cl}_2(\text{g}) + \text{F}\cdot(\text{g})$
 - 2 $\text{ClO}\cdot(\text{g}) + \text{O}(\text{g}) \rightarrow \text{Cl}\cdot(\text{g}) + \text{O}_2(\text{g})$
 - 3 $\text{Cl}\cdot(\text{g}) + \text{CH}_3\text{CCl}_2\text{F}(\text{g}) \rightarrow \text{HCl}(\text{g}) + \cdot\text{CH}_2\text{CCl}_2\text{F}(\text{g})$
- 37** The preparation of 1-bromopropane involves the controlled addition of concentrated sulfuric acid to a mixture of propan-1-ol and sodium bromide.



When the mixture is subsequently heated, by-products are formed as the reagents may react in more than one way or because the products formed may react with the reactants.

What could be a by-product of the reaction?

- 1 $\text{CH}_3\text{CH}=\text{CH}_2$
 - 2 Br_2
 - 3 SO_2
- 38** Oseltamivir, which is marketed widely as Tamiflu, is commonly used in the treatment of influenza.



Oseltamivir

In the following reactions, the –OR group is inert and does not react.

Which reactions would Oseltamivir undergo?

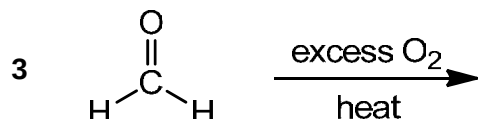
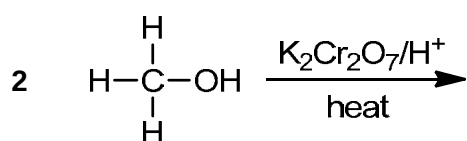
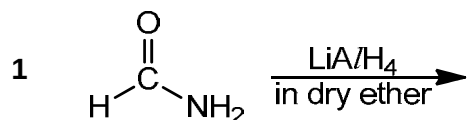
- 1 It decolourises purple KMnO_4 .
- 2 It gives a yellow precipitate with aqueous alkaline iodine.
- 3 It reacts with HCl at room temperature to give a neutral salt.

The responses **A** to **D** should be selected on the basis of:

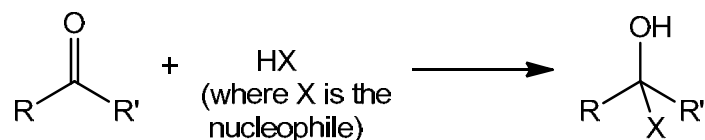
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

No other combination of statements is used as a correct response.

39 In which reaction will the oxidation number of carbon change by 4?



40 Carbonyl compounds undergo nucleophilic addition reactions as shown below.



Carbonyl compounds can also react with Grignard reagent in a similar way. Grignard reagent has the general formula $\text{R}''\text{MgBr}$ and is a good source of nucleophile (R''^-). For example, the nucleophile, " CH_3CH_2^- ", can be generated from the Grignard reagent, $\text{CH}_3\text{CH}_2\text{MgBr}$.

Which compounds can be obtained from reaction of an aldehyde with Grignard reagent?

- 1** $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- 2** $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
- 3** $(\text{CH}_3)_3\text{COH}$