

NATIONAL JUNIOR COLLEGE

PRELIMINARY EXAMINATIONS

Higher 2

CANDIDATE
NAME

SUBJECT
CLASS

REGISTRATION
NUMBER

CHEMISTRY

Paper 1 Multiple Choice

Additional Materials:

Multiple Choice Answer Sheet

Data Booklet

9647/01

Fri 16 Sept 2011

1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, 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 **40** 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.

This paper consists of **19** printed pages and **0** blank page.

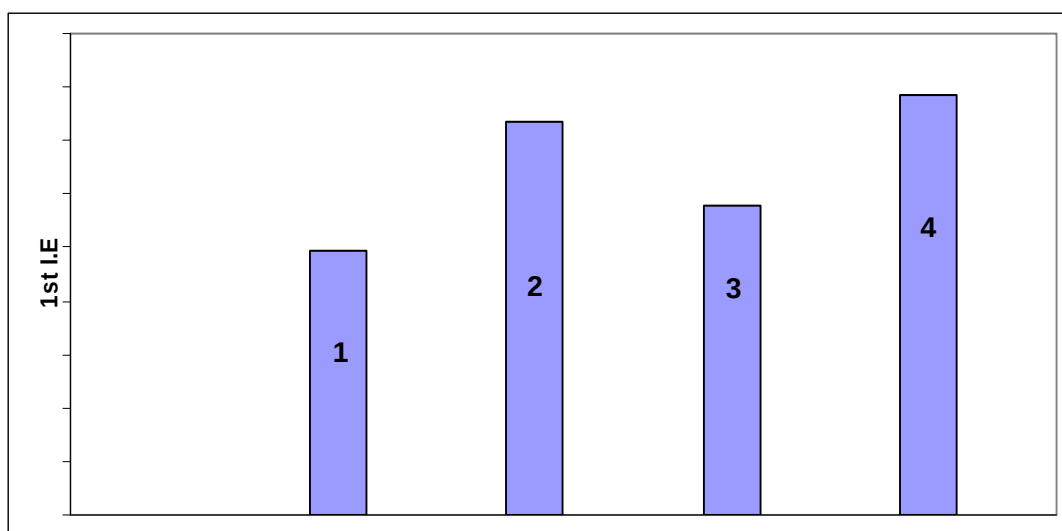
Section A

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

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

The bar chart gives some information about the first ionization energies of elements numbered 1 to 4.

The elements are adjacent to each other in the Periodic Table with increasing proton number either across a period from left to right, or down a group.



What could these four elements be?

- A** B, C, N, O
B Co, Ni, Cu, Zn
C Mg, Ca, Sr, Ba
D Na, Mg, Al, Si
- 2** The chloride ion, Cl^- , has the same electronic structure as
- A** F^-
B Ne
C Na^+
D Ca^{2+}

- 3 The table gives the successive ionization energies for an element **A** in Period 2.

	1 st	2 nd	3 th	4 th	5 th	6 th
Ionization energy / kJ mol ⁻¹	950	1800	2700	4800	6000	12300

What could be the formula of the chloride of **A**?

- A** ACl
- B** ACl_2
- C** ACl_3
- D** ACl_5
- 4 A mixture of 15 cm³ of oxygen and 50 cm³ of hydrogen is sparked continuously. What is the maximum theoretical decrease in volume? (All gases are recorded at room temperature and pressure.)
- A** 65 cm³
- B** 45 cm³
- C** 25 cm³
- D** 15 cm³

- 5 When the salt $(\text{C}_2\text{H}_5)_4\text{N}^+\text{Cl}^-$ is treated with hydrogen chloride, a white ionic solid **B** is formed. When **B** is dissolved in water, a 20 cm^3 sample of solution requires 12 cm^3 of 0.1 mol dm^{-3} barium hydroxide for neutralization.

Another 20 cm^3 sample of solution requires 48 cm^3 of 0.1 mol dm^{-3} AgNO_3 for complete precipitation of chloride as silver chloride.

What do these data show the formula of the anion in **B** to be?

- A HCl_2^-
- B HCl_3^{2-}
- C HCl_4^{3-}
- D $\text{H}_2\text{Cl}_3^{2-}$
- 6 Methane was burnt in an incorrectly adjusted burner. The methane was converted into a mixture of carbon dioxide and carbon monoxide in the ratio of 99:1, together with water vapour.

What will be the volume of oxygen consumed when $y\text{ cm}^3$ of methane is burned?

- A $(2y - \frac{0.01y}{2})\text{ cm}^3$
- B $(2y - 0.01y)\text{ cm}^3$
- C $(y - \frac{0.01y}{2})\text{ cm}^3$
- D $(y - 0.01y)\text{ cm}^3$

- 7 Sodium thiosulfate is used in the textile industry to remove an excess of chlorine from bleaching processes by reducing it to chloride ions.

20 cm³ of 0.10 mol dm⁻³ of sodium thiosulfate requires 192 cm³ of chlorine for complete reaction at room temperature and pressure. In this reaction, which of the following is a possible formula of sulfur containing product?

- A HSO₄⁻
- B SO₂
- C S
- D H₂S
- 8 A group of students attempted to estimate the concentration of a solution of Fe²⁺ by pipetting fixed volumes of the solution into a flask, adding an excess of dilute sulfuric acid, and then titrating with a standard solution of potassium manganate(VII) from a burette. The volume of KMnO₄ solution required by one student was 0.2 cm³ lower than that of the other students.

Which of the following is a possible explanation for this discrepancy?

- A The last drop of Fe²⁺ was blown from the pipette into the titration flask.
- B The pipette was rinsed with water instead of the solution of Fe²⁺ before the titration.
- C The titration flask was rinsed with the solution of Fe²⁺ instead of water before the titration.
- D The burette was rinsed with water instead of the solution of KMnO₄ before the titration.
- 9 In which of the following pairs of compounds does the first member have a higher boiling point than the second?
- A PCl₃ and MgCl₂
- B CH₃NH₂ and CH₃F
- C CH₃OH and CH₃CH₂OH
- D (CH₃)₃CCH₂CH₃ and CH₃(CH₂)₄CH₃

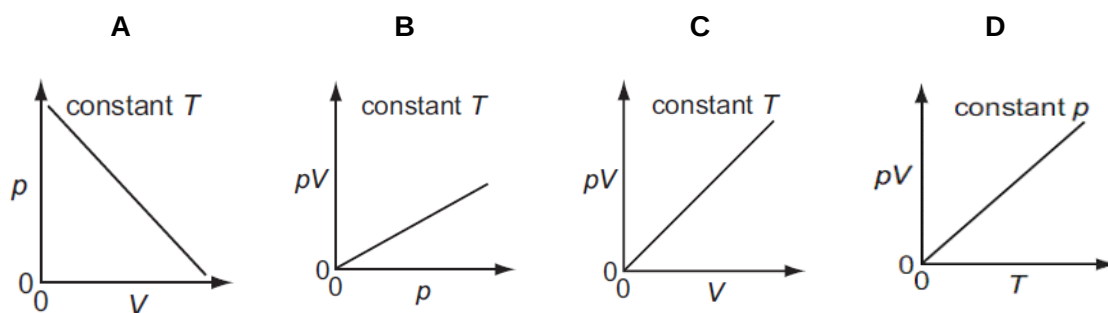
- 10** Molecular dimerization can be described as the process in which two identical molecules combine to give a single product.

Examples of dimers are: Al_2Cl_6 , N_2O_4 and $(CH_3CO_2H)_2$.

Which of the following descriptions about the above dimers is **incorrect**?

- A** Hydrogen bonds hold the CH_3CO_2H molecules together in the dimer.
 - B** Each aluminium atom is surrounded by four chlorine atoms in Al_2Cl_6 .
 - C** All the nitrogen-oxygen bonds in N_2O_4 are of equal length.
 - D** Al_2Cl_6 is a planar molecule.
- 11** Which of the following exerts the highest pressure?
- A** 1 mol of N_2 at $27^\circ C$ in 2 m^3
 - B** 1 mol of O_2 at $50^\circ C$ in 2 m^3
 - C** 1 mol of C_4H_{10} at its normal boiling point
 - D** 1 mol of H_2O at $50^\circ C$ in 2 dm^3

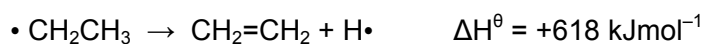
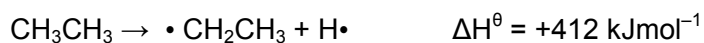
- 12** Which graph correctly describes the behaviour of a fixed mass of an ideal gas? (T is measured in K.)



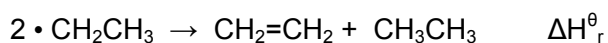
- 13 Which is true about the signs of the enthalpy and entropy changes when a liquid boils?

	ΔH	ΔS
A	+	+
B	–	+
C	–	–
D	+	–

- 14 The data below refer to gas phase reactions at constant pressure.



From these data, the enthalpy change ΔH^θ_r for the reaction is



- A +1030 kJmol^{–1}
 B +206 kJmol^{–1}
 C –206 kJmol^{–1}
 D –1030 kJmol^{–1}
- 15 In an aluminium-air battery, one of the electrodes is a carbon rod exposed to air while the other electrode is an aluminium rod. During discharge, aluminium is converted to insoluble aluminium hydroxide at the aluminium electrode and oxygen in the air is converted to hydroxide ions at the carbon electrode.

What is the mass of aluminium hydroxide precipitated if 0.030 moles of oxygen is used by the battery?

- A 0.51 g
 B 0.68 g
 C 2.04 g
 D 3.12 g

- 16** A sales pamphlet claims that 'ammonium sulfate solution which is acidic, improves the growth of acid-loving rhododendron bushes by increasing both the pH of the soil and the availability of nitrogen'.

Which part of this statement is **not** correct?

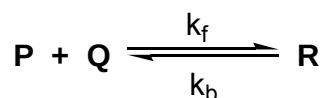
- A** Aqueous ammonium sulfate is not acidic.
 - B** Ammonium sulfate does not dissolve in water.
 - C** The pH of the soil will be reduced, not increased.
 - D** To be a fertiliser, nitrogen is needed in its oxidised form (nitrate) and not its reduced form (ammonium).
- 17** A sparingly soluble aluminium salt dissociates in aqueous solution as follows:



Given that the solubility product, K_{sp} of Al_2X_3 is **S**, what is the value of $[\text{X}^{2-}(\text{aq})]$ at equilibrium?

- A** $S^{\frac{1}{2}}$
- B** $\left(\frac{2}{5}S\right)^{\frac{1}{2}}$
- C** $\left(\frac{8}{27}S\right)^{\frac{1}{5}}$
- D** $\left(\frac{9}{4}S\right)^{\frac{1}{5}}$

- 18 Which of the following statements about the rate constant, k , of the chemical reaction given is true?



- A The rate constant is only dependent on temperature.
- B The forward and backward rate constants can have different units.
- C When a catalyst is added, the forward rate constant increases and the backward rate constant decrease.
- D When dynamic equilibrium is established, the rate constant for the forward and backward reaction is the same
- 19 S, T and U are chlorides of some elements in the Periodic Table.

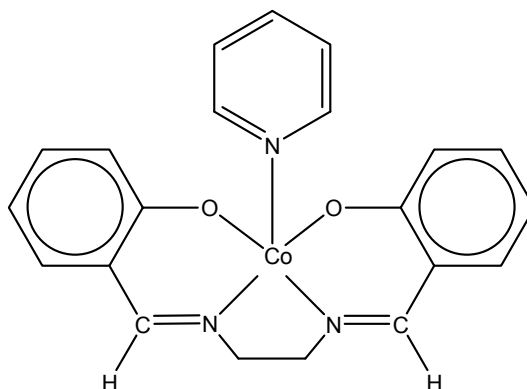
	Reaction of solid with water	Reaction of aqueous solution with aq NaOH
S	White fumes are liberated	White ppt soluble in excess aq NaOH
T	No fumes evolved	No ppt
U	White fumes are liberated	No ppt

Which of the following is the **correct** combination of S, T and U?

	S	T	U
A	AlCl_3	NaCl	PCl_5
B	ZnCl_2	BaCl_2	SiCl_4
C	PbCl_2	S_2Cl_2	SiCl_4
D	AlCl_3	MgCl_2	PCl_5

- 20 Which of the following statements about the elements calcium, strontium and barium is correct?
- A The elements react with cold water liberating hydrogen.
 - B Aqueous solutions of their chlorides have a pH greater than 7.
 - C The energy required for the process $M(g) \rightarrow M^{2+}(g) + 2e$ increases.
 - D The enthalpy change of hydration of the cations becomes more exothermic.
- 21 *Use of the Data Booklet is relevant to this question.*
- Which of the following is **not** true about the first row transition metals or its compounds?
- A $Fe(CN)_6^{3-}$ does not oxidise I^- .
 - B $Fe_2(CO_3)_3$ can be prepared by reacting $FeCl_3(aq)$ with $Na_2CO_3(aq)$.
 - C On addition of CoF_3 to water, a gas that relights a glowing splint is produced.
 - D On addition of $H_2O_2(aq)$ to hot acidified $K_2Cr_2O_7(aq)$, a green solution is formed.
- 22 Transition metals like platinum and rhodium are found in catalytic converters fitted into cars. Which of the following statements best explains the role of transition metals in this use?
- A Transition metals can exhibit variable oxidation states in their compounds as 3d and 4s electrons have similar energies.
 - B Transition metals form coloured ions due to absorption of energy in the visible light region to promote an electron from a lower to a higher energy 3d orbital.
 - C Transition metals have very high melting points because both 3d and 4s electrons are involved in forming strong metallic bond.
 - D Transition metals have available and partially filled 3d orbitals for adsorption of reactant molecules.

- 23 The following cobalt complex is known to be the functional model for biological oxygen carrier.



What is the electronic configuration of the cobalt cation in the above complex?

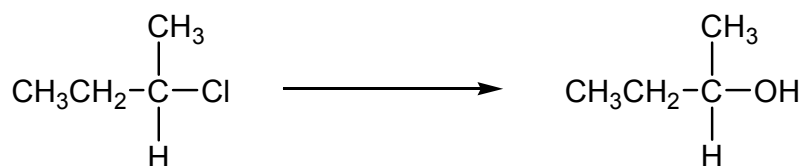
- A [Ar]3d⁶
 B [Ar]3d⁷
 C [Ar]3d⁵4s²
 D [Ar]3d⁷4s²
- 24 How many non cyclic isomers could be formed for an organic compound with molecular formula C₃H₉N?
- A 2
 B 3
 C 4
 D 5

- 25 When ethyl ethanoate, $\text{CH}_3\text{C}^{16}\text{O}_2\text{C}_2\text{H}_5$, undergoes acid hydrolysis in the presence of H_2^{18}O ,

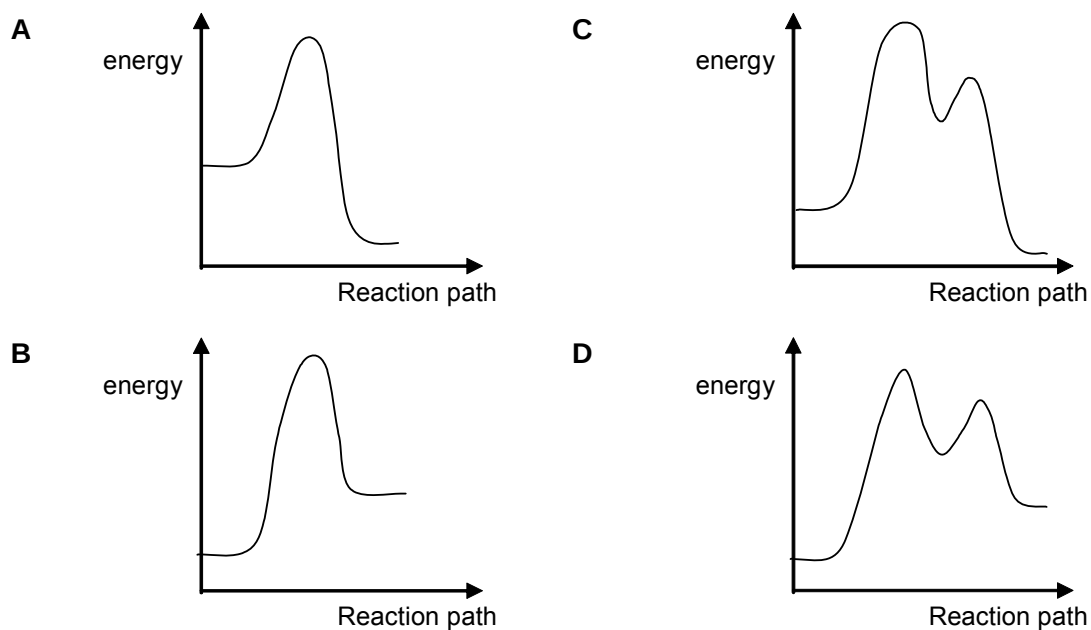
atoms of the ^{18}O isotope appear in the product as $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-^{18}\text{OH}$ and not as $\text{C}_2\text{H}_5^{18}\text{OH}$. Which one of the following may be deduced from this observation?

- A A $\text{C}-^{16}\text{O}$ bond is stronger than a $\text{C}-^{18}\text{O}$ bond.
- B The oxygen atom of the OC_2H_5 group undergoes attack by $\text{H}_3^{18}\text{O}^+$.
- C The $\text{O}-\text{C}$ bond of the $\text{O}-\text{C}_2\text{H}_5$ group of the ester is broken during the hydrolysis.
- D The single carbon-oxygen bond of the $-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}$ group of the ester is broken.

- 26 When an optically active sample of 2-chlorobutane is heated with aqueous KOH , the product, 2-butanol, is found to exhibit reversed optical isomerism.



Which diagram represents the reaction profile for this mechanism?

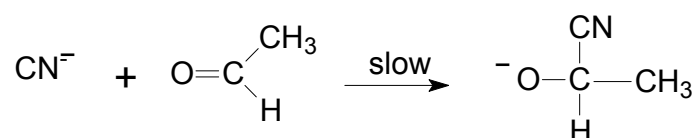


- 27 When compound **X** is heated with hot aqueous sodium hydroxide and the resulting mixture distilled, no organic compound was collected as the distillate. Which of the following could be compound **X**?

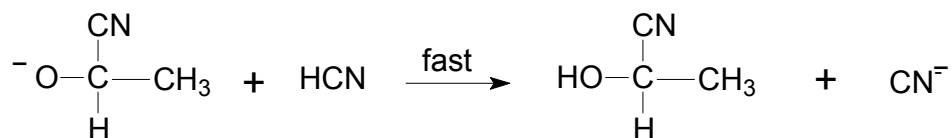
- A $\text{C}_6\text{H}_5\text{NHCOCH}_2\text{CH}_3$
 B $\text{C}_6\text{H}_5\text{OCOCH}_2\text{CH}_3$
 C $\text{C}_2\text{H}_5\text{OCOCH}_2\text{CH}_3$
 D $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$

- 28 The reaction between ethanal and HCN is given below:

Step I:



Step II:



Which one of the following statements about this reaction is **false**?

- A The reaction can be catalysed by a small amount of base.
 B The reaction is bimolecular.
 C The intermediate in the rate-determining step is tetrahedral in shape.
 D The resulting solution is optically active.

29 Which pair of the reactions could have the same common intermediate?



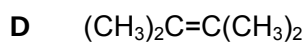
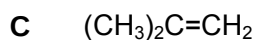
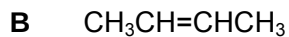
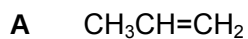
A W and X

B W and Y

C X and Z

D Y and Z

30 When an alkene Y was oxidized with cold, dilute alkaline potassium manganate(VII) followed by heating with hot acidified potassium dichromate(VI), the resulting organic compound gave an orange precipitate with 2,4-dinitrophenylhydrazine and effervescence with aqueous sodium carbonate. Which of the following could be the alkene Y?



Section B

For each of the questions in this section, 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 (you may find it helpful to put a tick against the statements that you consider to be correct).

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

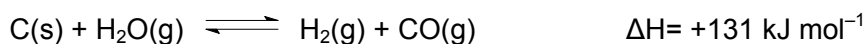
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

- 31** For which reactions does the value of ΔH^θ represent **both** a standard enthalpy change of combustion **and** a standard enthalpy change of formation?

- 1** $\text{C(s)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$
- 2** $\text{H}_2\text{(g)} + \frac{1}{2} \text{O}_2\text{(g)} \rightarrow \text{H}_2\text{O(g)}$
- 3** $2\text{C(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{CO(g)}$

- 32** The explosion at the Fukushima nuclear power plant in 2011 could be due to the graphite reactor being overheated and reacted with the cooling water as follows:



What are the possible reasons why the forward reaction is more likely to occur at high temperature?

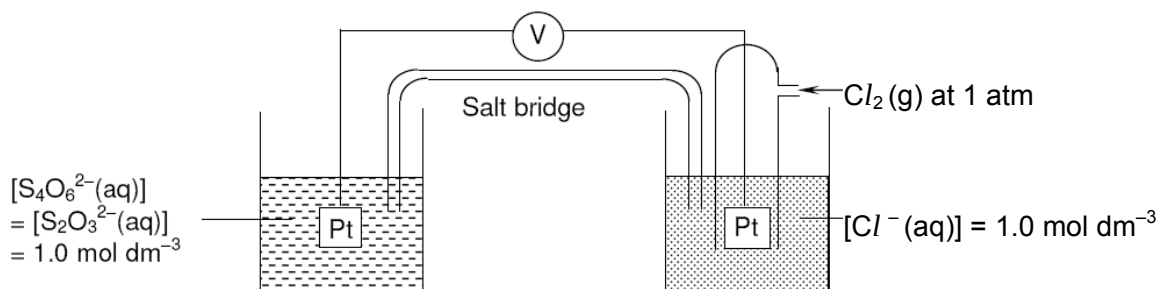
- 1** Hydrogen and carbon monoxide do not react at high temperature.
- 2** At lower temperature, the position of equilibrium lies too far to the left.
- 3** The activation energy is high.

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.

33 Use of the Data Booklet is relevant to this question.



Which of the following will reduce the cell potential?

- 1 Increasing the pressure of Cl_2 in the $\text{Cl}_2(\text{g})/\text{Cl}^-(\text{aq})$ half cell.
- 2 Adding water into the $\text{S}_4\text{O}_6^{2-}(\text{aq})/\text{S}_2\text{O}_3^{2-}(\text{aq})$ half cell.
- 3 Adding iodine crystals into the anodic half cell.

34 The table gives data for the reaction between **X** and **Y** at constant temperature.



Experiment	$[\text{X}] / \text{mol dm}^{-3}$	$[\text{Y}] / \text{mol dm}^{-3}$	Initial rate / $\text{mol dm}^{-3} \text{ s}^{-1}$
1	0.4	0.1	2.5×10^{-4}
2	0.2	0.2	5.0×10^{-4}
3	0.2	0.4	1.0×10^{-3}

Which statements follow from these results?

- 1 The half-life of this reaction is 277s.
- 2 This is a one step reaction.
- 3 The rate equation can be written as: rate = $k[\text{X}][\text{Y}]$.

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

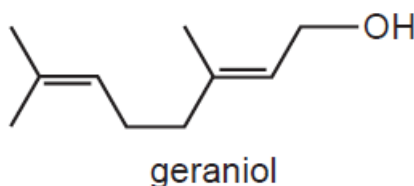
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

- 35** Which of the following suggestions concerning the element astatine (atomic number 85) are consistent with its position in Group VII?

- 1** Astatine is a solid at room temperature.
- 2** Silver astatide is insoluble in aqueous ammonia.
- 3** Hydrogen astatide is less stable to heat than hydrogen iodide.

- 36** Geraniol is one of several compounds produced by the scent glands of honey bees to help them mark nectar-bearing flowers and locate the entrances to their hives.



Which statements are true for geraniol?

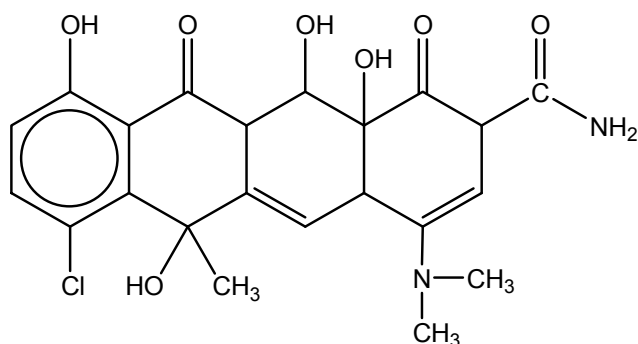
- 1** The molecule reacts with hot alkaline KMnO_4 to give 3 organic fragments.
- 2** The molecule has 4 sp^2 carbons and 6 sp^3 carbons.
- 3** There are 2 pi bonds and 10 sigma bonds in each molecule of geraniol.

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.

37 Compound **D** which is a structural isomer of the antibiotic Aureomycin is shown below.



Which of the following statements are true for the above compound **D**?

- 1** There are 6 chiral carbons in compound **D**.
- 2** 1 mole of compound **D** reacts with 4 moles of hydrogen gas in the presence of Ni catalyst at 150°C.
- 3** 1 mole of compound **D** reacts with 2 moles of gaseous HCl.

38 Which of the following are arranged with increasing ease of hydrolysis?

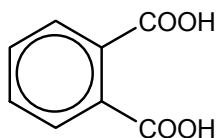
- 1** C₆H₅I, CH₃CH₂I, CH₃COC₂H₅
- 2** CH₃CONH₂, CH₃COOCH₃, CH₃COC₂H₅
- 3** C₆H₅COOK, C₆H₅OK, CH₃OK

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

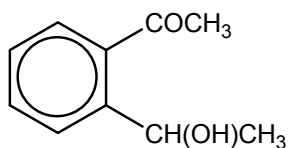
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

39 Which of the following reactions would produce the following organic compound?

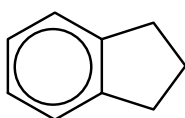


1



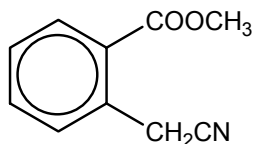
with hot aqueous alkaline I_2 followed by acidification

2



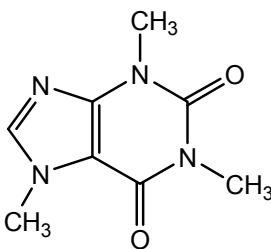
with hot acidified $KMnO_4$

3



with hot aqueous sulfuric acid

40 Which of the following types of reaction could occur for the following caffeine molecule?



1 Nucleophilic addition

2 Acid Base

3 Hydrolysis

