ANGLO-CHINESE JUNIOR COLLEGE
DEPARTMENT OF CHEMISTRY
Preliminary Examination

CHEMISTRY **9729/01**
Higher 2

Paper 1 Multiple Choice

18 September 2019
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, index number and tutorial class 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** 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.

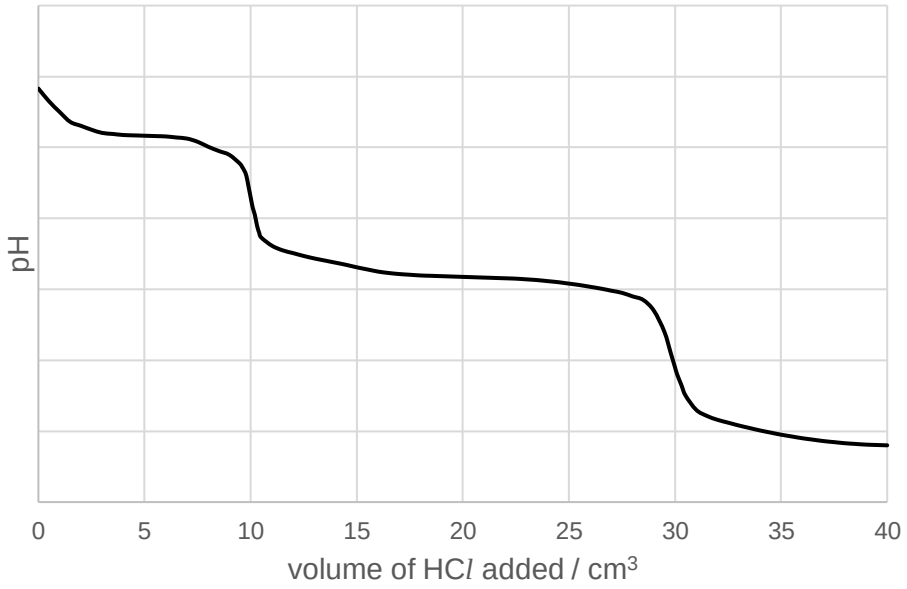
Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **18** printed pages.

1 An aqueous mixture of sodium carbonate and sodium hydrogencarbonate was titrated with hydrochloric acid and the pH was recorded.

What is a suitable indicator to use for detecting the first end point and the ratio of sodium carbonate to sodium hydrogencarbonate in the mixture?



	indicator	ratio
A	methyl orange	1:1
B	methyl orange	1:2
C	thymol blue	1:1
D	thymol blue	1:2

2 The most common oxidation state of americium, Am, in aqueous solution is +3.

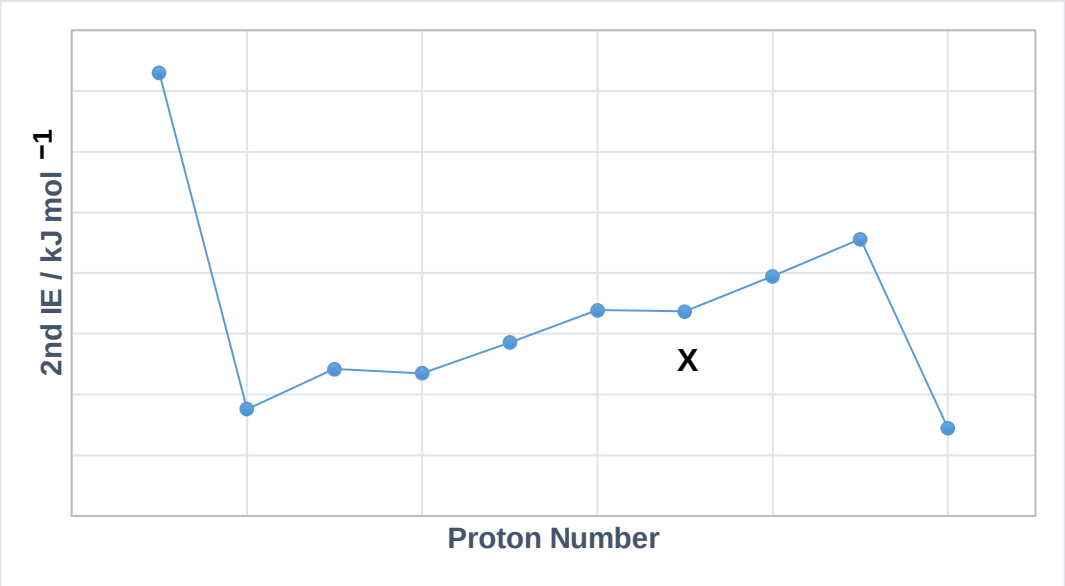
Recently, Cu^{3+} has been shown to quantitatively oxidise $Am^{3+}(aq)$ in dilute HNO_3, while itself is reduced to Cu^{2+}.

In an experiment, 20.0 cm^3 of 0.0120 mol dm^{-3} $Am^{3+}(aq)$ was found to require 24.00 cm^3 of 0.0300 mol dm^{-3} Cu^{3+} for complete oxidation.

What is the formula of the americium-containing species formed?

A AmO^+ **B** AmO^{2+} **C** AmO_2^{2+} **D** $Am_2O_2^{2+}$

3 The graph shows the second ionisation energies for ten consecutive elements.

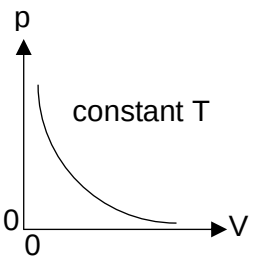


Which of the following could be **X**?

A oxygen **B** fluorine **C** neon **D** sodium

4 Which of the following graphs are correct about a fixed amount of an ideal gas?

1



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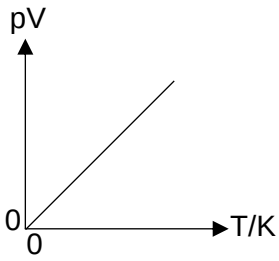

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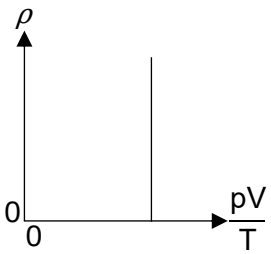


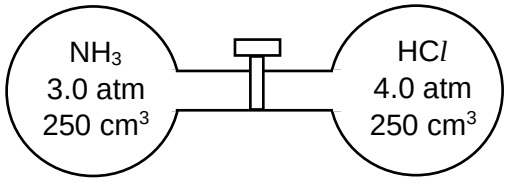
A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D all of the above

5 Two single-neck round-bottomed flasks were evacuated and insulated from the surroundings. They were filled separately with gaseous ammonia and gaseous hydrogen chloride at room temperature and connected with a gas tap joint.



When the gas tap joint is opened, the two gases are allowed to mix.

What is the final pressure of the resultant gas mixture?

A more than 3.5 atm but less than 7.0 atm

B exactly 3.5 atm

C more than 0.5 atm but less than 1.0 atm

D exactly 0.5 atm

6 When 1.00 g of ethanol was burned under a beaker of water, it was found that 100 cm^3 of water was heated from 15 ºC to 65 ºC. The process was known to be only 70% efficient.

Use these data and values from the *Data Booklet* to calculate the enthalpy change of combustion of ethanol.

A −209 kJ mol^{-1} **B** −673 kJ mol^{-1}

C −1373 kJ mol^{-1} **D** +1373 kJ mol^{-1}

7 Some standard enthalpy changes are given below.

	$\Delta H^{\ominus}$ / kJ mol^{-1}
$Ca^{2+}(g) + aq \longrightarrow Ca^{2+}(aq)$	–1650
$Cl^{-}(g) + aq \longrightarrow Cl^{-}(aq)$	–364
$Ca^{2+}(g) + 2Cl^{-}(g) \longrightarrow CaCl_2(s)$	–2258

What is the standard enthalpy change of solution of calcium chloride?

A +244 kJ mol^{-1}

B –120 kJ mol^{-1}

C –2378 kJ mol^{-1}

D –4636 kJ mol^{-1}

8 Hydrogen peroxide reacts with acidified iodide ions, liberating iodine.

$$H_2O_2 + 2I^- + 2H^+ \rightarrow I_2 + 2H_2O$$

In the investigation of this reaction, the following results were obtained.

initial concentrations of reactants / mol dm^{-3}			initial rate of formation of iodine / mol dm^{-3} s^{-1}
$[H_2O_2]$	$[I^-]$	$[H^+]$	
0.01	0.01	0.10	2.0×10^{-6}
0.03	0.01	0.10	6.0×10^{-6}
0.03	0.02	0.10	1.2×10^{-5}
0.03	0.02	0.20	1.2×10^{-5}

Which of the following statements are correct?

1 The rate equation can be written as: rate = k $[H_2O_2][I^-]$.

2 The reaction is second order with respect to H^+.

3 The value of the rate constant is 0.2.

A 1 only

B 2 only

C 1 and 2

D 1, 2 and 3

9 Phosphorus(V) chloride, PCl_5, is a white solid which sublimes at 160 °C.

When gaseous phosphorus(V) chloride is heated in a closed container, the following equilibrium is established.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g) \qquad \Delta H > 0$$

Rate constant, k_b, applies for the backward reaction and equilibrium constant, K_c, applies for the overall process.

How will the values of k_b and K_c change when the equilibrium is established at a higher temperature than before?

	k_b	K_c
A	increase	increase
B	increase	decrease
C	decrease	increase
D	decrease	decrease

10 When gaseous phosphorus(V) chloride is heated in a closed container, the following equilibrium is established.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g) \qquad \Delta H > 0$$

0.0200 moles of phosphorus(V) chloride was vaporised completely in a 2.0 dm^3 container. The amount of chlorine gas detected at equilibrium was found to be 0.00400 moles.

What is the value of K_c at this temperature?

A 1.0×10^{-3}

B 8.0×10^{-4}

C 5.0×10^{-4}

D 4.0×10^{-4}

11 The value of pK_w at 40 °C is 13.54.

What is the pH of an aqueous solution of 0.05 mol dm^{-3} $Ba(OH)_2$ at 40 °C?

A 12.23

B 12.54

C 12.70

D 13.00

12 In which of the following solutions will solid calcium phosphate, $Ca_3(PO_4)_2$, be the least soluble at 25 °C? The numerical value of K_{sp} of $Ca_3(PO_4)_2$ is 2.07×10^{-33}.

A 0.3 mol dm^{-3} $Ca(NO_3)_2$ (aq)

B 0.3 mol dm^{-3} Na_3PO_4 (aq)

C 0.6 mol dm^{-3} HNO_3 (aq)

D water

13 A cell diagram is written as follows:

$$Ti(s) \mid Ti^{2+}(aq) \parallel H_2SO_4(aq) \mid SO_2(g) \mid Pt(s)$$

Use relevant data from the *Data Booklet*, and the following electrode potential

$$Ti^{2+}(aq) + 2e^- \rightleftharpoons Ti(s) \qquad E^{\ominus} = -1.63V$$

to calculate the standard Gibbs free energy change of the cell in kJ mol^{-1}.

A −37 **B** −157 **C** −282 **D** −347

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

The standard reduction potentials of some vanadium species are tabulated below.

half-reaction	$E^{\ominus}$ / V
$V^{2+}(aq) + 2e^- \rightleftharpoons V(s)$	–1.20
$V^{3+}(aq) + e^- \rightleftharpoons V^{2+}(aq)$	–0.26
$VO^{2+}(aq) + 2H^+(aq) + e^- \rightleftharpoons V^{3+}(aq) + H_2O(l)$	+0.34

Which of the following metals, when added in excess, will reduce VO^{2+} to V^{3+}?

1 Sn

2 Zn

3 Pb

A 1 and 3

B 2 and 3

C 1 only

D 2 only

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

Impure copper containing traces of cobalt, iron and silver was purified via electrolysis.

Which cations of the trace metals can be found in solution?

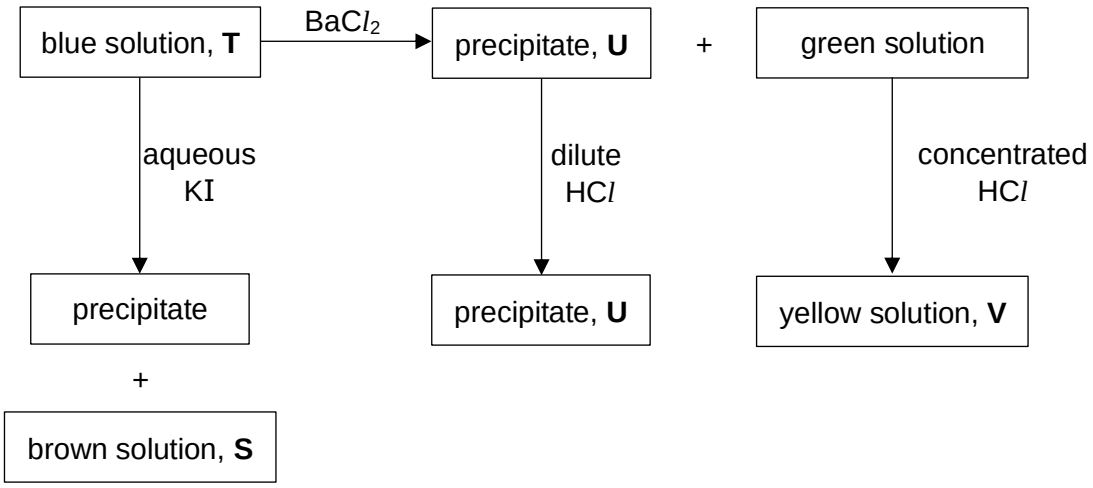
A Ag^+ only

B Ag^+ and Fe^{2+}

C Co^{2+} and Fe^{2+}

D Co^{3+} and Fe^{3+}

16 An aqueous transition metal compound, **T**, was subjected to a series of reactions.



Which statements are correct?

1 The anion in **S** is I^-.

2 The anion in **U** is SO_3^{2-}.

3 The anion in **V** is $CuCl_4^{2-}$

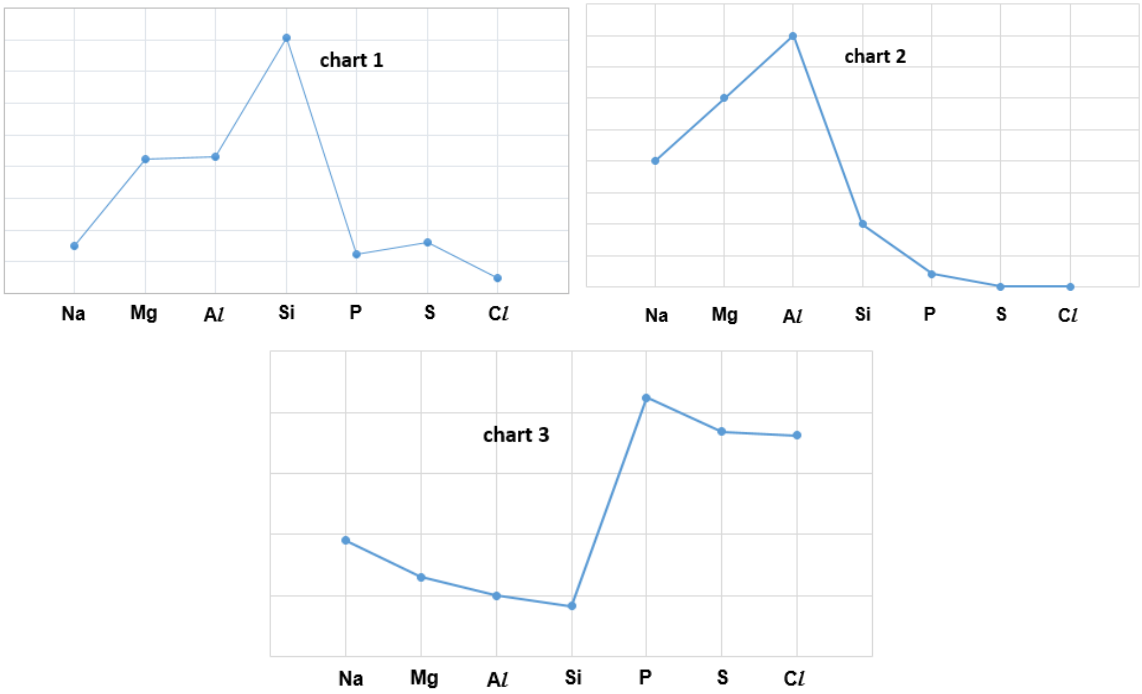
A 1 and 2

B 2 and 3

C 1, 2 and 3

D 3 only

17 Three charts below show the variation of three physical properties for the Period 3 elements.



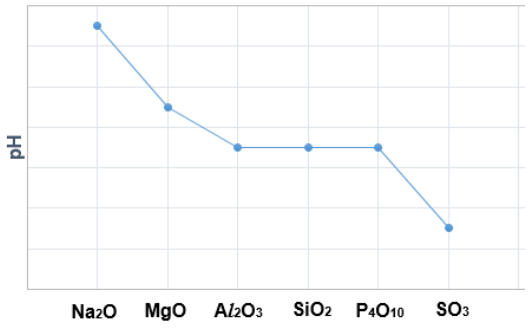
Which of the following is correct?

	chart 1	chart 2	chart 3
A	ionic radius	electrical conductivity	melting point
B	electrical conductivity	melting point	ionic radius
C	melting point	ionic radius	electrical conductivity
D	melting point	electrical conductivity	ionic radius

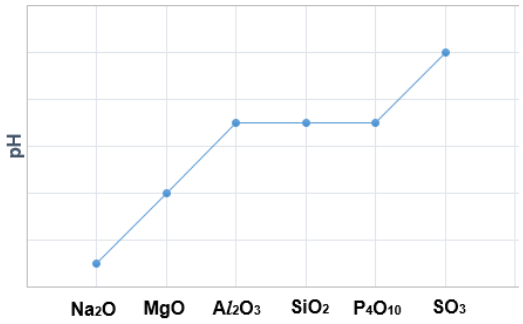
18 The highest oxides of the elements sodium to sulfur are added separately to water.

Which of the following diagrams best represents the pH of the solutions produced?

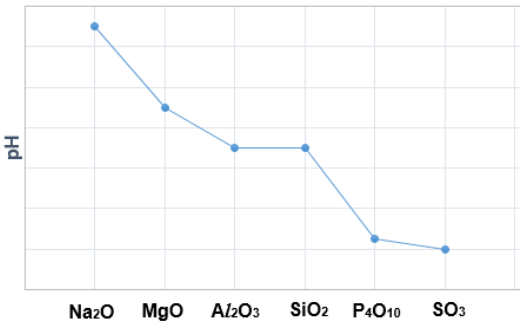
A



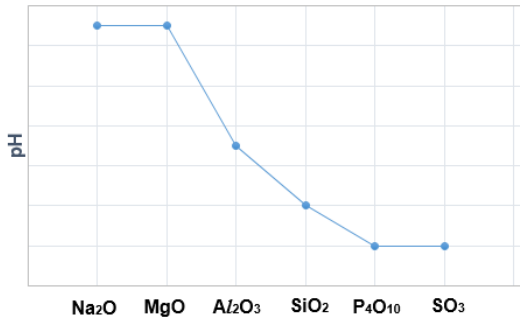
B



C



D



19 Stability constants and colours are given in the following table for this reaction.

$$Fe(H_2O)_6^{3+} + L^- \rightleftharpoons Fe(L)(H_2O)_5^{2+} + H_2O$$

ligand	lg K_{stab}	colour of $Fe(L)(H_2O)_5^{2+}$
SCN^-	2.1	blood red
F^-	5.4	colourless

What would be observed when the following reagents are added to a solution of iron(III) nitrate?

- potassium fluoride
- followed by potassium thiocyanate

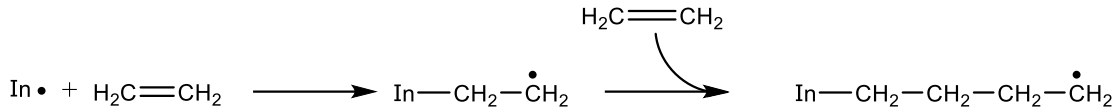
A Solution turns from green to colourless, and then blood red.

B Solution turns from green to colourless, and then remains colourless.

C Solution turns from yellow to colourless, and then to blood red.

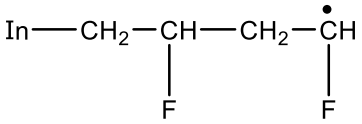
D Solution turns from yellow to colourless, and then remains colourless.

20 Free radical addition is a mechanism used in the synthesis of some addition polymers. Alkene monomers will polymerise in the presence of a radical initiator (In•). For instance, the synthesis of polyethene begins as such.

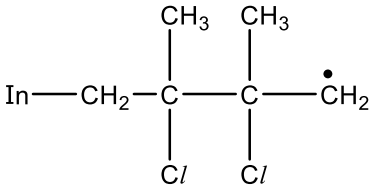


Which of the following chains could **not** have arisen from free radical addition?

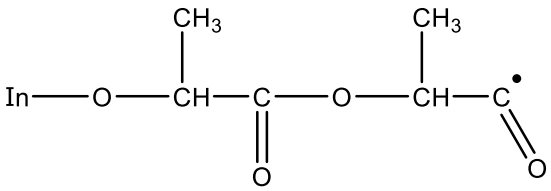
A



B



C



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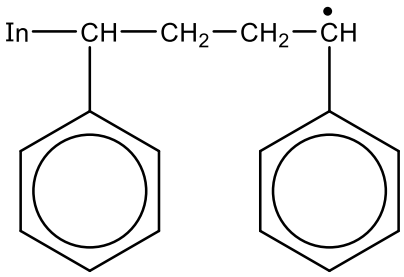
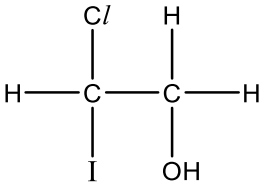
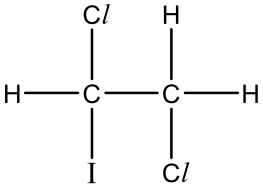
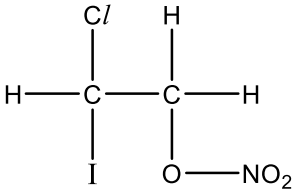
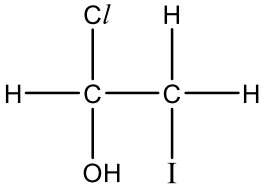
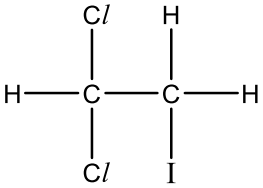
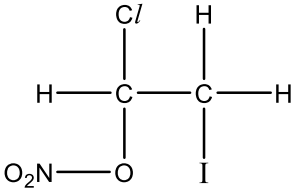
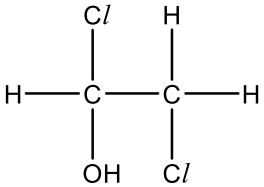
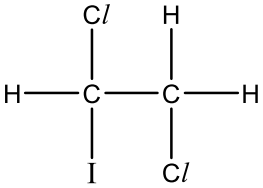
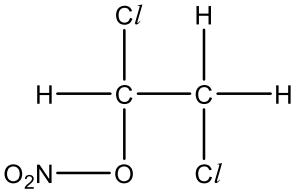
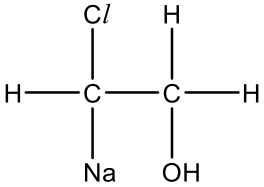
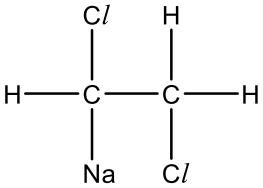
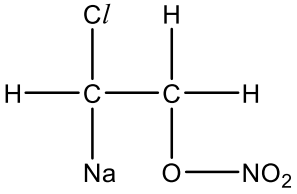
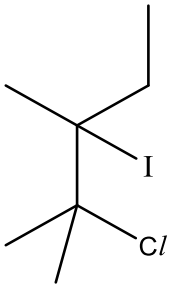


21 Chloroethene is reacted with iodine monochloride in the presence of aqueous sodium nitrate.

Which are the major and minor products?

	major product	minor products
A		 
B		 
C		 
D		 

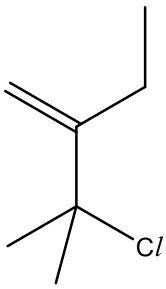
22 The following compound **Y** is reacted with ethanolic sodium hydroxide.



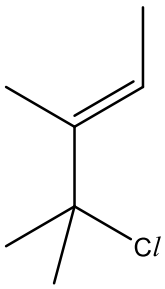
Compound **Y**

Which of the following is the **major** product?

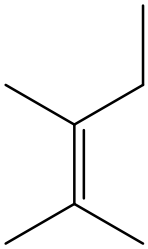
A



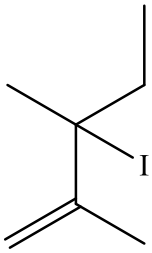
B



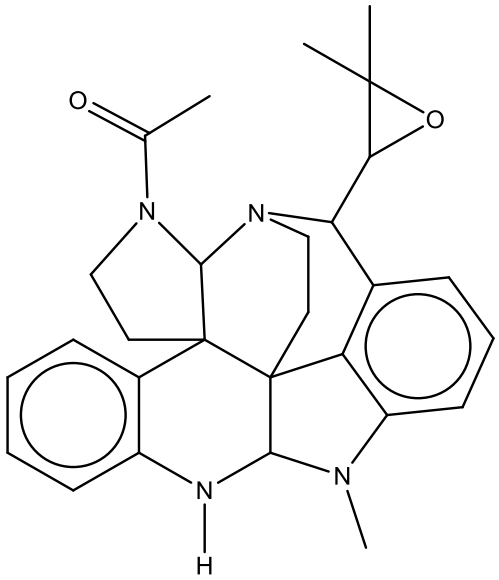
C



D



23 Communesin A is a natural product.



Which of the following statements about communesin A is correct?

A Communesin A gives a yellow precipitate when warmed with alkaline iodine solution.

B There are three tertiary amines in communesin A.

C It is a planar molecule.

D One of the oxygen atoms is sp^3 hybridised; the other is sp^2 hybridised.

24 Compound **B**, $C_6H_{12}O_6$, is an important biomolecule abundant in the brain as it mediates cell signal transduction in response to a variety of hormones and neurotransmitters.

All the atoms (besides the hydrogen atoms) in **B** are sp^3 hybridised.

On adding excess sodium to **B**, hydrogen gas is liberated.

Which of the following statements about compound **B** is true?

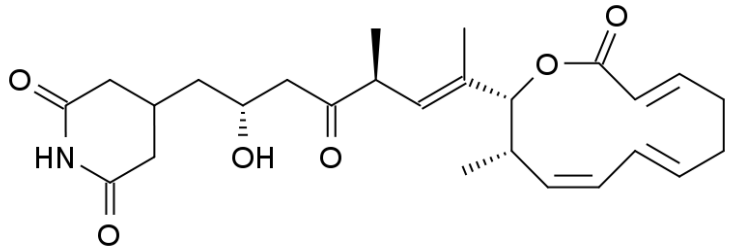
A Compound **B** forms a purple colouration with neutral iron(III) chloride solution.

B Compound **B** forms a yellow precipitate with warmed alkaline iodine solution.

C Compound **B** forms a bright orange precipitate with 2,4-dinitrophenylhydrazine.

D Compound **B** forms a brick-red precipitate with Fehling's solution.

25 Lactimidomycin is an antibiotic with anti-viral and anti-cancer properties.



Which statements about lactimidomycin are correct?

1 One mole of lactimidomycin reacts completely with four moles of 2,4-dinitrophenylhydrazine.

2 On reacting lactimidomycin with hot acidified $KMnO_4$, there is no gas evolved.

3 On heating lactimidomycin with KOH(aq), there is ammonia gas evolved.

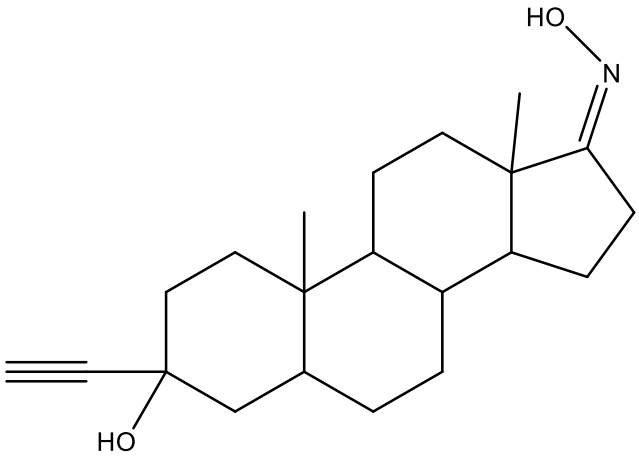
A 1 and 2

B 2 and 3

C 1 only

D 3 only

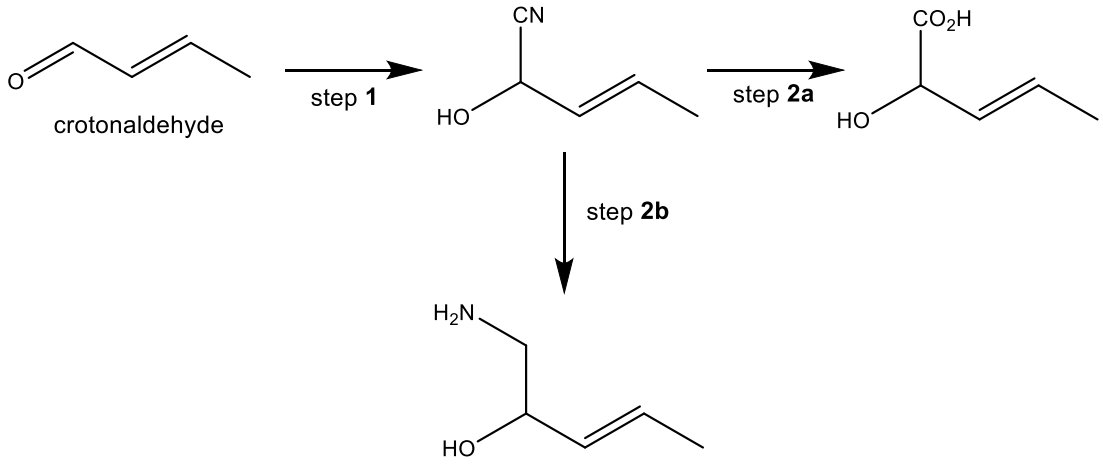
26 Golexanolone is a drug currently being studied for the treatment of hypersomnia.



What is the total number of stereoisomers exhibited by golexanolone?

A 512 **B** 256 **C** 128 **D** 64

27 Crotonaldehyde is an important biomolecule.



Which of the following statements is true about the above synthetic scheme?

A The reaction of crotonaldehyde with hot acidified $KMnO_4$ produces only one organic product.

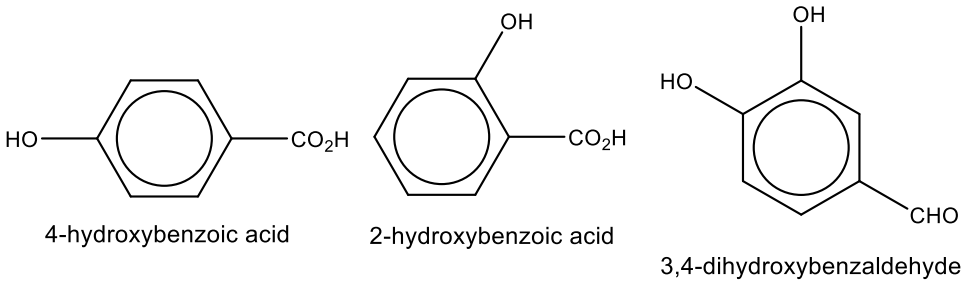
B Step **1** involves heating crotonaldehyde with NaCN in ethanol.

C Step **2a** involves the oxidation of crotonaldehyde because it gained oxygen atoms.

D $NaBH_4$ is the reagent used in step **2b**.

28 4-hydroxybenzoic acid, 2-hydroxybenzoic acid and 3,4-dihydroxybenzaldehyde share the same molecular formula.

The standard enthalpy changes of formation for 4-hydroxybenzoic acid, 2-hydroxybenzoic acid and 3,4-dihydroxybenzaldehyde are –481 kJ mol^{-1}, –493 kJ mol^{-1} and –392 kJ mol^{-1} respectively.



4-hydroxybenzoic acid 2-hydroxybenzoic acid 3,4-dihydroxybenzaldehyde

Which of the following statements is correct?

1 The thermodynamic stability of these three compounds decrease in the order: 2-hydroxybenzoic acid > 4-hydroxybenzoic acid > 3,4-dihydroxybenzaldehyde

2 3,4-dihydroxybenzaldehyde and 4-hydroxybenzoic acid are positional isomers.

3 The magnitude of the standard enthalpy change of combustion of these three compounds increase in the order: 3,4-dihydroxybenzaldehyde < 4-hydroxybenzoic acid < 2-hydroxybenzoic acid

A 1 only

B 2 only

C 1 and 3

D 2 and 3

29 Chloroethane can be used to make sodium propanoate.

chloroethane ⟶ **Z** ⟶ sodium propanoate

The intermediate, **Z**, is treated with boiling aqueous sodium hydroxide to give sodium propanoate.

Which reagent would produce the intermediate, **Z**, from chloroethane?

A potassium cyanide in ethanol

B hydrogen cyanide

C sodium hydroxide in ethanol

D alkaline $KMnO_4$

30 A polypeptide is subjected to hydrolysis by cyanogen bromide and two digestive enzymes.

- The chemical cyanogen bromide cleaves the peptide bond at the carboxylic end of methionine (met) to give a tetrapeptide and a tripeptide.
- The enzyme chemotrypsin hydrolyses a peptide bond at the carboxylic end of tryptophan (trp) to give two dipeptides and a tripeptide.
- The enzyme trypsin, which hydrolyses a peptide bond at the carboxylic end of lysine (lys) to give 2 tripeptides and gly.

What is the sequence of the amino acids in this polypeptide?

A ser-trp-lys-trp-met-lys-gly

B ser-trp-lys-met-trp-lys-gly

C gly-lys-met-trp-lys-trp-ser

D gly-lys-trp-met-lys-trp-ser