

CATHOLIC JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS
Higher 2

CHEMISTRY

9647/01

Paper 1 Multiple Choice

Wednesday 31 August 2016

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 and HT group on the Answer Sheet in the spaces provided.

There are **forty** 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 **17** printed pages and 1 blank page.

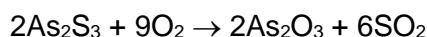
Section A

For each question there are **four** possible answers, **A**, **B**, **C** and **D**. Choose the one you consider to be **correct** and record your choice in soft pencil on the **separate Answer Sheet** provided.

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

Arsenic(III) sulfide, As_2S_3 , is a bright yellow solid which has been used as a pigment in paintings.

When arsenic(III) sulfide is heated in air, it reacts with oxygen to give arsenic(III) oxide and sulfur(IV) oxide.



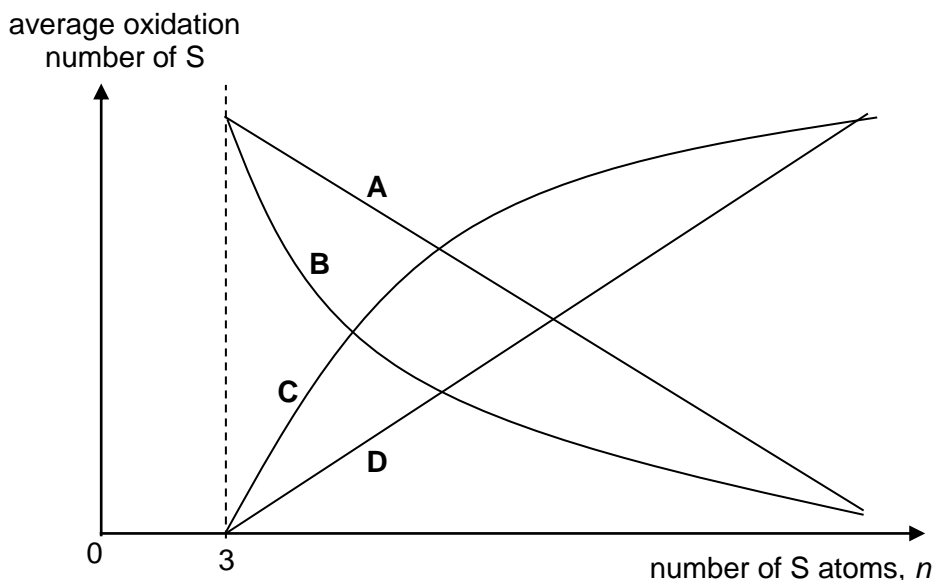
What would be the mass of arsenic(III) oxide produced if 550 dm^3 oxygen, measured at room temperature and pressure, reacted with arsenic(III) sulfide?

- A 1010 g B 1070 g C 2010 g D 2160 g
- 2 Incomplete combustion of 20 cm^3 of a gaseous hydrocarbon gave carbon dioxide and carbon monoxide in a 6:1 ratio, as well as water vapour. It was found that the carbon dioxide took up a volume of 51.4 cm^3 whereas the water vapour took up a volume of 80 cm^3 . All gas volumes are measured at the same temperature and pressure.

What is the molecular formula of the hydrocarbon?

- A C_2H_4 B C_2H_6 C C_3H_6 D C_3H_8
- 3 Polythionates are a series of sulfur-oxo anions with the general formula $\text{S}_n\text{O}_6^{2-}$, where $n > 2$. A simple example is tetrathionate ion, $\text{S}_4\text{O}_6^{2-}$.

Which of the following graphs best illustrates the variation in the average oxidation number of sulfur in $\text{S}_n\text{O}_6^{2-}$ with n ?



4 Which of the following species has the smallest bond angle around the central atom?

- A** NCI_3 **B** PCl_3 **C** SO_3 **D** BF_3

5 Which of the following shows the correct bonds present in solid CHI_3 ?

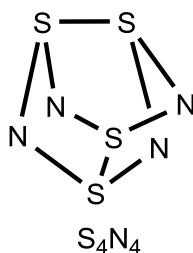
- A** Covalent bonds only
B Ionic bonds only
C Covalent bonds & temporary dipole-induced dipole forces of attraction
D Covalent bonds & permanent dipole-permanent dipole forces of attraction

6 Polymerisation is a process in which large number of small molecules (monomers) are joined together to form long-chain molecules.

Considering that polymerisation is a spontaneous reaction, what are the correct signs of ΔS and ΔH for the process?

	ΔS	ΔH
A	–	–
B	–	+
C	+	–
D	+	+

7 S_4N_4 is a thermochromic solid which changes colour with temperature. S_4N_4 has a cage structure as shown in the diagram.



Given the following data, what is the average bond energy of dissociation of S-N, in kJ mol^{-1} ?

$$\Delta H_f^\circ (\text{S}_4\text{N}_4) = +460 \text{ kJ mol}^{-1}$$

$$\Delta H_{\text{at}}^\circ (\text{sulfur}) = +279 \text{ kJ mol}^{-1}$$

$$\Delta H_{\text{at}}^\circ (\text{nitrogen}) = +497 \text{ kJ mol}^{-1}$$

$$(\text{S-S}) \text{ bond energy of dissociation in } \text{S}_4\text{N}_4 = +204 \text{ kJ mol}^{-1}$$

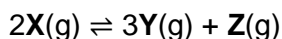
- A** +150 **B** +280 **C** +395 **D** +559

- 8 At 25 °C, a dented ping pong ball has an internal volume of 31.0 cm³ and internal pressure of 110 kPa. It is then placed in a water bath maintained at 60 °C, which returned the ball to its original spherical shape with internal volume of 33.5 cm³.

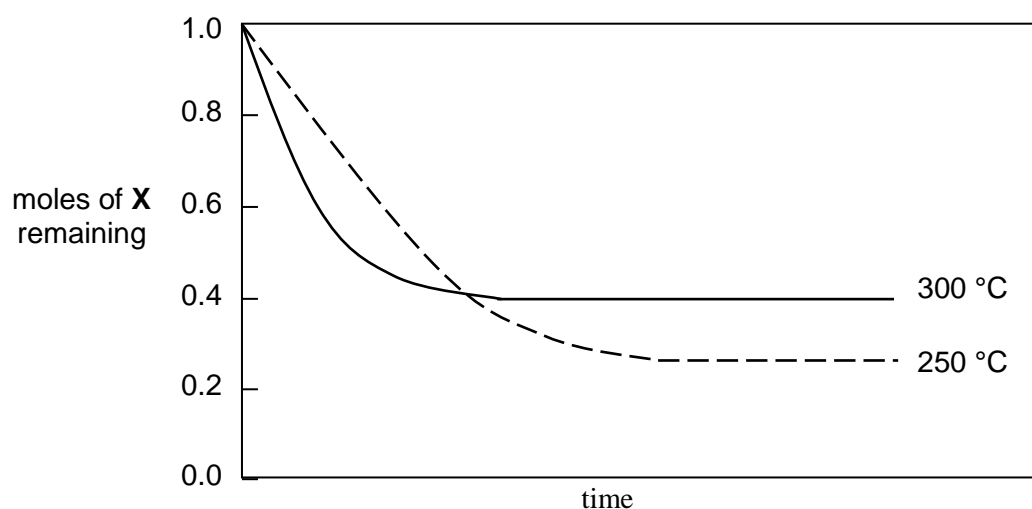
Assuming ideal gas behaviour, what is the pressure of air inside the ball at 60 °C in its original spherical shape?

- A 101 kPa B 114 kPa C 122 kPa D 244 kPa

- 9 Gas **X** decomposes to two other gases, **Y** and **Z**, according to the following equation:



The graph below shows the decomposition of 1.0 mol of pure gas **X** in the presence of a catalyst at various temperatures.



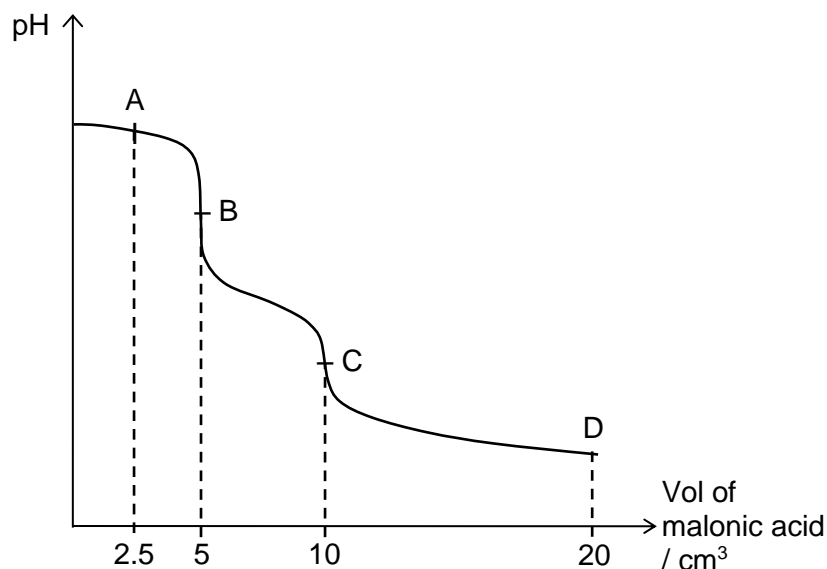
Which one of the following statements about the above system is **correct**?

- A The decomposition of **X** is endothermic.
 B The K_p of the system decreases with increasing temperature.
 C The percentage decomposition of **X** is 40 % at 300 °C.
 D The system becomes less disordered when it reaches equilibrium state.

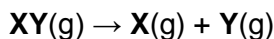
- 10 Malonic acid, $\text{HO}_2\text{CCH}_2\text{CO}_2\text{H}$, is a weak dibasic acid.

Malonic acid is titrated against 20.0 cm^3 of sodium hydroxide of the same concentration, the following pH-volume curve is obtained.

At which point on the titration curve is the mixture **most** able to resist pH change upon addition of a small amount of aqueous acid or base?



- 11 The following is the reaction for compound **XY**,



If the rate constant for the reaction is $5.78 \times 10^{-3} \text{ s}^{-1}$, what is the time taken for the concentration of a sample of **XY** to decrease from 1.80 mol dm^{-3} to $0.225 \text{ mol dm}^{-3}$?

- A 120 s B 240 s C 360 s D 480 s
- 12 The reaction between **C** and **D** is as follows:



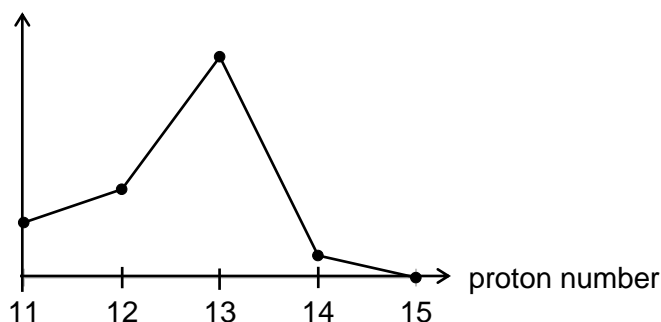
In an experiment to investigate the effect of concentrations on the rate of reaction, the following results were obtained at constant temperature.

Experiment	[C] / mol dm^{-3}	[D] / mol dm^{-3}	Initial rate / $\text{mol dm}^{-3}\text{s}^{-1}$
1	1.0	1.0	0.0008
2	1.0	2.0	0.0016
3	1.0	3.0	x
4	2.0	2.0	0.0032

What is the value of **x**?

- A 0.0008 B 0.0016 C 0.0024 D 0.0032

- 13 The following graph shows how a property of the elements in Period 3, from Na to P, or their compounds, varies with proton number.



What property is shown by the graph?

- A Melting point of element
 - B Melting point of oxide
 - C pH of aqueous chloride
 - D Electrical conductivity of element
- 14 Which of the following statements about calcium, strontium and barium is correct?
- A The magnitude of the hydration energy of the M^{2+} ion increases from calcium to barium
 - B The energy required for the process $M(g) \rightarrow M^{2+}(g) + 2e^{-}$ increases from calcium to barium.
 - C The reducing power decreases from calcium to barium.
 - D The reactivity of the elements with water increases from calcium to barium.
- 15 When 1.0 g of each of the following Group II metals is added to cold water and any gas produced is collected at 25 °C and 1 atm, which sample will most likely produce the largest volume of gas?
- A Mg B Ca C Sr D Ba
- 16 Which statement about the trends in the properties of the halogens is correct?
- A The volatility of halogens increases down the group.
 - B The electronegativity of halogens increases down the group.
 - C The reactivity of halogens with hydrogen decreases down the group.
 - D The bond dissociation energy of halogens increases down the group.

- 17 "Bromine tablets" are used as disinfectants. It is a source of HC/O(aq) and HBrO(aq) , both of which are oxidising agents.

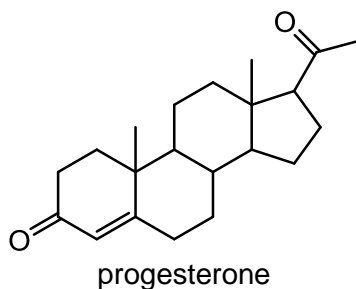
HBrO destroys bacteria, fungi and algae via its oxidising property in the process. HC/O is a stronger oxidising agent than HBrO and helps to sustain the effectiveness of the bromine tablets.

What is the likely role of HC/O in relation to HBrO ?

- A Oxidises Br^- to BrO^-
 - B Oxidises Br^- to Br_2
 - C Reduces BrO^- to Br^-
 - D Reduces BrO^- to Br_2
- 18 When drops of aqueous ammonia are added to a solution of CuSO_4 , a pale blue precipitate is formed. This precipitate dissolved when excess aqueous ammonia is added, forming a deep blue solution. On addition of dilute hydrochloric acid, the pale blue precipitate is reformed.

Which process does **not** occur in the above?

- A Dative bond formation
 - B Formation of a complex ion
 - C Precipitation of copper(II) hydroxide
 - D Reduction of copper(II) ions
- 19 Progesterone is an endogenous steroid involved in the menstrual cycle and pregnancy, of humans. It has the structure shown below.



How many chiral centers does progesterone contain?

- A 2
- B 4
- C 6
- D 8

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

An organic compound **A** is commonly used in skin-care products. It has the following features.

- It is a monobasic acid.
- One mole of compound **A** reacts with Na to give 1 mole of H_2 gas.
- It dimerises in the presence of hot concentrated H_2SO_4 to give an organic compound of relative molecular mass 116.

How many carbon atoms are in one molecule of this organic compound **A**?

- A** 1 **B** 2 **C** 3 **D** 4

- 21 3,3-dimethylpentane, C_7H_{16} , reacts with bromine to form monobromo compounds with molecular formula of $\text{C}_7\text{H}_{15}\text{Br}$.

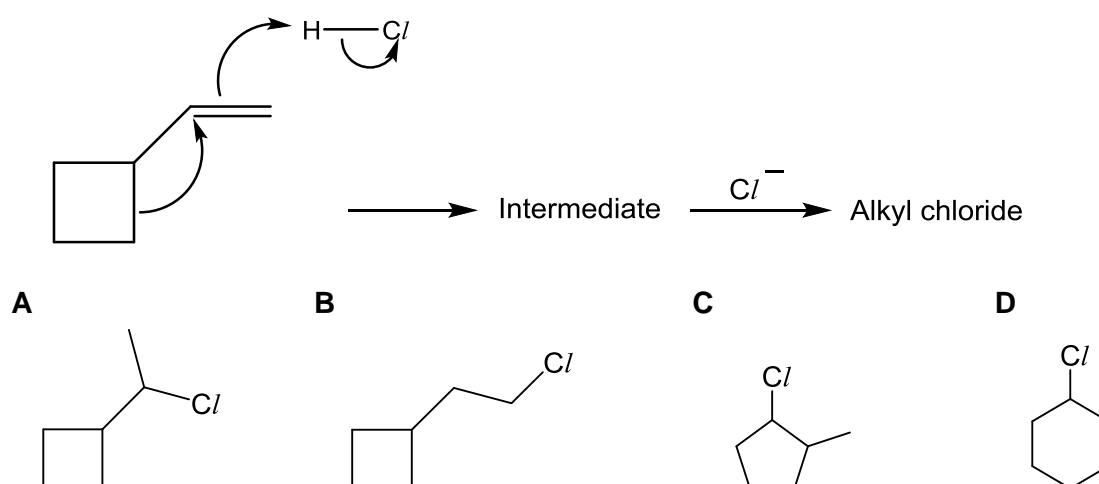


3,3-dimethylpentane

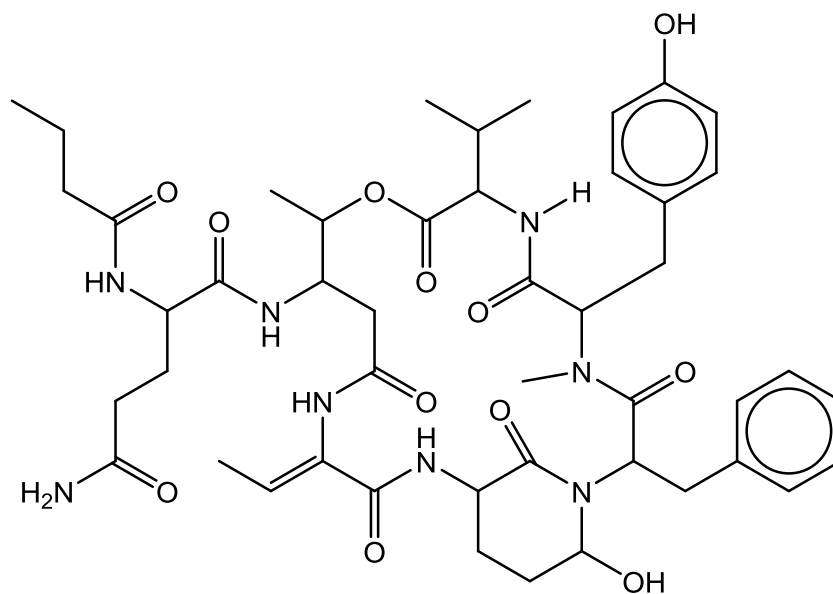
How many possible structural isomers, each with molecular formula $\text{C}_7\text{H}_{15}\text{Br}$, could be produced by 3,3-dimethylpentane?

- A** 3 **B** 4 **C** 6 **D** 7

- 22 Vinylcyclobutane can react with HCl to give a rearranged alkyl chloride. With the aid of the flow of electrons represented by the curved arrows, what is the alkyl chloride product obtained?



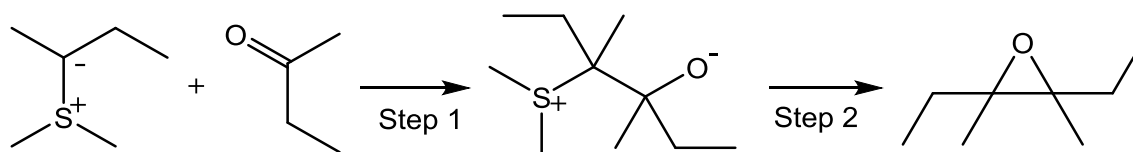
- 23 Yanucamide B can be extracted from a marine sponge and has the structure shown below.



Yanucamide B

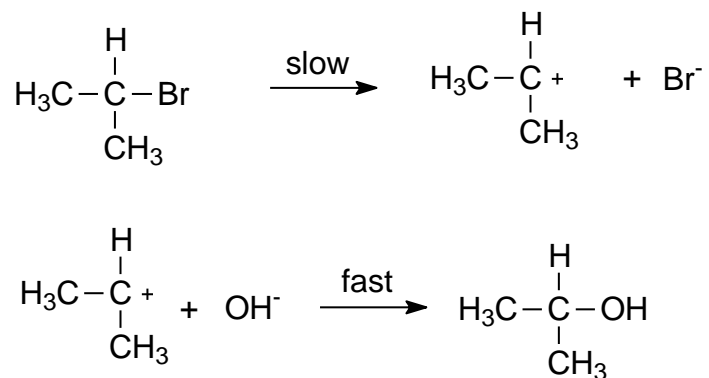
Which of the following set of reagents and conditions will not result in a colour change?

- A Br_2 in CCl_4
 - B neutral $\text{FeCl}_3(\text{aq})$
 - C LiAlH_4 in dry ether
 - D hot acidified $\text{K}_2\text{Cr}_2\text{O}_7$
- 24 In the following sequence of reactions, what is the mechanism of step 1?

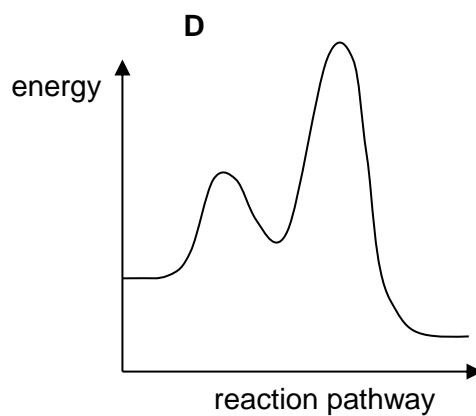
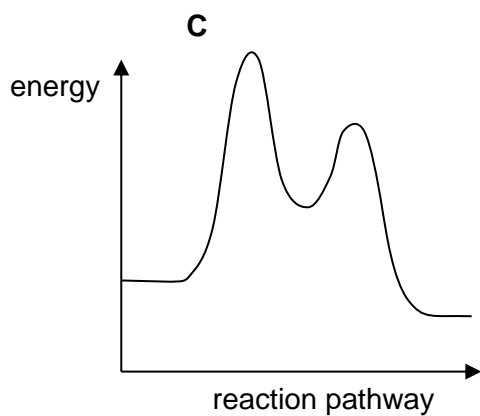
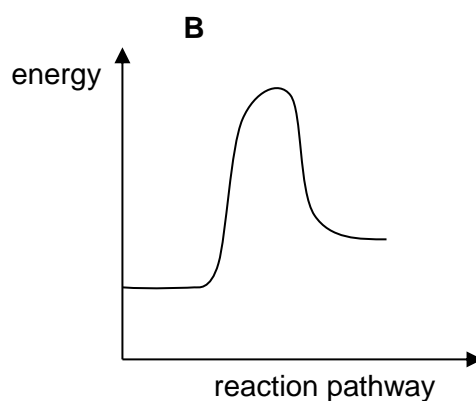
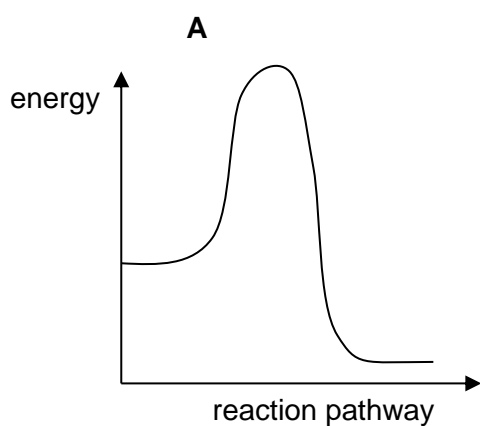


- A Nucleophilic Addition
- B Nucleophilic Substitution
- C Electrophilic Addition
- D Electrophilic Substitution

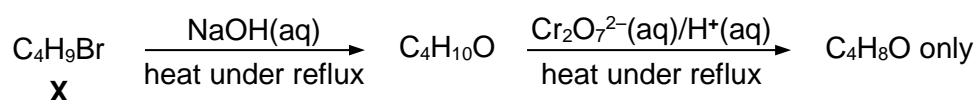
- 25 2-bromopropane undergoes nucleophilic substitution with aqueous NaOH via the following mechanism.



Which of the reaction pathway diagram fits the above mechanism?

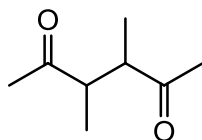


- 26 Compound **X**, C_4H_9Br , undergoes the following reactions:



What is **X** likely to be?

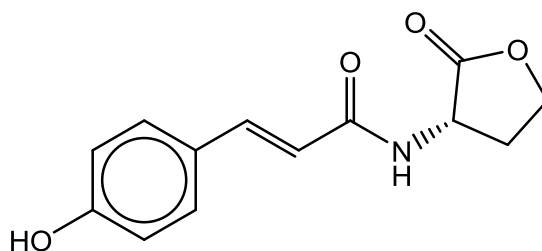
- A** 1-bromobutane
B 2-bromobutane
C 1-bromo-2-methylpropane
D 2-bromo-2-methylpropane
- 27 Compound **X** shown below is an intermediate used to generate pyrroles which are essential to the production of many different chemicals in the pharmaceutical industry.



Compound **X**

Which sentence is correct for compound **X**?

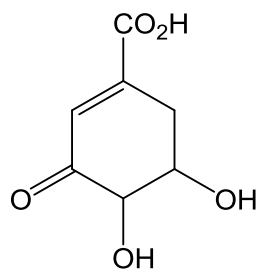
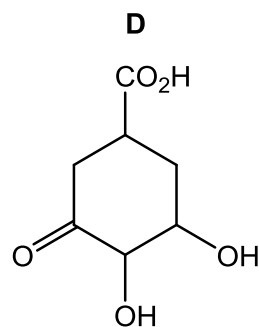
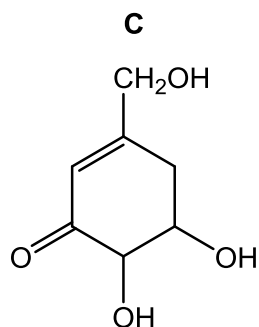
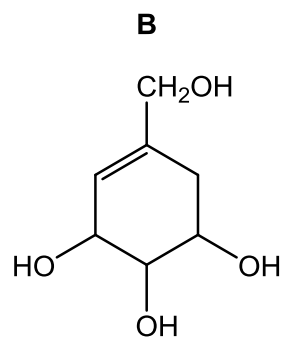
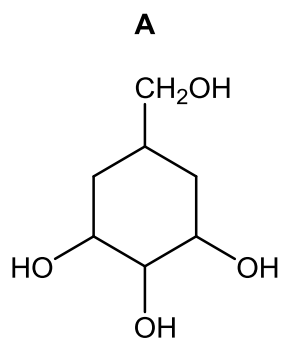
- A** It gives a silver mirror with Tollens' reagent.
B It decolourises acidified potassium manganate(VII).
C It does not give an orange precipitate with 2,4-dinitrophenylhydrazine.
D It gives yellow precipitate with alkaline aqueous iodine.
- 28 4-coumaroyl-HSL is a new type of bacterial, quorum sensing signal compound. When one mole of 4-coumaroyl-HSL is heated under reflux with $NaOH(aq)$ until no further reaction occurs, how many moles of $NaOH$ will react?



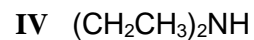
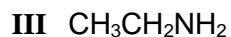
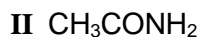
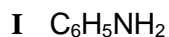
4-coumaroyl-HSL

- A** 1 **B** 2 **C** 3 **D** 4

- 29 Shikimic acid is found in star anise. The following compound **Y**, is the intermediate that can be used to form shikimic acid. When LiAlH_4 is added to compound **Y**, what is the product obtained?

Compound **Y**

- 30 Consider the following compounds below:



Which of the following shows the correct order of decreasing $\text{p}K_b$ values for the above compounds?



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 Use of the Data Booklet is relevant to this question.

Which of the following species has the electronic configuration of [Ar] 3d⁵ 4s¹?

- 1 Cr
- 2 Mn⁺
- 3 Fe²⁺

32 The value of the ionic product of water, K_w , varies with temperature.

temperature / °C	K_w / mol ² dm ⁻⁶
25	1.0 x 10 ⁻¹⁴
62	1.0 x 10 ⁻¹³

Which of the following statement is correct?

- 1 The ionic dissociation of water is an endothermic process.
- 2 Water is a neutral liquid at 62 °C.
- 3 pH < 7 at 62 °C.

33 Which of the following has the same value as the standard enthalpy change of formation, ΔH_f^\ominus , of carbon monoxide?

- 1 $\Delta H_{\text{combustion}}^\ominus(\text{C}) - \Delta H_{\text{combustion}}^\ominus(\text{CO})$
- 2 $\Delta H_f^\ominus(\text{CO}_2) - \Delta H_{\text{combustion}}^\ominus(\text{CO})$
- 3 $\frac{1}{2} \Delta H_f^\ominus(\text{CO}_2)$

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

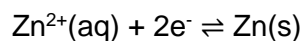
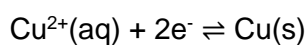
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

34 *Use of the Data booklet is relevant to this question.*

In the Daniell cell, copper and zinc electrodes are immersed in a solution of copper(II) sulfate and zinc sulfate respectively.

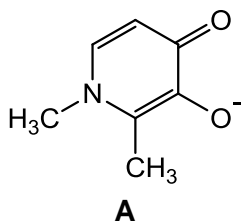
The two half-equations for a Daniell cell are given below



Which statements about this cell are correct when it is used?

- 1** The electron flow from the zinc electrode to the copper electrode in the external circuit.
- 2** The overall cell reaction is $\text{Cu}^{2+} + \text{Zn} \rightarrow \text{Cu} + \text{Zn}^{2+}$.
- 3** The cell potential is +1.10V.

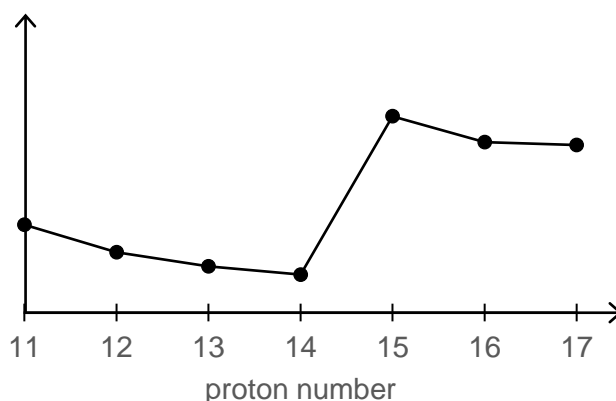
35 A neutral, red complex, FeA_3 , is formed when a bidentate ligand **A** is added to an aqueous solution of Fe^{3+} ions.



Which of the following statements is correct?

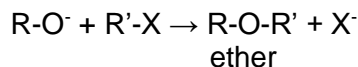
- 1** The complex has a coordination number of 3.
- 2** The complex absorbs radiation in the blue-green region of the visible spectrum.
- 3** The complex has a smaller energy gap between d-orbitals compared to yellow $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$.

- 36 The graph shows how a property from Na to Cl in Period 3 varies with proton number.



What is this property?

- 1 Ionic radius
 - 2 First ionisation energy
 - 3 Electronegativity
- 37 Williamson synthesis is one of the better methods to prepare ethers, R-O-R'. It involves a S_N2 displacement of halide ion in halogenoalkane (R'X) by an alkoxide ion nucleophile (RO⁻) as shown.



Which of the following statements are true?

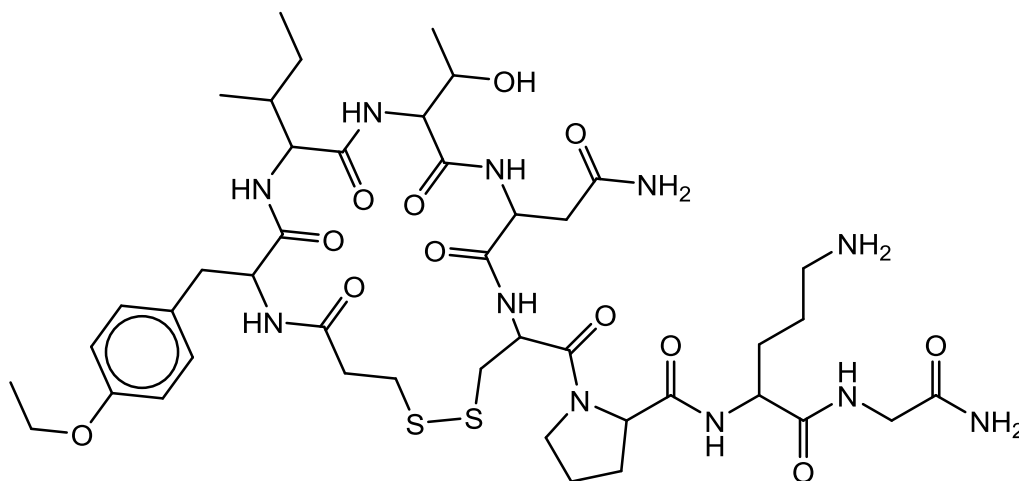
- 1 The rate equation involved is $\text{rate} = k[\text{RO}^-][\text{R}'\text{X}]$
 - 2 The reaction involving bromomethane will be faster compared to chloromethane.
 - 3 The reaction involving 2-bromopropane will be faster compared to bromomethane.
- 38 Cars are fitted with a catalytic converter. What reactions typically occur in a catalytic converter?
- 1 $2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$
 - 2 $\text{C}_x\text{H}_y + \left(\frac{x}{2} + \frac{y}{4}\right) \text{O}_2 \rightarrow x\text{CO} + \left(\frac{y}{2}\right) \text{H}_2\text{O}$
 - 3 $\text{CO}_2 + \text{NO} \rightarrow \text{CO} + \text{NO}_2$

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** Atosiban, a protein, is used as an intravenous medication as a birth labour repressant to halt premature labour.

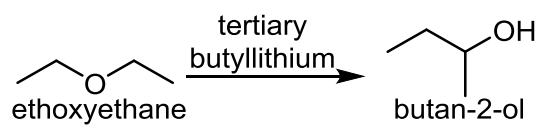


Atosiban

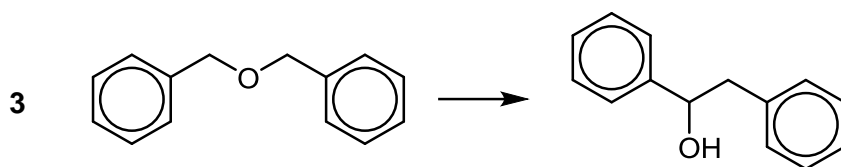
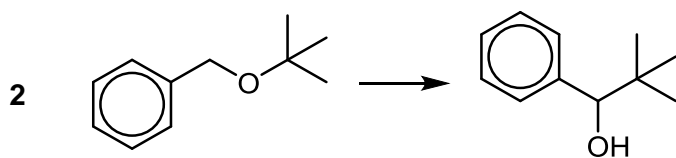
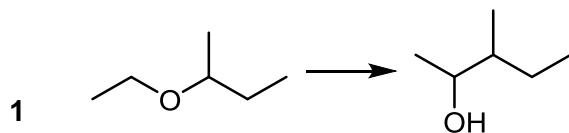
Which of the following R group interactions in the protein are possible?

- 1** Hydrogen bond
- 2** Disulfide bond
- 3** Ionic bond

- 40 The isomerisation of ethoxyethane to produce the corresponding alcohol is shown below.



Which of the following shows the correct product formed under the same conditions?



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