

NAME		Class	
ST ANDREW'S JUNIOR COLLEGE JC2 PRELIMINARY EXAMINATIONS			
Chemistry Higher 2 9729/01 Paper 1 Multiple Choice 18 September 2017 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 on the Answer Sheet in the spaces provided. 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. 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 19 printed pages and 1 blank page.			

- 1** During a laboratory practical exercise, a student tried to determine the concentration of $\text{Fe}^{2+}(\text{aq})$ and $\text{Fe}^{3+}(\text{aq})$ in a given mixture through two different experiments.
1. 25.0 cm^3 aliquot of the $\text{Fe}^{2+}(\text{aq})$ and $\text{Fe}^{3+}(\text{aq})$ mixture solution required 15.00 cm^3 of 0.1 mol dm^{-3} of acidified KMnO_4 solution for complete oxidation.
 2. Using another 25.0 cm^3 aliquot, all the $\text{Fe}^{3+}(\text{aq})$ was first reduced to $\text{Fe}^{2+}(\text{aq})$ using zinc metal before requiring 34.20 cm^3 of the same KMnO_4 solution for complete oxidation.

What is the concentration of $\text{Fe}^{2+}(\text{aq})$ and $\text{Fe}^{3+}(\text{aq})$ in the given mixture?

- A** $0.012 \text{ mol dm}^{-3} \text{ Fe}^{2+}(\text{aq})$ and $0.0154 \text{ mol dm}^{-3} \text{ Fe}^{3+}(\text{aq})$
- B** $0.180 \text{ mol dm}^{-3} \text{ Fe}^{2+}(\text{aq})$ and $0.230 \text{ mol dm}^{-3} \text{ Fe}^{3+}(\text{aq})$
- C** $0.300 \text{ mol dm}^{-3} \text{ Fe}^{2+}(\text{aq})$ and $0.384 \text{ mol dm}^{-3} \text{ Fe}^{3+}(\text{aq})$
- D** $0.300 \text{ mol dm}^{-3} \text{ Fe}^{2+}(\text{aq})$ and $0.684 \text{ mol dm}^{-3} \text{ Fe}^{3+}(\text{aq})$
- 2** A number of elements in the actinoid series are radioactive and undergo decay to other elements. The following equation is an example of such decay.



Which of the following gives the identity of element **A**?

	<u>Mass number</u>	<u>Atomic number</u>
A	205	81
B	205	86
C	223	81
D	237	90

- 3 Which of the following shows an increase in the bond angle of the compound from left to right?

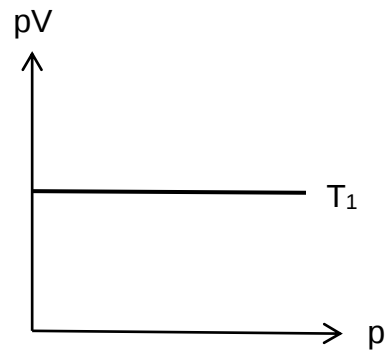
A	NH_3	H_2S	SiH_4
B	PH_3	NH_3	AlCl_3
C	PH_3	PF_3	PCl_3
D	XeF_4	SCl_6	CCl_4

- 4 In which of the following does Statement **II** give a correct explanation for Statement **I**?

	Statement I	Statement II
1	Magnesium has a higher melting point than sodium.	Magnesium has more delocalised valence electrons which results in stronger metallic bonds.
2	Glycine, $\text{H}_2\text{NCH}_2\text{COOH}$, has a higher melting point than 2-hydroxyethanoic acid, HOCH_2COOH .	Glycine can form stronger hydrogen bonds than 2-hydroxyethanoic acid.
3	Chloromethane undergoes nucleophilic substitution more easily than fluoromethane.	The $\text{C}-\text{Cl}$ bond in chloromethane is weaker than the $\text{C}-\text{F}$ bond in fluoromethane.

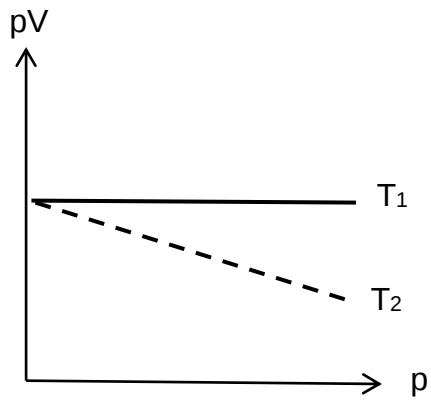
- A** 2 and 3
B 1 and 2
C 1 and 3
D 1, 2, and 3

- 5 The graph of pV against p is plotted for an ideal gas at constant temperature for a fixed mass of gas at T_1 .

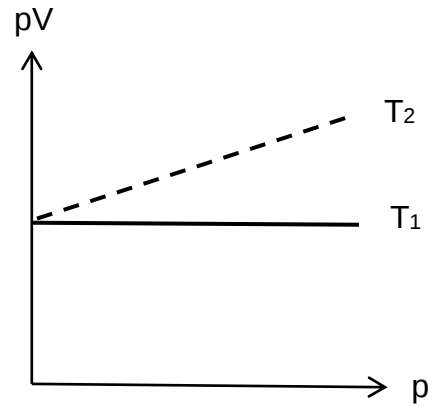


Which diagram shows the new graph at a lower temperature at T_2 ?

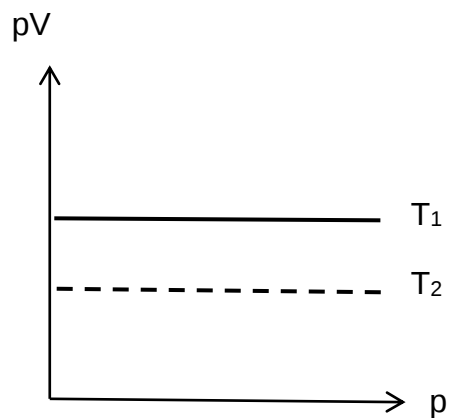
A



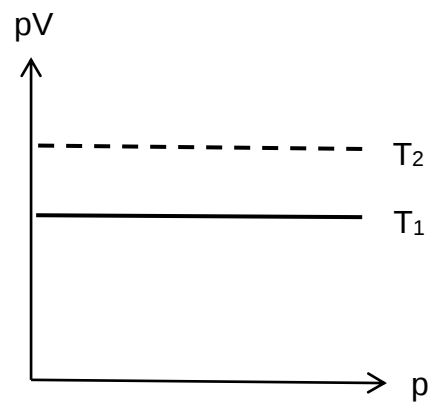
B



C



D



- 6 The enthalpy change of formation of carbon monoxide and carbon dioxide are given below.

$$\Delta H_f(\text{CO}) = -110 \text{ kJ mol}^{-1}$$

$$\Delta H_f(\text{CO}_2) = -393 \text{ kJ mol}^{-1}$$

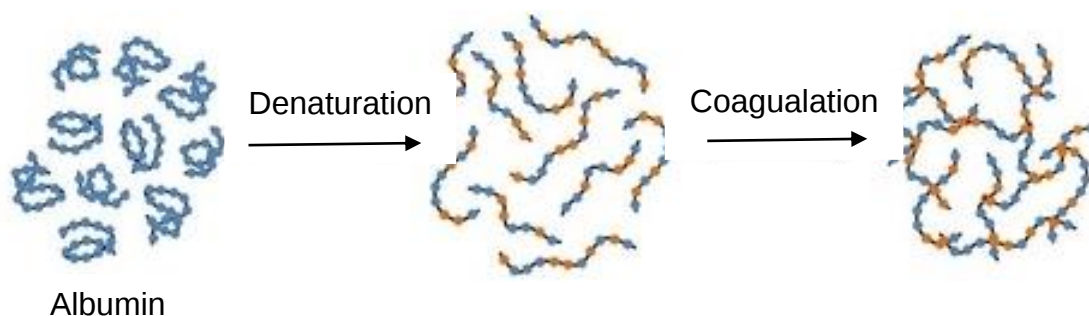
Which of these statements are correct?

- 1 Carbon dioxide is energetically more stable than carbon monoxide.
- 2 The enthalpy change of combustion of carbon is -283 kJ mol^{-1} .
- 3 $\Delta H_f(\text{CO}_2) - \Delta H_c(\text{CO})$ has the same value as enthalpy change of formation of CO.

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

- 7 A raw egg white contains the protein, albumin, which is made of chains of amino acids that fold into specific and stable three-dimensional structure.

Heating the protein in an egg white causes the intermolecular forces to break and “unfold” the protein. In this state, albumin is denatured and will readily coagulate to form an extensive protein network.

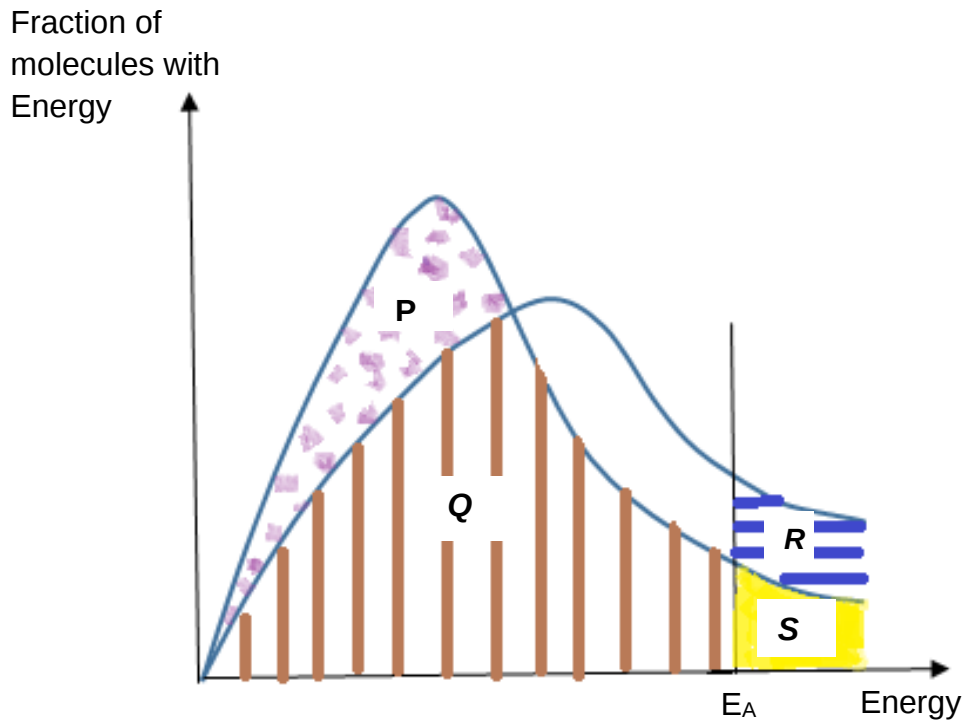


What are the correct signs of ΔS , ΔH , and ΔG for denaturation of albumin during cooking?

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

- 8 The diagram shows the Maxwell–Boltzmann energy distribution curves for air molecules at room temperature and inside the car engines where it is being combusted. The letters **P**, **Q**, **R** and **S** refer to the separate areas.

Which expression gives the fraction of the air molecules present inside the car engine?



A

$$\frac{S}{P}$$

B

$$\frac{R+S}{P+Q+S}$$

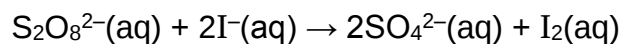
C

$$\frac{S}{P+Q+S}$$

D

$$\frac{S}{P+Q}$$

- 9** An experiment was carried out to investigate the kinetics of the reaction between ammonium peroxodisulfate, $(\text{NH}_4)_2\text{S}_2\text{O}_8$, an oxidising agent, and potassium iodide, KI, in the presence of a little starch.



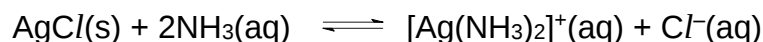
The volume of the $(\text{NH}_4)_2\text{S}_2\text{O}_8$ and KI solutions in the mixture, together with the time taken for the mixture to darken for the various experimental runs are given below:

Experiment	Volume used / cm^3			Time / s
	1.0 mol dm^{-3} KI	0.040 mol dm^{-3} $(\text{NH}_4)_2\text{S}_2\text{O}_8$	H_2O	
1	10.0	5.0	25.0	170
2	15.0	5.0	20.0	113
3	15.0	10.0	15.0	56.5
4	20.0	20.0	0.0	?

Which of the following statements about the reaction is false?

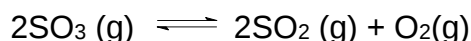
- A** The reaction can be catalysed by $\text{Fe}(\text{NO}_3)_2(\text{aq})$.
- B** The reaction involves the formation of an intermediate.
- C** The time taken for the mixture to darken in Experiment 4 is 40.5 s.
- D** The slow step involves the reaction between 1 mole of $(\text{NH}_4)_2\text{S}_2\text{O}_8$ and 1 mole of KI.

- 10** Silver chloride establishes an equilibrium with the relatively stable complex ion, $[\text{Ag}(\text{NH}_3)_2]^+$



Which of the following statements is correct?

- A** When acid is slowly added to the mixture, a white precipitate is observed.
- B** The K_c expression is $K_c = \frac{[\text{Ag}(\text{NH}_3)_2^+][\text{Cl}^-]}{[\text{AgCl}][\text{NH}_3]^2}$
- C** Added more NH_3 to the solution when equilibrium is established will decrease its K_c value.
- D** Removal of some $\text{AgCl}(\text{s})$ causes the position of equilibrium to shift left.
- 11** At a total pressure of 1.2 atm, sulfur trioxide is 50% dissociated according to the following equation at 150 K.



What is the mole fraction of oxygen in this equilibrium mixture?

- A** 0.60 **B** 0.20 **C** 0.30 **D** 0.24
- 12** Which of the following mixtures when dissolved in large amount of water could act as buffer solutions?

- 1 2 mol of HI and 1 mol of $\text{CH}_3\text{CH}_2\text{NH}_2$
- 2 2 mol of CH_3COCl and 3 mol of NaOH
- 3 2 mol of $\text{CH}_3\text{CH}_2\text{NH}_2$ and 1 mol of H_2SO_4

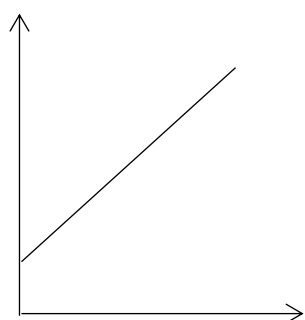
- A** 2 only
- B** 2 and 3
- C** 1 and 3
- D** None of the above

- 13** The solubility of 2 sparingly soluble solids MX_2 and LY is being determined experimentally.

Which of the following statements is always true?

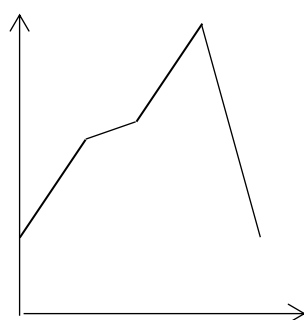
- A** The solubility product of MX_2 increases with increasing temperature.
- B** MX_2 will always be more soluble than LY if MX_2 has a higher K_{sp} value.
- C** The K_{sp} value of LY can be calculated from any concentration of L^+ and Y^- .
- D** Given that the solubility of LY is exothermic, the K_{sp} of LY will only change when temperature changes.

- 14** The following graphs show the variation of a property of the elements Na to P.



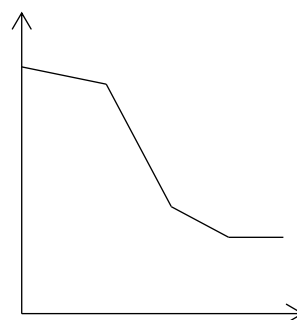
Proton Number

Graph 1



Proton Number

Graph 2



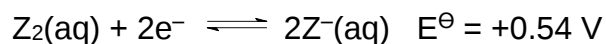
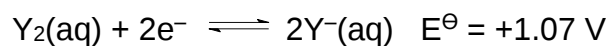
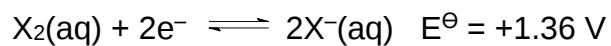
Proton Number

Graph 3

Which of the following correctly describes the property of the graphs?

	Graph 1	Graph 2	Graph 3
A	Electronegativity	Melting point of oxide	pH of oxide
B	Ionic radius	Melting point of element	pH of oxide
C	Covalent character	Melting point of chlorides	pH of chloride
D	Electronegativity	Melting point of element	pH of chloride

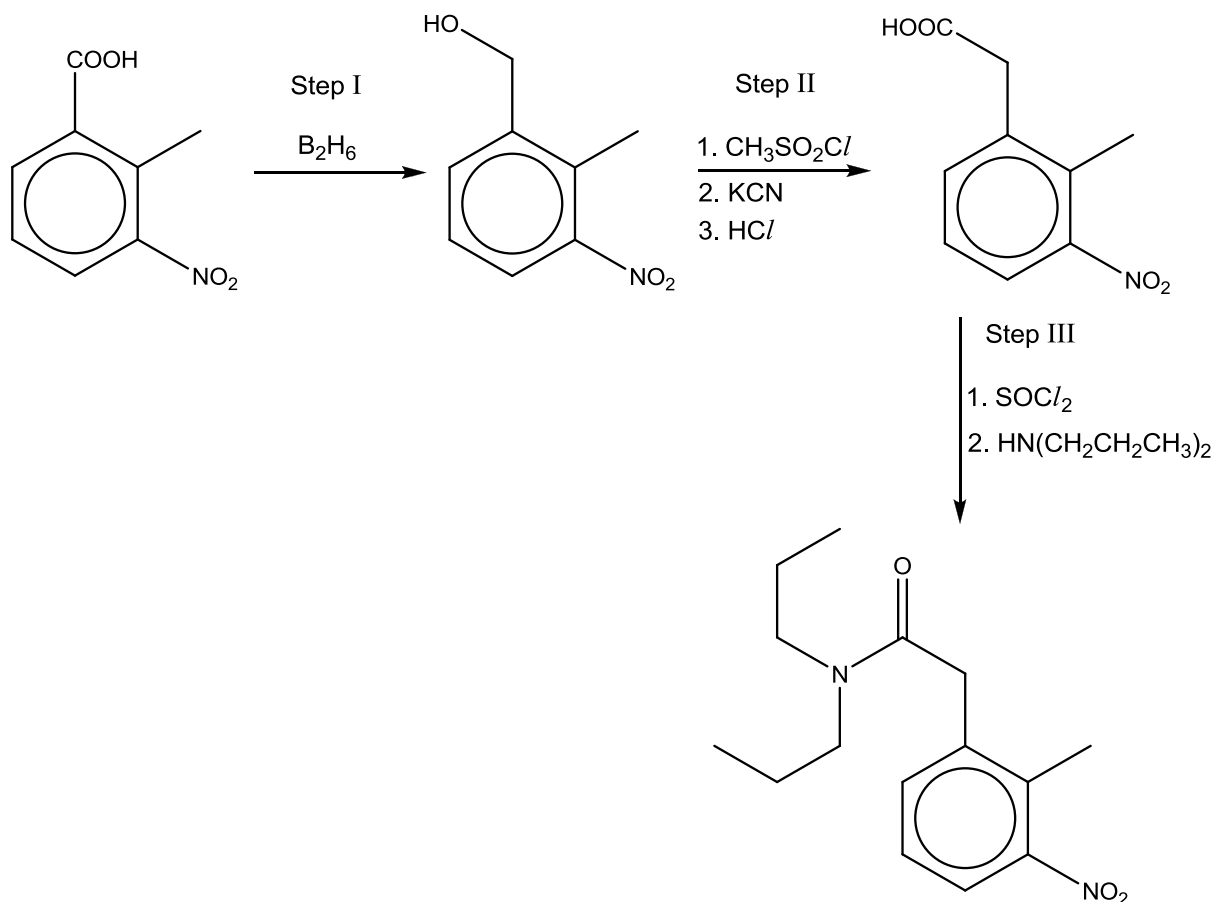
- 15** 1.0 mol dm⁻³ aqueous solutions of three elements in Group 17 of the Periodic Table have standard electrode potentials as follows.



Which statements are correct?

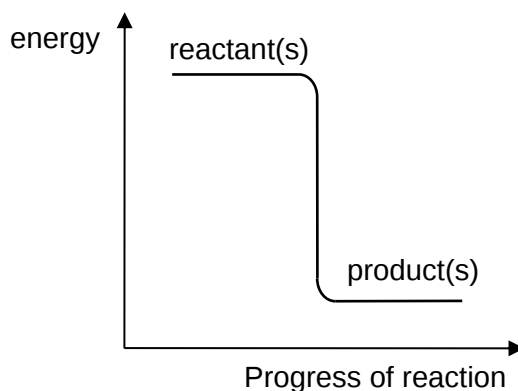
- 1 There is an increase in oxidising power in the sequence X₂, Y₂, Z₂.
 - 2 The reaction $\text{X}_2(\text{aq}) + 2\text{Z}^-(\text{aq}) \longrightarrow 2\text{X}^-(\text{aq}) + \text{Z}_2(\text{aq})$ is spontaneous under standard conditions.
 - 3 Z has the lowest electron affinity.
- A** 1 and 2
- B** 1 and 3
- C** 2 and 3
- D** 1, 2 and 3

- 16 Which of the following shows the correct type of reaction(s) occurring for each step of the synthesis?



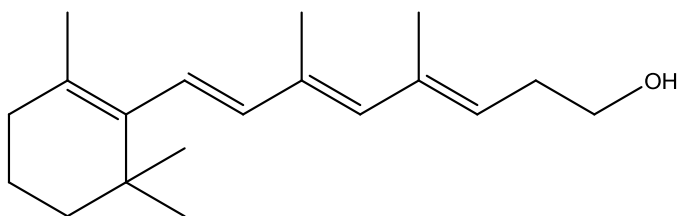
	Step I	Step II	Step III
A	Oxidation	Substitution followed by condensation	Condensation
B	Oxidation	Acid base reaction followed by oxidation	Substitution followed by condensation
C	Reduction	Substitution followed by hydrolysis	Substitution followed by condensation
D	Reduction	Hydrolysis followed by oxidation	Condensation

- 17 An energy level diagram for a single reaction step is shown below.



To which of the following steps in the reaction of ethane with bromine in the presence of light does this diagram apply?

- A $\text{Br}_2 \longrightarrow \text{Br}\cdot + \text{Br}\cdot$
 B $\text{CH}_3\text{CH}_3 + \text{Br}\cdot \longrightarrow \text{CH}_3\text{CH}_2\cdot + \text{HBr}$
 C $\text{CH}_3\text{CH}_2\cdot + \text{Br}_2 \longrightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{Br}\cdot$
 D $\text{CH}_3\text{CH}_2\cdot + \text{CH}_3\text{CH}_2\cdot \longrightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- 18 The structure of Vitamin A is shown below.



Vitamin A

Which of the following statements about Vitamin A is true?

- A White fumes is observed when it is treated with excess ethanoyl chloride.
 B When it reacts completely with LiAlH_4 in dry ether, a saturated compound that contains 4 chiral carbon centres is produced.
 C Effervescence is observed when it reacts with hot alkaline potassium manganate(VII) solution.
 D 1 mol of Vitamin A reacts with excess sodium metal to produce 22.7 dm^3 of hydrogen gas at 273 K and 1 bar.

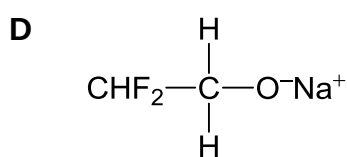
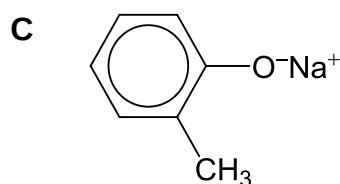
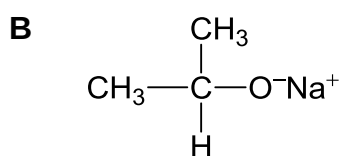
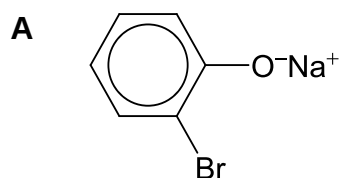
- 19** An optically active sample of 2-chlorobutane, $\text{CH}_3\text{CH}_2\text{CHClCH}_3$, was heated under reflux with aqueous sodium hydroxide to produce compound **Q**, which rotates plane of polarised light.

Which of the following statements about the reaction are correct?

- 1** The reaction occurred via a $\text{S}_{\text{N}}1$ mechanism.
- 2** $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_3$ is a functional group isomer of **Q**.
- 3** The rate of reaction increases when the sample is replaced with 2-bromobutane.
- 4** **Q** reacts with concentrated sulfuric acid at 170°C to give a mixture of three isomeric alkenes.

- A** 1 and 3 only
- B** 2 and 3 only
- C** 2 and 4 only
- D** 2, 3 and 4 only

- 20** Which of the following salts has the smallest $\text{p}K_{\text{b}}$?



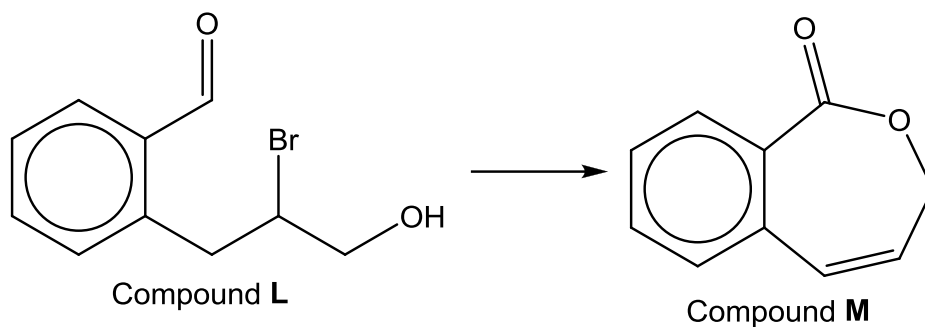
- 21** The uncatalysed reaction between propanal and HCN proceeds via two steps and the rate equation for the formation of cyanohydrin is as follows.

$$\text{Rate} = k[\text{CH}_3\text{CH}_2\text{CHO}][\text{CN}^-]$$

Which of the following statements is correct?

- A** The intermediate formed in this reaction is planar.
- B** Only one product is obtained since this is an addition reaction.
- C** The uncatalysed reaction between propanone and HCN occurs at a faster rate than that of propanal.
- D** The same product can be obtained by heating 1-chloropropan-1-ol with ethanolic NaCN.
- 22** ^{18}O is an isotope of oxygen.
- When butylethanoate is hydrolysed with dilute sulfuric acid in the presence of H_2^{18}O , a mixture of 2 products is formed. Which of the following pairs gives the correct structures of the two products?
- A** $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ and $\text{CH}_3\text{CO}^{18}\text{OH}$
- B** $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2^{18}\text{OH}$ and $\text{CH}_3\text{CO}_2\text{H}$
- C** $\text{CH}_3\text{CH}_2\text{OH}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}^{18}\text{OH}$
- D** $\text{CH}_3\text{CH}_2^{18}\text{OH}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$

23



Which of the following sequence of reagents and conditions can be used to carry out the conversion above?

	Stage 1	Stage 2	Stage 3
A	warm with ammonical silver nitrate solution	hot NaOH(aq)	heat in the presence of concentrated H ₂ SO ₄
B	warm with Fehling's solution	heat in the presence of concentrated H ₂ SO ₄	hot NaOH(aq)
C	warm with ammonical silver nitrate solution	hot NaOH(alc)	heat in the presence of concentrated H ₂ SO ₄
D	warm with Fehling's solution	heat in the presence of concentrated H ₂ SO ₄	hot NaOH(alc)

24 Compound **W** has the following properties :

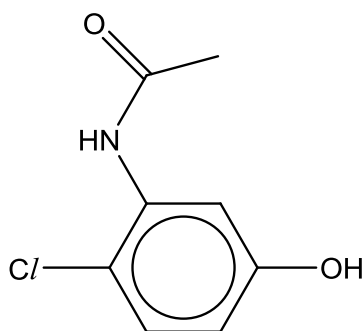
- Empirical formula : C_3H_7N
- Decolourises aqueous bromine
- Reacts with hot acidified $KMnO_4$ to form an α -amino acid

Which of the following could be compound **W**?

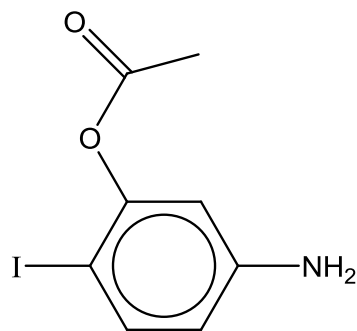
- 1 $CH_2=CHCH_2NH_2$
- 2 $CH_3CH=CHNH_2$
- 3 $CH_2(NH_2)CH_2CH=CHCH_2CH_2NH_2$
- 4 $CH_2(NH_2)CH_2CH_2CH=CHCH_2NH_2$

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

25 Which of the following reagents would give different observations when added to both compounds in separate test-tubes?



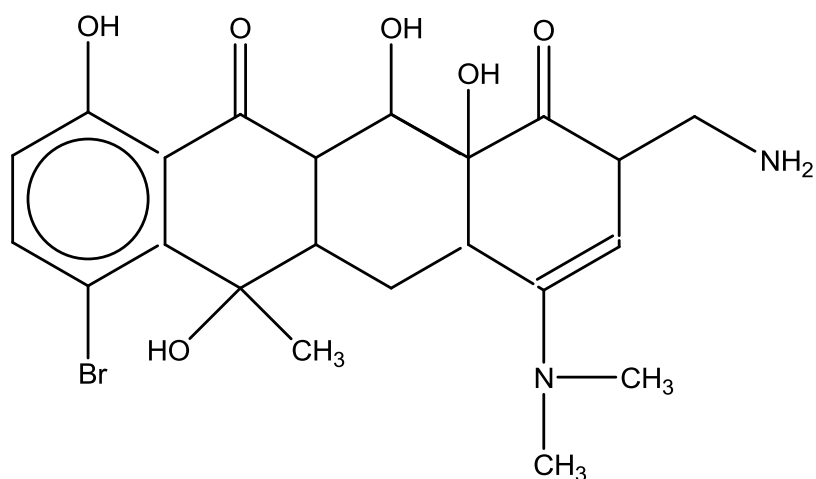
Compound **Y**



Compound **Z**

- aqueous bromine
- 2,4-dinitrophenylhydrazine
- $LiAlH_4$ in dry ether, followed by hot acidified $KMnO_4$
- ethanolic silver nitrate

26 Compound **X** is an isomer of the antibiotic *Aureomycin*.



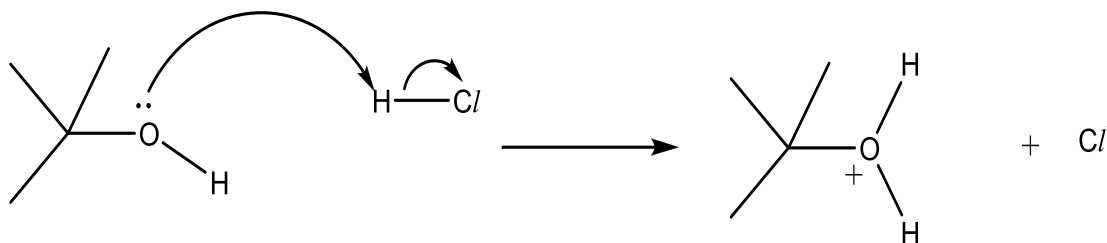
Compound **X**

Which of the following statements are true for compound **X**?

- 1 1 mole of **X** reacts with 5 moles of propanoyl chloride.
- 2 1 mole of compound **X** reacts with 3 moles of hydrogen gas in the presence of Ni catalyst at 150 °C.
- 3 1 mole of compound **X** reacts with 6 moles of HBr(g) at room temperature.

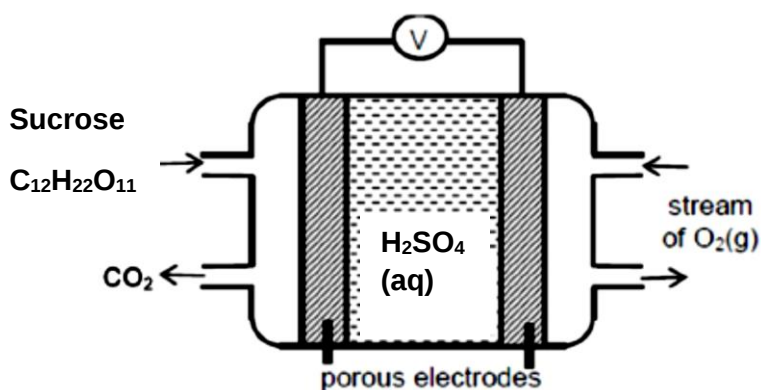
- A** 1 only
- B** 1 and 2
- C** 2 and 3
- D** 1, 2 and 3

- 27 Alkyl halides can be prepared from alcohol. The first step in the mechanism involves the following:



What is the role of the alcohol in the above step?

- A Brønsted–Lowry acid
 - B Lewis base
 - C Ligand
 - D Electrophile
- 28 A microbial fuel cell (MFC) is a bio–electrochemical system that drives an electric current by using bacteria and mimicking bacterial interactions found in nature. An example of an MFC is as shown below with $E^\theta_{\text{cell}} = +1.25 \text{ V}$.



Which of the following statements about the above MFC is **not** correct?

- A Electrons flow from the right electrode to the left electrode.
- B H^+ is produced at the anode.
- C Sucrose is oxidised in this reaction.
- D $E^\theta_{\text{(anode)}}$ is -0.02 V .

- 29** 0.0170 mol of chromium(III) iodide reacts with excess ammonia to form compound **Y** which has a coordination number of 6. When a solution of **Y** is treated with an excess of aqueous silver nitrate, 0.0340 mol of solid is precipitated.

What is the formula of compound **Y**?

- A** $\text{Cr}(\text{NH}_3)_3\text{I}_3$
- B** $\text{Cr}(\text{NH}_3)_4\text{I}_3$
- C** $\text{Cr}(\text{NH}_3)_5\text{I}_3$
- D** $\text{Cr}(\text{NH}_3)_6\text{I}_3$
- 30** The table shows the electronic configuration of three elements in the Periodic Table. (The elements are represented by letters which are not their symbols.)

Element	Electronic configuration
P	$[\text{Ar}]4s^1$
Q	$[\text{Ar}]3d^74s^2$
R	$[\text{Ar}]3d^{10}4s^1$

Which of the following statements are correct?

- Q**₂O₃ is likely to exist.
 - First ionisation energy of **P** is lower than that of **R**.
 - The compound **RI** is a white solid.
- A** 1 only
- B** 1 and 2
- C** 2 and 3
- D** 1, 2 and 3