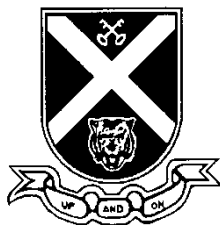


# ST ANDREW'S JUNIOR COLLEGE



## JC2 Preliminary Examinations

**Chemistry**

**Higher 2**

**Paper 1 Multiple Choice**

**9647/01**

**19<sup>th</sup> September 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, highlighters, glue or correction fluid.

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.

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 document consists of **27** printed pages **including** this page.

**[Turn Over**

**Section A**

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

1. What volume of  $\text{CO}_2$  will be liberated when  $y \text{ cm}^3$  of 40:60 mixture of volume of methane and ethene are completely burnt in oxygen?

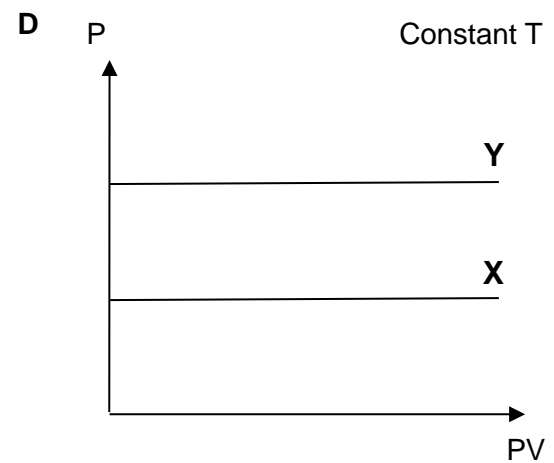
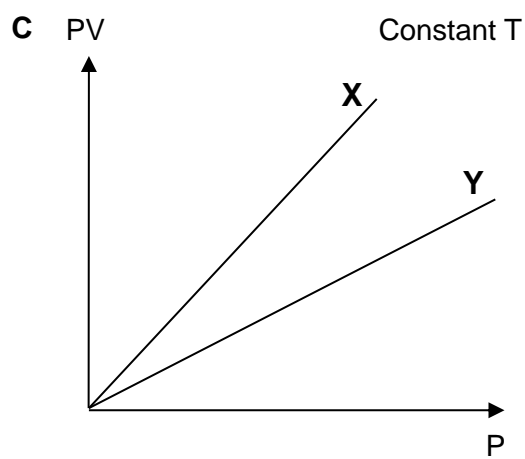
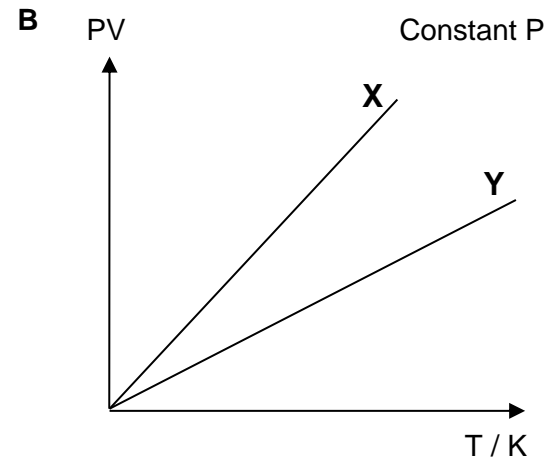
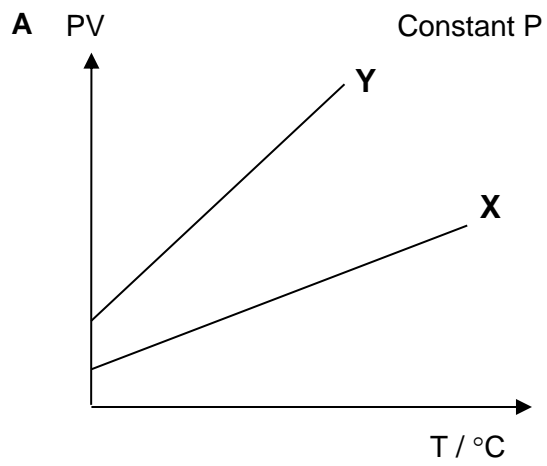
- A**  $y \text{ cm}^3$   
**B**  $\frac{2y}{5} \text{ cm}^3$   
**C**  $\frac{8y}{5} \text{ cm}^3$   
**D**  $2y \text{ cm}^3$

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

Ethanedioate ions,  $\text{C}_2\text{O}_4^{2-}$ , are oxidised by acidified, aqueous potassium manganate(VII) to give carbon dioxide. What volume of  $0.020 \text{ mol dm}^{-3}$  potassium manganate(VII) is required to oxidise completely  $1.0 \times 10^{-3} \text{ mol}$  of the salt  $\text{NaHC}_2\text{O}_4 \cdot \text{H}_2\text{C}_2\text{O}_4$ ?

- A**  $20 \text{ cm}^3$   
**B**  $40 \text{ cm}^3$   
**C**  $50 \text{ cm}^3$   
**D**  $125 \text{ cm}^3$

3. Which graph correctly describes the behaviour of fixed masses of the ideal gases **X** and **Y**, where **X** has a higher  $M_r$  than **Y**?



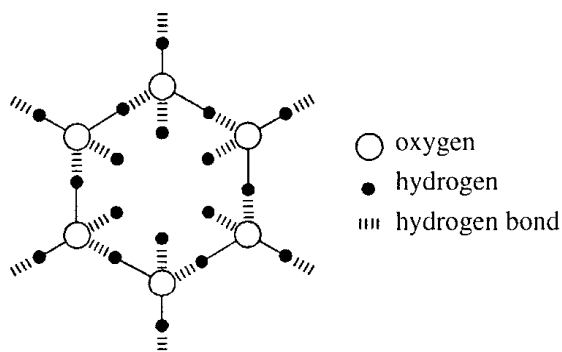
4. The table below shows the ionisation energy (in  $\text{kJ mol}^{-1}$ ) of four elements labelled **A**, **B**, **C** and **D**.

Element	1 <sup>st</sup> I.E.	2 <sup>nd</sup> I.E.	3 <sup>rd</sup> I.E.	4 <sup>th</sup> I.E.	5 <sup>th</sup> I.E.	6 <sup>th</sup> I.E.
<b>A</b>	1012	1907	2914	4964	6274	21 267
<b>B</b>	787	1577	3232	4356	16 091	19 805
<b>C</b>	1521	2666	3931	5771	7238	8781
<b>D</b>	738	1451	7733	10 543	13 630	18 020

Which element above has **no** *p* electrons in the valence shell?

- A** Element A
- B** Element B
- C** Element C
- D** Element D

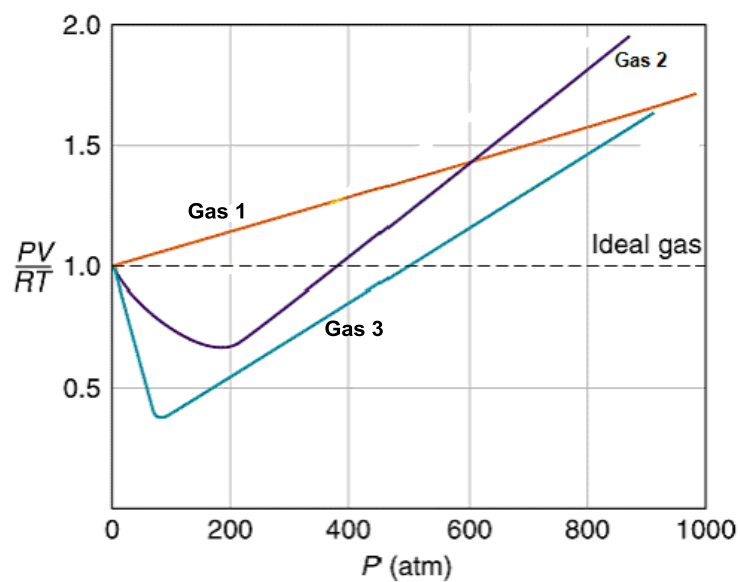
5. The diagram shows the structure of part of a crystal of ice.



Which of the following is **incorrect**?

- A** All bond angles surrounding each oxygen atom are  $109.5^\circ$ .
- B** Two electrons from each oxygen atom are involved in forming hydrogen bonds.
- C** The hydrogen bonds are weaker than the O–H covalent bonds.
- D** The open structure of ice causes ice to have a higher volume and lower density than water.
6. Which of the following has an exothermic enthalpy change?
- A**  $\text{Ba (g)} \rightarrow \text{Ba}^+ \text{ (g)} + \text{e}^-$
- B**  $\text{MgS (s)} \rightarrow \text{Mg}^{2+} \text{ (g)} + \text{S}^{2-} \text{ (g)}$
- C**  $\frac{1}{2} \text{N}_2 \text{ (g)} \rightarrow \text{N (g)}$
- D**  $\text{F (g)} + \text{e}^- \rightarrow \text{F}^- \text{ (g)}$

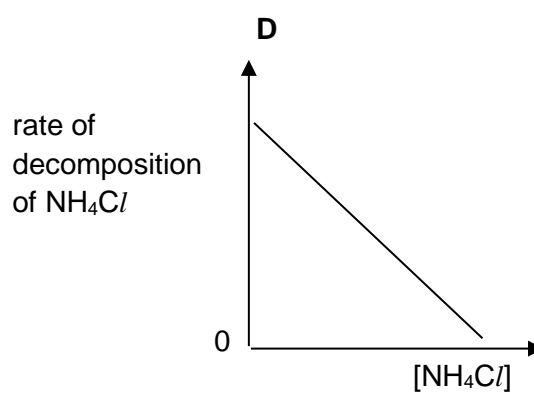
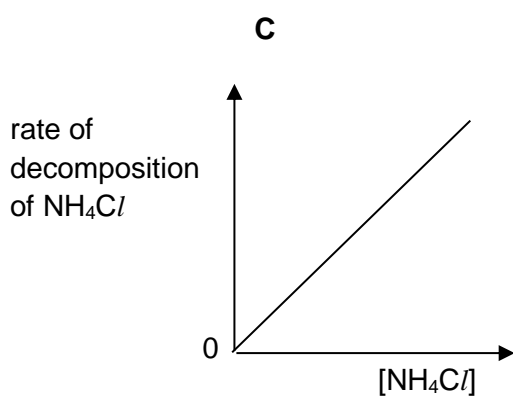
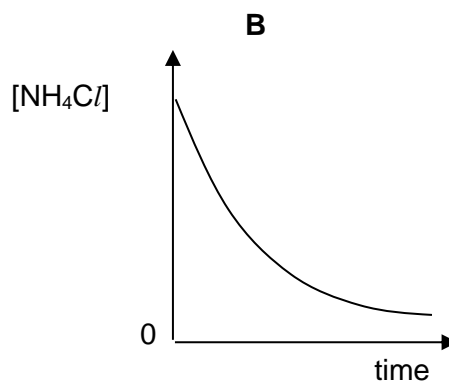
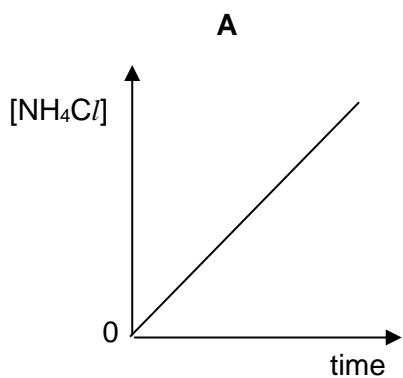
7. The value of  $\frac{pV}{RT}$  is plotted against  $p$  at the same temperature for three gases – Ne,  $\text{NH}_3$  and  $\text{C}_2\text{H}_6$ , where  $p$  is the pressure and  $V$  is the volume of the gas.



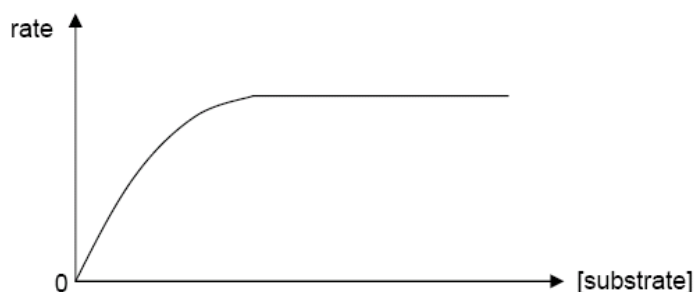
Which of the following correctly identifies the 3 gases?

	Gas 1	Gas 2	Gas 3
<b>A</b>	$\text{NH}_3$	$\text{C}_2\text{H}_6$	Ne
<b>B</b>	$\text{NH}_3$	Ne	$\text{C}_2\text{H}_6$
<b>C</b>	Ne	$\text{C}_2\text{H}_6$	$\text{NH}_3$
<b>D</b>	$\text{C}_2\text{H}_6$	Ne	$\text{NH}_3$

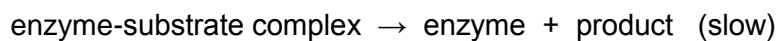
8. Which graph would confirm that the rate of decomposition of ammonium chloride is a first order reaction?



9. In an enzyme-catalysed reaction, the rate is affected by the concentration of substrate as shown in the graph below.



The mechanism for the reaction is as shown:

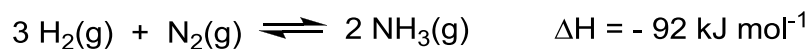


Which of the following is **incorrect**?

- A** When [substrate] is low, the reaction is first order with respect to the substrate.
- B** When [substrate] is high, the reaction is zero order with respect to the substrate.
- C** The rate equation is given as:  $\text{rate} = k [\text{enzyme-substrate complex}]$ .
- D** The reaction occurs in a two-step reaction.



10. The equation for the Haber Process is shown below.



Which of the following statements regarding the Haber Process is correct?

- A** The use of Fe catalyst helps to lower the activation energy of the forward reaction more than that of the backward reaction.
- B** The use of a higher pressure increases the equilibrium constant.
- C** The rate constant of the backward reaction will decrease more than the rate constant of the forward reaction when temperature is decreased.
- D** The rate constant of the backward reaction will decrease less than the rate constant of the forward reaction when temperature is increased.
11. A student carried out a titration involving  $0.10 \text{ mol dm}^{-3} \text{Ba(OH)}_2$  and  $0.20 \text{ mol dm}^{-3} \text{HCOOH}$ . Which of the following is a suitable indicator to indicate the end-point of this titration?
- A** Phenolphthalein (pH range 8.2 – 10.0)
- B** Methyl red (pH range 4.8 – 6.0)
- C** Methyl orange (pH range 3.2 – 4.4)
- D** There is no suitable indicator.

12. Magnesium arsenate,  $\text{Mg}_3(\text{AsO}_4)_2$ , is a sparingly soluble salt commonly used to make insecticides. It dissociates in water according to the equation below.

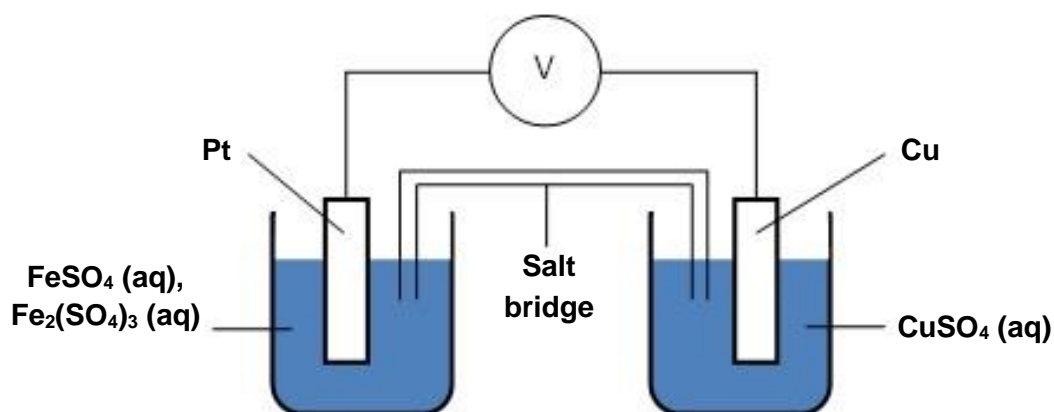


If the solubility product is  $S$ , what is the value of  $[\text{AsO}_4^{3-} (\text{aq})]$  at equilibrium?

- A  $S^{1/5}$
- B  $(\frac{2}{3}S)^{1/5}$
- C  $(\frac{2}{5}S)^{1/5}$
- D  $(\frac{8}{27}S)^{1/5}$

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

An electrochemical cell is set up as shown.



Which of the following correctly describes the cell?

- A  $E^\ominus_{\text{cell}}$  is + 0.43 V when sodium cyanide is added to the  $\text{Fe}^{3+}/\text{Fe}^{2+}$  half cell.
- B Cu is the positive electrode when sodium hydroxide is added to the  $\text{Fe}^{3+}/\text{Fe}^{2+}$  half cell.
- C The reaction is less spontaneous when excess aqueous ammonia is added to  $\text{Cu}^{2+}/\text{Cu}$  half cell.
- D The cations in the salt bridge will move over to  $\text{Cu}^{2+}/\text{Cu}$  half-cell to prevent accumulation of positive charges.

14. The properties of each Period 4 element resemble those of the Period 3 element directly above it.

Which Period 4 elements form oxides that dissolve in water to give an acid solution?

- A As and Se
- B Ga and Ge
- C Ga and Se
- D Ca and Se

15. Elements **W**, **X**, **Y** and **Z** are in Period 3 of the Periodic Table.

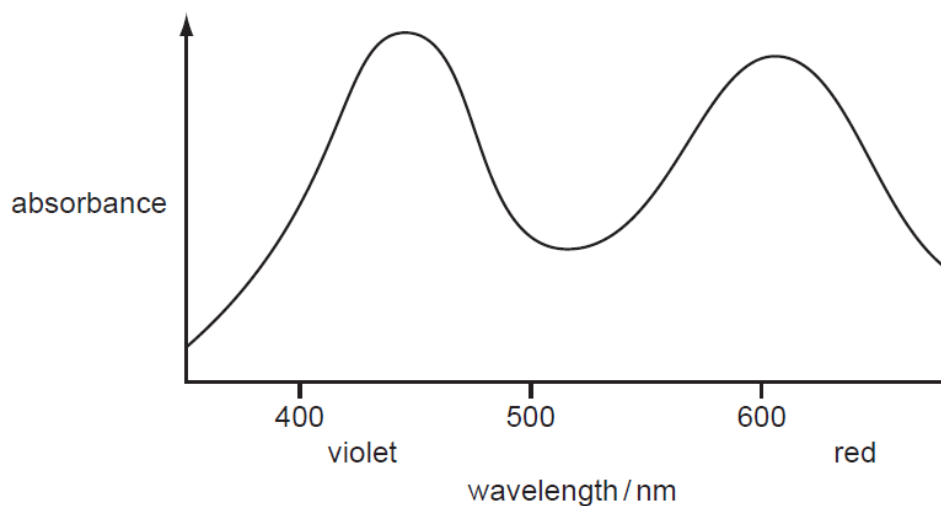
- **W** has the highest melting point among all the Period 3 elements.
- The chlorides of **Y** and **Z** are acidic while the chloride of **X** is neutral.
- The oxide of **Y** is basic while the oxide of **Z** is amphoteric.

Which of the following statements is correct?

- A The atomic radius increases in the following order: **W** < **Z** < **Y** < **X**.
- B The first ionisation energy decreases in the following order: **X** > **Y** > **Z** > **W**.
- C The pH of the chlorides decreases in the following order: **W** > **Z** > **Y** > **X**.
- D The electrical conductivity increases in the following order: **W** < **Z** < **Y** < **X**.

16. What can be seen when a piece of magnesium ribbon is placed in cold water?
- A A vigorous effervescence occurs.
  - B Bubbles of gas form slowly on the magnesium ribbon.
  - C The magnesium ribbon floats on the surface of the water and reacts quickly.
  - D The magnesium ribbon glows and a white solid is produced.
17. Aqueous chlorine is added to aqueous sodium bromide and the mixture is shaken with tetrachloromethane, an organic solvent. What observation would be made?
- A A colourless layer forms on top of a reddish brown layer.
  - B The solution in the test-tube turns orange.
  - C A brown solid is seen in a colourless solution.
  - D A yellowish-green gas is produced.

18. A compound of chromium has the general formula of  $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ . It is observed that 1 mole of this compound reacts with 3 moles of aqueous  $\text{AgNO}_3$ . Also, this compound gives the following absorption spectrum.



Colour	Wavelength (nm)
Violet	380 – 450
Blue	450 – 495
Green	495 – 570
Yellow	570 – 590
Orange	590 – 620
Red	620 – 750

Which of the following shows the correct structure of the chromium compound and its colour?

	Structure	Colour
A	$[\text{Cr}(\text{Cl})_2(\text{H}_2\text{O})_4]\text{Cl} \cdot 2\text{H}_2\text{O}$	Violet
B	$[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$	Green
C	$[\text{Cr}(\text{Cl})(\text{H}_2\text{O})_5]\text{Cl}_2 \cdot \text{H}_2\text{O}$	Orange
D	$[\text{Cr}(\text{Cl})_3(\text{H}_2\text{O})_3] \cdot 3\text{H}_2\text{O}$	Orange-violet

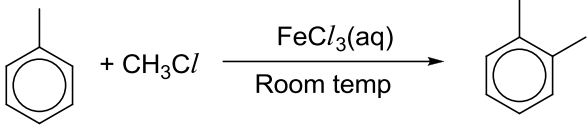
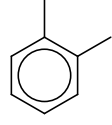
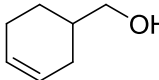
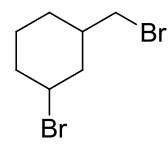
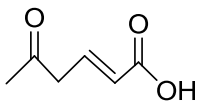
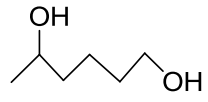
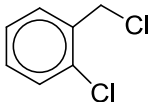
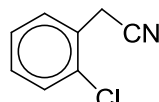
19. Compound **X**,  $C_3H_6O_3$

- can be oxidised by sodium dichromate(VI);
- reacts with  $NaBH_4$ .

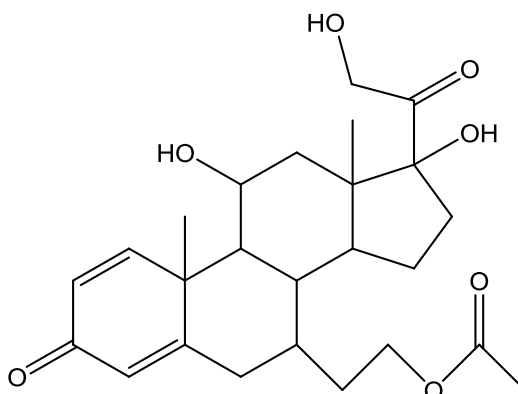
What could be **X**?

- A**  $CH_3COOCH_2OH$
- B**  $CH_3CH(OH)COOH$
- C**  $CH_3OCOCH_2OH$
- D**  $HOCH_2CH(OH)CHO$

20. Which transformation has a set of conditions that is correct?

- A**  +  $CH_3Cl \xrightarrow[\text{Room temp}]{FeCl_3(aq)}$  
- B**   $\xrightarrow[\text{Heat}]{NaBr, \text{conc } H_2SO_4}$  
- C**   $\xrightarrow[\text{in dry ether}]{LiAlH_4}$  
- D**   $\xrightarrow[\text{cold}]{HCN, NaCN(aq)}$  

21. Compound **W** has the following structure.



What reacts completely with 1 mole of **W**?

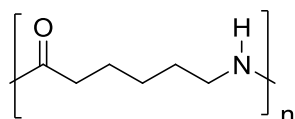
- A 4 mol of Na(s)
  - B 5 mol of HBr(g)
  - C 3 mol of NaOH(aq)
  - D 3 mol of 2,4-dinitrophenylhydrazine
22. Which liquid when shaken with AgNO<sub>3</sub> (aq) will give a precipitate in the shortest time?
- A tetrachloromethane
  - B propanoyl chloride
  - C 1-chlorobutane
  - D 2-chloropropene



23. For the following pairs of organic compounds, which reagent will be able to distinguish them?

			Reagent
<b>A</b>	$\text{CH}_3\text{CH}_2\text{CH}_3$	$\text{CH}_2=\text{CHCH}_3$	$\text{Cl}_2$ (g)
<b>B</b>	$\text{CH}_3\text{COCH}_2\text{I}$	$\text{CH}_3\text{CH}_2\text{CHO}$	$\text{I}_2$ in $\text{NaOH}$ (aq)
<b>C</b>	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$	$\text{NaOH}$ (aq)
<b>D</b>	$\text{CH}_3\text{CH}_2\text{CHO}$	$\text{HCOOH}$	Tollens' reagent

24. Nylon 6 is a type of polyamide that is used for construction materials due to its high tensile strength and resistance. A section of nylon 6 molecule is shown below.



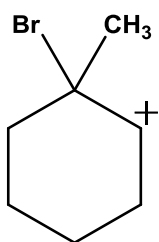
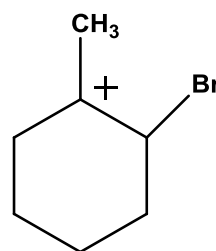
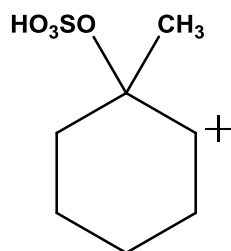
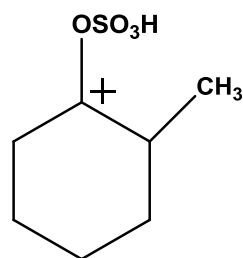
A sample of nylon 6 was subjected to a series of chemical reactions and Compounds **P**, **Q** and **R** were obtained at each step respectively.

	Reagent	Organic Compound
Step 1	Hot concentrated $\text{NaOH}$ , followed by careful acidification	<b>P</b>
Step 2	$\text{LiAlH}_4$ in dry ether	<b>Q</b>
Step 3	excess concentrated $\text{H}_2\text{SO}_4$ , heat	<b>R</b>

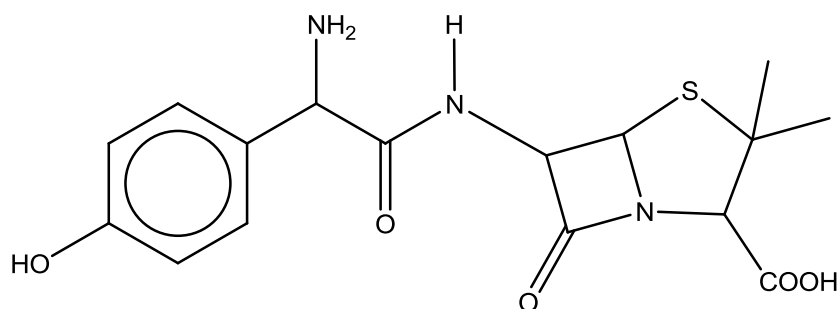
Which of the following statements is true?

- A** Compound **P** will react with 2,4-DNPH to produce orange precipitate.
- B** Compound **Q** gives off white fumes with  $\text{PCl}_5$ .
- C** Step 3 is an addition reaction.
- D** Compound **P** can undergo intramolecular nucleophilic substitution to form an amide.

25. Which of the following is the major intermediate for the reaction of 1-methylcyclohexene and bromine in the presence of concentrated magnesium hydrogensulfate,  $\text{Mg}(\text{OSO}_3\text{H})_2$ ?

**A****B****C****D**

26. The oxidation of alcohol **W** using hot acidified potassium manganate(VII) produced a compound of formula  $C_3H_6O$ . Which of the following reactions will produce the best yield of alcohol **W**?
- A Reacting 1-chloropropane with hot ethanolic NaOH
- B Reacting propanoic acid with  $LiAlH_4$
- C Reacting 2-chloropropane with hot aqueous NaOH
- D Reacting propene with cold water
27. Amoxicillin is an antibiotic useful for the treatment of bacterial infections, such as middle ear infections.

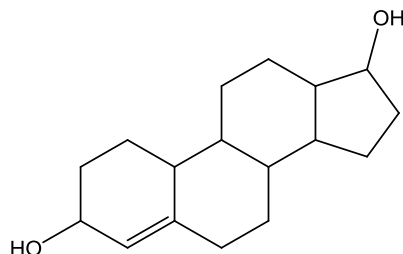


**Amoxicillin**

How many moles of  $NaOH(aq)$  will react with one mole of amoxicillin when it is heated under reflux with an excess of  $NaOH(aq)$ ?

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

28. Bolandiol is a banned synthetic anabolic steroid.



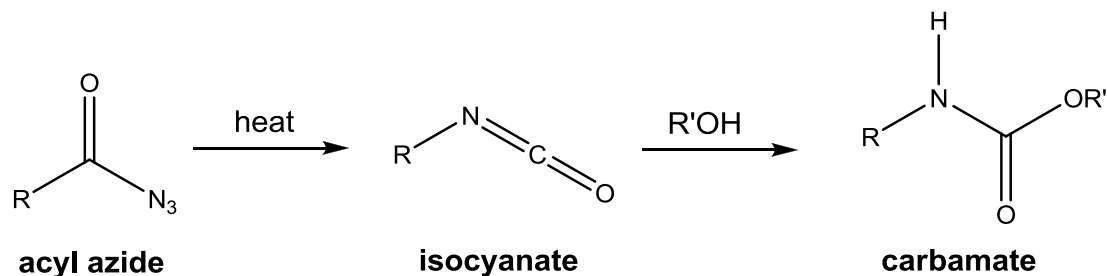
**Bolandiol**

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

- A** Bolandiol has  $2^7$  stereoisomers when reacted with liquid bromine.
- B** Passing hot aluminium oxide over bolandiol produces a compound with three double bonds.
- C** Orange potassium dichromate (VI) turns green when Bolandiol is heated with it.
- D** Bolandiol produces one mole of hydrogen gas when reacted with sodium metal.
29. When alkane **J**,  $C_6H_{14}$ , is reacted with bromine under ultraviolet light, only three isomeric monobromo compounds, **K**, **L**, and **M** are produced. Only compound **L** is chiral. What are the structures of **J** and **L**?

	<b>J</b>	<b>L</b>
<b>A</b>	$(CH_3)_3CCH_2CH_3$	$(CH_3)_3CCHBrCH_3$
<b>B</b>	$(CH_3)_2CHCH(CH_3)_2$	$(CH_3)CH(CH_2Br)CH(CH_3)_2$
<b>C</b>	$(CH_3)_2CHCH_2CH_2CH_3$	$(CH_3)_2CHCHBrCH_2CH_3$
<b>D</b>	$CH_3CH_2CH_2CH_2CH_2CH_3$	$CH_3CH_2CHBrCH_2CH_2CH_3$

30. The Curtius rearrangement can be used to produce carbamates from acyl azides. A general example of the Curtius rearrangement is shown below.



Which pair of compounds can be used to synthesise ethyl carbamate, CH<sub>3</sub>CH<sub>2</sub>OCONH<sub>2</sub>?

- A**
- 
- CH<sub>3</sub>CH<sub>2</sub>-C(=O)-N<sub>3</sub> + CH<sub>3</sub>OH
- B**
- 
- CH<sub>3</sub>-C(=O)-N<sub>3</sub> + CH<sub>3</sub>CH<sub>2</sub>OH
- C**
- 
- H-C(=O)-N<sub>3</sub> + CH<sub>3</sub>CH<sub>2</sub>OH
- D**
- 
- H-C(=O)-N<sub>3</sub> + CH<sub>3</sub>OH

## Section B

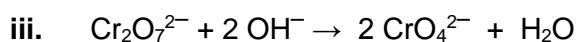
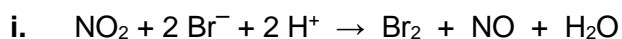
For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct. Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

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

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>1, 2 and 3</b> are correct	<b>1 and 2</b> only are correct	<b>2 and 3</b> only are correct	<b>1</b> only is correct

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

**31.** Which statements regarding the following reactions are true?

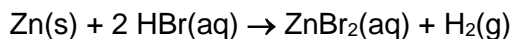


- 1** In reaction **i**, NO radical is produced.
- 2** NaH produced in reaction **ii** can act as an oxidising agent.
- 3** Reaction **iii** is a redox reaction as the number of oxygen atoms has decreased.

**32.** Which of the following sets of compounds consists of a giant ionic structure, a giant covalent structure and a simple covalent structure?

- 1**  $\text{AlF}_3$ , graphite,  $\text{BeCl}_2$
- 2**  $\text{AlBr}_3$ ,  $\text{P}_4\text{O}_{10}$ , Si
- 3**  $\text{Al}_2\text{O}_3$ ,  $\text{BF}_3$ ,  $\text{SiCl}_4$

33. Zinc reacts readily with dilute hydrobromic acid to form zinc bromide and hydrogen.



The standard enthalpy change for this reaction can be measured in the laboratory. What further information is needed in order to calculate the standard enthalpy change of formation of aqueous zinc bromide?

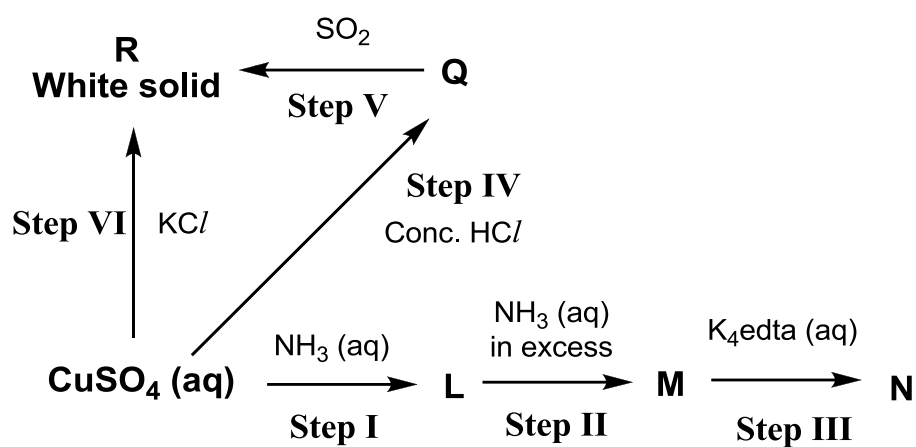
- 1  $\Delta H_f$  for HBr (aq)
- 2 1<sup>st</sup> and 2<sup>nd</sup> electron affinity of Zn
- 3  $\Delta H_f$  for H<sub>2</sub>(g)

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

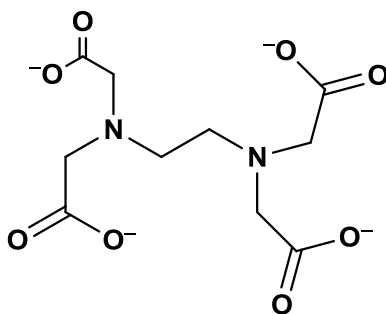
When chromium is heated separately with chlorine, bromine and iodine, which of the following can be obtained as the final product?

- 1 CrI<sub>2</sub>
- 2 CrCl<sub>3</sub>
- 3 CrBr<sub>3</sub>

35. The following shows a reaction scheme involving aqueous  $\text{CuSO}_4$ .



The structure of edta ion is as shown.

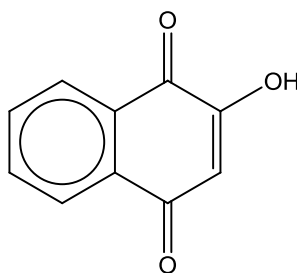


Which of the following statements regarding the reaction scheme are correct?

- 1  $\Delta S$  is positive for step III.
- 2 The d orbitals of Cu in species **Q** are degenerate.
- 3 Steps V and VI involve ligand exchange.



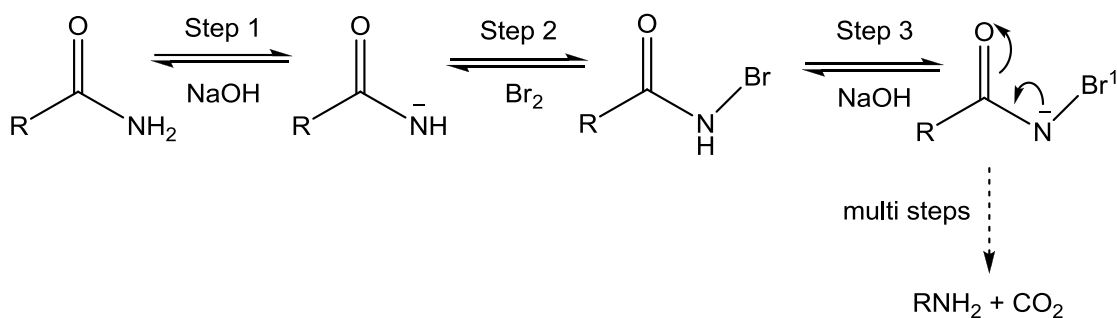
36. Lawsone is a dye which can be extracted from the henna plant, *Lawsonia inermis*.



**Lawsone**

Which of the following reagent will react with Lawsone?

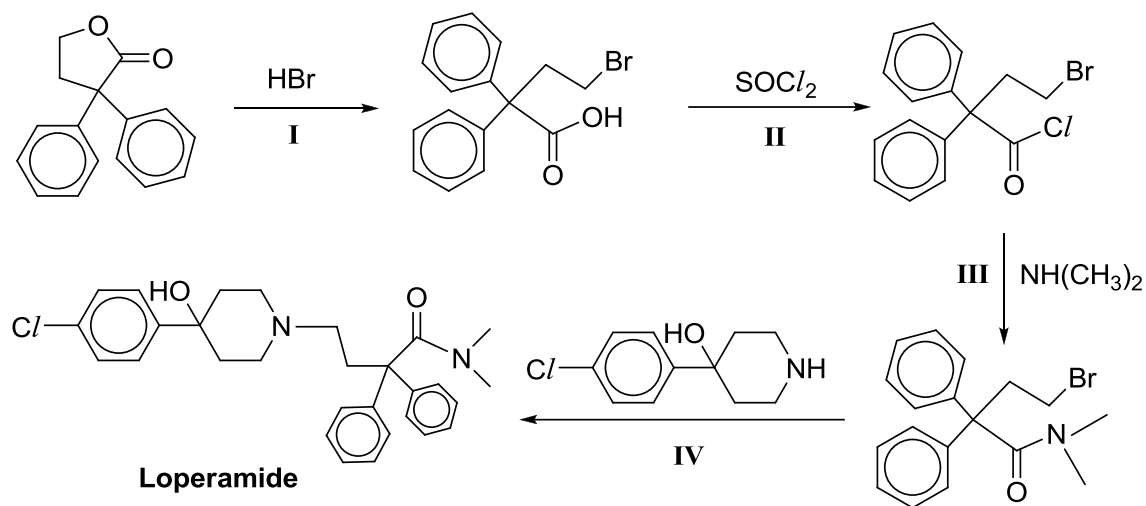
- 1  $\text{NH}_2\text{OH}$
  - 2  $[\text{Ag}(\text{NH}_3)_2]^+$
  - 3 Concentrated  $\text{HNO}_3$
37. An amine may be derived from an amide in a reaction known as Hoffmann rearrangement. Part of the mechanism is as shown:



Which of the following statements is likely to be true?

- 1  $\text{NaOH}$  is used as a base in Steps 1 and 3.
- 2  $\text{Br}_2$  is behaving as an electrophile in Step 2.
- 3 The oxidation state of  $\text{Br}^1$  in Step 3 is  $-1$ .

38. The active ingredient in anti-diarrhoea medicines is loperamide. The synthesis of loperamide is shown below.



What type of reaction is shown by at least one of the steps in the above route?

- 1 Hydrolysis
- 2 Nucleophilic substitution
- 3 Electrophilic substitution

39. Some of the amino acids found in soy protein are listed in the table below.

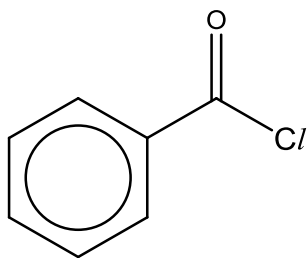
Amino acid	R-group
Cysteine	$-\text{CH}_2\text{SH}$
Threonine	$-\text{CH}(\text{OH})\text{CH}_3$
Glutamic acid	$-\text{CH}_2\text{CH}_2\text{COOH}$
Valine	$-\text{CH}(\text{CH}_3)_2$

Which of the following statements are true?

- 1 Adding a reducing agent will disrupt the disulfide bonds and denature the protein.
  - 2 The R-groups of glutamic acid and threonine will interact with each other through hydrogen bonds.
  - 3 Adding  $\text{NaOH}(\text{aq})$  will denature the protein.
40. Which of the following pairs of compounds would produce an amide when reacted together?

- 1  $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)_2\text{NH}_2$  and  $\text{CH}_3\text{COCl}$

2



and  $(\text{CH}_3)_3\text{N}$

- 3  $\text{CH}_3\text{CH}(\text{CH}_3)\text{NH}_2$  and  $\text{CH}_3\text{COOH}$

**END OF PAPER**