

NANYANG JUNIOR COLLEGE  
JC 2 PRELIMINARY EXAMINATION  
Higher 2

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## CHEMISTRY

Paper 1 Multiple Choice

**9647/01**

**27 September 2016**

**1 hour**

Additional Materials: Multiple Choice Answer Sheet  
Data Booklet

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### READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class and tutor's name on the Answer Sheet in the spaces provided unless this has been done for you.

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.

## Section A

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

- 1 In an experiment, lanthanum,  $^{57}\text{La}$ , was reacted with hydrogen to produce the non-stoichiometric ionic compound  $\text{LaH}_{2.9}$ . Assuming that the compound contains  $\text{H}^-$ ,  $\text{La}^{2+}$  and  $\text{La}^{3+}$ , what is the percentage of  $\text{La}^{3+}$  present in  $\text{LaH}_{2.9}$ ?

**A** 10%  
**B** 20%  
**C** 80%  
**D** 90%

- 2 The two most common isotopes of titanium are  $^{56}_{22}\text{Ti}$  and  $^{58}_{22}\text{Ti}$ .

Which statement about the isotopes of titanium is correct?

**A** Both isotopes have more electrons than neutrons.  
**B** One of the isotopes has more protons than the other.  
**C** The electronic configuration of  $\text{Ti}^{2+}$  ion for both isotopes is the same.  
**D** In the same electric field strength,  $^{56}_{22}\text{Ti}$  will be deflected more than  $^{58}_{22}\text{Ti}$ .

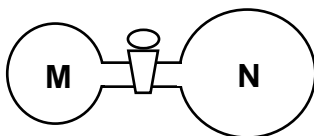
- 3 Which compound does **not** have a co-ordinate bond?

**A**  $\text{CO}$                       **B**  $\text{CS}_2$                       **C**  $\text{NO}_3^-$                       **D**  $\text{NH}_4^+$

- 4 In which of the following pairs do the species have the same bond angle?

**A**  $\text{H}_2\text{O}_2$  and  $\text{N}_2\text{F}_2$                       **B**  $\text{PH}_3$  and  $\text{SF}_3^+$   
**C**  $\text{POCl}_3$  and  $\text{SO}_3^{2-}$                       **D**  $\text{HCHO}$  and  $\text{BrF}_3$

- 5 Two glass vessels **M** and **N** are connected by a closed valve.



**M** contains helium at 20 °C at a pressure of  $1 \times 10^5$  Pa. **N** has been evacuated, and has three times the volume of **M**. In an experiment, the valve is opened and the temperature of the whole apparatus is raised to 100 °C.

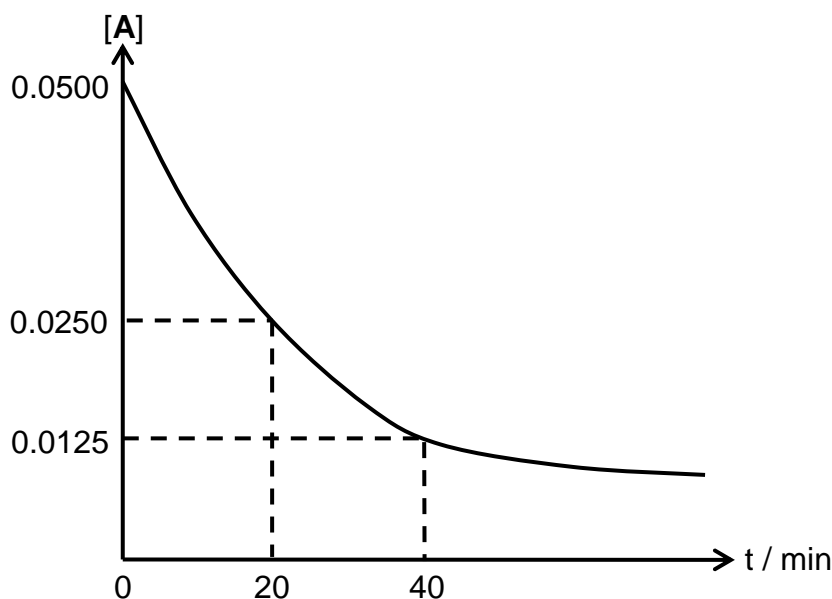
What is the final pressure in the system?

- A  $3.18 \times 10^4$  Pa
  - B  $4.24 \times 10^4$  Pa
  - C  $1.25 \times 10^5$  Pa
  - D  $5.09 \times 10^5$  Pa
- 6 Which value would be required to estimate the lattice energy for the hypothetical ionic compound MgH?
- A the electronic affinity of hydrogen
  - B the first ionisation energy of hydrogen
  - C the magnesium–hydrogen bond energy
  - D the standard enthalpy change of formation of  $\text{MgH}_2$

- 7 A student performed an experiment to investigate a hypothetical reaction.



The graph of  $[\text{A}]$  against time( $t$ ) for the experiment is shown below.



Given that the initial  $[\text{B}]$  is  $2.0 \text{ mol dm}^{-3}$  and units for the rate constant is  $\text{mol}^{-1} \text{ dm}^3 \text{ min}^{-1}$ , which of the following statements is true?

- A The reaction is elementary.
  - B The half-life of the reaction remains constant when a catalyst is added.
  - C The gradient of tangent at  $t = 0 \text{ min}$  increases by four times when the initial  $[\text{B}]$  doubles.
  - D The half-life of the reaction remains constant when  $[\text{A}]$  doubles but halved when  $[\text{B}]$  doubles.
- 8 Glauber's salt,  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ , was used by J. R. Glauber in the 17<sup>th</sup> century as a medicinal agent. At  $25^\circ\text{C}$ , the numerical value of the equilibrium constant,  $K_p$  for the loss of water of hydration from Glauber's salt is  $4.08 \times 10^{-25}$ .



Which of the following statements can be correctly deduced about this equilibrium reaction?

- A The reaction reaches dynamic equilibrium when the forward and reverse rate constants are equal.
- B The numerical value of the vapour pressure of water at  $25^\circ\text{C}$  in a closed container holding a sample of  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}(\text{s})$  is  $3.64 \times 10^{-3}$ .
- C The ratio of the hydrated form to anhydrous form of the Glauber's salt remains the same when nitrogen gas is added while keeping the total pressure of the system constant.
- D The numerical value of  $K_p$  will increase when temperature is increased.

- 9 Highly toxic disulfur decafluoride decomposes by a free-radical process.



In a study of the decomposition,  $\text{S}_2\text{F}_{10}$  was placed in a  $2.0 \text{ dm}^3$  flask and heated to  $100^\circ\text{C}$ . The equilibrium  $[\text{S}_2\text{F}_{10}]$  was found to be  $0.5 \text{ mol dm}^{-3}$ . More  $\text{S}_2\text{F}_{10}$  was then added and the new equilibrium  $[\text{S}_2\text{F}_{10}]$  was  $2.5 \text{ mol dm}^{-3}$ .

What is the amount of  $\text{S}_2\text{F}_{10}$  reacted in terms of the equilibrium constant,  $K_c$  of the decomposition reaction when more  $\text{S}_2\text{F}_{10}$  was added?

- A  $(0.5K_c)^{0.5} - (2.5K_c)^{0.5}$
- B  $(2.5K_c)^{0.5} - (0.5K_c)^{0.5}$
- C  $(2K_c)^{0.5} - (10K_c)^{0.5}$
- D  $(10K_c)^{0.5} - (2K_c)^{0.5}$

- 10 Phosphorus acid,  $\text{H}_3\text{PO}_3$ , has two acid dissociation values:

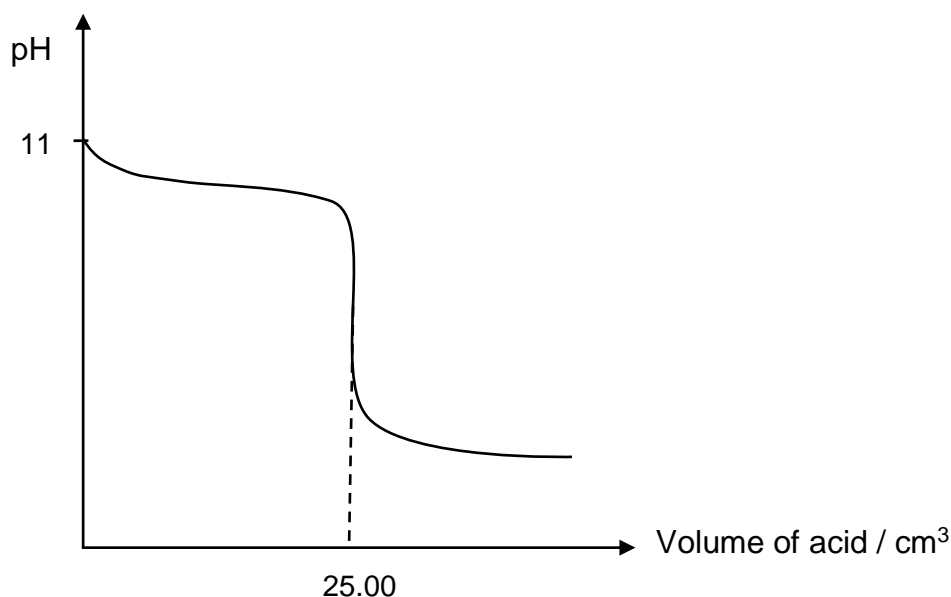
$$K_{a1} = 1.0 \times 10^{-2} \text{ mol dm}^{-3} \quad K_{a2} = 2.5 \times 10^{-7} \text{ mol dm}^{-3}$$

Which of the following statements is correct about  $\text{H}_3\text{PO}_3$ ?

- I:  $\text{H}_3\text{PO}_3$  is a dibasic acid as one of the H atom is bonded to P atom.
- II: The  $K_b$  values of  $\text{H}_2\text{PO}_3^-$  and  $\text{HPO}_3^{2-}$  are  $4.0 \times 10^{-12}$  and  $1.0 \times 10^{-12}$  respectively.
- III:  $K_{a2}$  is smaller than  $K_{a1}$  because it gets increasingly difficult to remove a  $\text{H}^+$  from a negatively charged ion.

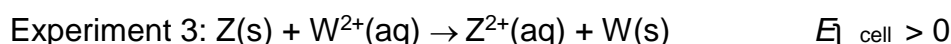
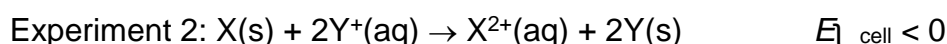
- A I only
- B I & III
- C II & III
- D All statements are correct

- 11 The diagram below shows the change of pH produced when 20.0 cm<sup>3</sup> of trimethylamine was titrated with 0.01 mol dm<sup>-3</sup> of HCl(aq) at 25 °C.



Which of the following statements is **incorrect**?

- A The  $K_b$  value of trimethylamine is  $8.00 \times 10^{-5}$ .
  - B When 35.00 cm<sup>3</sup> of acid is added, pH of the solution is 2.7.
  - C Phenolphthalein is not a suitable indicator for the above titration.
  - D When concentration of HCl is doubled, the end point volume of the titration would be halved while the pH at equivalence point would remain the same.
- 12 The e.m.f of three different experiments was measured under standard conditions and the results are shown below:



Which of the following statements is correct?

- A  $Z^{2+}$  is the strongest oxidising agent.
  - B If concentration of  $Y^+(aq)$  is lowered in experiment 2, the  $E_{\text{cell}}$  would be more positive.
  - C The reaction of  $Z(s) + W^{2+}(aq) \rightarrow Z^{2+}(aq) + W(s)$  is spontaneous.
  - D The reducing power decreases in the order  $Z > W > Y > X$ .
- 13 In a lead-acid battery reaction, the charging process is achieved by passing an electric current through the cell. The overall reaction equation for the charging process is given below.

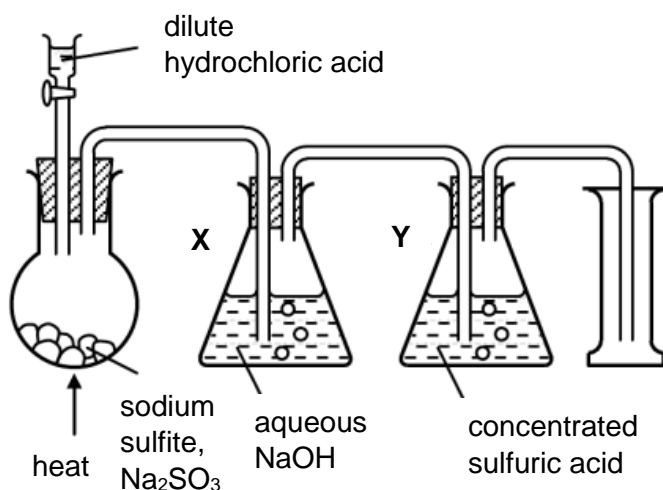


After charging,  $\text{PbSO}_4$  on one plate is converted to  $\text{PbO}_2$ . The other plate is converted to  $\text{Pb}$ . When the two plates are connected, a current will flow, enabling the discharging process to take place.

Which species is oxidised when the battery is discharged?

- A Pb
- B  $\text{H}_2\text{O}$
- C  $\text{PbO}_2$
- D  $\text{SO}_4^{2-}$

- 14 The diagram represents an **unsuccessful** attempt to prepare and collect sulfur dioxide.



Which modification would make the experiment successful?

- A omitting flask X entirely
- B omitting flask Y entirely
- C using dilute sulfuric acid instead of dilute hydrochloric acid
- D collecting by upward delivery

- 15 Which of the following statements for strontium or its compounds is **incorrect**?
- A Strontium sulfate is sparingly soluble in water.
  - B Strontium hydroxide is dehydrated to the oxide on strong heating.
  - C Strontium reacts with cold water to form strontium oxide and hydrogen.
  - D Strontium carbonate decomposes at a higher temperature than calcium carbonate.
- 16 Letters written on paper using aqueous ammonium thiocyanate are invisible until turned blood red by brushing the paper with aqueous iron(III) chloride. If the ammonium thiocyanate is first made alkaline, the letters are orange and less clear.
- Which of the following statements is correct?
- A The colour changes are due to ligand exchange reactions only.
  - B Aqueous iron(III) chloride can exist as  $[\text{Fe}(\text{OH})(\text{H}_2\text{O})_5]^{2+}$  in solution.
  - C With aqueous ammonium thiocyanate,  $[\text{Fe}(\text{SCN})(\text{H}_2\text{O})_5]^{3+}$  complex is formed.
  - D With alkaline ammonium thiocyanate, the letters are less clear because a less stable complex is formed.
- 17 For the sequence hydrogen chloride, hydrogen bromide and hydrogen iodide, there is a decrease in
- I volatility
  - II  $\text{p}K_{\text{a}}$  value
  - III thermal stability
  - IV reducing power
- A I & IV
  - B II & III
  - C I, II & III
  - D All of the above
- 18 A mixture of 1 mol of chlorine and 1 mol of bromine was reacted completely with iron(II) solution. The resulting mixture was subsequently treated with excess  $\text{AgNO}_3(\text{aq})$ . After standing for 5 minutes, excess dilute  $\text{NH}_3(\text{aq})$  was added to the mixture and filtered to obtain filtrate **F** and residue **G**.
- Which of the following statements is correct?
- A If excess  $\text{HNO}_3(\text{aq})$  is added to filtrate **F**, a white precipitate of mass 143.5 g will be obtained.
  - B Mass of residue **G** is 376 g.
  - C Filtrate **F** contains  $[\text{Ag}(\text{NH}_3)_2]^+$ ,  $\text{Cl}^-$  and  $\text{Fe}^{3+}$  ions.
  - D Residue **G** is made up of more than one precipitate.



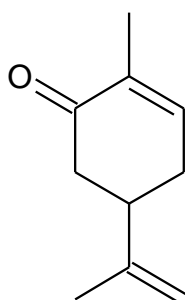
- 19** Cracking is a thermal decomposition process by which large hydrocarbon molecules are broken down by passing them over a heated catalyst at high pressure. The products are smaller alkanes and alkenes.

The cracking of a single hydrocarbon molecule,  $C_nH_{2n+2}$ , produces two hydrocarbon molecules only. Each hydrocarbon product contains the same number of carbon atoms in one molecule. Each hydrocarbon product has non-cyclic structural isomers.

What is the value of  $n$ ?

- A** 4                      **B** 6                      **C** 8                      **D** 9

- 20** Carvone is found in spearmint.



Carvone

How many  $\sigma$  and  $\pi$  bonds are present in this molecule?

- |          | $\sigma$ | $\pi$ |
|----------|----------|-------|
| <b>A</b> | 11       | 6     |
| <b>B</b> | 13       | 6     |
| <b>C</b> | 25       | 3     |
| <b>D</b> | 25       | 6     |

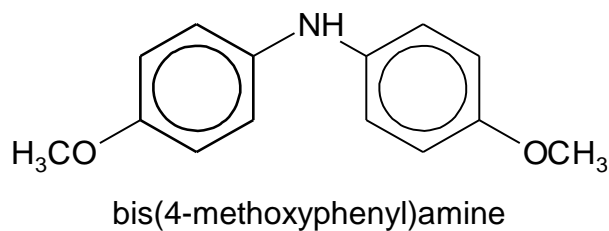
- 21** Many different compounds have been used in aerosol sprays, refrigerators and in making foamed plastics.

Which compound will cause the most ozone depletion?

- A**  $CCl_3F$   
**B**  $CH_2FCHClF$   
**C**  $CH_3CH_2CH_2CH_3$   
**D**  $N_2O$

22 The reactivity of methoxybenzene,  $\text{C}_6\text{H}_5\text{OCH}_3$  is similar to that of phenol.

How many moles of aqueous nitric acid are required to react with one mole of bis(4-methoxyphenyl)amine?

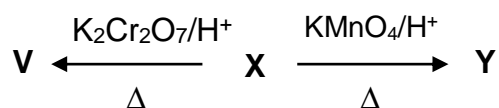


- A 2
- B 3
- C 4
- D 5

23 Which of the following will **not** yield a final organic product containing deuterium? ( $\text{D} = {}^2\text{H}$ )

	compound	reagents and conditions
A		$\text{DCI}$ , $\text{D}_2\text{O}$ , heat under reflux
B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{COCl}$	$\text{D}_2\text{O}$ , room conditions
C	$\text{CH}_3\text{CH}_2\text{CHO}$	$\text{DCN}$ , trace $\text{NaCN}$ , $15^\circ\text{C}$
D		$\text{CH}_3\text{OD}$ , conc $\text{D}_2\text{SO}_4$ , heat under reflux

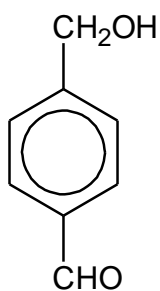
- 24 Compound **X** is used to synthesize DEET, a common active ingredient in mosquito repellent. A brick-red precipitate is observed when it reacts with Fehling's reagent. 1 mol of **X** undergoes the following reactions.



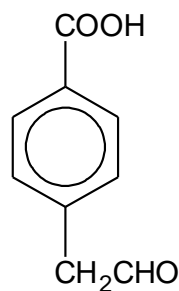
**Y** reacts with  $\text{HNO}_3$  under suitable conditions to produce only 1 possible organic product. **V** reacts with  $\text{Na}_2\text{CO}_3$  to produce only 1 mol of  $\text{CO}_2(\text{g})$ .

What could **X** be?

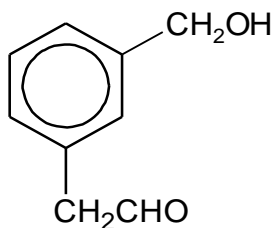
**A**



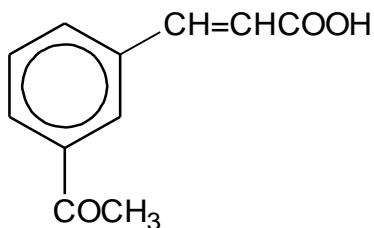
**B**



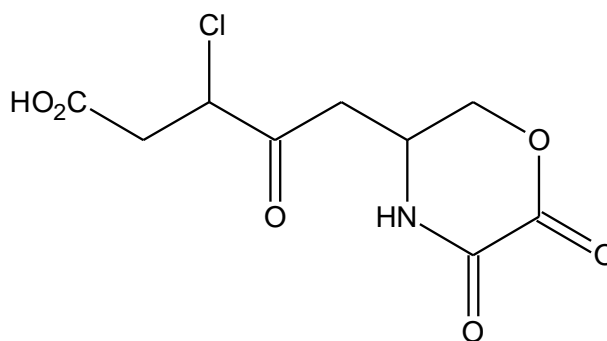
**C**



**D**



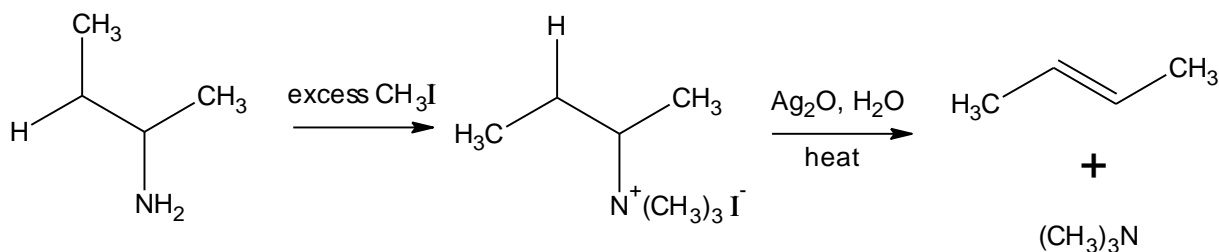
25 Which of the following statements about compound **W** is correct?



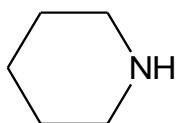
compound **W**

- A** An aqueous solution of **W** is approximately neutral as there is 1 carboxylic acid group and 1 amine group present in the structure.
- B** The product formed when **W** is reduced by  $\text{LiAlH}_4$  will react with  $\text{Na}$  to produce 2 moles of  $\text{H}_2(\text{g})$ .
- C** The reduction of **W** by  $\text{LiAlH}_4$  will cause the oxidation state of any carbon involved in the reduction to decrease from +3 to -1.
- D** **W** will require 3 moles of  $\text{NaOH}(\text{aq})$  for complete reaction if the reaction is to take place with heating.

- 26** The Hofmann elimination is a process where an amine undergoes treatment with excess methyl iodide to form a tertiary amine intermediate followed by treatment with silver oxide, water and heat to form an alkene.

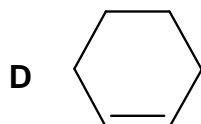
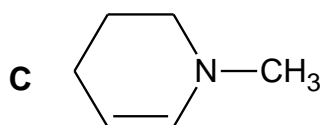


What is the structure of the alkene formed when a cyclic amine, piperidine, undergoes the Hofmann elimination?

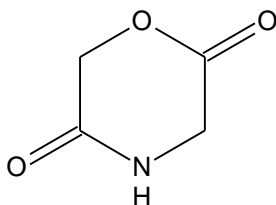


Piperidine

- A**  $\text{CH}_2=\text{CHCH}_2\text{CH}_2\text{CH}_2\text{N}(\text{CH}_3)_2$   
**B**  $\text{CH}_2=\text{CHCH}_2\text{CH}_2\text{CH}_3$



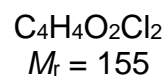
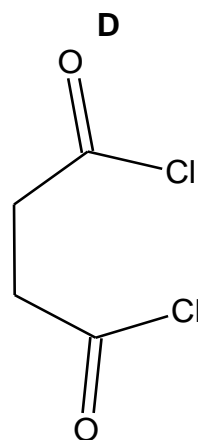
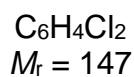
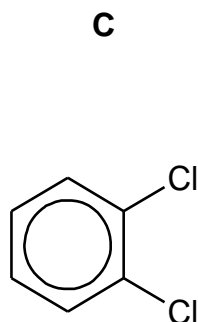
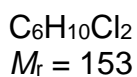
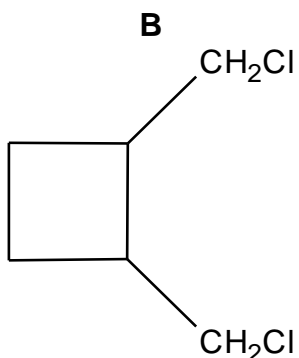
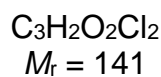
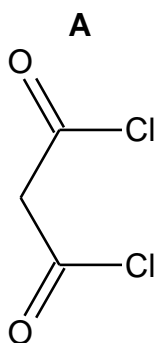
- 27** Which of the following compounds can be used, in a 1-step conversion, to produce the following cyclic structure?



- A**  $\text{HO}_2\text{CCH}_2\text{NH}_2$  and  $\text{HO}_2\text{CCH}_2\text{OH}$   
**B**  $\text{HO}_2\text{CCH}_2\text{CONHCH}_2\text{OH}$   
**C**  $\text{ClOCCH}_2\text{COCl}$  and  $\text{H}_2\text{NCH}_2\text{OH}$   
**D**  $\text{ClOCCH}_2\text{OH}$  and  $\text{H}_2\text{NCH}_2\text{CO}_2\text{H}$

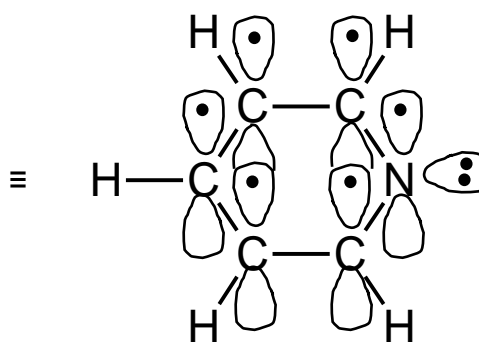
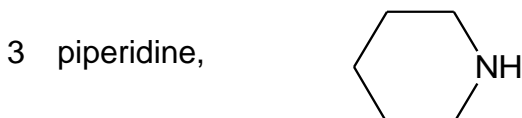
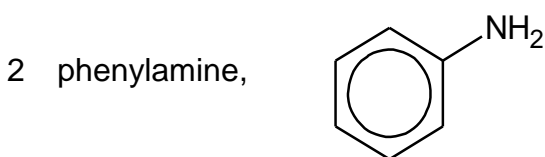
- 28 One gram of each of the following compounds was heated with NaOH(aq), and then dilute HNO<sub>3</sub>(aq) and AgNO<sub>3</sub>(aq) were added.

Which compound will produce the largest mass of AgCl(s) in 30 seconds?



- 29 Consider the following four compounds.

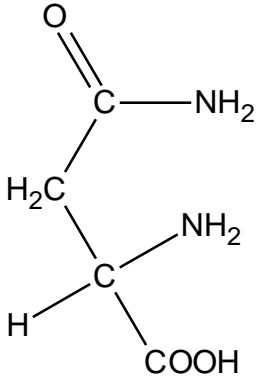
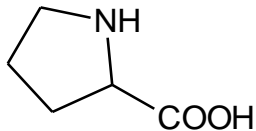
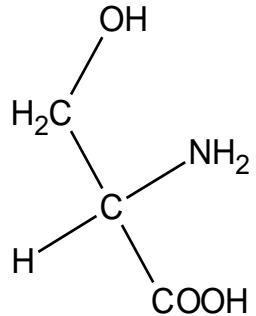
1 ethanamide,  $\text{CH}_3\text{CONH}_2$



What is the relative order of decreasing basicity of these compounds?

- |          |   |   |   |   |
|----------|---|---|---|---|
| <b>A</b> | 3 | 2 | 1 | 4 |
| <b>B</b> | 3 | 2 | 4 | 1 |
| <b>C</b> | 3 | 4 | 2 | 1 |
| <b>D</b> | 3 | 4 | 1 | 2 |

30 Upon complete hydrolysis, 1 mol of polypeptide **X** gives the following amino acids.

amino acid	structure	$M_r$	mass of amino acid / g
asparagine		132	16.8
proline		115	7.3
serine		105	13.3

What is the  $M_r$  of **X**?

- A** 352
- B** 499
- C** 517
- D** 589

## 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 which 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 only</b> is correct

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

- 31** The hexagonal form of boron nitride, h-BN, is analogous to graphite where it has a planar hexagonal layered structure of alternating boron and nitrogen atoms.

Which properties are shown by h-BN?

- 1** Its N atoms are  $sp^2$  hybridised.
- 2** It can be used as a dry lubricant.
- 3** It is soluble in organic solvents but not soluble in water.

- 32** Which of the following has the same value as the standard enthalpy change of formation of carbon monoxide?

- 1**  $\Delta H_f(\text{CO}_2) - \Delta H_f(\text{CO})$
- 2**  $\Delta H_f(\text{CO}) - \Delta H_f(\text{graphite})$
- 3**  $\frac{1}{2} \Delta H_f(\text{CO}_2)$

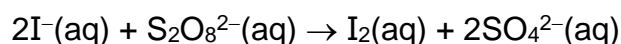


The responses **A** to **D** should be selected on the basis of

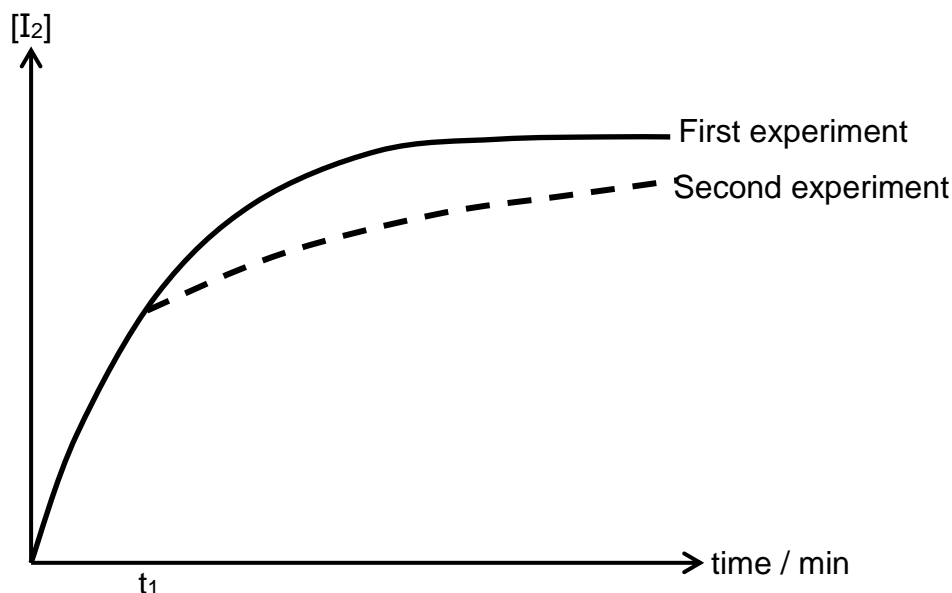
<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

**33** A student investigated the reaction between iodide and peroxodisulfate.

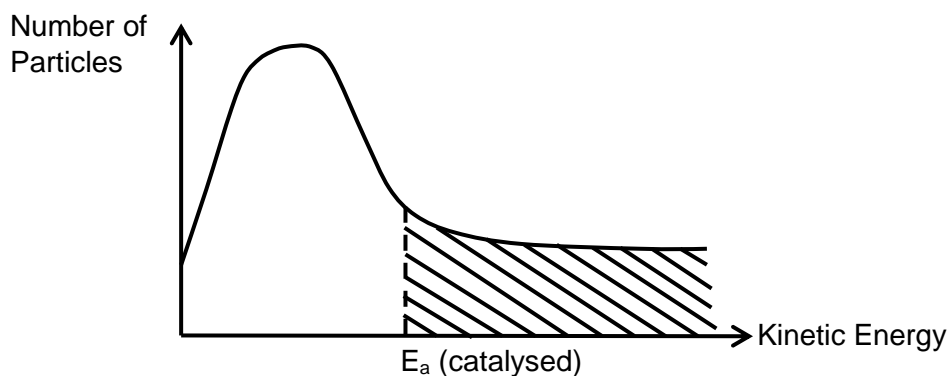


He first performed the experiment by adding  $\text{Fe}^{3+}(\text{aq})$  as catalyst. He then performed a second experiment under the same condition but did a change at  $t_1$ . The graphs of  $[\text{I}_2]$  against time for both experiments are shown below.



Which of the following statements are correct?

- 1 acidified  $\text{VO}_2\text{Cl}(\text{aq})$  can also be used as a catalyst.
- 2 Sodium cyanide could have been added at  $t_1$ .
- 3 The Boltzmann distribution graph for the first experiment is as follow



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 only</b> is correct

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

**34** Phosphorus is an element in the third period, Na to Ar, of the Periodic Table.

What is true for phosphorus and none of the other elements in this period?

- 1** Phosphorus is the only element in this period with exactly four atoms in its molecules.
- 2** Phosphorus is the only element in this period which forms two acidic oxides.
- 3** Phosphorus is the only element in this period whose chlorides react with water to form acidic solutions.

**35** Which of the statements of the Group II elements (magnesium to barium) or their compounds is correct?

- 1** Reactivity of Group II elements with oxygen increases down the group.
- 2** The volume of acidic gas evolved from the decomposition of 1 mol of Group II nitrate is four times that of the neutral gas evolved.
- 3** Solubility of the Group II sulfates decreases down the group.

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 only</b> is correct

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

**36** The use of the *Data Booklet* is relevant to this question.

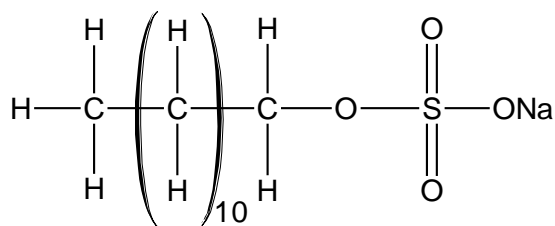
Which of the following species would convert manganese(II) sulfate to manganese(IV) oxide in acidic solution?

- 1**  $\text{Pb}(\text{NO}_3)_4$
- 2**  $\text{Na}_2\text{S}_2\text{O}_8$
- 3**  $\text{CoCl}_2$

**37** Which of these **always** applies to a nucleophile?

- 1** It has a lone pair of electrons.
- 2** It is negatively charged.
- 3** It attacks a double bond.

**38** Long-chain alkanes are converted on an industrial scale into alkylsulfates for use as detergents, e.g. sodium lauryl sulfate.



sodium lauryl sulfate

What deductions about the properties of this substance can be made from this structure?

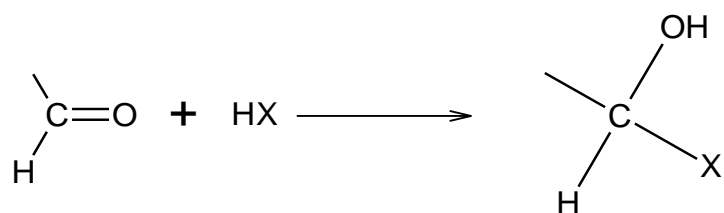
- 1** Part of the structure is polar and is hydrophilic.
- 2** The alkyl chain is soluble in oil droplets.
- 3** All the C–C–C bond angles are  $109^\circ$ .

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 only</b> is correct

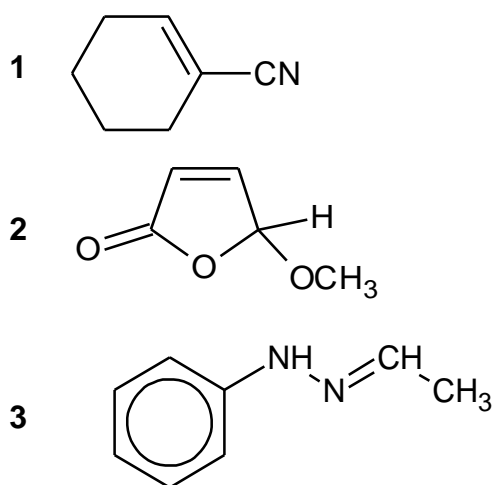
No other combination of statements is used as a correct response.

**39** There is a range of reactions of the aldehyde group which have the pattern



of which the formation of a cyanohydrin (where  $\text{X} = \text{CN}$ ) is one.

Which compounds could be obtained by such an addition to an aldehyde group, followed by a dehydration?



**40** Which of the following reactions produce a carbocation as an intermediate product and an organic molecule containing a chiral centre that is optically inactive as the final product?

- 1**  $\text{C}_6\text{H}_{10} + \text{HBr} \rightarrow \text{C}_6\text{H}_{11}\text{Br}$
- 2**  $\text{CH}_3\text{CH}=\text{CH}_2 + \text{Br}_2 + \text{NaNO}_3 \rightarrow \text{CH}_3\text{CH}(\text{ONO}_2)\text{CH}_2\text{Br} + \text{NaBr}$
- 3**  $\text{CH}_3\text{C}(\text{CH}=\text{CH}_2)(\text{CH}_2\text{CH}_3)\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{C}(\text{CH}=\text{CH}_2)(\text{CH}_2\text{CH}_3)\text{OH} + \text{NaBr}$