



CATHOLIC JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS
Higher 2

CHEMISTRY

Paper 1 Multiple Choice

9647/01

FRIDAY 16 SEPTEMBER 2011

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.

Write and/or shade your name, NRIC / FIN number and HT group on the Multiple Choice Answer Sheet in the spaces provided.

There are **40 MCQ** questions in 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 Multiple Choice 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.

Calculators may be used.

Section A

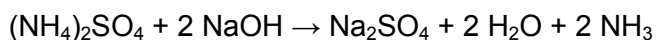
For each question there are **four** possible answers, **A**, **B**, **C** and **D**. Choose the one you consider to be **correct** and record your choice in soft pencil on the **separate Answer Sheet** provided.

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

How many atoms of oxygen are present in 24 cm³ of oxygen gas under room conditions?

- A $24 \times 6.02 \times 10^{23} \times 32$
 B $\frac{2 \times 24 \times 24000}{6.02 \times 10^{23}}$
 C $\frac{2 \times 6.02 \times 10^{23}}{24000}$
 D $\frac{2 \times 6.02 \times 10^{23}}{1000}$

- 2 5.00 g of a fertilizer containing ammonium sulfate was dissolved in water and diluted to 250 cm³. 25.0 cm³ of this solution was added to an excess of sodium hydroxide solution. The reaction between ammonium sulfate and sodium hydroxide is given by the following equation:



The ammonia produced was passed into 50.0 cm³ of 0.050 mol dm⁻³ sulfuric acid solution. The residual acid then required 25.80 cm³ of 0.100 mol dm⁻³ sodium hydroxide solution for complete neutralisation.

What is the percentage by mass of ammonium sulfate ($M_r = 132.1$) in the fertiliser?

- A 10.6% B 16.0% C 32.0% D 40.0%
- 3 A student made up a 0.100 mol dm⁻³ solution of Ba(OH)₂·8H₂O which he found in the laboratory cupboard and left the solution in an open beaker. A week later, he returned to the laboratory, used the solution for titration with 0.100 mol dm⁻³ HCl and was surprised to discover his titres were lower than expected.

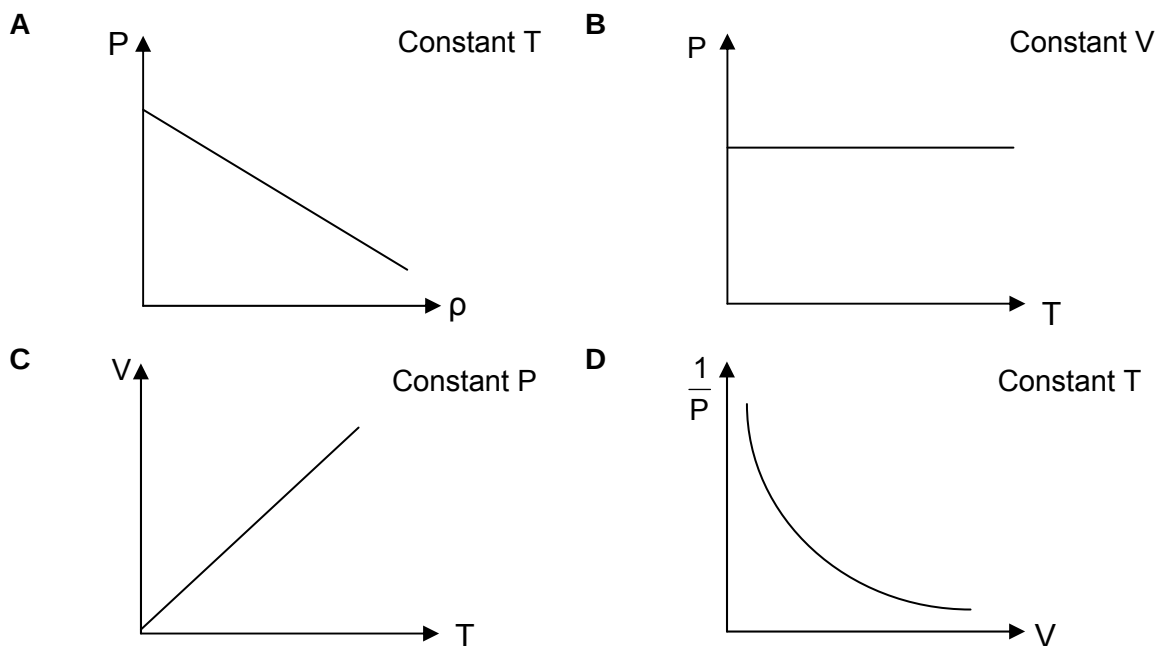
Which one of the following reasons explains why the volumes of HCl used were lower than expected?

- A Some water had evaporated from the barium hydroxide solution.
 B The concentration of HCl was less than the stated 0.100 mol dm⁻³.
 C The barium hydroxide crystals had less water of crystallization than stated.
 D Some of the barium hydroxide had reacted with carbon dioxide in the air to form solid barium carbonate.

- 4 Which of the following electronic configurations represents an element that most likely forms a simple ion with a charge of -3?

- A $1s^2 2s^2 2p^6 3s^2 3p^1$
 B $1s^2 2s^2 2p^6 3s^2 3p^3$
 C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$
 D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$

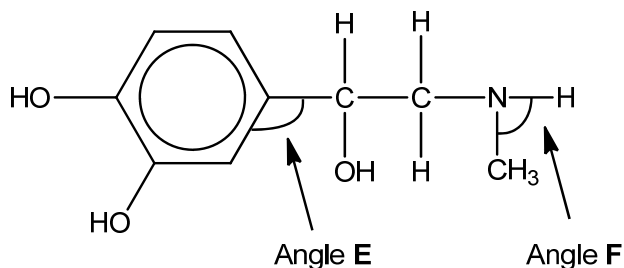
- 5 Which graph best represents the behaviour of a fixed mass of ideal gas under the given conditions? (where ρ is the density of the gas)



- 6 In which one of the following pairs of species is the melting point of the first member lower than that of the second member?

- A diamond, graphite
 B H_2O , NH_3
 C Br_2 , ICl
 D pentane, 2,2-dimethylpropane

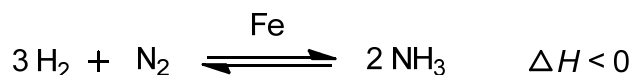
- 7 **Adrenaline** is a hormone which, when secreted directly into the blood stream, acts as a stimulant. It has the following structure:



What are the values of angle **E** and angle **F** in a molecule of **adrenaline**?

	angle <i>E</i>	angle <i>F</i>
A	120°	107°
B	120°	90°
C	109°	107°
D	109°	90°

- 8 Ammonia is manufactured industrially via the Haber process where nitrogen and hydrogen is passed through an iron catalyst at high temperature and pressures.



Which of the following statements is true for the above reaction?

- A** The activation energy of the forward and backward reaction is the same.
- B** An increase in temperature increases the rate constant but decreases the equilibrium constant.
- C** The reaction is carried out at high temperatures because it will favour the formation of ammonia.
- D** Increasing the concentration of H_2 and N_2 causes the equilibrium constant of the reaction to increase as more ammonia is formed.
- 9 Which of the following processes is spontaneous only at high temperatures?

- A** $2 \text{CO(g)} + 2 \text{NH}_3\text{(g)} \rightarrow \text{C}_2\text{H}_6\text{(g)} + 2 \text{NO(g)}$ $\Delta H = +409 \text{ kJ mol}^{-1}$
- B** $2 \text{NO(g)} + \text{O}_2\text{(g)} \rightarrow 2 \text{NO}_2\text{(g)}$ $\Delta H = -114 \text{ kJ mol}^{-1}$
- C** $\text{N}_2\text{O(g)} \rightarrow \text{N}_2\text{(g)} + \frac{1}{2} \text{O}_2\text{(g)}$ $\Delta H = -82 \text{ kJ mol}^{-1}$
- D** $\text{CO}_2\text{(g)} + 2 \text{H}_2\text{O(l)} \rightarrow \text{CH}_4\text{(g)} + 2 \text{O}_2\text{(g)}$ $\Delta H = +890 \text{ kJ mol}^{-1}$

- 10** Gallstones can form in the gall bladder. Patients who have gallstones may experience great pain. The component of gallstones is calcium ethanedioate which is insoluble in water. The corresponding magnesium ethanedioate is however, soluble in water.

Which factor accounts for the difference in the solubility between magnesium ethanedioate and calcium ethanedioate?

- A** Magnesium ethanedioate has a lower solubility product than calcium ethanedioate.
- B** Magnesium ethanedioate has a lower lattice energy than calcium ethanedioate.
- C** Magnesium ions have a higher hydration energy than calcium ions.
- D** Magnesium is less electropositive than calcium.

- 11** Two substances **A** and **B** react according to the following equation:



To determine the order of reaction with respect to each substance, four experiments were performed and the results are shown below:

Experiment	[A] / mol dm ⁻³	[B] / mol dm ⁻³	Initial rate of formation of C / mol dm ⁻³ min ⁻¹
1	0.10	0.10	0.0010
2	0.40	0.10	0.0160
3	0.10	0.20	0.0020
4	0.20	0.20	?

Which is the correct value for the initial rate of formation of **C** for experiment 4?

- A** 0.0040 **B** 0.0080 **C** 0.0160 **D** 0.0320
- 12** The pH of normal human blood is 7.4. Strenuous exercise can cause the condition called acidosis in which the pH falls. If the pH drops to 6.8, death may occur.

How many times greater is the hydrogen ion concentration in blood at pH 6.8 compared to that at pH 7.4?

- A** 0.3
- B** 0.6
- C** 1.1
- D** 4.0

13 Which of the following statements explain why silver chloride is soluble in aqueous ammonia, but silver iodide is not?

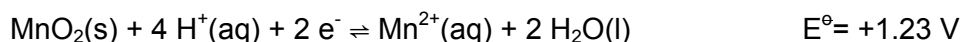
- A** The solubility product of silver iodide is numerically larger than that of silver chloride.
- B** The equilibrium constant for $\text{AgX(s)} + 2 \text{NH}_3(\text{aq}) \rightleftharpoons \text{Ag(NH}_3)_2\text{X(aq)}$ is numerically larger for $\text{X} = \text{Cl}$ than that for $\text{X} = \text{I}$.
- C** The lattice energy of silver chloride is numerically larger than that of silver iodide.
- D** Ammonia is a more powerful ligand that can displace chloride but not iodide ions.

14 During electroplating, a current is passed through a cell containing aqueous silver nitrate using inert electrodes. After a certain time, 2.70 g of silver was deposited at one electrode. What volume of gas would be produced at the other electrode at r.t.p.?

- A** 70 cm³
- B** 75 cm³
- C** 140 cm³
- D** 150 cm³

15 Two separate students accidentally spilled chemicals on their clothes in the laboratory which resulted in brown MnO_2 stains and I_2 stains. Their teacher suggested the use of bleaching agent (H_2O_2) for removal of these stains.

The relevant standard redox potentials are listed below:



Which of the following is true regarding the removal of the stains?

- A** Only I_2 will be successfully removed.
- B** Only MnO_2 will be successfully removed.
- C** Both MnO_2 and I_2 will be successfully removed.
- D** Both stains cannot be removed.

- 16** Transition metals are similar to s-block metals (Group I and II) in certain ways, e.g. both manganese and magnesium have a 'silver-metallic' appearance. However, typical transition metal compounds have a variety of colours.

Which one of the following statements is **not** correct?

- A** Transition metals have a large increase in first ionisation energy from Ti to Cu, similar to that of s-block metals from Na to Mg.
- B** Transition metal compounds are coloured due to the presence of ligands and splitting of d-orbitals to different energy levels.
- C** Aqueous complexes of the same transition metal can have different colours due to the different oxidation states and ligands.
- D** Transition metals differ from s-block metals in their physical properties, such as high melting point and high density.

- 17** Elements **X**, **Y** and **Z** react with oxygen to form compounds **P**, **Q** and **R** respectively.

When dissolved in water, **P** gives a strongly alkaline solution while **R** gives a strongly acidic solution. **Q** is able to react with both acids and bases.

Given that elements **X**, **Y** and **Z** are Period 3 elements, which of the following is **false** for these three elements?

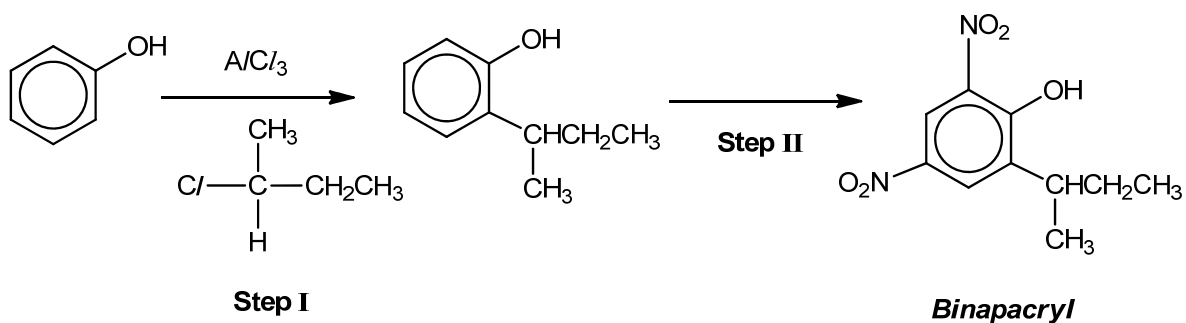
- A** The atomic radius decreases from **X** to **Y** to **Z**.
 - B** The electronegativity increases from **X** to **Y** to **Z**.
 - C** The first ionization energy increases from **X** to **Y** to **Z**.
 - D** **X**, **Y** and **Z** could be sodium, magnesium and aluminium respectively.
- 18** Lime mortar is made from quicklime, water and sand. Over a period of time, lime mortar changes into a much harder form. Both fresh and old lime mortar react with aqueous hydrochloric acid but only the old lime mortar effervesces during the reaction.

Which equation describes the change from fresh to old lime mortar?

- A** $\text{CaO} + \text{CO}_2 \rightarrow \text{CaCO}_3$
 - B** $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$
 - C** $\text{Ca(OH)}_2 \rightarrow \text{CaO} + \text{H}_2\text{O}$
 - D** $\text{CaCO}_3 + \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{Ca(HCO}_3)_2$
- 19** What is the total number of isomers (including stereoisomers) for a non-cyclic organic compound, $\text{C}_3\text{H}_5\text{Cl}$?

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

- 20 **Binapacryl** is used as a fungicide and can be synthesized from phenol via the following synthetic route. Which of the following describes Steps I and II correctly?

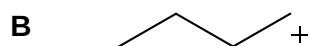


Electrophile in Step I

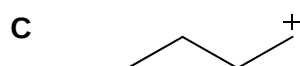
Reagents and Conditions for Step II



concentrated HNO_3



concentrated HNO_3 , concentrated H_2SO_4 , 60°C



dilute HNO_3

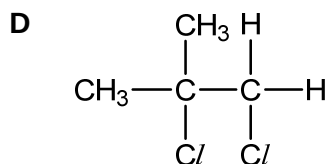
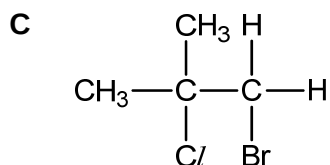
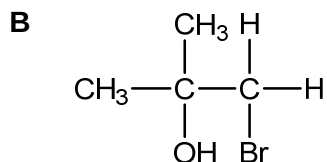
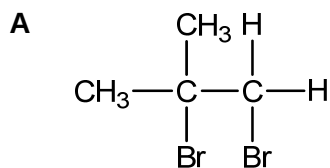


concentrated HNO_3 , concentrated H_2SO_4 , 30°C

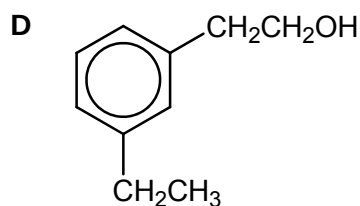
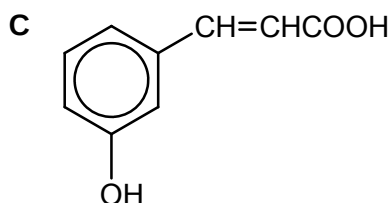
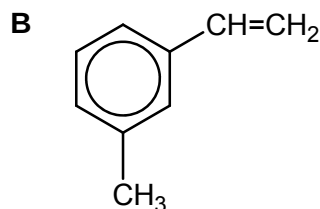
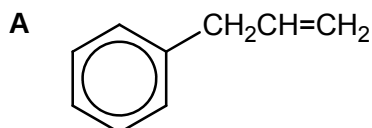
- 21 Which of the following salts will give a solution with the highest pH when dissolved in water?

- A $\text{CH}_3\text{CO}_2^-\text{Na}^+$
 B $\text{C}_6\text{H}_5\text{CO}_2^-\text{Na}^+$
 C $\text{C}_6\text{H}_5\text{O}^-\text{Na}^+$
 D $\text{CH}_3\text{CH}_2\text{O}^-\text{Na}^+$

- 22 Which of the following is **not** a possible product when 2-methylpropene is reacted with aqueous bromine in aqueous sodium chloride?



- 23 Which one of the following will **not** liberate 2 moles of carbon dioxide when 1 mole of the compound is treated with excess hot acidified potassium manganate(VII)?

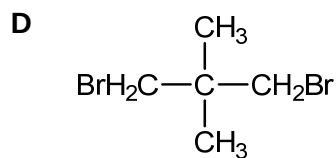
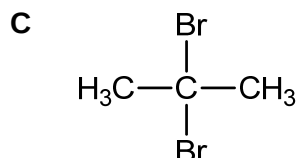
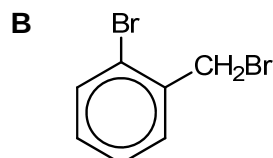
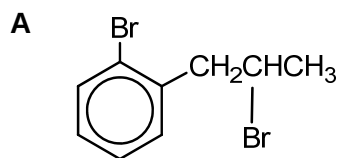


- 24 Which of the following reagents may be used to distinguish between 1-bromobutane and 2-bromobutane?

- A alkaline aqueous iodine
- B sodium hydroxide
- C acidified potassium manganate(VII)
- D aqueous silver nitrate

- 25** 1 mole of an organic compound **P** undergoes a reaction with alcoholic sodium hydroxide to form 2 moles of HBr.

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

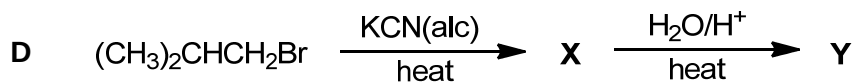
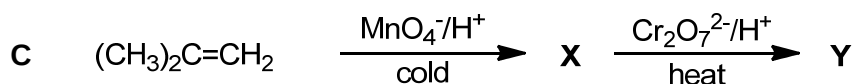
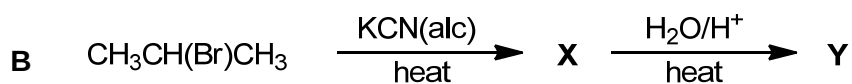
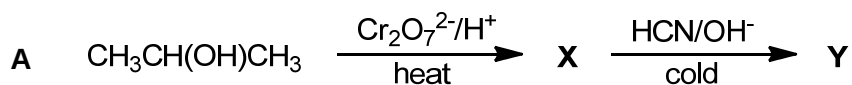


- 26** Which pair of the following reactions could have the same reaction intermediate?

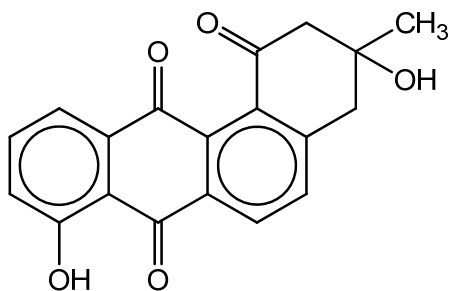
- W $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3 \rightarrow \text{intermediate} \rightarrow \text{CH}_3\text{CH}(\text{CN})\text{CH}_3$
X $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3 \rightarrow \text{intermediate} \rightarrow (\text{CH}_3)_2\text{C}(\text{OH})\text{CN}$
Y $\text{CH}_3\text{CH}=\text{CH}_2 \rightarrow \text{intermediate} \rightarrow \text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
Z $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_2\text{CH}_3 \rightarrow \text{intermediate} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$

- A** W and X **C** X and Z
B W and Y **D** Y and Z

- 27** Which of the following syntheses will produce compound **Y**, 2-methylpropanoic acid?

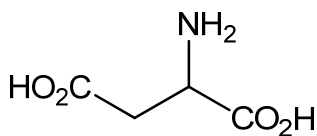


- 28 ***Tetrangomycin*** is one of the first member of the class of antibiotics under the angucycline group. Which of the following reagents will react with ***tetrangomycin***?



Tetrangomycin

- A acidified potassium dichromate(VI)
 B alkaline copper(II) complex
 C alkaline aqueous iodine
 D sodium hydroxide
- 29 Aspartic acid is a non-essential amino acid that can be synthesised by the body.

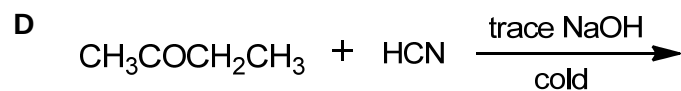
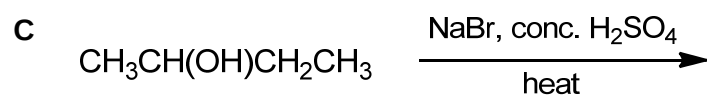
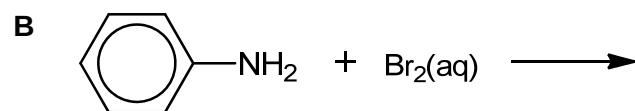
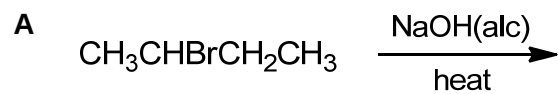


Aspartic acid

Which statement about aspartic acid is **not** true?

- A It acts as a buffer at pH 7.
 B It exists as a zwitterion at pH 7.
 C It reacts with ethanoyl chloride to form an amide.
 D It exists as a crystalline solid at room temperature.

- 30 In which of the following reactions will the affected carbon atom change from being sp^2 hybridised to sp^3 hybridised?



Section B

For each of the following questions, 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

31 Which of the following substances conduct electricity due to delocalized electrons?

- 1** Graphite
- 2** Benzene
- 3** Molten sodium chloride

32 The standard enthalpy changes of combustion of carbon are as follows.

$$\text{C(graphite)} = -393.1 \text{ kJ mol}^{-1}$$

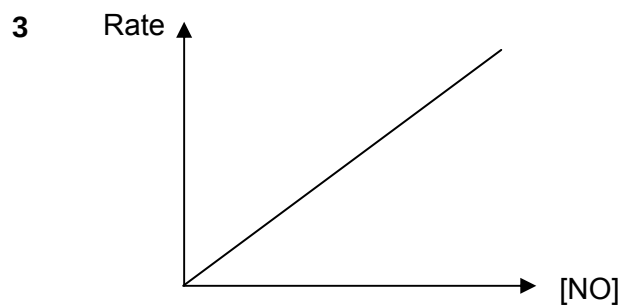
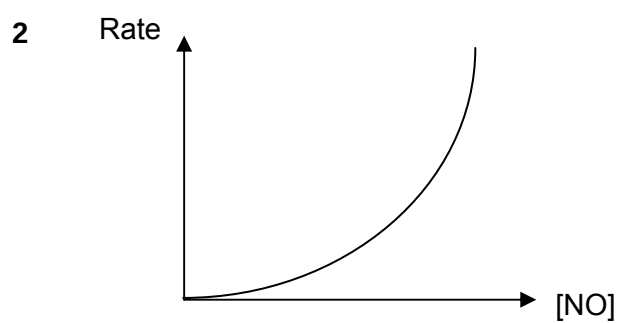
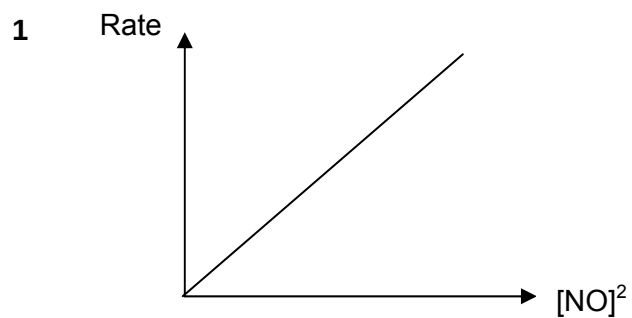
$$\text{C(diamond)} = -395.0 \text{ kJ mol}^{-1}$$

Which of the following deductions can be made from the data above?

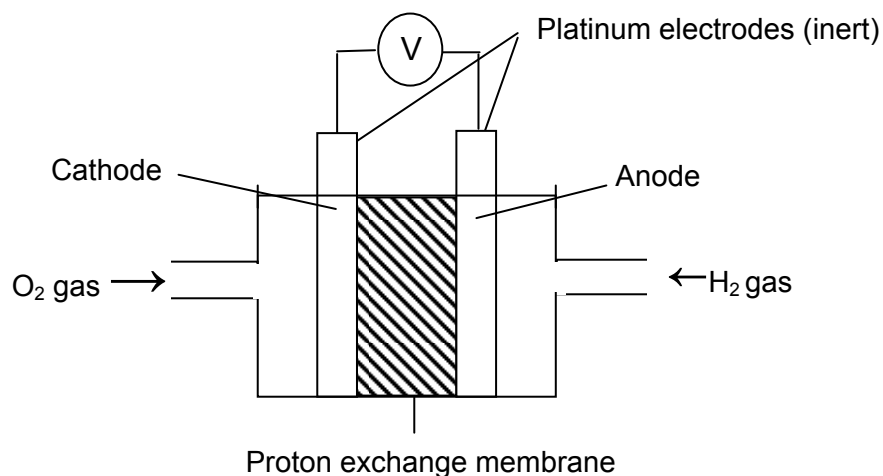
- 1** Graphite is less stable than that of diamond.
- 2** Graphite has a lower energy content than that of diamond.
- 3** Graphite is formed exothermically from diamond.

- 33** A student proposed that the conversion of nitrogen monoxide, NO, to nitrogen dioxide is second-order with respect to the concentration of nitrogen monoxide.

Which graphs show that the student's proposal may be correct?



- 34 A hydrogen fuel cell as illustrated below has a typical e.m.f. of 1.23 V.



Which of the following is true regarding the operation of this fuel cell?

- 1 The e.m.f can be increased by increasing the pressure of oxygen gas to 2 atm.
- 2 The electrode is platinised to increase the rate of reaction, but e.m.f. is not affected.
- 3 The proton exchange membrane allows the passage of H^+ ions in order to complete the circuit and maintains electrical neutrality.

- 35** Halogens have many similarities and trends in their physical and chemical properties. In particular aqueous solutions of bromine and iodine have similar appearance. A student has a type of partial colour blindness condition (Deuteranopia), and was attempting to identify 2 unlabelled bottles **X**, **Y** of NaBr and NaI.

His perception of colour is impaired in the following manner,

Normal Vision	Deuteranopia
Red	Dirty Yellow
Orange	
Yellow	Pale Yellow (Cream)
Green	
Blue	Dark Blue
Violet	

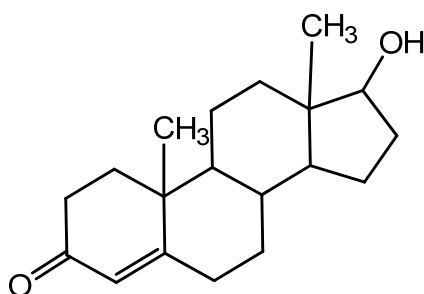
He can choose to first oxidize the halides to halogens and do further testing.

X (halide) → **A** (halogen)

Y (halide) → **B** (halogen)

Which of the following methods can he use to correctly identify the halogen?

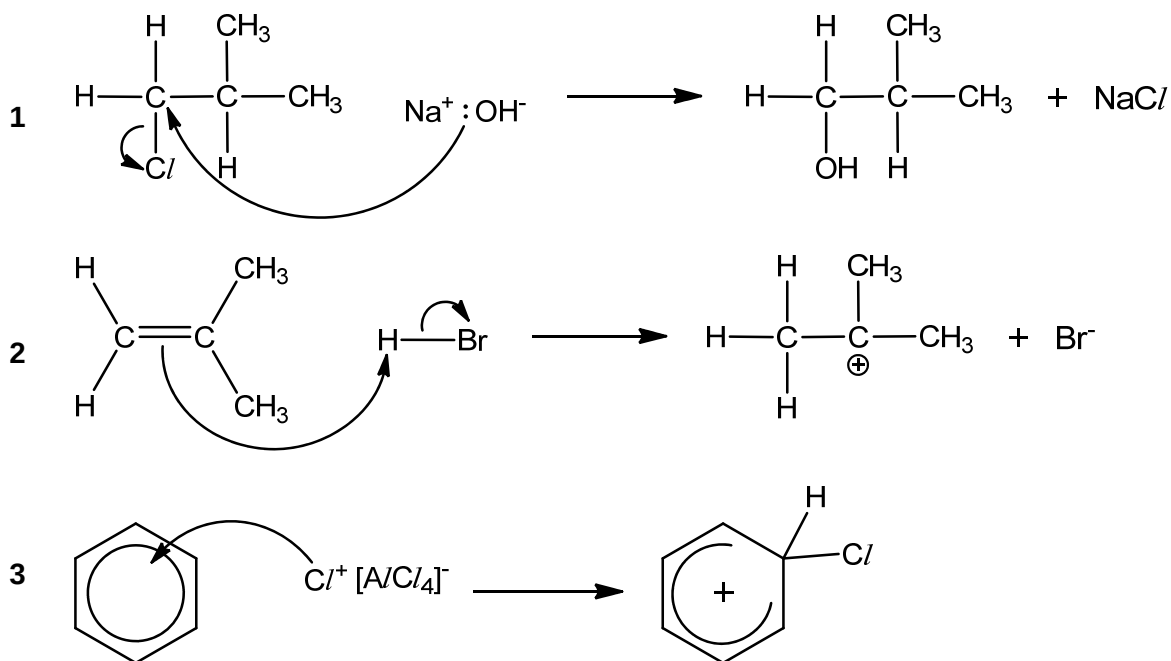
- 1 Add hexane (organic solvent) to samples of **A** and **B** separately, and identify the dark blue solution as iodine.
 - 2 Adding silver nitrate to **X** and **Y**, and identify the pale yellow solution as iodine.
 - 3 Mix some aqueous bromine with **X** and **Y**, and identify the yellow solution as iodine.
- 36** **Testosterone** is one of the most important male sex hormones and its structure is given below. Which of the following statements is true?



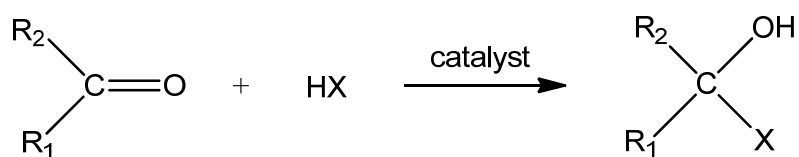
Testosterone

- 1 Testosterone exhibits both geometric and optical isomerism.
- 2 When reacted with NaBH₄, a compound with 7 chiral centres is formed.
- 3 It contains three sp² hybridised carbon atoms.

37 Which of the following reaction mechanisms/steps is correct?

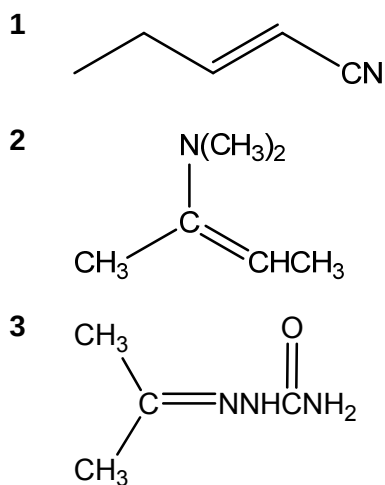


38 There is a range of reactions involving ketones which have the pattern

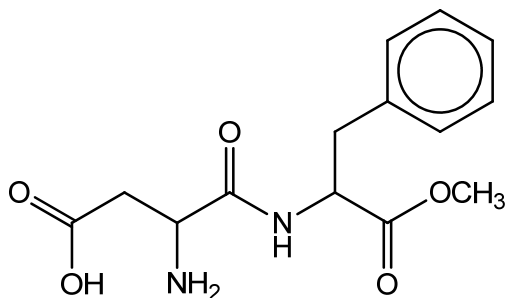


of which the formation of a hydroxynitrile (where $\text{X} = \text{CN}$) is one such product.

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



- 39** Aspartame is an artificial, non-saccharide sweetener used as a sugar substitute in some foods and beverages. The structure is shown below:



Which deductions about the reactions of aspartame can be made from this structure?

- 1** It undergoes hydrolysis to form two α -amino acids.
 - 2** It reacts with 2,4-dinitrophenylhydrazine to give an orange precipitate.
 - 3** The solution remains orange when heated with acidified potassium dichromate(VI).
- 40** Which will yield a carbon compound with two deuterium atoms (D) when reacted with D_2 in the presence of a nickel catalyst? (D = 2H)
- 1** $CH_3CH=CH_2$
 - 2** CH_3CO_2H
 - 3** CH_3CN