

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CHEMISTRY

9647/01

Paper 1 Multiple Choice

23 Sep 2013**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 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.

This document consists of **19** printed pages.

[Turn over

2

Section A

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

- 1** A 15 cm^3 mixture of carbon monoxide and methane was mixed with excess oxygen and exploded. There was a contraction in volume of 15 cm^3 at room temperature and pressure. What is the percentage by volume of methane in the mixture?

A 33 **B** 50 **C** 60 **D** 75

- 2** Nitrogen is essential in plants for the synthesis of proteins and nucleic acids. A farmer intends to switch his nitrogen fertiliser from potassium nitrate to urea.

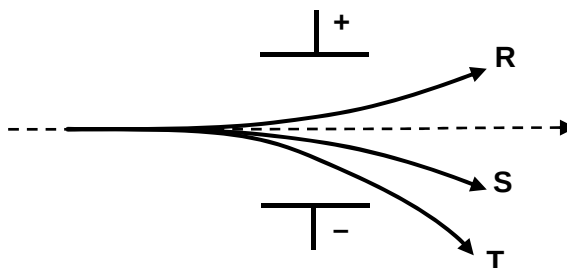
Currently, he uses 300 kg of potassium nitrate per month. Given the following information about the two fertilisers, calculate his monthly savings (to the nearest dollar) if he switches to urea as a fertiliser.

Fertiliser	Potassium nitrate	Urea
Chemical Formula	KNO_3	$\text{CO}(\text{NH}_2)_2$
M_r	101.1	60.0
Cost / tonne [1 tonne = 1000 kg]	\$850	\$340

A \$310 **B** \$225 **C** \$195 **D** \$153

3

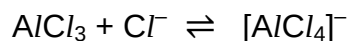
- 3 The following are flight paths of charged particles when accelerated in an electric field.



Which of the following are correct positions for the particles?

	R	S	T
A	$^{16}\text{O}^+$	$^{14}\text{C}^+$	$^{14}\text{N}^+$
B	$^{15}\text{O}^-$	$^{14}\text{C}^+$	$^{28}\text{Si}^+$
C	$^{14}\text{N}^-$	$^{15}\text{O}^+$	$^{28}\text{Si}^{2+}$
D	$^{14}\text{N}^-$	$^{14}\text{C}^+$	$^{28}\text{Si}^{4+}$

- 4 Consider the following reaction of aluminium chloride:

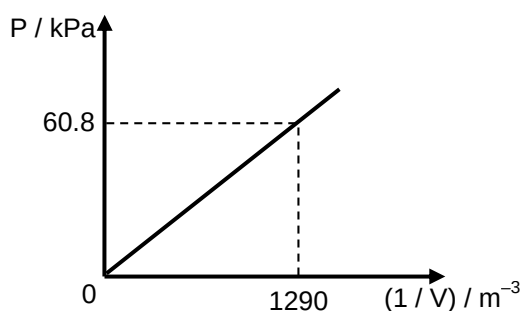


Which of the following is correct regarding AlCl_3 and $[\text{AlCl}_4]^-$?

- A Both AlCl_3 and $[\text{AlCl}_4]^-$ are tetrahedral in shape.
- B AlCl_3 is tetrahedral in shape and $[\text{AlCl}_4]^-$ is planar in shape.
- C The $\text{Cl}-\text{Al}-\text{Cl}$ bond angle in AlCl_3 is larger than that in $[\text{AlCl}_4]^-$.
- D There are more electron pairs around the Al atom in AlCl_3 than that in $[\text{AlCl}_4]^-$.

4

- 5 The graph of P / kPa against $(1 / V) / \text{m}^{-3}$ was obtained for 0.400 g of an unknown gas at 25°C .



What is the relative molecular mass of the gas?

- A** 19.3 **B** 21.0 **C** 28.0 **D** 47.1
- 6 In a calorimetric experiment conducted at standard conditions, 1.60 g of fuel underwent complete combustion. The reaction was 45 % efficient in heating 200 g of water. The temperature of the water rose to 73°C .

Given that the specific heat capacity of water is $4.2 \text{ J g}^{-1} \text{ K}^{-1}$, what is the total energy released per gram of fuel burnt?

- A** 18.1 kJ g^{-1} **B** 40.3 kJ g^{-1} **C** 56.0 kJ g^{-1} **D** 85.2 kJ g^{-1}
- 7 Under standard conditions, solid iodine slowly sublimates into a violet gas.

Data for each form of iodine is given in the table.

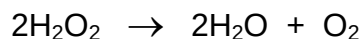
	$\Delta H_f^\theta / \text{kJ mol}^{-1}$	$S^\theta / \text{J K}^{-1} \text{mol}^{-1}$
$\text{I}_2(\text{s})$	0	116
$\text{I}_2(\text{g})$	62.4	261

What is the value of ΔG^θ in $\text{kJ K}^{-1} \text{mol}^{-1}$, for the formation of gaseous iodine from solid iodine at 25°C ?

- A** -15.4 **B** +19.2 **C** +27.8 **D** +106

5

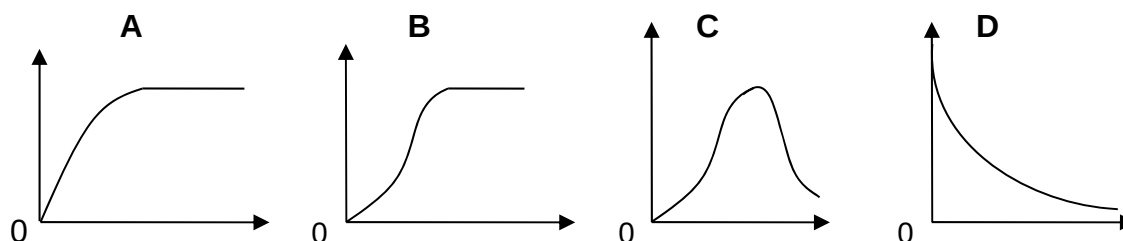
- 8 The decomposition of hydrogen peroxide is known to be a first order reaction.



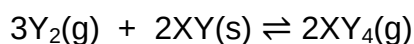
The rate constant is found to be $4.95 \times 10^{-2} \text{ min}^{-1}$. If the initial concentration of H_2O_2 is 4.0 mol dm^{-3} , what will be the concentration of H_2O_2 after 42 min?

- A 0.5 mol dm^{-3} B 1.0 mol dm^{-3}
 C 0.25 mol dm^{-3} D 2.0 mol dm^{-3}

- 9 Which curve is obtained if the rate of reaction is plotted against time for an autocatalytic reaction (i.e. a reaction in which one of the products catalyses the reaction)?



- 10 Consider the following equilibrium.



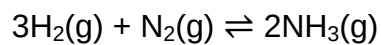
When 3 mol of XY_4 was heated in a 2 dm^3 container, the equilibrium mixture contained 0.8 mol of XY.

What is the numerical value of the equilibrium constant, K_c ?

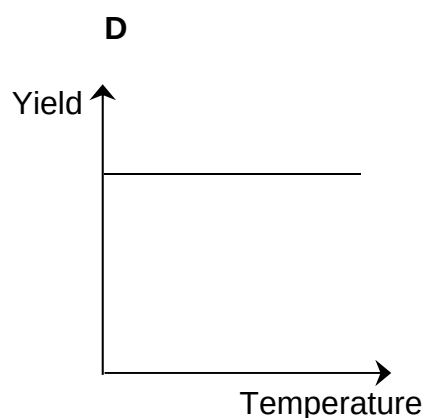
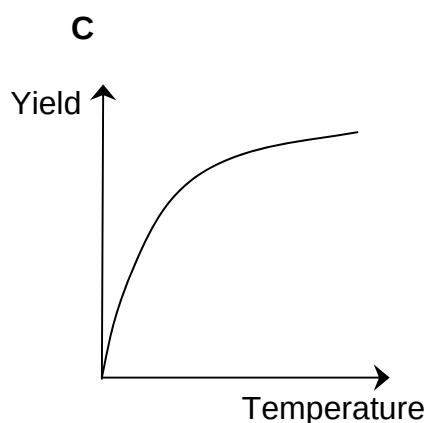
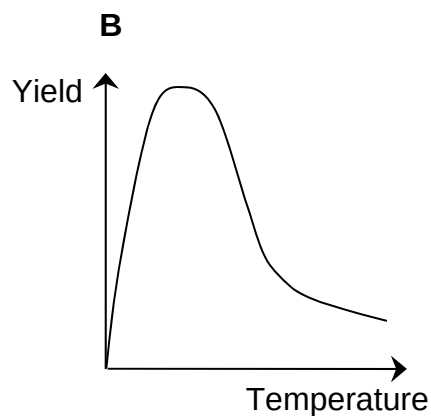
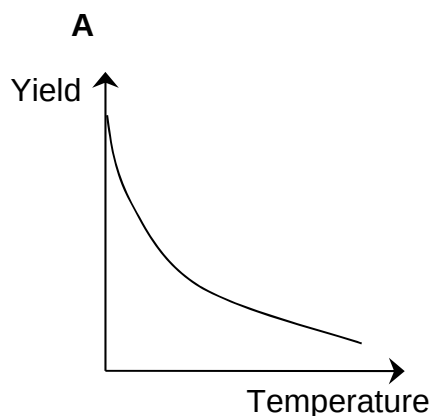
- A 0.0286 B 0.179 C 5.60 D 35.0

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

Ammonia can be synthesised directly using a mixture of hydrogen gas and nitrogen gas in a reversible reaction as shown:



Which one of the following describes the change in yield of ammonia at equilibrium as temperature increases?



12 Given that a $0.500 \text{ mol dm}^{-3}$ of HNO_2 solution has a K_a value of 7.1×10^{-4} , calculate the percentage of undissociated HNO_2 molecules.

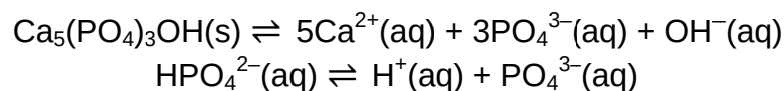
A 1.88 %

B 3.77 %

C 96.2 %

D 98.1 %

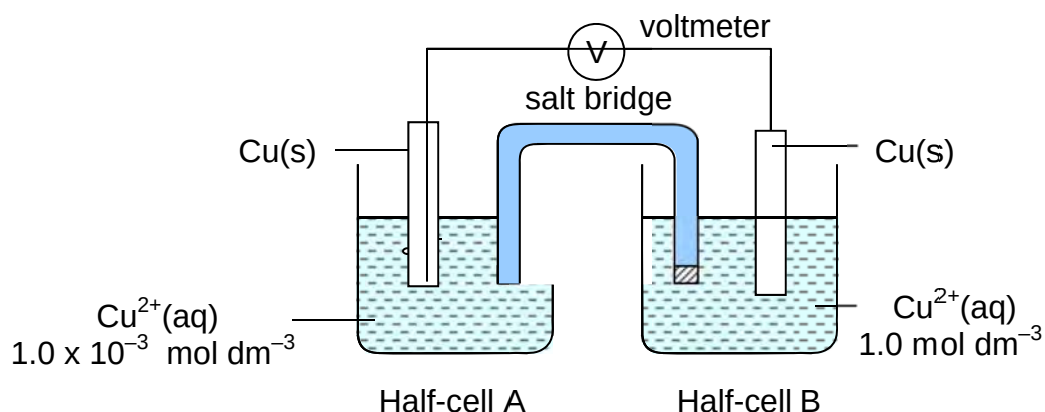
- 13** Hydroxyapatite, $\text{Ca}_5(\text{PO}_4)_3\text{OH}$, is the main constituent of tooth enamel. In the presence of saliva, which contains a buffer system, the following equilibria exist:



Which of the following statements does not help to explain why tooth enamel is dissolved more readily when saliva is acidic?

- A** The phosphate ion PO_4^{3-} accepts H^{+} .
 - B** The hydroxide ions are neutralised by the acid.
 - C** The concentration of PO_4^{3-} decreases in this medium.
 - D** The calcium ions can precipitate to form $\text{Ca}(\text{OH})_2$.
- 14** A concentration cell is an electrochemical cell where electrical energy is generated due to a difference in the electrolyte concentration.

The diagram of a concentration cell is shown below. The cell potential, E_{cell} , is measured to be 0.10 V.



Which statement about the concentration cell is incorrect?

- A** The reduction potential of half-cell A is +0.44 V.
- B** In the external circuit, electrons flow from half-cell A to half-cell B.
- C** A ten times dilution of the electrolyte in half-cell B decreases the E_{cell} .
- D** E_{cell} eventually becomes zero when the concentration of Cu^{2+} in both cells becomes equal.

- 15 During electrolysis under suitable conditions, 0.785 g of chromium is deposited on the cathode when a current of 5.0 A is passed into a chromium-containing electrolyte for 9.7 min.

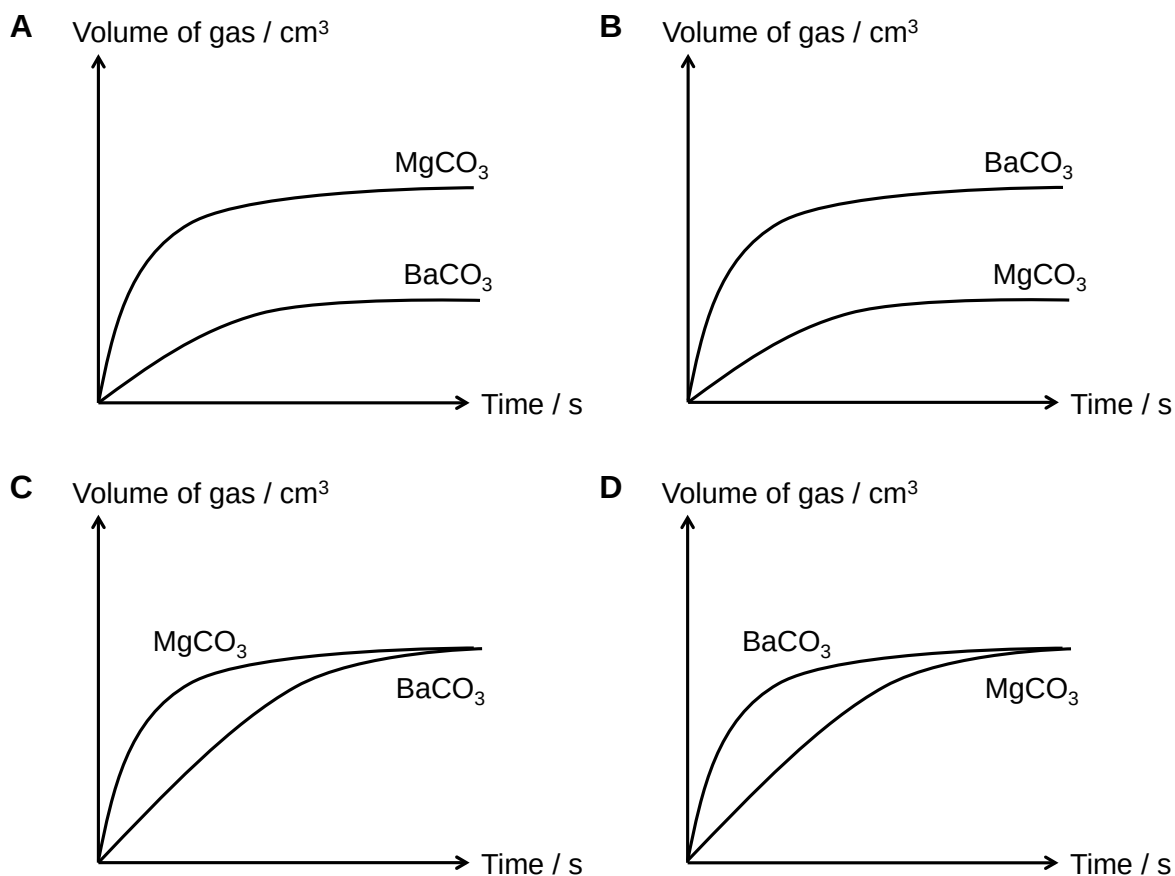
What could the electrolyte be?

- A CrCl_2 B CrCl_3 C K_2CrO_3 D K_2CrO_4

- 16 Which of the following statements is correct?

- A The ionic radius of Na^+ ion is greater than that of Cl^- ion.
B The electronegativity of phosphorus is greater than that of nitrogen.
C The first ionisation energy of magnesium is less than that of aluminium.
D The energy required to remove an electron from F^- is less than that for Ne atom.

- 17 Which graph represents the volume of gas collected when separate 1.0 g samples of powdered magnesium carbonate and powdered barium carbonate are heated at the same temperature?



18 Which of the following statements about chloride, iodide and their hydrogen halides is true?

- A** Hydrogen chloride is a stronger acid than hydrogen iodide.
- B** Chloride has a weaker oxidising strength than iodide.
- C** Boiling point of hydrogen chloride is lower than hydrogen iodide.
- D** Hydrogen chloride decomposes at a lower temperature than hydrogen iodide.

19 For which property are the data under the correct element?

	property	copper	calcium
A	density / g cm ⁻³	8.92	1.54
B	electrical conductivity / relative units	9.6	85
C	melting point / °C	810	1083
D	metallic radius / nm	0.197	0.117

20 What is the total number of all possible isomers for secondary alcohols with the molecular formula C₅H₁₂O?

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

21 Which of the following statements about the reaction of Cl₂ and ethane to form 1,2-dichloroethane is true?

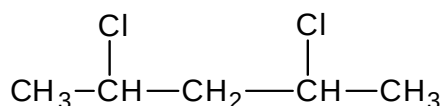
- A** Cl₂ acts as a catalyst.
- B** Ultra violet light is required for heterolytic fission to take place.
- C** CH₃CH₂CHClCH₂Cl cannot be formed in the termination step.
- D** Hybridisation about the reactive carbon centre changes from sp³ to sp² in the first propagation step.

10

- 22 In the upper atmosphere, chlorofluoroalkanes (CFCs) are broken down to give chlorine radicals but not fluorine radicals.

What is the best explanation for this?

- A Fluorine is more electronegative than chlorine.
 - B The C—F bond is longer than the C—Cl bond.
 - C The C—F bond is stronger than the C—Cl bond.
 - D Fluorine radicals recombine immediately owing to their reactivity.
- 23 A study was conducted to measure the enthalpy change of mixing of PVC with plasticisers. As the reaction between PVC and plasticiser is too slow, low molecular weight analogues such as 2,4-dichloropentane are used instead of PVC.



2,4-dichloropentane

Which of the following statements about 1 mole of 2,4-dichloropentane is false?

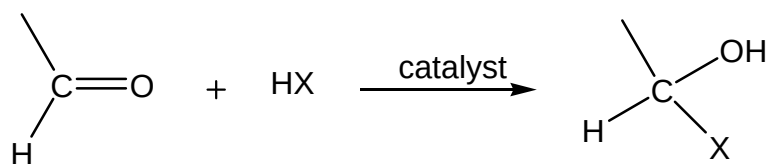
- A It has 4 stereoisomers.
 - B One of its stereoisomer does not rotate plane polarised light.
 - C A total of 3 structural isomers are formed when it undergoes elimination.
 - D A maximum of 287g of white precipitate may be obtained when it is warmed with ethanolic silver nitrate.
- 24 When an organic compound X is shaken with aqueous silver nitrate at room temperature, there is no immediate precipitate. However, when X is boiled under reflux for some time with aqueous sodium hydroxide, cooled, acidified with dilute nitric acid and aqueous silver nitrate added, a white precipitate readily forms.

What could X be?

- A $\text{C}_4\text{H}_9\text{Cl}$ B CH_3COCl C $\text{C}_6\text{H}_5\text{COCl}$ D $\text{C}_6\text{H}_5\text{Cl}$

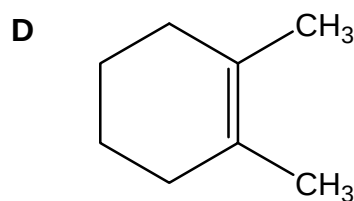
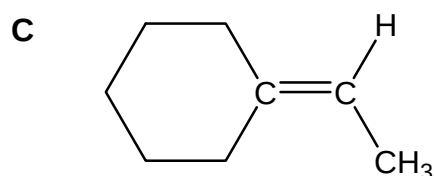
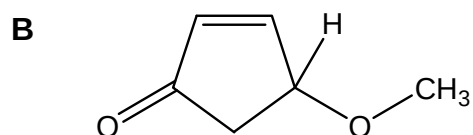
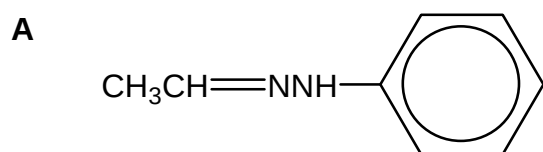
11

- 25 Aldehydes can undergo addition reactions with a variety of compounds of the form HX according to the following equation.



An example of such a reaction is the formation of cyanohydrin, where $\text{X} = \text{CN}$.

Which of the following compounds cannot be obtained by such an addition reaction to an aldehyde, followed by dehydration?

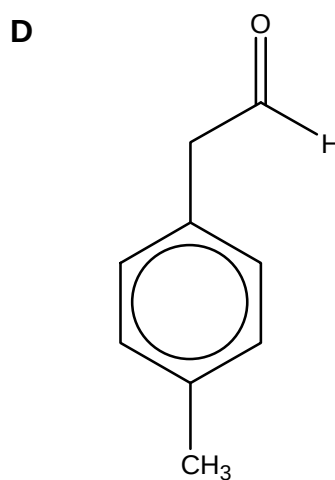
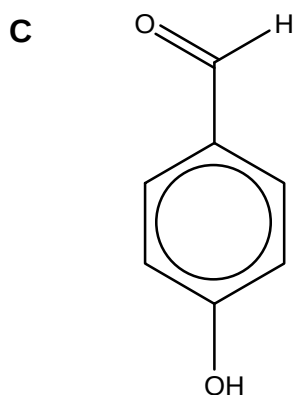
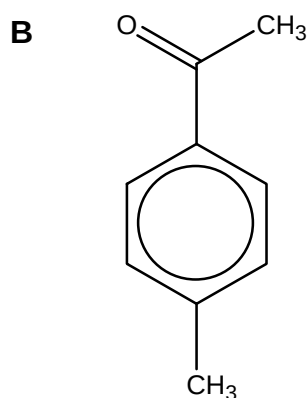
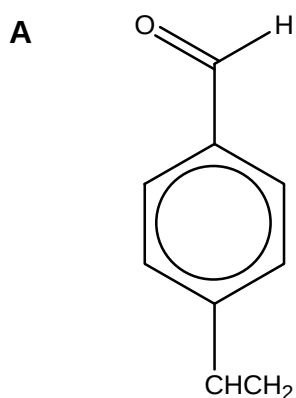


12

- 26 Compound Q was subjected to the following tests and the results are recorded below.

Reagents and Conditions	Observations
Acidified KMnO_4 , warm	Purple solution decolourises, CO_2 gas is evolved
2,4-DNPH, warm	Orange precipitate observed
$\text{Cu}(\text{NO}_3)_2$, $\text{NaOH}(\text{aq})$, warm	No precipitate observed

Which of the following could be compound Q?

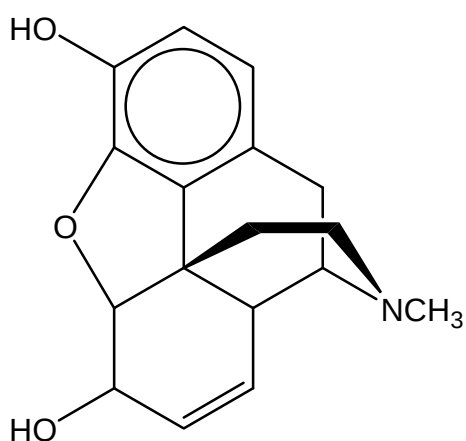


- 27 In which of the following sequence is the value of pK_a decreasing?

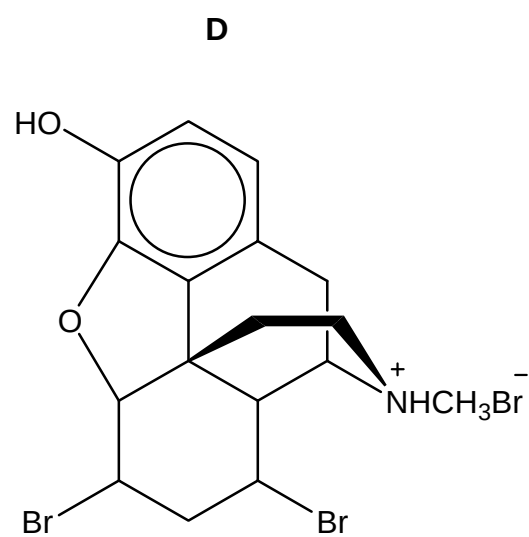
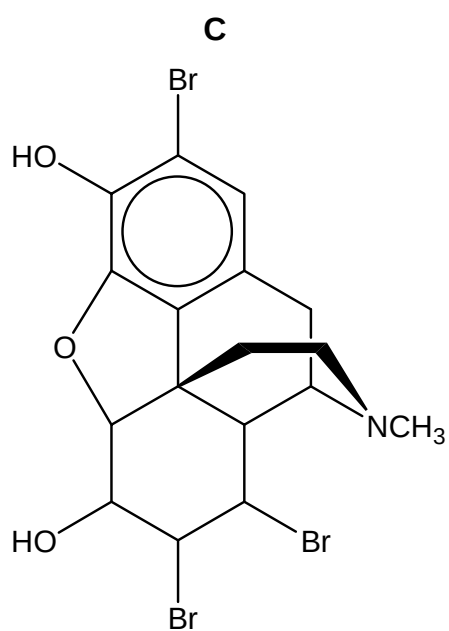
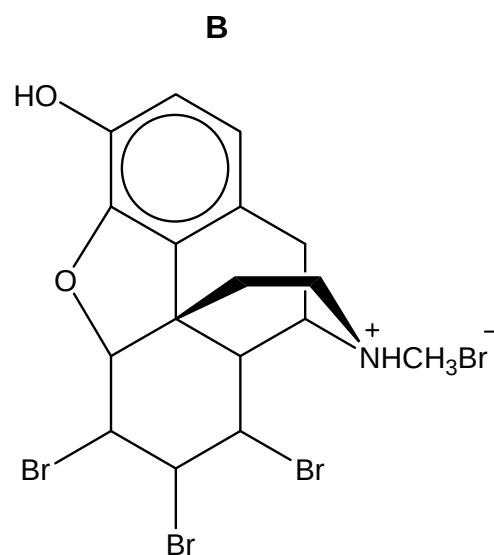
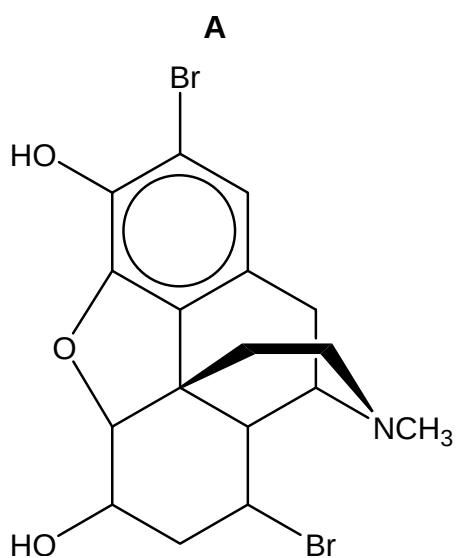
- A** $\text{C}_6\text{H}_5\text{OH} > \text{CH}_3\text{CHClCHClCH}_2\text{OH} > \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} > (\text{CH}_3)_3\text{COH}$
B $(\text{CH}_3)_3\text{COH} > \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} > \text{CH}_3\text{CHClCHClCH}_2\text{OH} > \text{C}_6\text{H}_5\text{OH}$
C $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} > (\text{CH}_3)_3\text{COH} > \text{CH}_3\text{CHClCHClCH}_2\text{OH} > \text{C}_6\text{H}_5\text{OH}$
D $\text{CH}_3\text{CHClCHClCH}_2\text{OH} > (\text{CH}_3)_3\text{COH} > \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} > \text{C}_6\text{H}_5\text{OH}$

13

28 The structure of morphine is shown below.

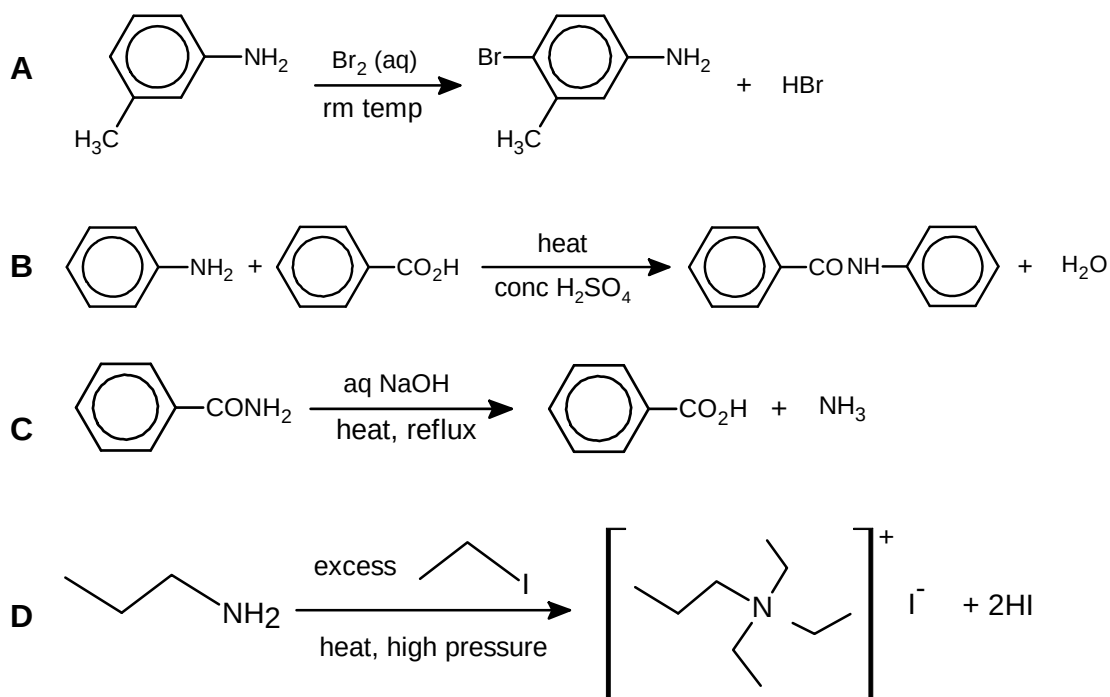


The reaction between morphine and dry HBr (g) gives



14

29 Which of the following reactions will take place under the given reagents and conditions?



30 What will be the net charge of the following part of the protein chain at pH 7.4?



Amino acid	$\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{N}-\text{C}-\text{CO}_2\text{H} \\ \\ (\text{CH}_2)_4 \\ \\ \text{H}_2\text{N} \end{array}$ lysine (lys)	$\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{N}-\text{C}-\text{CO}_2\text{H} \\ \\ (\text{CH}_2)_2 \\ \\ \text{HO}_2\text{C} \end{array}$ Glutamic acid (glu)
pKa of R group	10.53	4.25

A –1 **B** 0 **C** +1 **D** +2

15

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

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

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

31 Which of the following molecules are bent?

- 1** SCl_2
- 2** NO_2^+
- 3** XeF_2

32 Which of the following statements are incorrect?

- 1** All substances with covalent bonding cannot conduct electricity.
- 2** Ionic compounds can be distinguished from metals by their electrical conductivity in the liquid states.
- 3** Metals are conductors of electricity in all states.

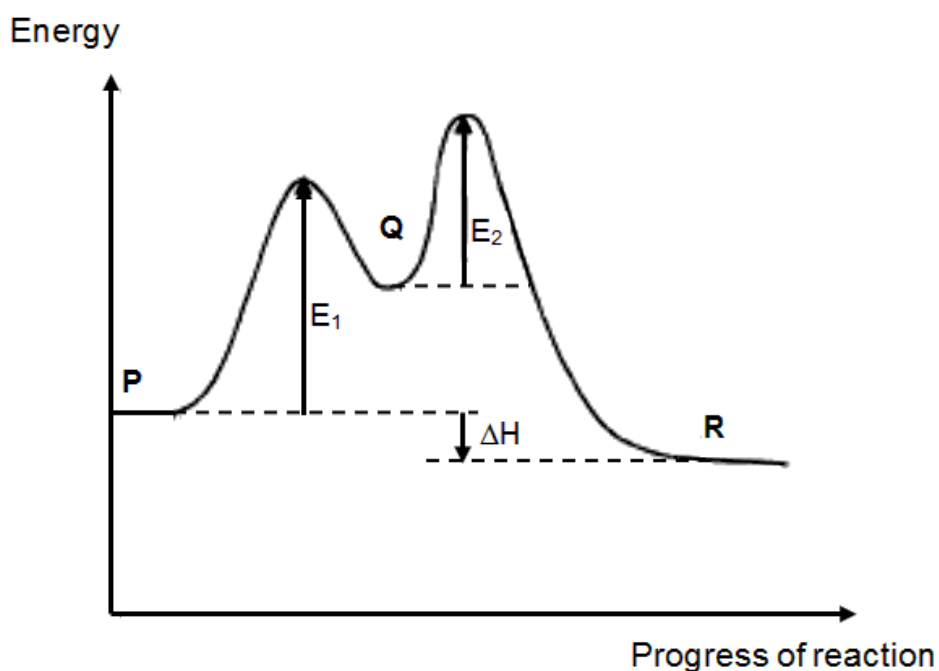
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The responses **A** to **D** should be selected on the basis of

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

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

33 The energy profile for a reaction, $P \rightarrow R$ is shown below.



Which of the following statements are true?

- 1** The mechanism for the reaction is
 $P \rightarrow Q$ slow
 $Q \rightarrow R$ fast
- 2** The addition of a catalyst does not affect ΔH .
- 3** Increasing the temperature decreases both the values of E_1 and E_2 .

17

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

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

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

- 34** The table below shows the numerical value of the solubility product, in mol dm^{-3} for three metal sulfides.

In an acidic solution, $[\text{S}^{2-}]$ in a saturated solution = $10^{-18} \text{ mol dm}^{-3}$.

Metal ion	Mn^{2+}	Ni^{2+}	Ag^+
K_{sp} of sulfide	10^{-16}	10^{-21}	10^{-36}

Which of the following statements are correct?

- 1** NiS and Ag_2S would be precipitated from the acidic solution containing $0.010 \text{ mol dm}^{-3}$ of the metal ion when the solution is saturated with hydrogen sulfide.
- 2** Ag_2S is the least soluble salt because its K_{sp} is the smallest amongst the three sulfides.
- 3** When the concentration of sulfide is increased, the value of the solubility product for the three metal sulfides will increase.

- 35** Which of the reagents can be used to differentiate the pair of compounds given?

	Compound 1	Compound 2	Reagent
1	AlCl_3	SiCl_4	H_2O
2	Al_2O_3	SiO_2	dil HCl
3	NaCl	MgO	dil H_2SO_4

- 36** Which transition metal ions possess unpaired electrons?

- 1** TiO_2
- 2** $\text{Ni}(\text{CO})_4$
- 3** $[\text{Fe}(\text{CN})_6]^{4-}$

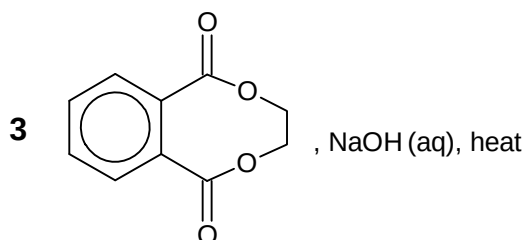
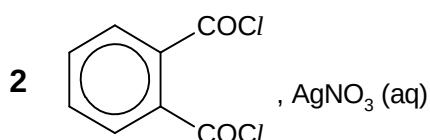
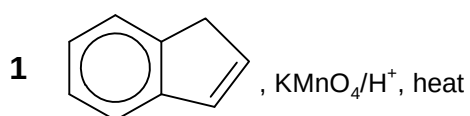
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The responses **A** to **D** should be selected on the basis of

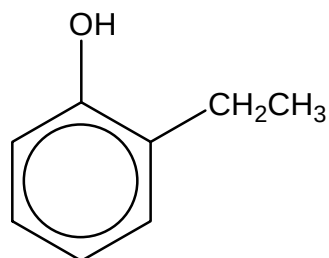
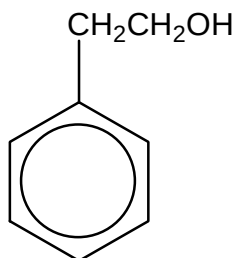
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

37 Which of the following organic compounds will produce 1,2-benzene-dicarboxylic acid when subjected to the reagents and conditions as specified?



38 Which of the following reagents will result in different observations when reacted with the following two compounds?



- 1** Br_2 (aq)
- 2** $\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}^+$ (aq)
- 3** NaOH (aq)

19

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

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

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

39 Which products are formed when phenylpropanoate undergoes acidic hydrolysis in the presence of water labelled with ^{18}O isotope?

- 1** $\text{CH}_3\text{CH}_2\text{CO}^{18}\text{OH}$
- 2** $\text{C}_6\text{H}_5^{18}\text{OH}$
- 3** $\text{C}_6\text{H}_5\text{CO}^{18}\text{OH}$

40 A tripeptide, thr-ala-arg, was analysed using electrophoresis. The tripeptide was hydrolysed and the resulting solution was then placed at the centre of the plate in a buffer solution of pH 7.0. A potential difference was then applied across the plate.

Amino acid	$\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{N}-\text{C}-\text{CO}_2\text{H} \\ \\ \text{H}_3\text{C}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$ threonine (thr)	$\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{N}-\text{C}-\text{CO}_2\text{H} \\ \\ \text{CH}_3 \end{array}$ alanine (ala)	$\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{N}-\text{C}-\text{CO}_2\text{H} \\ \\ (\text{CH}_2)_3 \\ \\ \text{HN} \\ \\ \text{HN}=\text{C}-\text{NH}_2 \end{array}$ arginine (arg)
Isoelectric point	5.60	6.00	10.76

With reference to the above table, which of the following statements is correct?

- 1** Alanine would migrate towards the anode while arginine would migrate towards the cathode.
- 2** Threonine would migrate a lesser distance from the centre of the plate as compared to alanine.
- 3** The above amino acids will exist as $\text{H}_3\text{N}^+\text{CHRCO}_2^-$ at their isoelectric point.