



ANDERSON JUNIOR COLLEGE
2016 JC2 PRELIMINARY EXAMINATIONS

CHEMISTRY

Higher 2

Paper 1 Multiple Choice

9647/01

22 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, glue or correction fluid.

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 Multiple Choice Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

Multiple Choice Answer Sheet

Write your name, PDG and NRIC / FIN number, **including** the reference letter.

Shade the NRIC / FIN number.

Exam Title: JC2 Prelim

Exam Details: H2 Chemistry / Paper 1

Date: 22/09/2016

This document consists of **18** printed pages.

Section A

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

- 1** Antimony (Sb) can be produced in a two-stage process from its ore stibnite, Sb_2S_3 .

The ore is first roasted in oxygen, producing Sb_4O_6 and SO_2 .

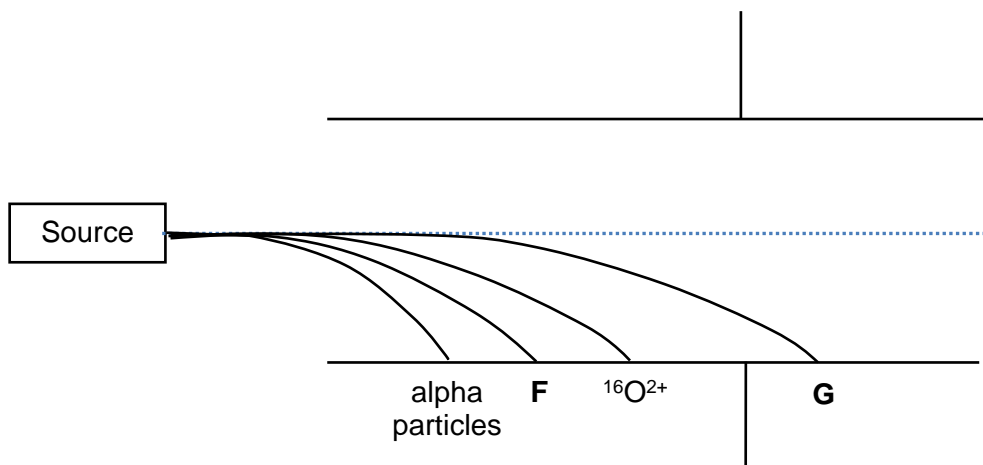
The Sb_4O_6 is then reduced by carbon, producing Sb and CO_2 .

What volume of CO_2 , measured at room temperature and pressure, is produced from 20 moles of Sb_2S_3 ?

- A** 360 dm^3 **B** 670 dm^3 **C** 720 dm^3 **D** 1440 dm^3

- 2** Alpha particles, ${}^4\text{He}^{2+}$, are commonly emitted by large radioactive nuclei.

The path of a mixture of ${}^{16}\text{O}^{2+}$ ions, alpha particles and two unknown ions, **F** and **G**, upon entering an electric field is shown below.



Which of the following represent **F** and **G**?

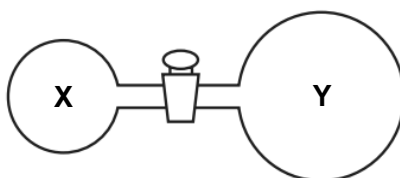
	F	G
A	${}^1\text{H}^+$	${}^9\text{Be}^{2+}$
B	${}^{12}\text{C}^{2+}$	${}^{27}\text{Al}^{3+}$
C	${}^9\text{Be}^{2+}$	${}^{14}\text{N}^{3+}$
D	${}^{12}\text{C}^+$	${}^1\text{H}^+$

- 3 In a research on the atomic nucleus, scientists have been comparing the stability of isotopes with the same neutron : proton ratio.

Which isotope has the same neutron : proton ratio as ^{10}B ?

- A ^{32}P B ^{32}S C ^{40}Ar D ^{40}K

- 4 Two glass vessels **X** and **Y** are connected by a closed valve.



X contains helium at 20 °C at a pressure of 1×10^5 Pa. **Y** has been evacuated, and has three times the volume of **X**. 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 3.18×10^4 Pa
 B 4.24×10^4 Pa
 C 1.25×10^5 Pa
 D 5.09×10^5 Pa
- 5 The interhalogen compound BrF_3 is a volatile liquid which autoionises.



The electrical conductivity of BrF_3 decreases with increasing temperature.

Which statement is correct?

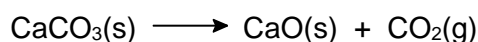
- A The autoionisation process is endothermic and the shape of the cation is linear.
 B The autoionisation process is endothermic and the shape of the cation is non-linear.
 C The autoionisation process is exothermic and the shape of the cation is linear.
 D The autoionisation process is exothermic and the shape of the cation is non-linear.

- 6 In an experiment, it was found that complete combustion of 10.0 g of an alcohol, **J**, raised the temperature of 100 g of water in a container from 25 °C to 75 °C.

Given that the process is only 65% efficient and the specific heat capacity of water is $4.18 \text{ J g}^{-1} \text{ K}^{-1}$, what is the total heat energy released per gram of **J** burnt?

- A** 2.09 kJ g⁻¹ **B** 3.22 kJ g⁻¹ **C** 13.5 kJ g⁻¹ **D** 20.8 kJ g⁻¹

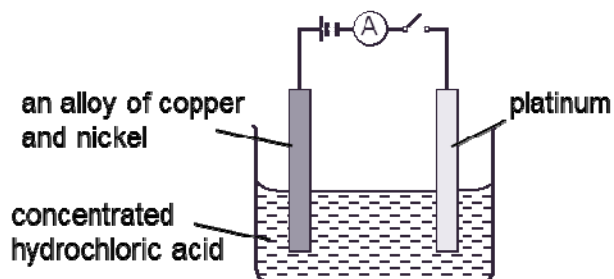
- 7 Limestone is a sedimentary rock largely made up of different crystal forms of calcium carbonate. At high temperatures, calcium carbonate decomposes to form calcium oxide and carbon dioxide.



What are the correct signs of ΔH and ΔS for this decomposition?

	ΔH	ΔS
A	–	–
B	–	+
C	+	–
D	+	+

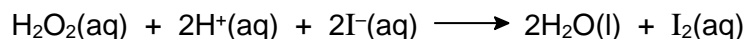
- 8 The circuit shown in the diagram was set up.



Which electrode reactions will occur on closing the switch?

- | | anode reaction | cathode reaction |
|----------|--|-------------------------|
| A | neither nickel nor copper is dissolved | hydrogen is evolved |
| B | copper is dissolved preferentially | copper is deposited |
| C | nickel is dissolved preferentially | hydrogen is evolved |
| D | nickel and copper are both dissolved | copper is deposited |

- 9 The reaction of hydrogen peroxide with iodide ions in acidic solution can be monitored by an initial rate method.



The following results were obtained for a series of experiments with different volumes of each reagent used.

experiment number	volume of $\text{H}_2\text{O}_2(\text{aq}) / \text{cm}^3$	volume of $\text{H}^+(\text{aq}) / \text{cm}^3$	volume of $\text{I}^-(\text{aq}) / \text{cm}^3$	volume of water / cm^3	time taken / s
1	40	40	20	0	33
2	20	40	20	20	66
3	40	20	30	10	22
4	20	40	30	10	44

What could be the mechanism of this reaction?

- A** $\text{H}_2\text{O}_2 + \text{H}^+ \longrightarrow \text{H}_2\text{O} + \text{OH}^+$ (fast)
 $\text{OH}^+ + 2\text{I}^- + \text{H}^+ \longrightarrow \text{H}_2\text{O} + \text{I}_2$ (slow)
- B** $\text{H}_2\text{O}_2 + \text{I}^- \longrightarrow \text{H}_2\text{O} + \text{IO}^-$ (slow)
 $\text{H}^+ + \text{IO}^- \longrightarrow \text{HIO}$ (fast)
 $\text{HIO} + \text{H}^+ + \text{I}^- \longrightarrow \text{I}_2 + \text{H}_2\text{O}$ (fast)
- C** $2\text{H}^+ + 2\text{I}^- \longrightarrow 2\text{HI}$ (fast)
 $2\text{HI} + \text{H}_2\text{O}_2 \longrightarrow \text{I}_2 + 2\text{H}_2\text{O}$ (slow)
- D** $\text{H}_2\text{O}_2 + \text{I}^- + \text{H}^+ \longrightarrow \text{H}_2\text{O} + \text{HIO}$ (fast)
 $\text{HIO} + \text{I}^- \longrightarrow \text{I}_2 + \text{OH}^-$ (slow)
 $\text{OH}^- + \text{H}^+ \longrightarrow \text{H}_2\text{O}$ (fast)

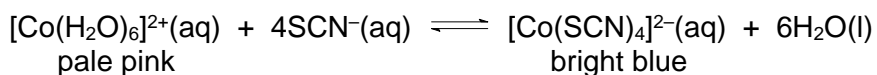
- 10 The same amount of electricity is passed through two electrolytic cells connected in series for 30 minutes. Cell 1 and Cell 2 contain aqueous solutions of $\text{Mn}(\text{NO}_3)_2$ and $\text{Au}(\text{NO}_3)_3$ respectively.

Given that 1.3 g of manganese is deposited on the cathode for Cell 1, what is the current used for electrolysis and the mass of the gold deposited on the cathode for Cell 2?

	current	mass of gold
A	1.3 A	3.1 g
B	1.3 A	4.7 g
C	2.5 A	3.1 g
D	2.5 A	4.7 g

- 11 Cobalt forms many coloured complexes with ligands such as H_2O and SCN^- .

A 100 cm^3 solution of $\text{Co}^{2+}(\text{aq})$ turns from pink to bright blue when 10 cm^3 of $\text{KSCN}(\text{aq})$ is added to the solution.



At equilibrium, $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ and $[\text{Co}(\text{SCN})_4]^{2-}$ are found to be present in a mole ratio of 1:10.

Given that $\lg K_c$ for the equilibrium is 3.00, which of the statements is **incorrect**?

- A The units of K_c is $\text{mol}^{-4}\text{ dm}^{12}$.
- B At equilibrium, $[\text{SCN}^-] = 3.16 \times 10^{-1}\text{ mol dm}^{-3}$.
- C $[\text{Co}(\text{SCN})_4]^{2-}$ is more stable than $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$.
- D Dilution of the reaction mixture decreases the proportion of $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ at equilibrium.

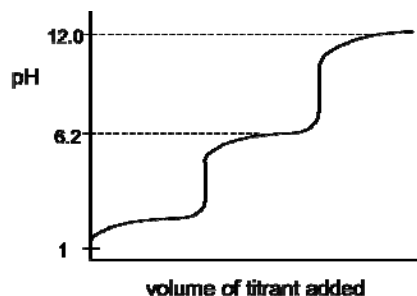
- 12 In which reaction is the underlined substance acting as a base?

- A $\text{HNO}_3 + \underline{\text{H}_2\text{SO}_4} \longrightarrow \text{H}_2\text{NO}_3^+ + \text{HSO}_4^-$
- B $\text{HSiO}_3^- + \underline{\text{HCN}} \longrightarrow \text{CN}^- + \text{H}_2\text{O} + \text{SiO}_2$
- C $\text{HNO}_2 + \underline{\text{HCO}_3^-} \longrightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{NO}_2^-$
- D $\text{C}_6\text{H}_5\text{O}^- + \underline{\text{CH}_2\text{C}/\text{CO}_2\text{H}} \longrightarrow \text{C}_6\text{H}_5\text{OH} + \text{CH}_2\text{C}/\text{CO}_2^-$

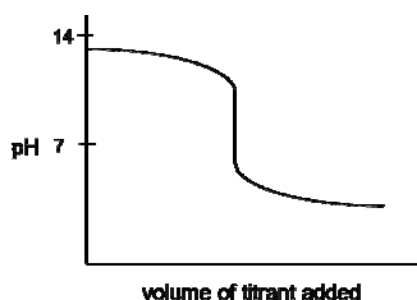
- 13 The change of colour for an indicator occurs over a limited range of pH that falls between ± 1.00 of the pK_a value of the indicator.

Which is the **most** suitable indicator that can be used to determine the end point of the corresponding titration?

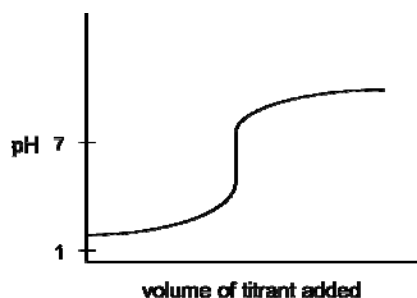
- A alizarin yellow
($pK_a = 11.0$)



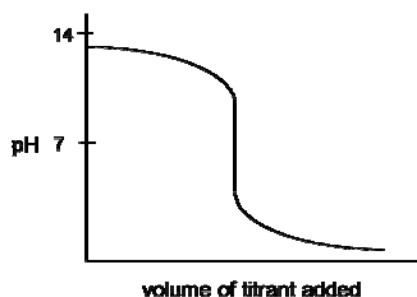
- B bromothymol blue
($pK_a = 7.1$)



- C methyl yellow
($pK_a = 3.3$)

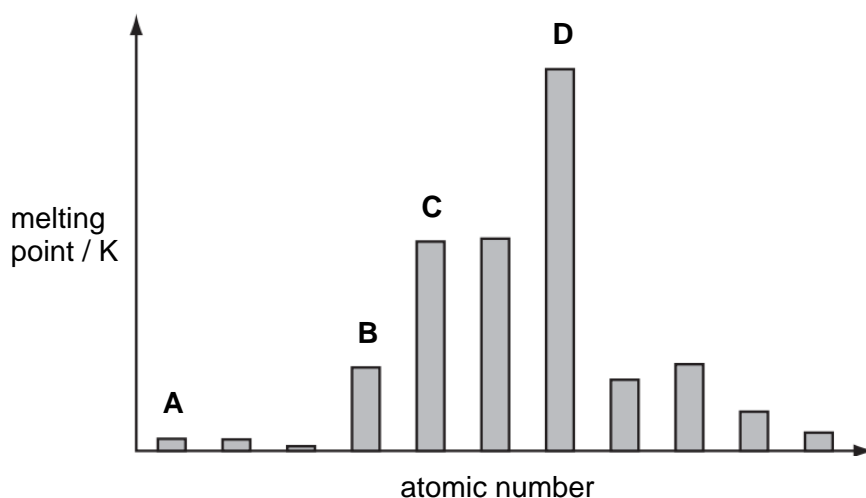


- D thymol blue
($pK_a = 1.6$)



- 14 The bar chart shows the melting points of a series of consecutive elements arranged in order of increasing atomic number. The elements sodium to chlorine form part of this series.

Which bar represents sodium?



- 15 Which oxide does **not** react with dilute sodium hydroxide to produce a salt?

A Al_2O_3 B P_4O_{10} C SO_2 D SiO_2

- 16 The three minerals below are obtained from mines around the world. Each one behaves as a mixture of two carbonate compounds. They can be used as fire retardants because they decompose in the heat, producing CO_2 . This gas smothers the fire.

Barytocide	$\text{BaCa}(\text{CO}_3)_2$
Dolomite	$\text{CaMg}(\text{CO}_3)_2$
Huntite	$\text{Mg}_3\text{Ca}(\text{CO}_3)_4$

What is the order of effectiveness as fire retardant, from best to worst?

	best → worst		
A	dolomite	barytocide	huntite
B	dolomite	huntite	barytocide
C	huntite	barytocide	dolomite
D	huntite	dolomite	barytocide

- 17** Iodine is far less soluble in water than it is in aqueous potassium iodide, where it forms the complex ion I_3^- . For this reason, reactions involving aqueous iodine are often carried out in potassium iodide solution.

Which equation describes the quantitative determination of iodine in the presence of excess potassium iodide?

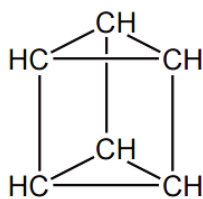
- A** $\text{I}_2 + 2\text{SO}_4^{2-} \longrightarrow 2\text{I}^- + \text{S}_2\text{O}_8^{2-}$
B $2\text{I}^- + 2\text{S}_2\text{O}_3^{2-} \longrightarrow \text{I}_2 + \text{S}_4\text{O}_6^{2-}$
C $\text{I}_3^- + 2\text{SO}_4^{2-} \longrightarrow 3\text{I}^- + \text{S}_2\text{O}_8^{2-}$
D $\text{I}_3^- + 2\text{S}_2\text{O}_3^{2-} \longrightarrow 3\text{I}^- + \text{S}_4\text{O}_6^{2-}$

- 18** Astatine, At, is below iodine in Group VII of the Periodic Table.

Which statement is most likely to be correct?

- A** AgAt(s) reacts with excess dilute aqueous ammonia to form a solution of a soluble complex.
B At_2 and KCl(aq) react to form KAt(aq) and Cl_2 .
C KAt(aq) and dilute sulfuric acid react to form white fumes of HAt(g) .
D NaAt(s) and concentrated sulfuric acid react to form At_2 .

- 19** In 1869 Ladenburg suggested a structure for benzene, C_6H_6 , in which one hydrogen atom is attached to each carbon atom.



Ladenburg structure

A compound $\text{C}_6\text{H}_4\text{Cl}_2$ could be formed with the same carbon skeleton as the Ladenburg structure.

How many structural isomers would this compound have?

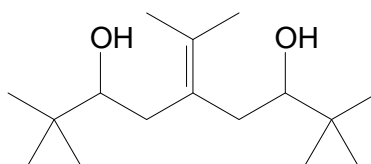
- A** 3 **B** 4 **C** 5 **D** 6

- 20 High-energy irradiation in the stratosphere produces radicals from chlorofluoroalkanes, commonly known as CFCs.

Which radical could result from this irradiation of $\text{CHFC/CF}_2\text{Cl}$?

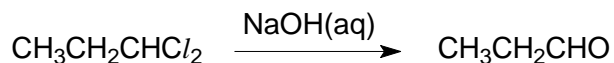
- A $\text{CHFC/}\dot{\text{C}}\text{FC/}$
 B $\dot{\text{C}}\text{HC/CF}_2\text{Cl}$
 C $\dot{\text{C}}\text{HFCF}_2\text{Cl}$
 D $\dot{\text{C}}\text{FC/CF}_2\text{Cl}$

- 21 Compound **L** has the following structure.



What is the total number of geometrical isomers that can be formed from the product of the reaction of compound **L** with excess concentrated sulfuric acid at 170 °C?

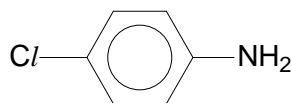
- A 8 B 7 C 4 D 3
- 22 1,1-dichloropropane reacts with excess hot aqueous sodium hydroxide in a series of steps to give propanal.



Which term describes the **second** step of this reaction?

- A addition
 B elimination
 C oxidation
 D substitution

- 23 4-chloroaniline is a pale yellow solid which is an important building block used for the production of pesticides, drugs and dyestuffs.

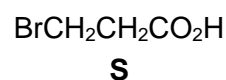
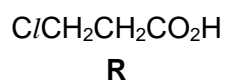
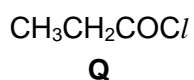
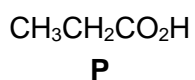


4-chloroaniline

Which of the following shows a suitable starting compound and sequence of steps to produce a good yield of 4-chloroaniline?

	starting compound	step 1	step 2
A		conc. HNO_3 , conc. H_2SO_4	Sn , conc. HCl followed by NaOH(aq)
B		dil. HNO_3	LiAlH_4
C		Cl_2 , AlCl_3	Sn , conc. HCl followed by NaOH(aq)
D		LiAlH_4	Cl_2 in CCl_4

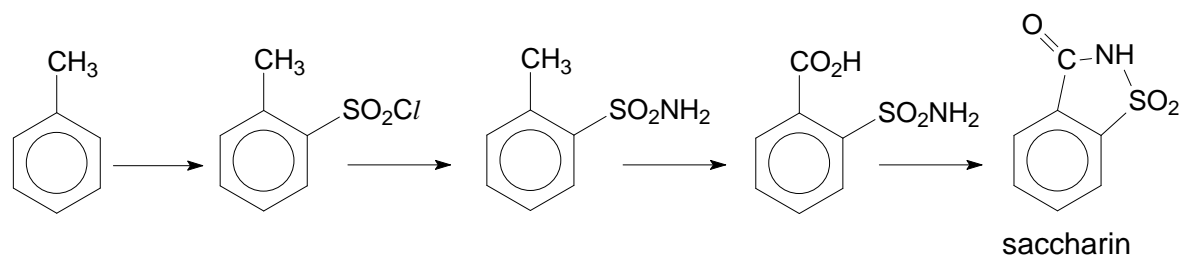
- 24 Why does hydrogen cyanide add to propanone but not to propene?
- A** Propanone is more susceptible to H^+ attack than propene.
B Propanone is more susceptible to CN^- attack than propene.
C The $\text{C}=\text{C}$ bond in propene is stronger than the $\text{C}=\text{O}$ bond in propanone.
D The two methyl groups in propanone exert a stronger electron donating effect than the single methyl group in propene.
- 25 Equal amounts of compounds **P**, **Q**, **R** and **S** are separately shaken with 100 cm^3 of water. The pH of each resultant solution is then measured.



Which of the following shows the correct order of **decreasing** pH of the solutions formed?

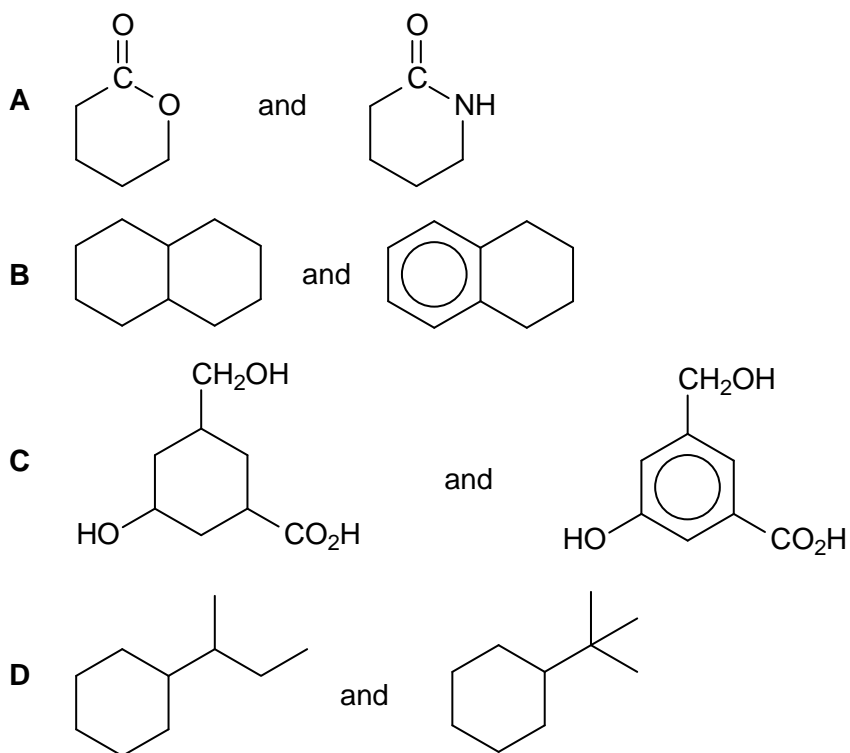
- A** P, R, S, Q
B P, S, R, Q
C Q, P, S, R
D Q, S, R, P

- 26 Saccharin is an artificial sweetening agent which can be synthesised from methylbenzene in the laboratory.

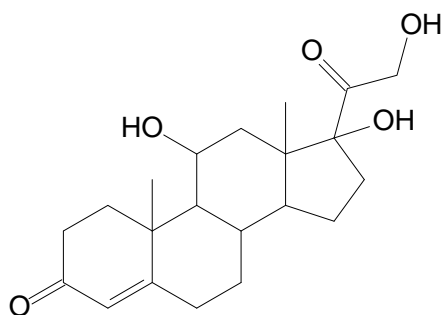


What type of reaction is **not** shown in this reaction scheme?

- A electrophilic substitution
 - B elimination
 - C nucleophilic substitution
 - D oxidation
- 27 Which pair of organic compounds **cannot** be distinguished by a chemical test?



- 28 Cortisol is a steroid hormone which is released in response to stress and low blood glucose. Its structure is shown in the diagram below.

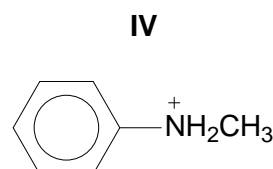
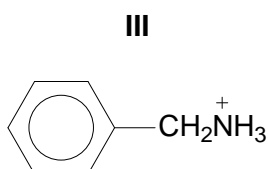
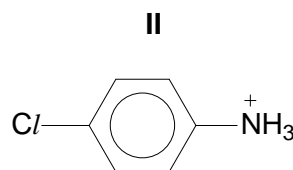
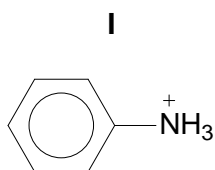


Cortisol is reduced with hydrogen in the presence of a platinum catalyst, and then oxidised by heating with acidified KMnO_4 . The product formed is further reacted with excess sodium to give an organic ion.

What is the charge on the organic ion produced?

- A 1- B 2- C 3- D 5-

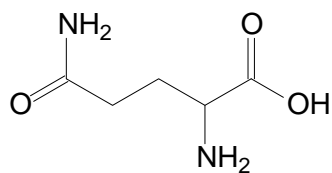
- 29 Consider the four species below.



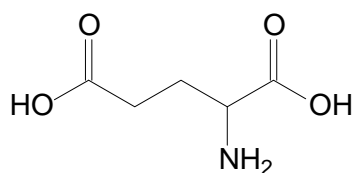
Which of the following shows the given species arranged in order of **decreasing** pK_a values?

- A III, IV, I, II
 B III, IV, II, I
 C IV, III, I, II
 D IV, II, III, I

- 30 The amino acids glutamine and glutamic acid can react with each other to form amide linkages.



glutamine



glutamic acid

What is the maximum number of different compounds, each containing one amide linkage, that can be formed from one molecule of glutamine and one molecule of glutamic acid?

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

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

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

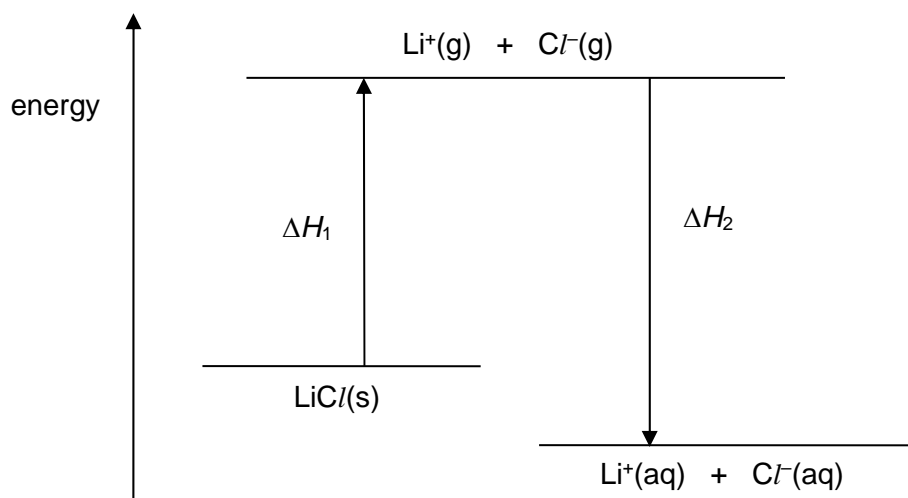
No other combination of statements is used as a correct response.

31 Which of the following ions has more electrons than protons and more protons than neutrons?

[$\text{H} = {}^1_1\text{H}$; $\text{D} = {}^2_1\text{H}$; $\text{C} = {}^{12}_6\text{C}$; $\text{O} = {}^{16}_8\text{O}$]

- 1 OH^-
- 2 HCO_3^-
- 3 DCO_3^-

32 An energy level diagram is shown below for the case of dissolving lithium chloride in water.



Which of the following about the enthalpy change of solution of lithium chloride is correct?

- 1 It is equal to $\Delta H_1 + \Delta H_2$.
- 2 It implies that dissolving lithium chloride is accompanied by an increase in temperature.
- 3 It is expected to be less exothermic than that of silver chloride.

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** Why does raising the pressure of a fixed mass of gaseous reactants at a constant temperature cause an increase in the rate of reaction?

- 1 More collisions occur per second when the pressure is increased.
- 2 More molecules have energy greater than the activation energy at the higher pressure.
- 3 Raising the pressure lowers the activation energy.

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

Which ions contain one or more unpaired electrons?

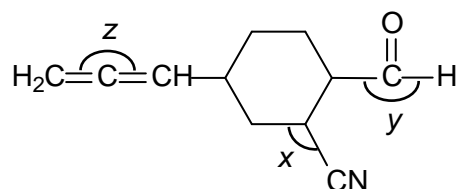
- 1 Cu^{2+}
- 2 Mn^{3+}
- 3 V^{3+}

- 35** When a hot glass rod is placed in a gas jar of hydrogen iodide, there is an immediate reaction as the hydrogen iodide decomposes.

Which statements about this reaction are correct?

- 1 Brown hydrogen iodide decolourises.
- 2 The hot rod provides the activation energy.
- 3 Purple fumes are observed.

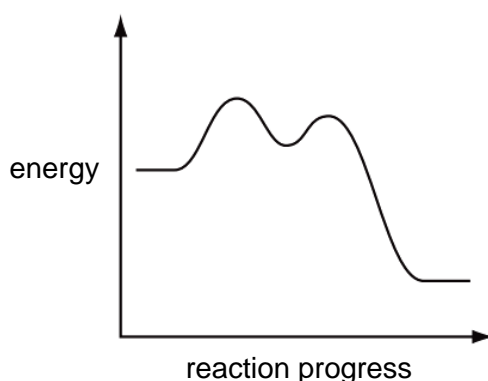
- 36** Which of the following statements are correct about compound **M**?



compound **M**

- 1 The bond angles in compound **M** increase in the order $x < y < z$.
- 2 There is only one sp hybridised carbon atom in compound **M**.
- 3 Compound **M** is planar.

37 A reaction pathway diagram is shown.



Which reactions would have this profile?

- 1 $(\text{CH}_3)_3\text{CBr} + \text{NaOH} \longrightarrow (\text{CH}_3)_3\text{COH} + \text{NaBr}$
- 2 $\text{CH}_3\text{CH}_2\text{Br} + \text{NaOH} \longrightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{NaBr}$
- 3 $(\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{Cl} + 2\text{NH}_3 \longrightarrow (\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{NH}_2 + \text{NH}_4\text{Cl}$

38 Which of the following reactions will produce a racemic mixture?

- 1 $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)_2\text{Cl}$ heated under reflux with aqueous KOH.
- 2 CH_3CHO with HCN and a small amount of KOH.
- 3 $\text{CH}_3\text{CH}=\text{CHCH}_3$ with HBr dissolved in CCl_4 .

39 Compound **N** can react with alkaline aqueous iodine to form a yellow precipitate. When compound **N** reacts with hot acidified KMnO_4 , two products are obtained. Both products can also form a yellow precipitate with alkaline aqueous iodine.

What could be the identity of compound **N**?

- 1
- 2
- 3

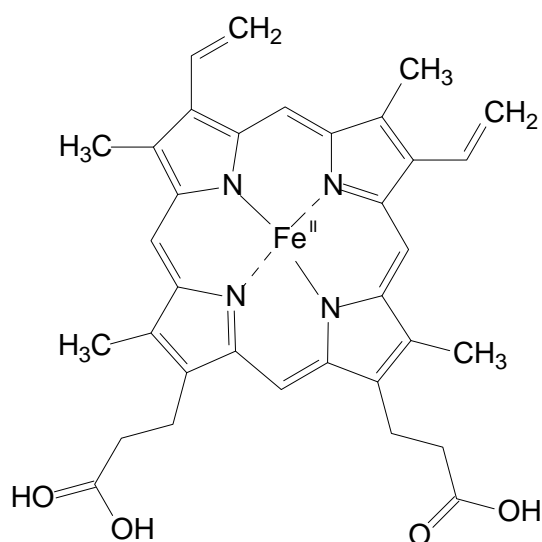
The responses **A** to **D** should be selected on the basis of

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.

- 40** Haemoglobin is a type of protein found in red blood cells. It transports oxygen from the lungs to body tissues. A haemoglobin molecule is a tetramer made up of four globular protein subunits. Each subunit is composed of a protein chain tightly associated with a non-protein haem group.

The diagram below shows the structure of a haem group.



Which of the following is correct about haemoglobin?

- 1** Haemoglobin has higher affinity for carbon monoxide than oxygen.
- 2** Each haemoglobin molecule can carry four oxygen molecules.
- 3** The polypeptide chains in haemoglobin are held together by hydrogen bonding only.