



VICTORIA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATIONS
Higher 2

CHEMISTRY

9647/01

Paper 1 Multiple Choice

24 September 2014

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 NRIC/FIN number, name and CT group on the Answer Sheet.

There are **forty** questions. 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 choices 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.

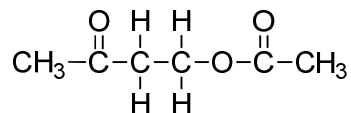
Any rough working should be done in this booklet.

This document consists of **17** printed pages and **1** blank page.

Section A

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

- 1 Compound **X** reacts with ethanoic acid in the presence of an H^+ catalyst to produce the compound below.



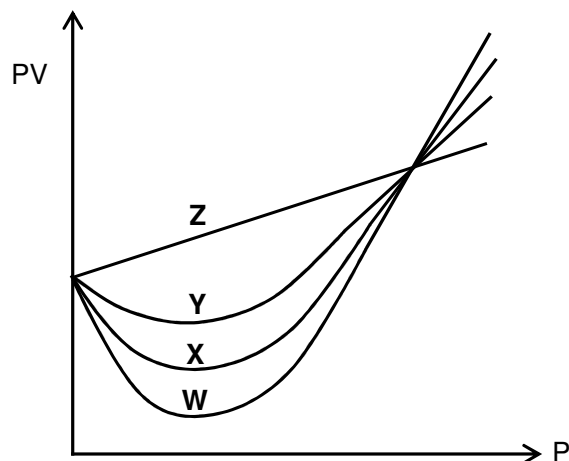
What is the molecular formula of compound **X**?

- A** $\text{C}_2\text{H}_6\text{O}_2$ **B** $\text{C}_2\text{H}_6\text{O}_3$ **C** $\text{C}_4\text{H}_8\text{O}$ **D** $\text{C}_4\text{H}_8\text{O}_2$
- 2 When $\text{Tl}^+(\text{aq})$ ions are reacted with $\text{VO}_3^-(\text{aq})$ ions, $\text{Tl}^{3+}(\text{aq})$ ions and $\text{V}^{2+}(\text{aq})$ ions are formed.
- Assuming the reaction goes to completion, how many moles of $\text{Tl}^+(\text{aq})$ and $\text{VO}_3^-(\text{aq})$ would result in a mixture containing equal number of moles of $\text{VO}_3^-(\text{aq})$ and $\text{V}^{2+}(\text{aq})$ once the reaction had taken place?

	moles of $\text{Tl}^+(\text{aq})$	moles of $\text{VO}_3^-(\text{aq})$
A	1	2
B	1	3
C	2	3
D	3	4

- 3 Which of the following contains only one unpaired electron?
- A** Ga^- **B** Se^- **C** Te^+ **D** As^+
- 4 Which of the following substances contains a central atom having eight electrons only?
- A** NO_2 **B** SO_2 **C** F_2O **D** ClO_2
- 5 For which of the following pairs does the first species have a smaller bond angle?
- A** $\text{SnCl}_2, \text{OCl}_2$
B $\text{H}_2\text{O}, \text{H}_2\text{S}$
C $\text{I}_3^-, \text{N}_3^-$
D $\text{NF}_3, \text{NCl}_3$

- 6 The value of PV is plotted against P at the same temperature for four gases, where P is the pressure and V is the volume of the gas.

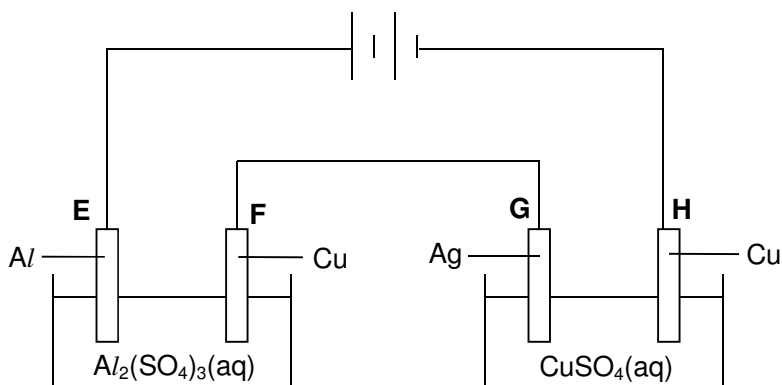


Which of the following represents the possible identities of gases **W**, **X**, **Y** and **Z**?

	W	X	Y	Z
A	$\text{CH}_3\text{CH}_2\text{OH}$	HCO_2H	CH_3CHO	$\text{CH}_3\text{CH}_2\text{CH}_3$
B	$\text{CH}_3\text{CH}_2\text{OH}$	CH_3CHO	HCO_2H	$\text{CH}_3\text{CH}_2\text{CH}_3$
C	HCO_2H	$\text{CH}_3\text{CH}_2\text{OH}$	CH_3CHO	$\text{CH}_3\text{CH}_2\text{CH}_3$
D	HCO_2H	CH_3CHO	$\text{CH}_3\text{CH}_2\text{OH}$	$\text{CH}_3\text{CH}_2\text{CH}_3$

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

Two cells are connected in series as shown in the diagram where **E**, **F**, **G** and **H** are electrodes.



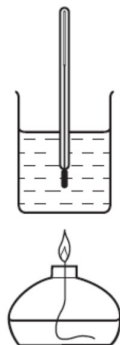
After the current is passed for some time, at which electrode will there be the greatest change in mass?

- A** E **B** F **C** G **D** H

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

A student carried out an experiment to determine the enthalpy change for the combustion of methanol.

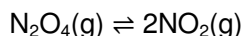
The following results were obtained by the student.



initial temperature of the water:	20 °C
final temperature of the water:	53 °C
mass of alcohol burner before burning:	259.65 g
mass of alcohol burner after burning:	259.15 g
mass of beaker plus water:	150.00 g
mass of beaker:	50.00 g

How much of the heat energy produced by the burning of methanol went into the water?

- A** 209 J **B** 13800 J **C** 20700 J **D** 22200 J
- 9 If N_2O_4 gas is placed in a sealed vessel, the following equilibrium is established.

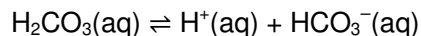


The forward reaction is endothermic.

Which of the following is **incorrect** when the temperature is increased?

- A** The equilibrium constant increases.
B The partial pressure of NO_2 increases.
C The enthalpy change increases.
D The activation energy is unchanged.
- 10 Which of the following equilibria is **not** affected by the addition of aqueous ammonia?
- A** $\text{BaSO}_4(\text{s}) \rightleftharpoons \text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
B $\text{AgCl}(\text{s}) \rightleftharpoons \text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
C $\text{Fe}(\text{OH})_3(\text{s}) \rightleftharpoons \text{Fe}^{3+}(\text{aq}) + 3\text{OH}^-(\text{aq})$
D $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}(\text{aq}) + 4\text{Cl}^-(\text{aq}) \rightleftharpoons [\text{CuCl}_4]^{2-}(\text{aq}) + 6\text{H}_2\text{O}(\text{l})$

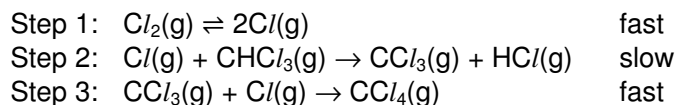
- 11 Human plasma is buffered mainly by dissolved CO_2 which has reacted to form carbonic acid.



Usually the pH of human plasma is 7.4. The acid dissociation constant, K_a , of carbonic acid is $7.90 \times 10^{-7} \text{ mol dm}^{-3}$.

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

- A** This buffer system can be prepared by mixing suitable amounts of sodium hydrogencarbonate and hydrochloric acid.
- B** The ratio of $[\text{HCO}_3^-]$ to $[\text{H}_2\text{CO}_3]$ in human plasma is 20 : 1.
- C** Its pH value remains constant when diluted with water.
- D** It has a pH value equal to the $\text{p}K_a$ value of carbonic acid.
- 12 The mechanism below has been proposed for the reaction of CHCl_3 with Cl_2 .



Which of the following rate equations is consistent with this mechanism?

- A** $\text{rate} = k[\text{CHCl}_3][\text{Cl}]$
- B** $\text{rate} = k[\text{CHCl}_3][\text{Cl}_2]$
- C** $\text{rate} = k[\text{CHCl}_3][\text{Cl}_2]^{1/2}$
- D** $\text{rate} = \frac{k[\text{CHCl}_3]}{[\text{Cl}_2]}$
- 13 Consecutive elements **X**, **Y** and **Z** are in the third period of the Periodic Table. Element **Y** has the highest first ionisation energy and the lowest melting point of these three elements.

What could be the identities of **X**, **Y** and **Z**?

- A** sodium, magnesium, aluminium
- B** magnesium, aluminium, silicon
- C** aluminium, silicon, phosphorus
- D** silicon, phosphorus, sulfur

- 14 The nitrates of beryllium and aluminium can undergo thermal decomposition similarly as magnesium nitrate. Using relevant data from the *Data Booklet*, which of the following shows the correct trend of the decomposition temperatures for these three compounds?
- A $\text{Mg}(\text{NO}_3)_2 > \text{Al}(\text{NO}_3)_3 > \text{Be}(\text{NO}_3)_2$
 B $\text{Mg}(\text{NO}_3)_2 > \text{Be}(\text{NO}_3)_2 > \text{Al}(\text{NO}_3)_3$
 C $\text{Be}(\text{NO}_3)_2 > \text{Al}(\text{NO}_3)_3 > \text{Mg}(\text{NO}_3)_2$
 D $\text{Al}(\text{NO}_3)_3 > \text{Be}(\text{NO}_3)_2 > \text{Mg}(\text{NO}_3)_2$

- 15 The table below shows the results of experiments in which the halogens, X_2 , Y_2 and Z_2 were added to separate aqueous solutions containing X^- , Y^- and Z^- ions.

	$\text{X}^-(\text{aq})$	$\text{Y}^-(\text{aq})$	$\text{Z}^-(\text{aq})$
X_2	no reaction	no reaction	Z_2 formed
Y_2	X_2 formed	no reaction	Z_2 formed
Z_2	no reaction	no reaction	no reaction

In which sequence is the solubility of the silver halides in aqueous ammonia arranged in increasing order?

- A AgX, AgY, AgZ
 B AgY, AgX, AgZ
 C AgY, AgZ, AgX
 D AgZ, AgX, AgY
- 16 Which of the following reactions of first row transition metal ions is correct?
- A Addition of $\text{NaOH}(\text{aq})$ to $\text{K}_2\text{CrO}_4(\text{aq})$ produces an orange solution of $\text{K}_2\text{Cr}_2\text{O}_7$.
 B Addition of $\text{KI}(\text{aq})$ to $\text{Fe}_2(\text{SO}_4)_3(\text{aq})$ produces a brown precipitate of FeI_3 .
 C Addition of concentrated HCl to $\text{CuSO}_4(\text{aq})$ produces a yellow solution of $\text{H}_2[\text{CuCl}_4]$.
 D Addition of $\text{Na}_2\text{CO}_3(\text{aq})$ to $\text{CrCl}_3(\text{aq})$ produces a green precipitate of $\text{Cr}_2(\text{CO}_3)_3$.

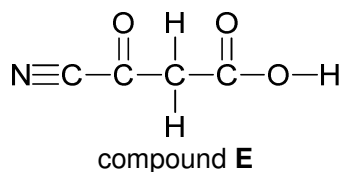
- 17 Use of the *Data Booklet* is relevant to this question.

Which set of reagents, when added in the order shown below, would convert $\text{Fe}^{3+}(\text{aq})$ to $[\text{Fe}(\text{CN})_6]^{3-}(\text{aq})$?

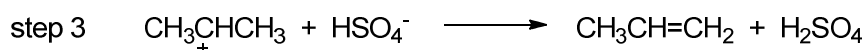
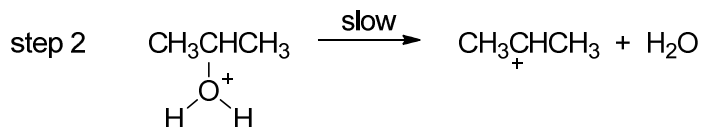
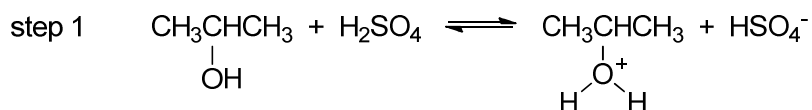


	step 1	step 2	step 3
A	Zn(s)	$\text{CN}^-(\text{aq})$	$\text{SO}_2(\text{g})$
B	$\text{I}^-(\text{aq})$	$\text{CN}^-(\text{aq})$	$\text{Cl}_2(\text{g})$
C	$\text{H}_2\text{O}_2(\text{aq})$	$\text{I}^-(\text{aq})$	$\text{CN}^-(\text{aq})$
D	Ag(s)	$\text{I}^-(\text{aq})$	$\text{CN}^-(\text{aq})$

- 18 Which of the following reagents, upon reaction with compound **E**, gives only one sp^2 hybridised carbon atom in the product molecule?



- A** NaBH_4 in methanol
B LiAlH_4 in dry ether
C $\text{HCl}(\text{aq})$, heat
D SOCl_2
- 19 The dehydration of propan-2-ol to form propene is thought to involve the following steps.



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

- A** Propan-2-ol acts as a base in step 1.
B H_2SO_4 is a catalyst in this reaction.
C A possible side product of the reaction is $\text{CH}_3\text{CH}(\text{OSO}_3\text{H})\text{CH}_3$.
D It is more likely for primary alcohols to proceed via this mechanism than tertiary alcohols.
- 20 Compound **S** upon reaction with hot acidified potassium manganate(VII) yields CH_3COCH_3 , $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CO}_2\text{H}$ and $\text{CH}_2(\text{CO}_2\text{H})_2$.

Which compound could be **S**?

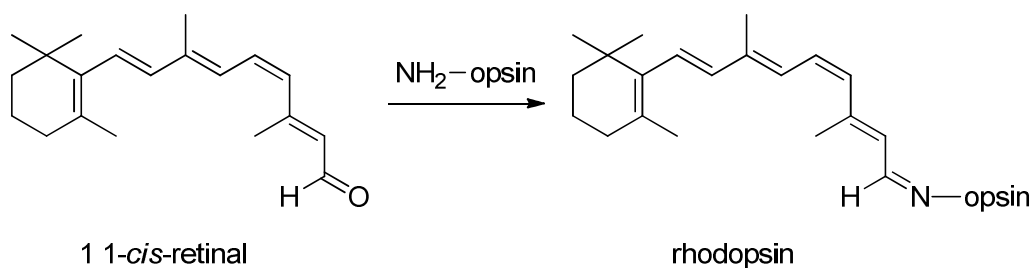
- A** $\text{CH}_3\text{CH}=\text{C}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{C}(\text{CH}_3)=\text{CHCH}_2\text{CH}_2\text{OH}$
B $(\text{CH}_3)_2\text{C}=\text{CHCH}_2\text{CH}_2\text{C}(\text{CH}_3)=\text{CHCH}_2\text{CH}_2\text{OH}$
C $(\text{CH}_3)_2\text{C}=\text{CHCH}_2\text{CH}_2\text{C}(\text{CH}_2\text{OH})=\text{CHCH}_2\text{CH}_3$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

- 21 **P**, **Q** and **R** are three isomeric aromatic compounds with the molecular formula, $C_8H_8O_2$. **P** and **Q** are monobasic acids whereas **R** is a neutral compound. The pK_a of **P** and **Q** are 3.90 and 4.31 respectively. When **R** is heated strongly with $NaOH(aq)$, one of the organic products yielded is $C_6H_5O^-Na^+$.

Which of the following shows the correct identities of **P**, **Q** and **R**?

	P	Q	R
A			
B			
C			
D			

- 22 A key molecule in the chemistry of vision is the highly conjugated rhodopsin, which is synthesised in the rod cells of the eye from 1-*cis*-retinal and a primary amine in the protein opsin.

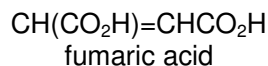


Which of the following statements is correct?

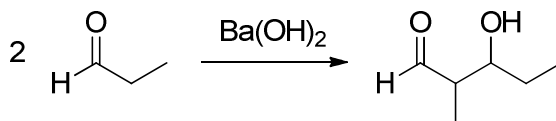
- A** 1 mol of 1-*cis*-retinal reacts with 5 mol of hydrogen gas.
- B** The reaction between 1-*cis*-retinal and NH_2 -opsin is a condensation reaction.
- C** The reaction of 1-*cis*-retinal with $LiAlH_4$ produces a product that is optically active.
- D** The reaction between 1-*cis*-retinal and excess hot acidified potassium manganate(VII) produces a total of five different organic products.

- 23 Which of the following compounds are arranged in decreasing order of their solubility in water?
- A $\text{CH}_3\text{CH}_2\text{CO}_2\text{Na}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
- B $\text{CH}_3\text{CH}_2\text{CO}_2\text{Na}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$
- C $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$, $\text{CH}_3\text{CH}_2\text{CO}_2\text{Na}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
- D $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$, $\text{CH}_3\text{CH}_2\text{CO}_2\text{Na}$

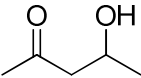
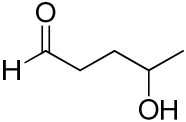
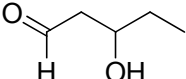
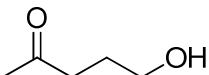
- 24 Which of the following compounds **cannot** be prepared using fumaric acid as a starting material?



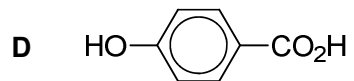
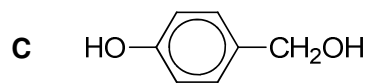
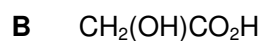
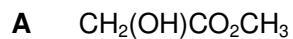
- A $(\text{CO}_2\text{H})_2$
- B $\text{CH}_2(\text{CO}_2\text{H})\text{CH}_2\text{CO}_2\text{H}$
- C $\text{CH}(\text{OH})(\text{CO}_2\text{H})\text{CH}(\text{OH})\text{CO}_2\text{H}$
- D $\text{HO}_2\text{C}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2\text{CO}_2\text{H}$
- 25 Aldehydes and ketones undergo addition in the presence of a strong base. A reaction involving propanal, $\text{CH}_3\text{CH}_2\text{CHO}$, and barium hydroxide is shown below.



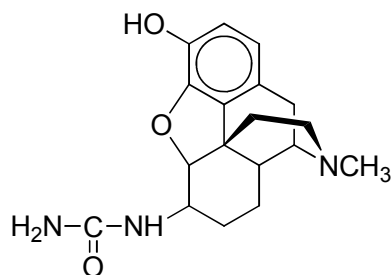
Which product could be formed when barium hydroxide is added to a mixture of ethanal, CH_3CHO , and propanone, CH_3COCH_3 ?

- A 
- B 
- C 
- D 

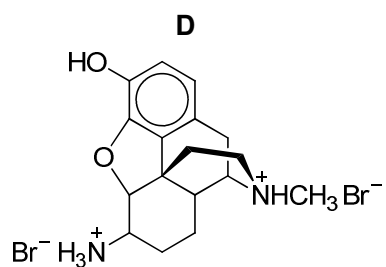
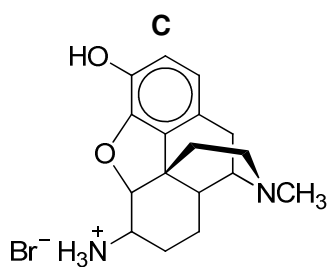
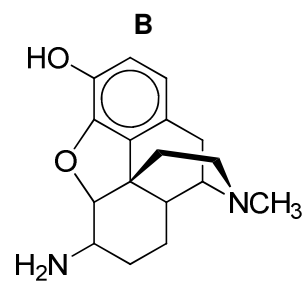
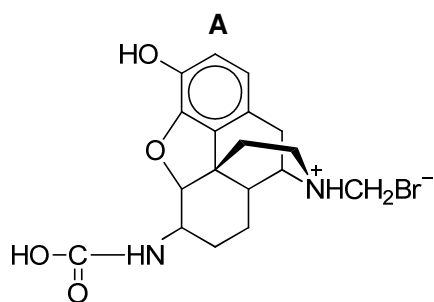
26 Which of the following compounds will react with SOCl_2 but **not** react with $\text{HCl}(\text{g})$?



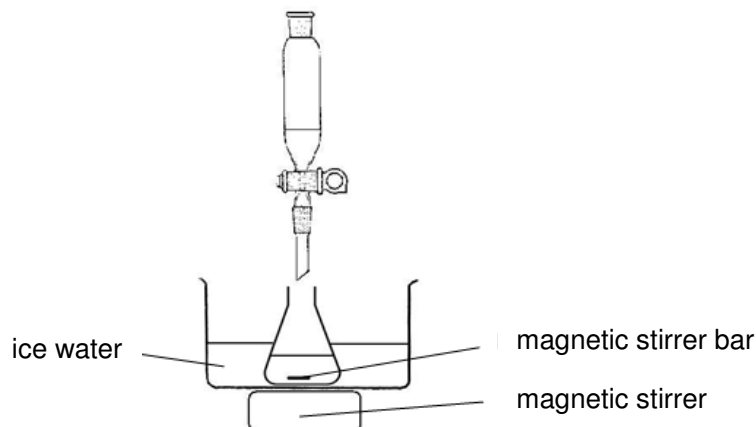
27 A derivative of morphine has the structure shown below.



What is the product formed when the above compound is heated with excess $\text{HBr}(\text{aq})$?

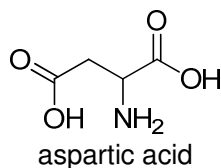


28 The diagram shows an experimental setup used in a laboratory.



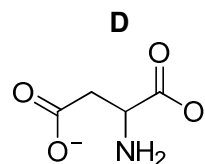
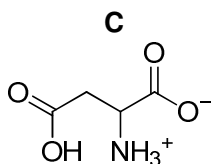
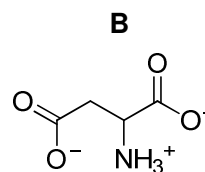
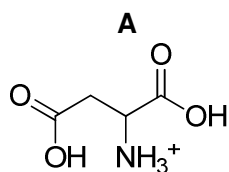
Which of the following preparations could this setup be used for?

- A 2,4,6-tribromophenol from phenol and bromine in tetrachloromethane
 - B ethanol from ethene and concentrated sulfuric acid
 - C ethylamine from ethanamide and lithium aluminium hydride in dry ether
 - D methyl methanoate from methanol, methanoic acid and concentrated sulfuric acid
- 29 Aspartic acid was first discovered in 1827 by Plisson. It is found in animal sources such as luncheon meat and sausages as well as vegetable sources such as sprouting seeds, oat flakes, avocado and asparagus.



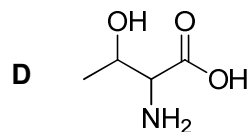
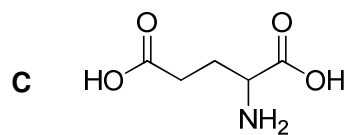
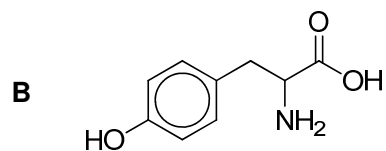
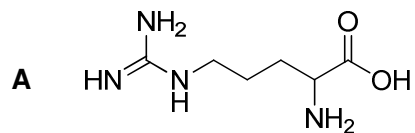
There are three pK_a values associated with aspartic acid: 2.10, 3.86, 9.82.

Using the pK_a values, what is the major species present in solutions of aspartic acid at pH 7?



- 30 Electrophoresis is an analytical method frequently used in molecular biology to analyse and separate proteins and amino acids. Amino acid samples are placed in a gel slab containing a buffer. The ends of the gel slab are connected to charged electrodes and the charged amino acid particles move towards the oppositely charged electrodes.

Which amino acid will move most readily towards the anode at pH 10?



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 The table shows the electronic configurations of two d-block elements in the Periodic Table.

element	electronic configuration
X	$[\text{Ar}]3d^74s^2$
Y	$[\text{Ar}]3d^{10}4s^1$

Which statements about **X** and **Y** are **incorrect**?

- X** is likely to exist as $\text{K}_2\text{X}_2\text{O}_7$.
 - The E^\ominus value of $\text{X}^{3+}/\text{X}^{2+}$ is more positive than that of $\text{Y}^{3+}/\text{Y}^{2+}$.
 - Upon reduction from $\text{YCl}_2(\text{aq})$ to $[\text{YCl}_2]^{-}(\text{aq})$, the solution turns colourless.
- 32 Which of the following graphs have the same general shape according to the ideal gas law for a fixed mass of gas?
- PV against P (at constant T) and V/T against T (at constant P)
 - V against T (at constant P) and V against 1/P (at constant T)
 - T against 1/P (at constant V) and T against V (at constant P)

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 table below shows the results of three experiments conducted for the reaction $\text{P} + \text{Q} \rightarrow \text{products}$.

[P] / mol dm ⁻³	[Q] / mol dm ⁻³	rate / mol dm ⁻³ s ⁻¹
0.012	0.005	0.9×10^{-4}
0.024	0.010	2.0×10^{-4}
0.048	0.010	4.0×10^{-4}

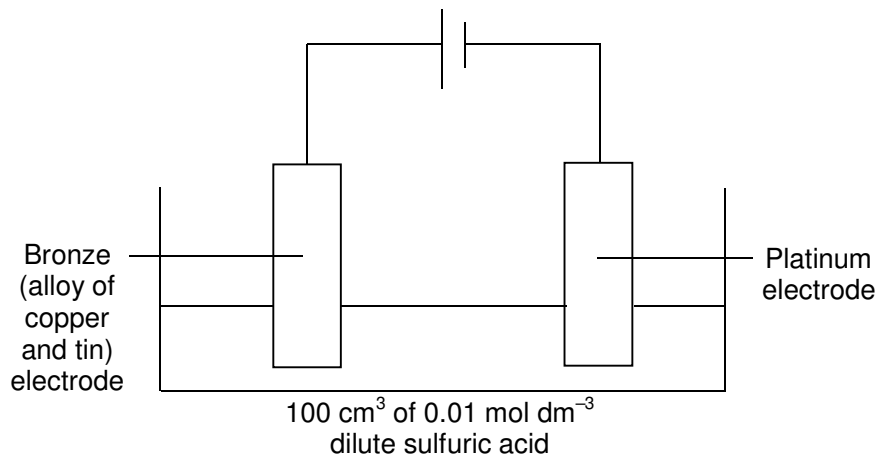
If the rate constant doubles for each 10 °C rise in temperature, which pairs of experimental conditions will result in the same rate?

	[P] / mol dm ⁻³	[Q] / mol dm ⁻³	temperature / °C
condition 1	0.10	0.20	40
condition 2	0.20	0.20	30
condition 3	0.30	0.30	20

- 1** conditions 1 and 2
- 2** conditions 1 and 3
- 3** conditions 2 and 3

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

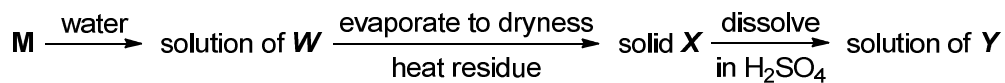
An experiment is set up as shown below. A steady current of 2 A was passed through the electrolyte for 10 min at s.t.p.



Which statements regarding the electrolysis are correct?

- 1 The anode becomes pinkish in colour.
- 2 140 cm³ of gas will be collected at the cathode.
- 3 A straight line graph showing the mass of anode decreasing with time can be obtained.

35 A Group II metal, **M**, undergoes two reaction routes.



Which sets contain at least two identical compounds?

- 1 **P** **Q** **Y**
- 2 **Q** **W** **Y**
- 3 **R** **W** **X**

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

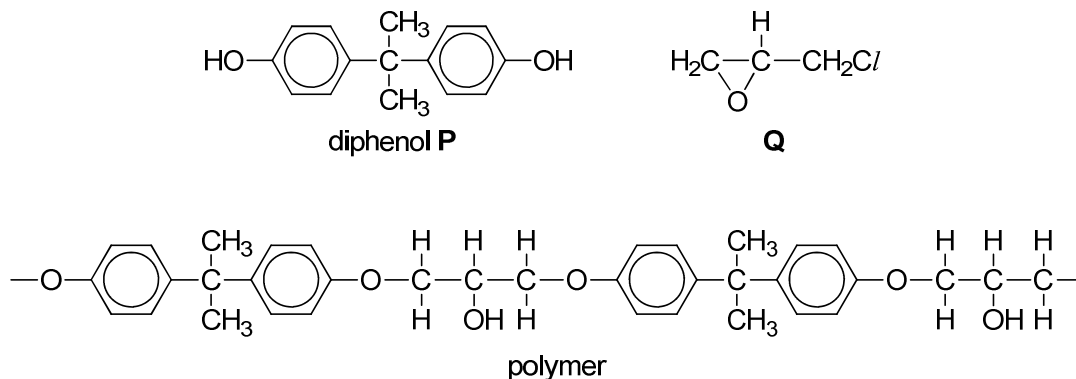
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

- 36** The properties of astatine (At), a Group VII element, can be deduced from the trends of other Group VII elements. Which of the following statements about astatine are likely to be correct?

- HAt is a stronger acid compared to HCl.
- At₂ disproportionates in hot dilute sodium hydroxide to yield AtO₃⁻ and At⁻ as major products.
- Potassium astatide forms a precipitate with silver nitrate quickly and can dissolve in dilute aqueous ammonia solution.

- 37** Diphenol **P** reacts with **Q** to give a polymer. A segment of the polymer with two repeat units is shown below.

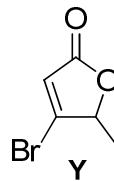
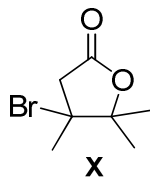


Which of the following statements are correct?

- Condensation reaction takes place.
 - One HCl molecule is removed for each repeat unit of the polymer formed.
 - A polymer made up of n number of repeat units will contain n number of chiral centres.
- 38** Which of the following compounds will give a precipitate of triiodomethane (iodoform) when reacted with iodine and aqueous sodium hydroxide?

- CH₃CH₂CH(OH)CH₃
- C₆H₅COCH₃
- CH₃OCOCHI₂

39 Below are the structures of compounds **X** and **Y**.



Which sets of reagents and conditions can be used to distinguish between compounds **X** and **Y**?

- 1 acidified $K_2Cr_2O_7$, heat
 - 2 aqueous alkaline iodine, heat
 - 3 $NaOH(aq)$, followed by excess $HNO_3(aq)$ and $AgNO_3(aq)$
- 40 Which of the following are involved in the mechanism of the reaction between aqueous sodium hydroxide and 2-bromo-2-methylbutane?
- 1 a curly arrow from a lone pair on the OH^- ion to the $C^{\delta+}$ atom of 2-bromo-2-methylbutane
 - 2 the heterolytic fission of the C-Br bond
 - 3 an attack by a nucleophile on a carbocation