

ANGLO-CHINESE JUNIOR COLLEGE
DEPARTMENT OF CHEMISTRY
Preliminary Examination

CHEMISTRY
Higher 2

9729/01

Paper 1 Multiple Choice

14 September 2021
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.

Write your name, index number and tutorial class on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** 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.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages and **1** blank page.



- 1 In an organic synthesis, a 62% yield of product is achieved.

Which conversions are consistent with the given information?

- 1 74 g of butan-2-ol ($M_r = 74.0$) $\rightarrow$ 44.64 g of butanone ($M_r = 72.0$)
- 2 72 g of butanal ($M_r = 72.0$) $\rightarrow$ 45.88 g of butan-1-ol ($M_r = 74.0$)
- 3 56 g of but-2-ene ($M_r = 56.0$) $\rightarrow$ 37.20 g of ethanoic acid ($M_r = 60.0$)

- A 1, 2 and 3
 B 1 and 2 only
 C 2 and 3 only
 D 1 only

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

Sodium percarbonate, $x(\text{Na}_2\text{CO}_3) \cdot y(\text{H}_2\text{O}_2)$ is a chemical that is used in cleaning powders. When dissolved in water, it releases hydrogen peroxide and sodium carbonate, both of which are useful cleaning agents.

A sample of 10.0 cm^3 of $0.100 \text{ mol dm}^{-3}$ sodium percarbonate requires 20.0 cm^3 of $0.100 \text{ mol dm}^{-3}$ of acidified KI before the end point of titration is reached.

Another identical sample releases 48.0 cm^3 of carbon dioxide at room conditions on reaction with excess acid.

What are the values of x and y respectively?

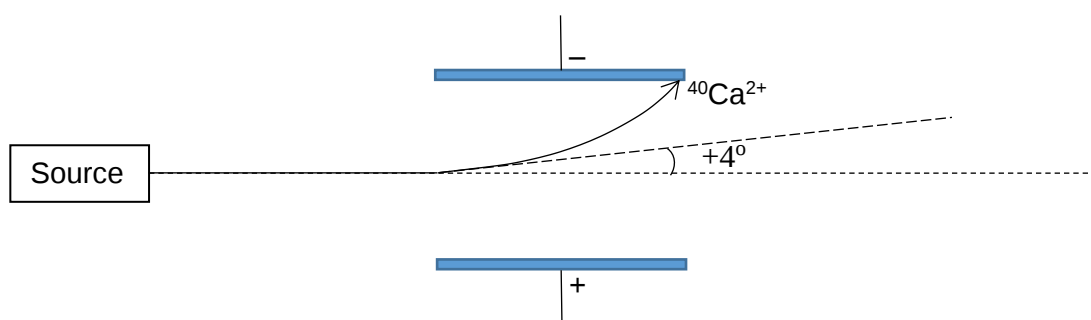
	x	y
A	2	1
B	3	2
C	2	3
D	3	1

- 3 An ion X^{2+} contains 24 protons.

What is the electronic configuration of X^{3+} ?

- A $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$
 B $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$
 C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^2$
 D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

- 4 A sample of the element calcium was vaporised, ionised and passed through an electric field. It was observed that a beam of $^{40}\text{Ca}^{2+}$ particles gave an angle of deflection of $+4^\circ$.



Assuming an identical set of experimental conditions, by what angle would a beam of $^{19}\text{F}^-$ particles be deflected?

- A $+2^\circ$ B -2° C $+4^\circ$ D -4°
- 5 *Use of Data Booklet is relevant to this question.*

X, **Y** and **Z** are isotopes of three different elements. An isotope of Argon has a mass number of 41 and the same number of neutrons in the nucleus as each of the isotopes **X**, **Y** and **Z**.

The species Ar , X^+ , Y^{2+} and Z^{3+} all contain the same number of electrons.

What are the mass numbers of **X**, **Y** and **Z**?

	X	Y	Z
A	42	41	40
B	40	41	42
C	44	43	42
D	42	43	44

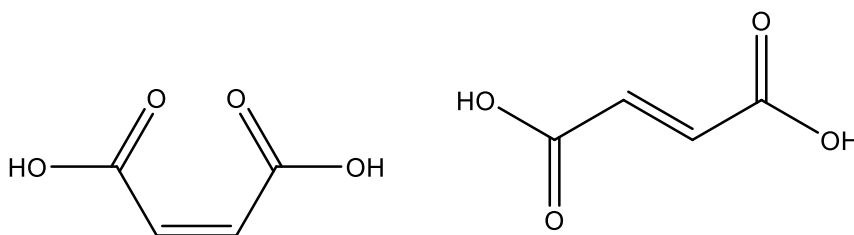
- 6 Equimolar amounts of the liquids, water and ethanol, are mixed together at 20 °C. The original intermolecular forces in the pure liquids are disrupted and weaker intermolecular forces between water and ethanol are made simultaneously.

The boiling point of water is 100 °C. The boiling point of ethanol is 78 °C.

Which row is correct?

	initial temperature of mixture	boiling point of mixture
A	above 20 °C	above 78 °C
B	above 20 °C	below 78 °C
C	below 20 °C	above 100 °C
D	below 20 °C	below 100 °C

- 7 The pK_a and solubility values of maleic acid and fumaric acid are as follows:



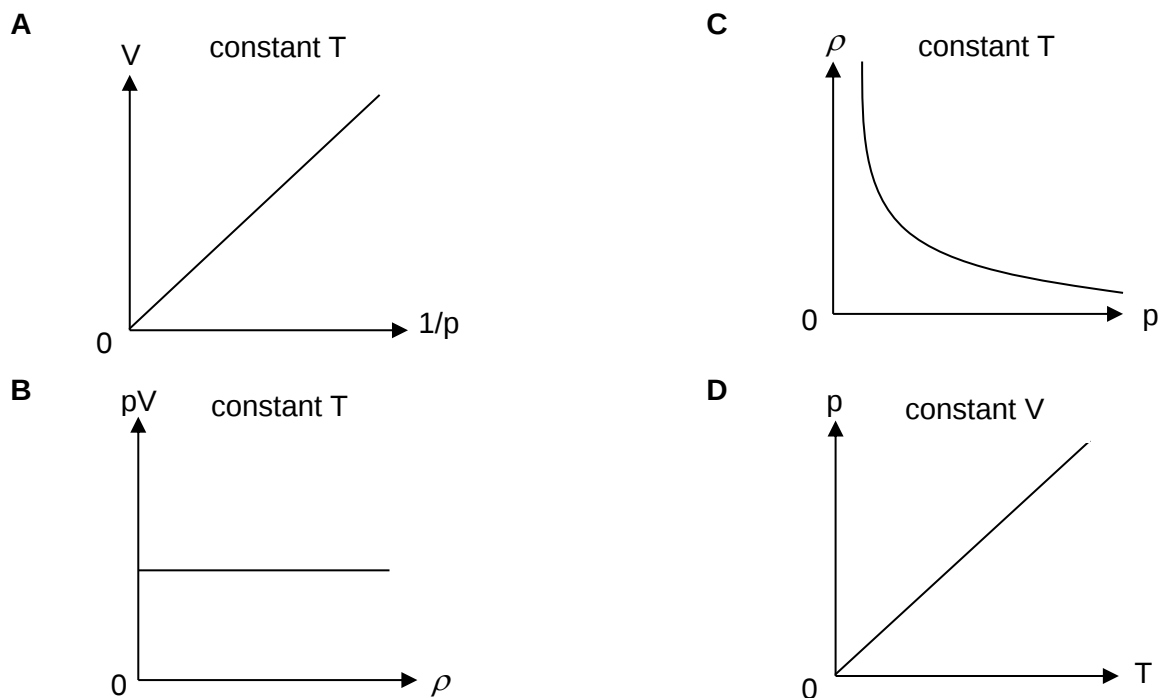
	<u>maleic acid</u>	<u>fumaric acid</u>
pK_{a1}	1.94	3.03
pK_{a2}	6.22	4.54
solubility / g per 100g water	78.8	0.49

Which statements are correct?

- 1 The pK_{a1} value of maleic acid is less than the pK_{a1} value of fumaric acid because the conjugate base of maleic acid can form intramolecular hydrogen bond, while that of fumaric acid cannot form such intramolecular hydrogen bond.
- 2 The pK_{a1} value of maleic acid is less than the pK_{a1} value of fumaric acid because maleic acid is much more soluble in water than fumaric acid.
- 3 The pK_{a2} value of maleic acid is greater than the pK_{a2} value of fumaric acid because intramolecular hydrogen bond prevents the conjugate base of maleic acid from deprotonating the second hydrogen atom.

- A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 only

- 8 Which diagram **does not** describe the behaviour of a fixed mass of an ideal gas?
(ρ = density of the gas, T = temperature measured in K)



- 9 Which equation corresponds to the enthalpy change stated?

- A** $\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}(\text{g}) + \text{O}(\text{g})$ $\Delta H = 2 \times \text{Bond Energy (O-H)}$
- B** $\frac{1}{2} \text{Cl}_2(\text{g}) \rightarrow \text{Cl}^-(\text{aq})$ $\Delta H_{\text{formation}}(\text{Cl}^-(\text{aq}))$
- C** $\text{CO}(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$ $\Delta H_{\text{combustion}}(\text{CO}_2(\text{g}))$
- D** $\text{Na}^+(\text{g}) \rightarrow \text{Na}^+(\text{aq})$ $\Delta H_{\text{solution}}(\text{Na}^+(\text{g}))$

- 10 Given the following data in kJ mol^{-1}

enthalpy change of atomisation of Na(s)	+107
electron affinity of Cl atom	-349
enthalpy change of formation of NaCl(s)	-411
enthalpy change of atomisation of Cl(g)	+122
1 st IE of Na atom	+494

What is the lattice energy of NaCl(s) in kJ mol^{-1} ?

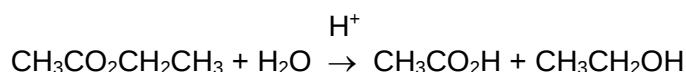
- A** -785 **B** -907 **C** -1269 **D** -1483

- 11** Trouton's rule states that the entropy change of vaporisation is about $+85 \text{ J K}^{-1} \text{ mol}^{-1}$ for various kinds of liquids.

Propan-1-ol boils at 371 K and its enthalpy change of vaporisation is $+47 \text{ kJ mol}^{-1}$.

Which statement is correct?

- A** Entropy change of vaporisation of propan-1-ol cannot be calculated because there is no data on Gibbs free energy change of vaporisation of propan-1-ol.
- B** Entropy change of vaporisation of propan-1-ol is $+85 \text{ J mol}^{-1} \text{ K}^{-1}$.
- C** Entropy change of vaporisation of propan-1-ol is $+127 \text{ J mol}^{-1} \text{ K}^{-1}$ which is more positive than $+85 \text{ J mol}^{-1} \text{ K}^{-1}$ because of the strong hydrogen bonds between molecules.
- D** Entropy change of vaporisation of propan-1-ol is $+127 \text{ J mol}^{-1} \text{ K}^{-1}$ which is more positive than $+85 \text{ J mol}^{-1} \text{ K}^{-1}$ because of the weak instantaneous dipole induced dipole attraction between molecules.
- 12** Ethyl ethanoate undergoes a slow acid-catalysed hydrolysis in water.



The rate equation is found to be

$$\text{rate} = k[\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3][\text{H}^+]$$

When 0.1 mol dm^{-3} of HCl is reacted with 0.2 mol dm^{-3} of ethyl ethanoate, the half-life was found to be 62 min.

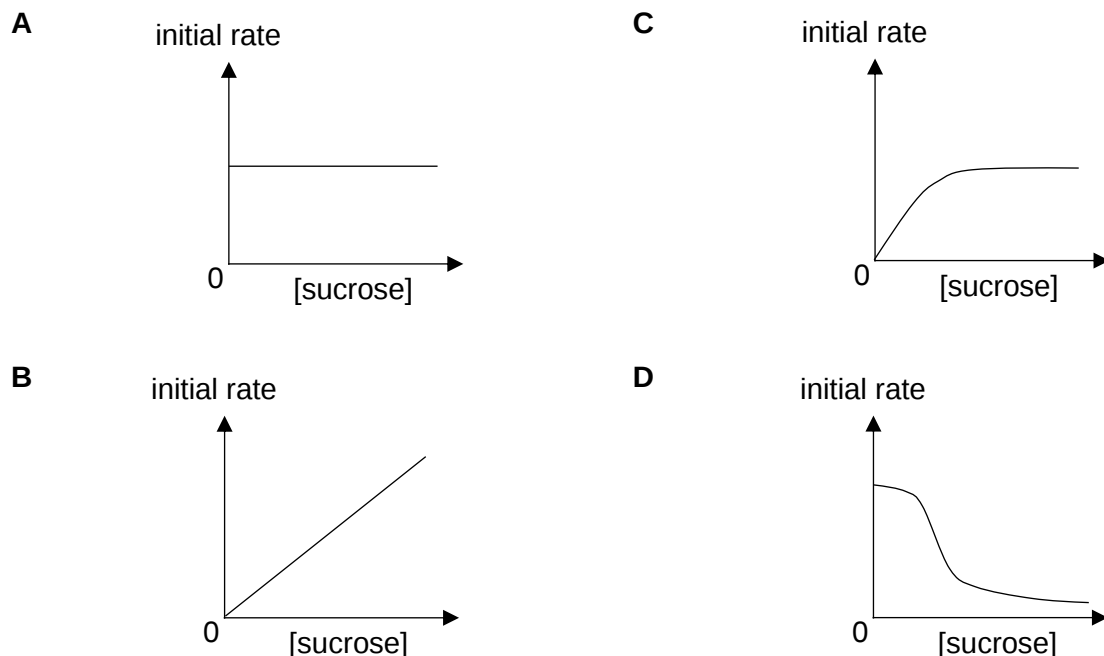
Another reaction was carried out with 0.2 mol dm^{-3} of HCl and 0.2 mol dm^{-3} of ethyl ethanoate.

How long does it take for the concentration of ethyl ethanoate to fall to $0.025 \text{ mol dm}^{-3}$?

- A** 31 min **B** 62 min **C** 93 min **D** 124 min

- 13** Sucrase is a digestive enzyme that catalyses the hydrolysis of sucrose to fructose and glucose. In an experiment, the amount of sucrase and the temperature of the reaction mixture is kept constant.

Which graph is correct?



- 14** Highly toxic disulfur decafluoride, S_2F_{10} , decomposes by a free-radical process.



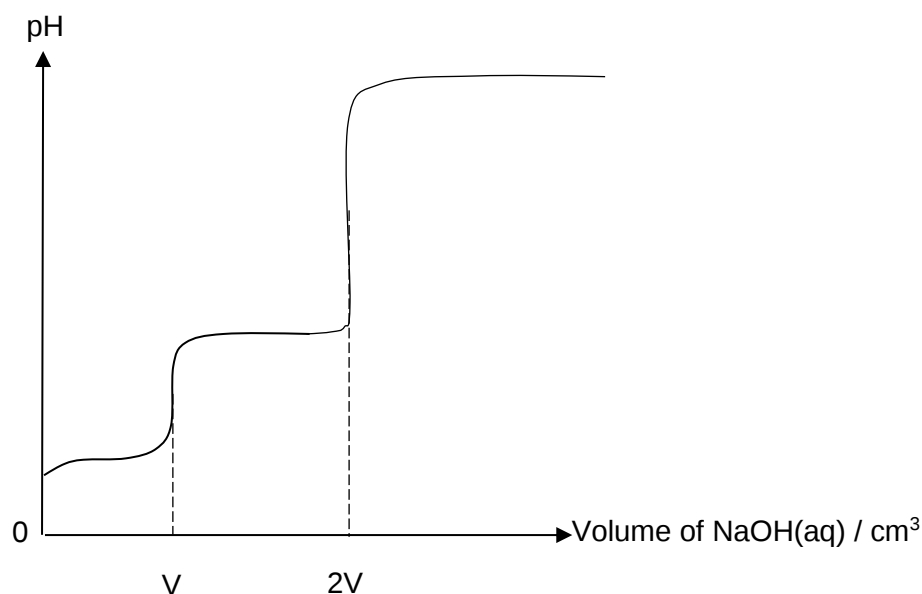
Some S_2F_{10} was placed in a 2.0 dm^3 flask and heated to 110°C to reach equilibrium. The equilibrium concentration of S_2F_{10} was found to be 0.6 mol dm^{-3} . More S_2F_{10} was then added and the new equilibrium concentration of S_2F_{10} was 2.6 mol dm^{-3} .

What is the change in concentration of S_2F_{10} that occurred in terms of the equilibrium constant, K_c , of the decomposition reaction when more S_2F_{10} was added?

- A** $(0.6K_c)^{0.5} - (2.6K_c)^{0.5}$
B $(2.6K_c)^{0.5} - (0.6K_c)^{0.5}$
C $(2.4K_c)^{0.5} - (10.4K_c)^{0.5}$
D $(10.4K_c)^{0.5} - (2.4K_c)^{0.5}$

- 15** Ethanedioic acid has these pK_a values: $pK_{a1} = 1.25$ and $pK_{a2} = 4.14$.

The titration curve below shows how the pH changes when 0.10 mol dm^{-3} aqueous sodium hydroxide is added to 25.0 cm^3 of 0.10 mol dm^{-3} ethanedioic acid.



Which statement is correct?

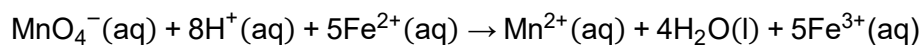
- A** The pH of ethanedioic acid is 1.03 before NaOH(aq) is added.
 - B** The pH of solution mixture is 1.15 when 12.50 cm^3 of NaOH(aq) is added,.
 - C** The pH of solution mixture is 3.54 when 30.00 cm^3 of NaOH(aq) is added.
 - D** Methyl orange can be used as pH indicator for the second endpoint.
- 16** The numerical value of solubility product of silver chromate(VI), Ag_2CrO_4 is 2.5×10^{-22} at 25°C .

Which statement is correct?

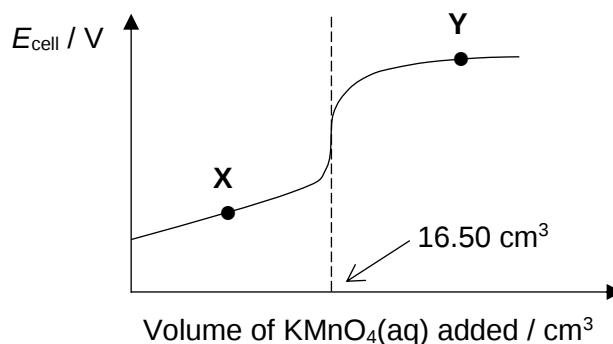
- A** The units of solubility product of silver chromate(VI) are $\text{mol}^2 \text{ dm}^{-6}$.
- B** The solubility of silver chromate(VI) is $3.97 \times 10^{-8} \text{ mol dm}^{-3}$.
- C** Addition of aqueous sodium hydroxide will increase the solubility product of silver chromate(VI).
- D** Addition of aqueous sodium hydroxide will decrease the solubility of silver chromate(VI).

17 Use of Data Booklet is relevant to this question.

Iron(II) salts are often used as a dietary supplement to help cure anaemia. A pill was dissolved in 10 cm^3 of dilute sulfuric acid and titrated against $0.02\text{ mol dm}^{-3}\text{ KMnO}_4(\text{aq})$.



The E_{cell} of the solution mixture was measured against a standard hydrogen electrode and the following graph was obtained.

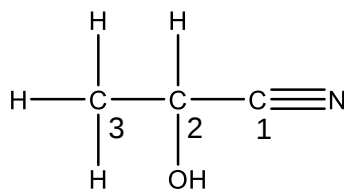


Which statements are correct?

- 1 At point X, $E_{\text{cell}} = +0.77\text{ V}$.
- 2 At point Y, $E_{\text{cell}} = +1.52\text{ V}$.
- 3 The pill contains 1.65×10^{-3} mole of Fe^{2+} .

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

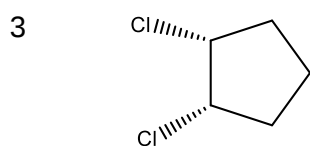
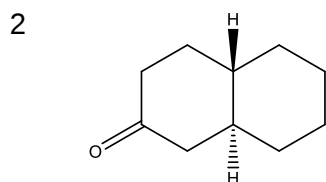
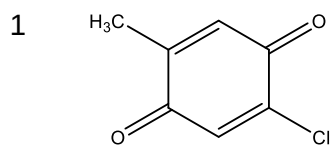
18 2-hydroxypropanenitrile has the following structure.



Which row correctly describes the bonding and hybridisation in the molecule?

	number of π bonds	hybridisation of C1 atom	hybridisation of N atom	hybridisation of O atom
A	2	sp	sp	sp^3
B	2	sp	sp^3	sp^2
C	4	sp^2	sp^2	sp^2
D	4	sp^2	sp^3	sp

19 Which of the following molecules are meso compounds?



A 1, 2 and 3 **B** 1 and 3 only **C** 2 only **D** 3 only

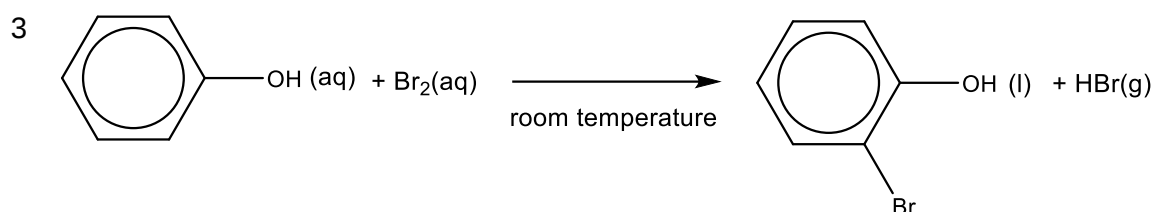
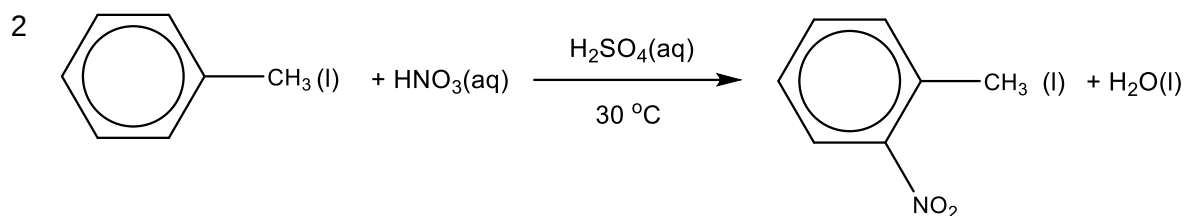
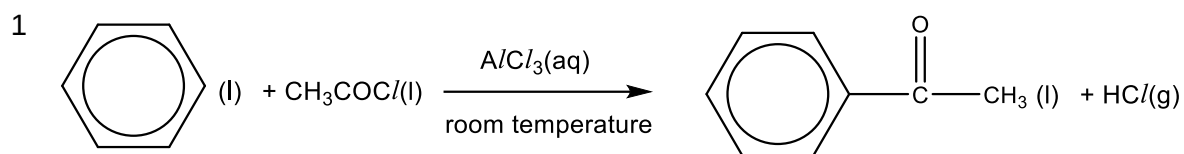
20 CH_3F and Cl_2 are mixed together in the presence of sunlight.

Which statements are correct?

- 1 $\text{F}\bullet$ free radicals are produced.
- 2 Hydrogen gas is produced.
- 3 The reaction involves homolytic fission and σ bond formation.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

21 Which of the following transformation has a set of conditions that is **not** correct?



A 1, 2 and 3 B 1 and 3 only C 2 and 3 only D 3 only

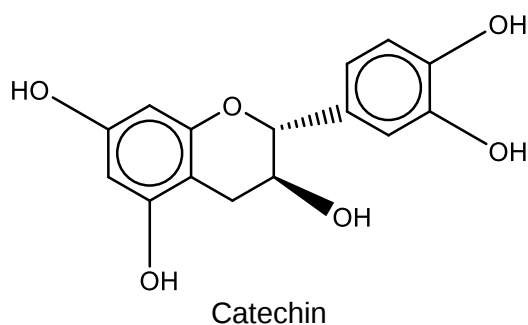
22 A student added aqueous silver nitrate to bromoethane, bromoethene and bromobenzene.

Which statements are correct?

- 1 White precipitate forms for bromoethane.
- 2 Cream precipitate forms for bromoethene.
- 3 No precipitate forms for bromobenzene.

A 1 only B 2 only C 3 only D 2 and 3 only

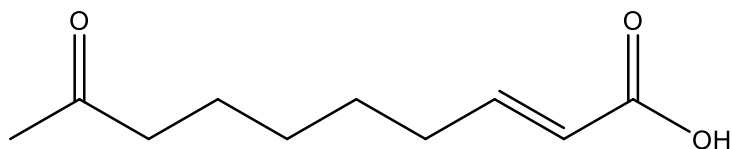
- 23 Catechin is an antioxidant found in green tea, chocolate and peaches.



The C–O–C bond is inert.

Which statement is correct?

- A** 1 mol of catechin reacts with 5 mol of aqueous sodium hydroxide.
- B** 1 mol of catechin reacts with sodium to produce 5 mol of hydrogen gas.
- C** 1 mol of catechin reacts with 5 mol of aqueous bromine.
- D** A ketone functional group is produced when catechin is oxidised by hot acidified $\text{KMnO}_4(\text{aq})$.
- 24 Queen honeybee secretes “queen substance” that is eaten by worker bees. This prevents them from producing rival queen bees in the same colony. The “queen substance” is 9-oxo-2-decenoic acid.



9-oxo-2-decenoic acid

What is the number of hydrogen atoms added per molecule of “queen substance” for the following reactions?

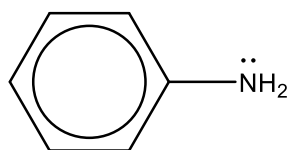
	reducing agent	number of hydrogen atoms added per molecule of queen substance
1	H_2 , Pt	6
2	LiAlH_4 in dry ether	4
3	NaBH_4 in methanol	2

- A** 1, 2 and 3 **B** 2 and 3 only **C** 2 only **D** 1 only

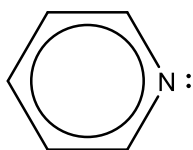
25 Which of the following reagents and conditions are appropriate for making methanoic acid from methanol?

- A $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$, dilute $\text{H}_2\text{SO}_4(\text{aq})$, heat with distillation
- B $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$, dilute $\text{H}_2\text{SO}_4(\text{aq})$, heat under reflux
- C $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$, dilute $\text{HCl}(\text{aq})$, heat under reflux
- D $\text{KMnO}_4(\text{aq})$, dilute $\text{H}_2\text{SO}_4(\text{aq})$, heat under reflux

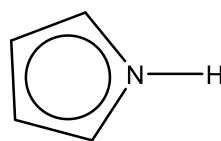
26 Consider the following compounds.



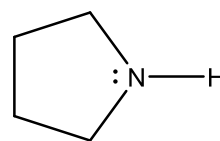
phenylamine



pyridine



pyrrole



pyrrolidine

Which of the following shows the correct order of decreasing $\text{p}K_{\text{b}}$ value?

- A pyrrole > phenylamine > pyridine > pyrrolidine
- B pyrrolidine > pyridine > phenylamine > pyrrole
- C pyrrole > phenylamine > pyrrolidine > pyridine
- D phenylamine > pyridine > pyrrole > pyrrolidine

27 A particular section of keratin polypeptide was digested with two enzymes.

The first enzyme digests at the carboxyl end of leucine and yields the following peptides:

glu-ala
val-leu
glu-asp-thr-leu
ala-glu-leu

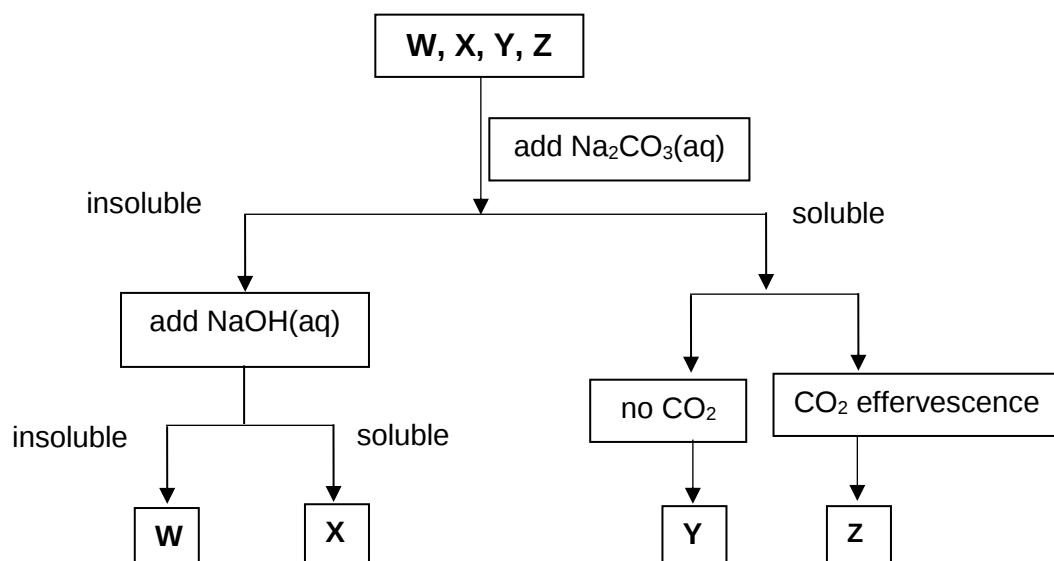
The second enzyme digests at the carboxyl end of glutamic acid and yields the following peptides:

ala
val-leu-glu
asp-thr-leu-ala-glu
leu-glu

What is the primary structure in this section of polypeptide chain?

- A ala-glu-leu-glu-asp-thr-leu-val-leu-glu-ala
- B val-leu-glu-asp-thr-leu-ala-glu-leu-glu-ala
- C glu-asp-thr-leu-ala-glu-leu-val-leu-glu-ala
- D glu-ala-ala-glu-leu-glu-asp-thr-leu-val-leu

- 28 The labels of four containers containing NaCl , AlCl_3 , Al_2O_3 and SiO_2 were detached from the containers. The compounds could be identified using the following flowchart.



What are **W**, **X**, **Y** and **Z**?

	W	X	Y	Z
A	SiO_2	Al_2O_3	NaCl	AlCl_3
B	Al_2O_3	SiO_2	NaCl	AlCl_3
C	NaCl	AlCl_3	SiO_2	Al_2O_3
D	SiO_2	Al_2O_3	AlCl_3	NaCl

- 29 Which of the following statements about Group 2 elements is **not** correct?

- A** The reactivity with cold water increases down the group.
- B** The thermal stability of the carbonate increases down the group.
- C** The solubility of the hydroxide decreases down the group.
- D** The solubility of the sulfate decreases down the group.

- 30** A mixture of two halogens was reacted with excess aqueous sodium thiosulfate. The resulting solution was colourless. When excess aqueous barium nitrate was added, precipitate **X** was formed.

Precipitate **X** was then filtered off and the filtrate was treated with excess aqueous silver nitrate. Some precipitates were formed and then filtered off. Excess dilute aqueous ammonia was added to wash this residue. The remaining residue was precipitate **Y** that dissolved in excess concentrated ammonia. The filtrate was treated with excess dilute nitric acid to give precipitate **Z**.

What are **X**, **Y** and **Z**?

	X	Y	Z
A	BaS ₄ O ₆	AgI	AgBr
B	BaS ₂ O ₃	AgBr	AgCl
C	BaSO ₄	AgI	AgBr
D	BaSO ₄	AgBr	AgCl

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