TEMASEK JUNIOR COLLEGE

2022 JC2 PRELIMINARY EXAMINATION

Higher 2

Chemistry **9729/01**

Paper 1 Multiple Choice **16 September 2022**

1 hour

Additional Materials: Multiple Choice Answer Sheet (OMS)
Data Booklet

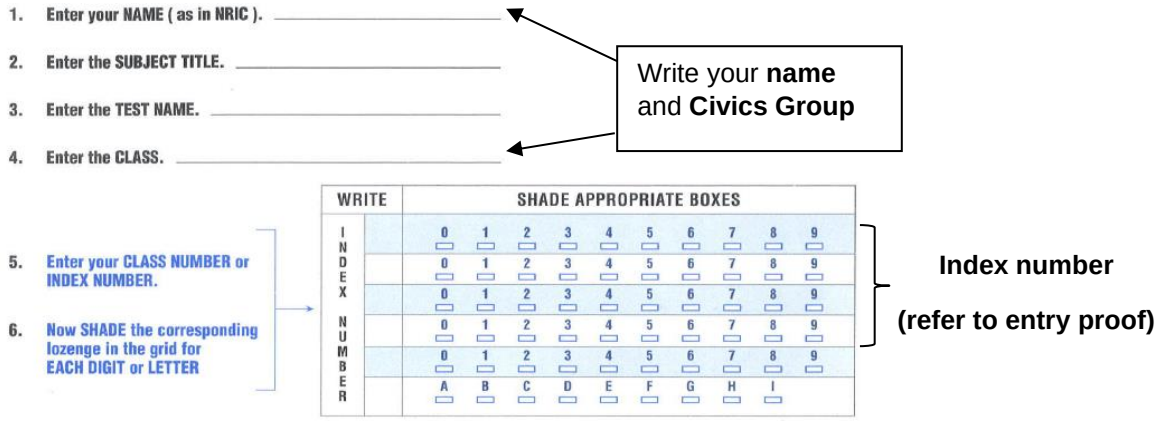
READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C**, **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate OMS.

Read the instructions on the OMS very carefully.

Write your name & Civics Group on the OMS. Shade your index number in the appropriate boxes.



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 **16** printed pages.

[Turn over

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

Atoms or ions that contain the same number of neutrons are isotonic.

Which of the following pairs of ions fulfil both criteria below?

- The two ions are isotonic.
- The first ion deflects more than the second ion when passed through an electric field.

A $^{35}Cl^{-}$, $^{31}P^{-}$

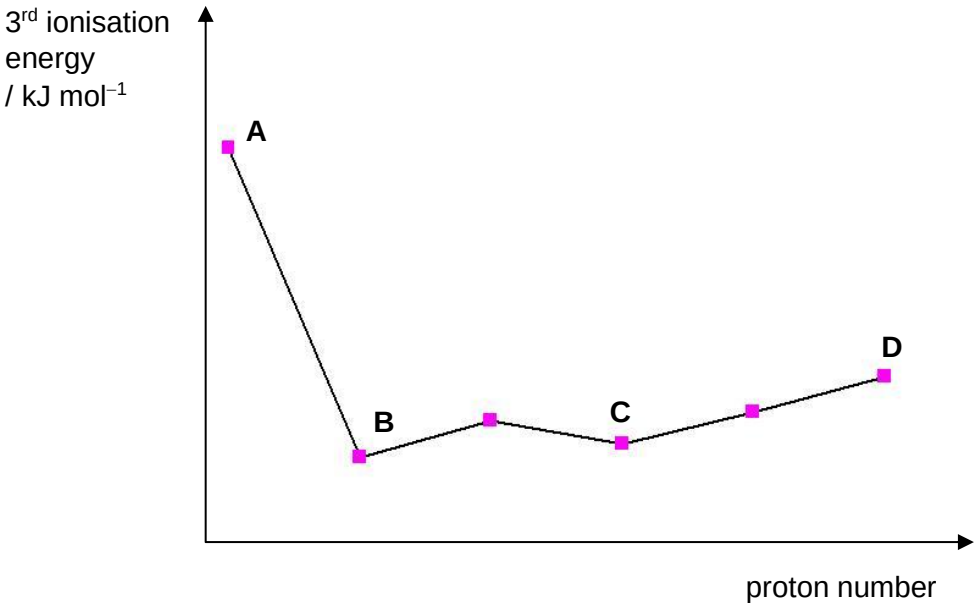
B $^{31}P^{-}$, $^{31}P^{3-}$

C $^{31}P^{3-}$, $^{32}P^{2-}$

D $^{31}P^{3-}$, $^{32}S^{2-}$

2 The variation in the third ionisation energy of six consecutive elements in the Periodic Table is shown in the graph.

Which of these elements is a Group 15 element?



3 Which group of particles is in order of increasing first ionisation energy?

1 Ga Ge As

2 As Se Br

3 Se Br Kr

4 P As Sb

A 1 and 3 **B** 2 and 4

C 2 and 3 **D** 1 and 4

4 Carbon forms double bonds with oxygen, and with two other Group 16 elements, ***Y*** and ***Z***.

In the molecules CO_2, CO***Y*** and CO***Z***, the polarities of these double bonds do not necessarily cancel.

	overall polarity of molecule
CO_2	0
CO***Y***	0.71
CO***Z***	0.73

Which factor best accounts for these observations?

A The C=O bond is the least polar, while the C=***Z*** bond is the most polar.

B Electronegativity increases in the order: ***Z*** < ***Y*** < O

C The C=O, C=***Y*** and C=***Z*** bonds are all polar.

D Bond length increases in the order: C=O < C=***Y*** < C=***Z***

5 Which of the following best describes the change in bond angle when SO_2 is converted to SO_3?

A Decreases to 107°

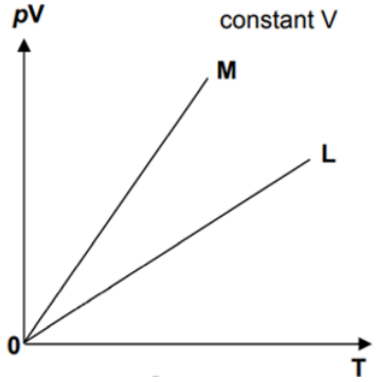
B Increases to 107°

C Decreases to 120°

D Increases to 120°

6 Which graph correctly describes the behaviour of fixed masses of the ideal gases **L** and **M** where the number of moles of **L** is greater than number of moles of **M**?

A



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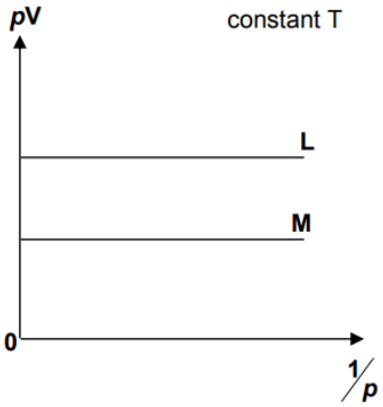

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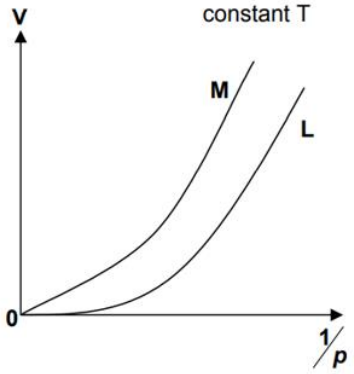

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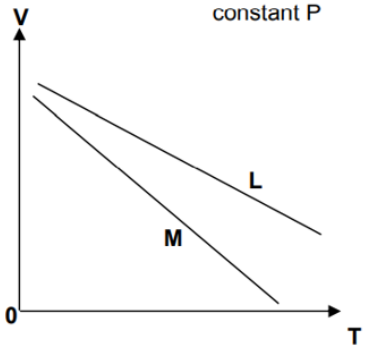


7 **X**, **Y** and **Z** are elements in Period 3 of the Periodic Table. The table below shows the changes in pH when compounds of these elements are added to water.

element	change in pH of solution when oxide of element is added to water	change in pH of solution when chloride of element is added to water
X	increases	no change
Y	decreases	decreases
Z	no change	decreases

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

	X	**Y**	**Z**
A	Na	A*l*	Mg
B	Na	P	A*l*
C	Si	P	A*l*
D	P	Na	Si

8 Which of the following statements about Group 2 elements is correct?

A Solubility of hydroxides decreases down the group.

B Covalent character of chlorides increases down the group.

C Thermal stability of carbonates increases down the group.

D Electrode potential, $E^{\ominus}(M^{2+}/M)$, becomes more positive down the group.

9 Which of the following statements about the Group 17 elements and compounds is **incorrect**?

A When aqueous sodium chloride is added to aqueous bromine, the orange solution is decolourised.

B When aqueous silver nitrate is added to aqueous sodium chloride followed by nitric acid, a white precipitate remains.

C When aqueous chlorine is added to excess sodium thiosulfate, followed by barium nitrate, a white precipitate is formed.

D When chlorine gas is bubbled through potassium iodide, the solution turns brown.

10 A 15 cm^3 mixture of carbon monoxide and methane was mixed with excess oxygen and exploded.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

$$CO + \frac{1}{2}O_2 \rightarrow CO_2$$

There was a contraction in volume of 15 cm^3 at room temperature and pressure after the reaction.

What is the percentage by volume of methane in the mixture?

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

11 Magnesium reacts readily with dilute hydrochloric acid to form magnesium chloride and hydrogen.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

The standard enthalpy change for this reaction can be measured in the laboratory.

What further information is needed in order to calculate the standard enthalpy change of formation of magnesium chloride?

1 ΔH_f for $HCl(aq)$

2 lattice energy of $MgCl_2$

3 enthalpy change of solution of $MgCl_2$

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

12

$$2\mathbf{A} + 2\mathbf{B} \rightarrow \mathbf{A_2B_2}$$

The mechanism for the above reaction involves the following steps.

$2\mathbf{A} \rightleftharpoons \mathbf{C}$	fast
$\mathbf{B} + \mathbf{C} \rightarrow \mathbf{D}$	slow
$\mathbf{B} + \mathbf{D} \rightarrow \mathbf{A_2B_2}$	fast

Based on the information, what is the rate equation for this reaction?

A rate = $k\,[\mathbf{A}]^2\,[\mathbf{B}]^2$

B rate = $k\,[\mathbf{B}]\,[\mathbf{C}]$

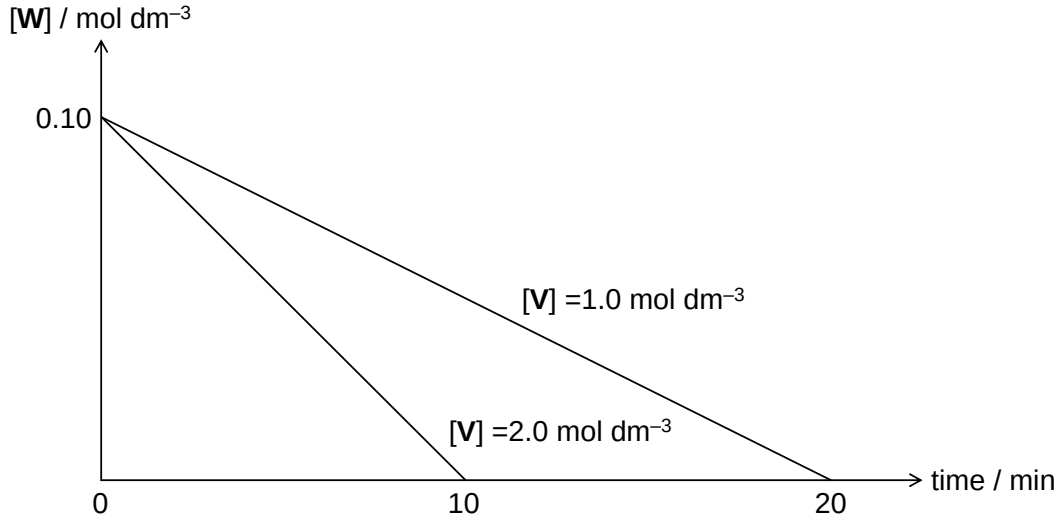
C rate = $k\,[\mathbf{A}]^2\,[\mathbf{B}]$

D rate = $k\,[\mathbf{A}]\,[\mathbf{B}]^2$

13 Consider the reaction

$$\mathbf{V} + \mathbf{W} + \mathbf{X} \longrightarrow \text{products}$$

Two separate experiments were carried out using 1.0 mol dm^{-3} and 2.0 mol dm^{-3} of **V** respectively. A graph of the variation of the concentration of **W** with time is plotted.



Which of the following statements can be determined from the above information?

1 The reaction is first order with respect to **V**.

2 The reaction is zero order with respect to **W**.

3 The reaction is first order with respect to **X**.

A **1, 2** and **3**

B **1** and **2** only

C **2** and **3** only

D **1** only

14 When 0.1 mol of bismuth chloride is added to 2 dm^3 of water, it reacts to form 0.02 mol of white precipitate of bismuth oxychloride and a solution of hydrochloric acid.

The equation for the reaction is as follows:

$$BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl(s) + 2HCl(aq)$$

What is the correct expression for the equilibrium constant K_c?

A $\dfrac{(2 \times 0.02)^2}{0.08}$

B $\dfrac{(0.02)(2 \times 0.02)^2}{0.08}$

C $\dfrac{\left(\dfrac{0.02}{2}\right)\left(\dfrac{2 \times 0.02}{2}\right)^2}{\dfrac{0.08}{2}}$

D $\dfrac{\left(\dfrac{2 \times 0.02}{2}\right)^2}{\dfrac{0.08}{2}}$

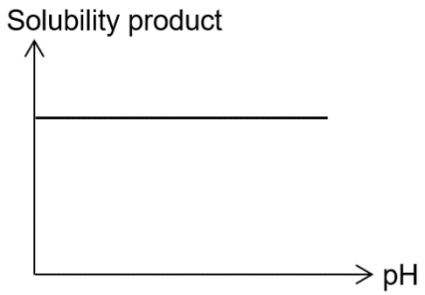
15 The enthalpy change of dissociation of ethanoic acid in water is +1.0 kJ mol^{-1}.

Which correctly describes the value of acid dissociation constant and degree of dissociation when temperature increases?

	acid dissociation constant	degree of dissociation
A	increase	remain constant
B	increase	increase
C	decrease	remain constant
D	decrease	increase

16 The numerical value of the solubility product of copper(I) iodide is 1.27×10^{-12}. Given that HI is a strong acid, which diagram shows how the solubility product of CuI will vary with pH at constant temperature?

A



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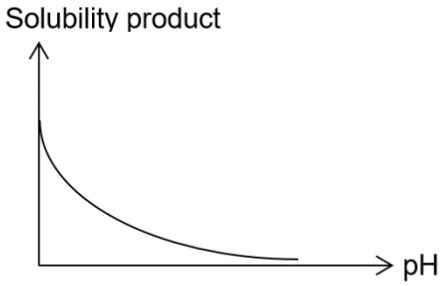

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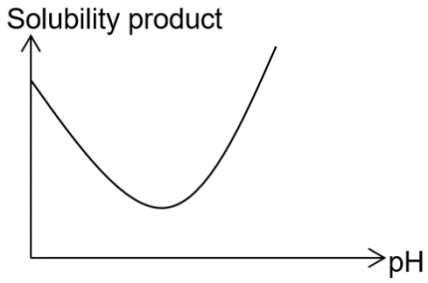

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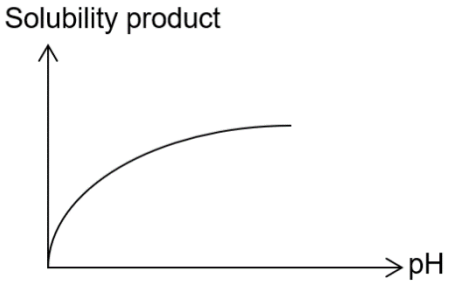


17 Buta-1,3-diene, CH_2=CH-CH=CH_2, reacts completely with two moles of hydrogen chloride.

Which of the following about the products formed is correct?

	No. of constitutional isomers	No. of products that are secondary chloroalkanes
A	2	1
B	3	1
C	3	2
D	4	2

18 Both cyclohexene and benzene react with bromine, but under different conditions.

Cyclohexene reacts readily with liquid bromine while benzene requires a catalyst before a reaction with bromine can occur.

Which of the following explains why cyclohexene is more reactive than benzene?

A The localised π electron cloud in cyclohexene makes the molecule more susceptible to attack by electrophiles.

B Cyclohexene is not a planar molecule while all atoms in benzene lie on the same plane.

C The delocalised π electron cloud in benzene repels electrophiles.

D Cyclohexene has a higher boiling point than benzene.

19 Chloroalkane **W**, $C_5H_{11}Cl$, rotates plane polarised light. On heating **W** with alcoholic NaOH, two alkenes **U** and **X** are formed, with **U** being formed in larger amount.

A yellow precipitate is produced when aqueous alkaline iodine is warmed with one of the products of the reaction between **U** and hot acidified $KMnO_4$.

Which of the following is **W**?

A $CH_3CH_2CHClCH_2CH_2CH_3$

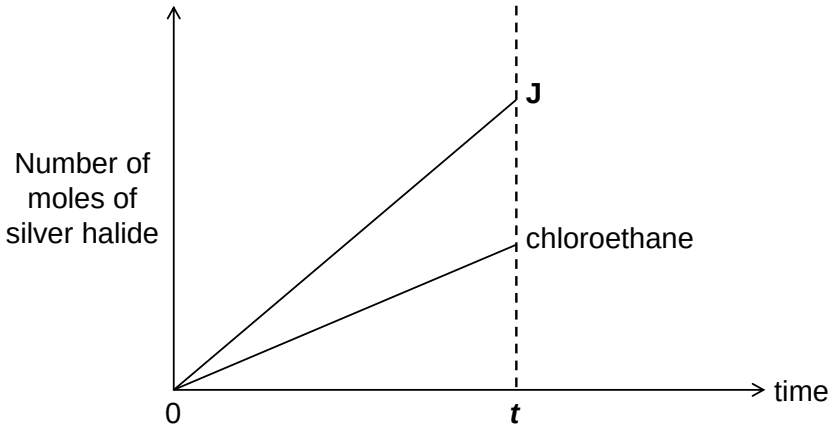
B $CH_3CH(CH_3)CHClCH_3$

C $CH_3CH_2CHClCH_2CH_3$

D $CH_3CCl(CH_3)CH_2CH_3$

20 When halogenoalkanes are heated with ethanolic silver nitrate, insoluble silver halides are formed.

A student investigated the rate of formation of silver halides when the same amount of chloroethane and **J** were reacted separately with hot ethanolic silver nitrate. Each reaction was monitored till time, ***t***, and the following graphs were obtained.



Which of the following compounds could be **J**?

1 C*l*CH_2CH_2C*l*

2 CH_3CH_2Br

3 CH_3CH_2I

A 1, 2 and 3

B 1 and 2

C 2 and 3

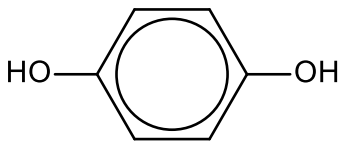
D 1 only

21 1 mole of each of the following four compounds is reacted separately with

- an excess of Na, and
- an excess of $NaHCO_3$.

Which compound produces the same volume of gas with each of the two reagents?

A



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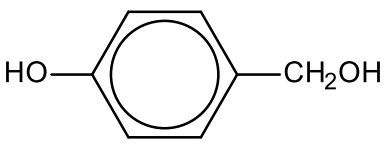

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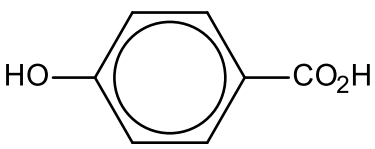

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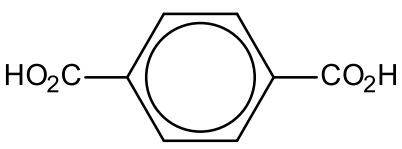
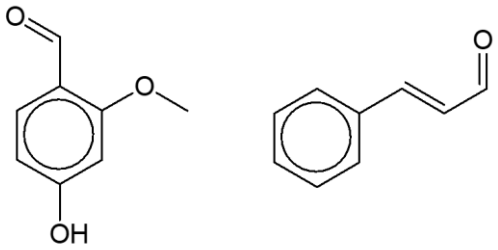


22 Vanillin and cinnamaldehyde are some naturally occurring flavouring agents.



vanillin cinnamaldehyde

Which reagent, when added separately to the two compounds, would enable them to be distinguished from one another?

A 2,4-dinitrophenylhydrazine

B Fehling's solution

C Hot acidified $K_2Cr_2O_7$

D Tollens' reagent

23 What is the relative order of decreasing acidity for the following compounds?

1 2-nitrophenol

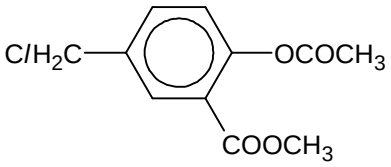
2 benzoic acid

3 2-chlorobenzoic acid

4 cyclohexanol

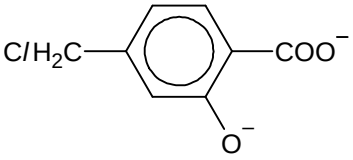
	most acidic	⟶		least acidic
A	2	3	4	1
B	2	3	1	4
C	3	2	4	1
D	3	2	1	4

24 Which one of the following represents the organic product when an excess of hot aqueous sodium hydroxide is added to compound **R**?



R

A



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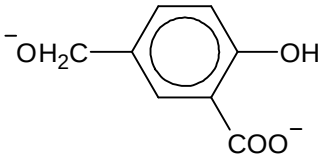

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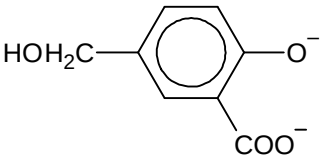

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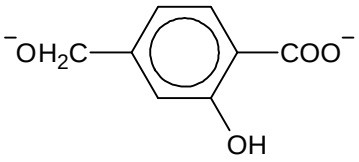
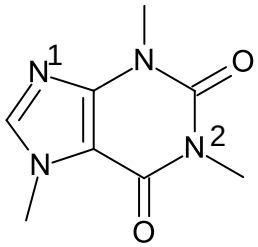


25 Caffeine is a central nervous system stimulant and is used as a cognitive enhancer to increase alertness. All the atoms in the 2 rings are planar.



caffeine

Which of the following statements about caffeine are correct?

1 N^1 is more basic than N^2.

2 Caffeine undergoes a condensation reaction with ethanoyl chloride.

3 1 mole of caffeine reacts with excess hot aqueous sodium hydroxide to form 2 moles of methylamine.

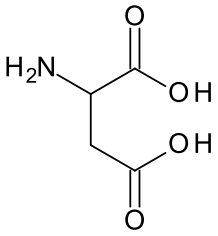
A 1 only

B 2 only

C 1 and 3

D 1, 2 and 3

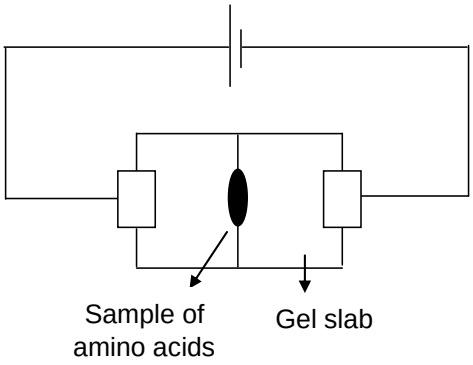
26 Aspartic acid is an α-amino acid that occur naturally in the body.



Aspartic acid

The three pK_a values associated with aspartic acid are 1.88, 3.65 and 9.60.

Electrophoresis is a technique of separating amino acids. Samples are placed on a gel slab containing a buffer and the ends of the gel slab are connected to charged electrodes. Positively charged species migrate towards the negative electrode while negatively charged species migrate towards the positive electrode. Ions of higher charge to mass ratio will migrate at a faster rate.



A solution of aspartic acid buffered at pH = 4 was placed in the electrophoresis set-up.

Which of the following is correct?

A The major species has a net charge of +1.

B The major species present will migrate to the cathode.

C The major species present will migrate to neither electrodes.

D The major species will migrate faster if the pH was 11.

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

Which of the following is the strongest reducing agent?

A hexacyanoferrate(III)

B manganese(II)

C nitrogen dioxide

D vanadyl, VO^{2+}

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

The reaction between iodide, I^- and peroxydisulfate, $S_2O_8^{2-}$ is very slow at room conditions.

Which of the ions is unable to alter the rate of reaction between iodide and peroxydisulfate?

A Co^{2+} **B** Cu^{2+} **C** Fe^{3+} **D** Fe^{2+}

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

Which one of the following is true about vanadium and its compounds?

A The maximum oxidation state of vanadium is found in VO^{2+}.

B V_2O_5 is used as a catalyst in the manufacture of ammonia.

C Zinc reduces VO_2^+(aq) to V^{2+}(aq).

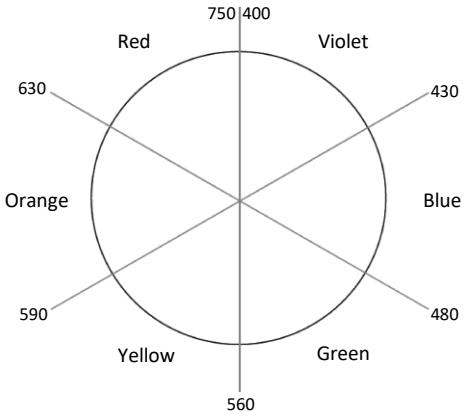
D Vanadium is less dense than calcium.

30 A partial spectrochemical series with ligands arranged in order of decreasing field strength is given below.

ethylenediamine (en) > $H_2NCH_2CO_2^-$ (gly^-) > $C_2O_4^{2-}$

Stronger field ligands are known to give rise to a larger energy gap between the two sets of d-orbitals in a transition metal complex.

The figure below shows a colour wheel with approximate wavelength values (in nm) for different colour light. As wavelength decreases, the energy of the light increases.



An aqueous solution containing the $[Co(gly)_3]$ complex is violet.

Which combination could be the colours of $[Co(C_2O_4)_3]^{3-}$(aq) and $[Co(en)_3]^{3+}$(aq)?

	$[Co(C_2O_4)_3]^{3-}$(aq)	$[Co(en)_3]^{3+}$(aq)
A	green	yellow
B	yellow	orange
C	red	blue
D	blue	green