

TAMPINES MERIDIAN JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION

H2 CHEMISTRY

Paper 1 Multiple Choice

9729/01 19 September 2024 1 hour

Additional materials: Multiple Choice Answer Sheet Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Write your name, class and register number on the Answer Sheet in the spaces provided.

There are **thirty** questions in 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 use of the Answer Sheet very carefully.

You are advised to fill in the Answer Sheet as you go along. No additional time will be given for the transfer of answers once the examination has ended.

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.

Use of the Answer Sheet

Ensure you have written your name, class register number and class on the Answer Sheet.

Use a **2B** pencil to shade your answers on the Answer Sheet; erase any mistakes cleanly. Multiple shaded answers to a question will not be accepted. For **shading of class register number** on the Answer Sheet, please follow the given examples:

If your register number is **1**, then shade **<u>01</u>** in the index number column.

If your register number is **21**, then shade **<u>21</u>** in the index number column.

This document consists of **14** printed pages.

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

A stream of gaseous ${}^{40}_{20}$ Ca²⁺ charged ions was passed through an electric field between two oppositely charged plates and the Ca²⁺ ions were deflected at an angle of +15.0°.

Under the same electric field, a stream of unknown gaseous X^{3-} ion was deflected at an angle of -29.0°. What is a possible atomic number of X?

- **A** 15
- **B** 24
- **C** 31
- **D** 34

Answer: A

angle of deflection $\propto \frac{q}{m}$ ratio $\frac{q}{m}$ of $\frac{40}{20}$ Ca²⁺ = $\frac{2}{40} \rightarrow +15.0^{\circ}$ $\frac{q}{m}$ of $X^{3-} = \frac{3}{Ar \text{ of } X} \rightarrow -29.0^{\circ}$ $\frac{29}{15} = \frac{\frac{3}{Ar \text{ of } X}}{\frac{2}{40}}$ A_r, mass of X = 31.0 X could be phosphorus with 15 protons and 16 neutrons

- **2** Which statements correctly describe an electron shell with the principal quantum shell number n = 2?
 - 1 A total of 10 electrons can be accommodated in this shell.
 - 2 An orbital from this shell must be dumb-bell in shape.
 - 3 The energy level of the orbitals in this shell is higher than that in n = 1.

	Α	1, 2 and 3	В	1 and 2 only	С	2 and 3 only	D	3 only
--	---	------------	---	--------------	---	--------------	---	--------

Answer: D

Only 3 is correct

An orbital in this shell may **either** be spherical or dumb-bell in shape.

A total of 8 electrons can be accommodated in this shell.



3 The table identifies the shape and polarity of four molecules.

Which row is correct?

	molecule	molecular shape	polarity
Α	bromine trifluoride	bent	polar
В	phosphorus trichloride	trigonal pyramidal	polar
С	sulfur dichloride	linear	non-polar
D	trifluoromethane	tetrahedral	non-polar

Answer: B

BrF ₃	3 bp 2 lp	T-shaped	polar
PCl ₃	3 bp 1 lp	trigonal pyramidal	polar
SCl ₂	2 bp 2 lp	bent	polar
CHF ₃	4 bp 0 lp	tetrahedral	polar

4 The table shows four species with their corresponding physical properties. Which species does **not** correspond to its description of physical properties?

	species	physical properties
Α	copper	high melting point, conducts electricity when solid and when molten
В	silicon dioxide	high melting point, does not conduct electricity in any state
С	aluminium bromide	high melting point, conducts electricity when molten but not when solid
D	phosphorus pentachloride	low melting point, does not conduct electricity in any state

Answer: C

	species	structure
Α	Cu	giant metallic
В	SiO ₂	giant molecular
С	A/Br ₃	simple molecular, not giant ionic , does not conduct electricity in any state
D	PCl ₅	simple molecular



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

Which of the following shows the correct trends when the melting points of the elements, Mg, A*l*, Si and P are plotted against their atomic radii?



Across the period,

⇒ Si has the highest melting point. (Option B is wrong.)

 \Rightarrow <u>Al has a higher melting point than Mg</u> due to stronger metallic bonds. (Option D is wrong.)

- **6** Which statement is correct about the halogens (X₂) chlorine, bromine and iodine as well as their corresponding hydrogen halides (HX)?
 - **A** The colour intensity of the halogens decreases from Cl_2 to I_2 .
 - **B** The oxidising power of the halogens decreases from Cl_2 to I_2 .
 - **C** The thermal stability of HX increases from HC*l* to HI.
 - **D** The volatility of HX increases from HC*l* to HI.

Answer: B

The **<u>oxidising power of the halogens decreases down the group</u>** from chlorine to iodine.

Which graph correctly represents the relationship between $\left(\frac{1}{pV}\right)$ and pressure for an 7 ideal gas at constant temperature?



 $\frac{1}{pV} = \frac{1}{nRT} = \mathbf{k}$

Graph is straight line graph with gradient = 0 (horizontal line)

8 1 dm³ of a gaseous hydrocarbon was mixed with excess oxygen. When the mixture undergoes complete combustion, the volume contracted by 2 dm³. When the resultant mixture was passed through concentrated sodium hydroxide, the gas volume further decreased by 2 dm³. All volumes were measured at room temperature and pressure.

What is the empirical formula of the hydrocarbon?

- СН Α
- CH_2 В
- С C_2H_3
- D C_3H_4

Answer: B

Since gaseous volume \propto amounts, put in the coefficients, deducing: $1 C_{x}H_{v}(g) + 3 O_{2}(g) \rightarrow 2 CO_{2}(g) + ? H_{2}O(I)$ Balancing C atoms, we get x = 2Balancing O atoms, we find coefficient of H_2O is 2, hence y = 4 Hence, hydrocarbon is C₂H₄ and empirical formula is CH₂.

9 Substances X and Y react to form product Z.

$$2\mathbf{X} + \mathbf{Y} \rightarrow 2\mathbf{Z}$$

The reaction was studied and the following data were obtained.

experiment	[X] / mol dm ⁻³	[Y] / mol dm ⁻³	initial rate / mol dm ⁻³ min ⁻¹
1	0.10	0.10	0.020
2	0.20	0.10	0.080
3	0.15	0.23	0.045

What is the order of reaction with respect to X and Y?

- A First order with respect to X and zero order with respect to Y.
- **B** Second order with respect to **X** and first order with respect to **Y**.
- **C** First order with respect to **X** and first order with respect to **Y**.
- **D** Second order with respect to **X** and zero order with respect to **Y**.

Answer: D

Compare experiments 1 and 2 to determine the order with respect to X: **[X]** changes from 0.10 to 0.20 (doubles), **[Y]** is constant. Initial rate changes from 0.020 to 0.080 (quadruples) $\Rightarrow 2^{nd}$ order wrt X

Compare experiments 1 and 3 to determine the order with respect to Y: **[X]** changes from 0.10 to 0.15 (x 1.5), and since 2nd order wrt X, this will cause the rate to multiply by $(1.5)^2 = 2.25$ times Initial rate changes from 0.020 to 0.045 (2.25 times) \Rightarrow change in **[Y]** had no additional effect on initial rate \Rightarrow zero order wrt Y

10 The following enthalpy changes of the following substances are provided.

	/ kJ mol⁻¹
standard enthalpy change of combustion of graphite	-394
standard enthalpy change of formation of water	-286
standard enthalpy change of formation of liquid ethanol	-277

What is the standard enthalpy change of combustion of liquid ethanol?

- A -403 kJ mol⁻¹
- **B** –957 kJ mol⁻¹
- C −1369 kJ mol⁻¹
- D –1865 kJ mol⁻¹



Answer: C

Target equation is $C_2H_5OH(I) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(I)$

Note that $\Delta H_c[C(graphite)]$ is essentially $\Delta H_f[CO_2(g)]$, both based on the equation $C(\text{graphite}) + O_2(g) \rightarrow CO_2(g)$

7

The standard enthalpy change of combustion can be calculated using the formula: Sum of ΔH_f of products – (sum of ΔH_f of reactants) $= [(2 \times -394) + (3 \times -286)] - [(-277) + 0] = -1369 \text{ kJ mol}^{-1}$

- 11 Which processes result in an increase in entropy?
 - 1 crystallisation of salt from its saturated solution
 - 2 condensation of steam to water
 - 3 combustion of hydrogen gas
 - 4 mixing of two miscible liquids
 - Α 1 and 2 only В 2 and 3 only C 3 and 4 only **D** 4 only

Answer: D

- 1 crystallisation is change from aqueous to solid state \Rightarrow entropy decreases
- condensation is change from gaseous to liquid state \Rightarrow entropy decreases 2
- 3 combustion of hydrogen gas has equation $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(I)$ Hence it is a change from gaseous to liquid state \Rightarrow entropy decreases (note that even if we assume H₂O as water vapour, the entropy is still decreasing due to a decrease in amount of gases)
- 4 mixing of two miscible liquids grants more kinds of particles to be arranged in a larger, combined volume \Rightarrow entropy increases
- 12 Consider the following equilibrium reaction:

$$H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$$
 $\Delta H < 0$

Which of the following changes will decrease the equilibrium yield of HCl?

- Α adding more H₂(g)
- В adding a suitable catalyst
- С decreasing the volume of the system.
- D increasing the temperature

Answer: D

- The system will adjust to reduce the concentration of H_2 by shifting the Α equilibrium position to the right, producing more HCl(g).
- В Catalysts speed up the reaction but do not increase the equilibrium yield.

C Decreasing the volume results in an increase in pressure. The equilibrium position will shift to the side with fewer moles of gas. Since this equilibrium reaction has the same number of gases on both sides, increasing pressure has no effect on equilibrium position.

8

- **D** For an exothermic reaction, increasing the temperature adds heat to the system, causing the equilibrium position to shift to the left to absorb the added heat, decreasing yield of HC*l*.
- 13 Which of the following is **not** an acid-conjugate base pair?
 - A HC*l* and NaC*l*
 - **B** Na₂HPO₄ and H_3PO_4
 - \mathbf{C} H₂O₂ and HO₂⁻



Answer: B

Acid-conjugate base pair differs by 1 H⁺, but HPO₄²⁻ and H₃PO₄ differs by 2 H⁺.

14 Values of ionic product, K_w , for water at different temperatures are given below.

temperature / °C	0	25	100
K _w / mol ² dm ⁻⁶	1.1 x 10 ⁻¹⁵	1.0 x 10 ⁻¹⁴	5.1 x 10 ⁻¹³

Which statement is true?

- **A** $pOH + pK_w = 14 \text{ at } 0 \, {}^{\circ}C.$
- **B** At temperatures higher than 25 °C, $[H^+] > [OH^-]$.
- **C** The pH of water is expected to be 6.1 at 100 °C.
- **D** The dissociation of water is an exothermic process.

Answer: C

Temperature / °C	0	25	100
K _w / mol ² dm ⁻⁶	1.1 x 10 ⁻¹⁵	1.0 x 10 ⁻¹⁴	5.1 x 10 ⁻¹³
<i>p</i> K _w / mol ² dm ⁻⁶	14.96	14	12.29
<i>p</i> H of water	7.5	7	6.1

The dissociation of water into H^+ and OH^- is an endothermic process and water contains same concentration of H^+ and OH^- at all temperatures.



- **15** What is the largest mass of sodium ethanedioate, $Na_2C_2O_4$ ($M_r = 134.0$) that can be added to 25 cm³ of 1.1×10^{-3} mol dm⁻³ solution of calcium nitrate, $Ca(NO_3)_2$ before a precipitate forms? [K_{sp} of $CaC_2O_4 = 2.50 \times 10^{-9}$ mol² dm⁻⁶]
 - A 2.5 × 10^{−5} g
 - **B** 7.6 × 10⁻⁶ g
 - **C** 7.5×10^{-9} g
 - **D** 2.5×10^{-9} g

Answer: B

For ppt to form, ionic product > K_{sp} .

K_{sp}=[Ca²⁺][C₂O₄²⁻]

Ionic product = K_{sp} (solution is saturated with $Na_2C_2O_4$)

$$\left(\frac{mass}{(134.0)} \div \frac{25}{1000}\right)(1.1 \times 10^{-3}) = 2.50 \times 10^{-9}$$

Minimum mass of $Na_2C_2O_4$ added for ppt to be formed= 7.61 x 10^{-6} g Largest mass that can be added before ppt forms = 7.6 x 10^{-6} g

16 When reacted with chlorine, hydrocarbon **X** undergoes free radical substitution. In a propagation step, the free radical **Y**• is formed.

$$\mathbf{X} + \mathbf{C}l \bullet \rightarrow \mathbf{Y} \bullet + \mathbf{H}\mathbf{C}l$$

What is a likely structure of hydrocarbon X if there are 5 possible constitutional isomers of $Y \bullet$?





[Turn over





10

17 Compound J reacts with excess concentrated sulfuric acid to form compound K.



How many stereoisomers exist for J and for K?

	J	К
Α	4	4
В	4	8
С	8	4
D	8	8

Answer: C



2 ¹⁺¹ = 4 isomers

No of stereoisomers = 2^{n+m} where n = no of chiral C and m= no of alkenes that can exhibit cis-trans isomerism



18 The compound zingiberene gives ginger its distinct flavour.



Which of the following compound is **not** produced from the reaction between zingiberene and hot acidified $KMnO_4$?





19 The molecular formula of alcohol **V** is $C_5H_{12}O$.

Alcohol V:

- can be dehydrated to form two alkenes only.
- reacts with alkaline aqueous iodine to form yellow ppt.

What could be the identity of V?

- A CH₃C(CH₃)₂CH₂OH
- **B** $(CH_3)_2C(OH)CH_2CH_3$
- $\textbf{C} \qquad (CH_3)_2 CHCH(OH)CH_3$
- $\textbf{D} \qquad CH_3CH_2CH_2CH(OH)CH_3$

Answer: C

A and **B** do not contain methyl alcohol, hence will not be able to undergo oxidation with alkaline aqueous iodine to give yellow ppt.

When **C**, $(CH_3)_2CH$ **CH(OH)CH₃** undergoes dehydration, it produces two alkenes only as shown below.



When **D** ($CH_3CH_2CH_2CH_2CH(OH)CH_3$) undergoes elimination, it produces three alkenes as shown below.





Epoxidation of ethene occurs much more readily than epoxidation of benzene.



Which statements explain the above observation?

- 1 The extent of delocalisation of six unbonded p electrons of benzene will decrease if benzene undergoes epoxidation.
- 2 The aromaticity of benzene gives it extra stability which makes epoxidation more unlikely to occur.
- 3 The carbon-carbon double bond of alkene is weaker than carbon-carbon bond of benzene.

	Α	1, 2 and 3	В	1 and 2 only	С	2 and 3 only	D	1 on
--	---	------------	---	--------------	---	--------------	---	------

Answer: B

Statements 1 and 2 are true.

Delocalisation of six unbonded p electrons that gives benzene its extra stability, The extra stability conferred by aromaticity/resonance will be lost if benzene undergoes addition to form an epoxide. Hence, the reaction is much less likely to occur.

BE (C=C) = $610kJ mol^{-1}$

BE (carbon-carbon bond in benzene) = 520kJ mol⁻¹

21 A comparison is made on the rate of hydrolysis of four halogen-containing organic compounds by hot NaOH(aq).

CH₃CH₂COC <i>l</i>	C_6H_5Cl	(CH ₃) ₃ CI	(CH ₃) ₃ CC <i>l</i>
W	X	Y	Z

How would these rates compare?

	fastest		slowest	
Α	W	Y	Z	X
В	W	Z	Y	Х
С	Х	Z	Y	W
D	Y	Z	Х	W



Answer: A

	CH₃CH₂COC <i>l</i> ₩	C ₆ H₅C <i>l</i> X	(CH ₃) ₃ CI Y	(CH ₃) ₃ CC <i>l</i> Z
Functional Group	Acyl chloride	Halogenoarene	Halogenoalkane	Halogenoalka ne
Relative ease of reaction	Fastest The carboxyl C atom is bonded to two electronegative atoms O and Cl This makes the carboxyl C atom highly electron– deficient. Hence, the highly electron deficient carbonyl C atom is very susceptible to nucleophilic acyl substitution (hydrolysis) which occurs readily	Slowest (CCl bond is strong; most difficult to break) The lone pair of electrons on the chlorine atom is delocalised into the benzene ring. This strengthens the carbon-chlorine (C Cl) bond in chlorobenzene due to presence of partial double bond character. Nucleophilic substitution does not occur under normal conditions.	Faster (C–I bond is weaker than C–C <i>I</i> bond; relatively easier to break)	Fast (C–C/ bond is stronger than C–I bond; relatively harder to break)

Thus, relative rate of hydrolysis should be: fastest \rightarrow slowest <u>W, Y, Z, X</u> (Option A)



14

- 22 Which reaction results in the smallest change in M_r of the organic compound?
 - A chloroethane with hot ethanolic NaOH
 - B chloroethane with excess NH₃ heated in a sealed tube
 - C chloroethane with hot ethanolic NaCN, followed by LiA/H₄
 - D chloroethane with hot aqueous NaOH, followed by hot acidified KMnO₄

Answer: D



23 *Aldosterone* is a hormone produced in the adrenal gland and is crucial for blood pressure regulation.



Which reagent will not give an observable change when added to aldosterone?

- A Fehling's reagent
- B sodium carbonate
- **C** phosphorus pentachloride
- D 2,4-dinitrophenylhydrazine

Answer: B



- Aliphatic aldehyde & ketone (positive observation with 2,4-DNPH)
- Aliphatic aldehyde (positive observation with Fehling's reagent)
- Primary & Secondary alcohol (positive observation with PCI₅)



24 Chiral halogenoalkanes undergo nucleophilic substitution with hot NaOH(aq) to form alcohols.

The reaction mechanism is either S_N1 or S_N2 .

Which statements are correct?

- 1 S_N1 mechanism involves only one step.
- 2 Racemisation can occur in the S_N1 mechanism.
- 3 Hydrolysis of a 3° halogenoalkane takes place by the S_N1 mechanism because the alkyl groups stabilise the carbocation intermediate.
- Α 1.2 and 3 В 1 and 2 only С 1 and 3 only **D** 2 and 3 only

Answer: D (2 and 3 only)

Statement 1 x : Two steps are involved in S_N 1 mechanism.

- (Rate determining) Step 1: Generation of carbocation intermediate via breaking of the C-X bond
- Step 2: Incoming nucleophile attacks the carbocation intermediate

Statement 2 \checkmark : S_N1 mechanism results in the generation of a racemic mixture.

The incoming nucleophile in step 2 can attack the trigonal planar sp² hybridised carbocation intermediate from top and bottom of the plan with equal probability, giving rise to equal amounts of each enantiomer, forming a racemic mixture.

Statement 3 \checkmark : S_N1 mechanism proceeds predominantly due to the stability of the carbocation intermediate.

• The tertiary carbocation intermediate is stabilised by the electrondonating alkyl groups. Thus, a tertiary halogenoalkane undergoes predominantly S_N1 mechanism. The bulky alkyl groups also prevent the backside attack of the incoming nucleophile, hence inhibiting S_N2 from occurring.



25 Ammonia and propanoyl chloride react to form propanamide via the nucleophilic acyl substitution mechanism.



Which statement is correct about the above mechanism?

- **A** Ammonia behaves as an electrophile.
- **B** Propanoyl chloride behaves as a nucleophile.
- **C** The curly arrows in step 1 have been shown incorrectly.
- **D** The deprotonation in step 3 has been shown incorrectly.

Answer: D

A: NH₃ donates a pair of electrons to the electron-deficient acyl carbon, hence NH₃ behaves as a nucleophile. ×

B: The acyl carbon is electron deficient as it is bonded to two electronegative atoms, O and C*l*, hence attracting the NH_3 nucleophile. **Propanoyl chloride behaves as an electrophile. ×**

C: The **arrow pushing in step 1 is correct**, leading to the generation of the intermediate and subsequently, the regeneration of C=O and expulsion of the Cl-leaving group. **×**

D: The <u>arrow pushing in step 3 is wrong</u> as the pair of N–H electrons end up on the H, which will lead to formation of H⁻ and a doubly positive N instead. \checkmark





26 Abscisic acid is a plant hormone involved in many plant developmental processes.



Which are the products formed when abscisic acid reacts with the following reducing agents?

	LiA/H4 in dry ether	H ₂ , Pt catalyst			
A	HO HO	HO HO HO			
В	ОННО				
с	НО НО НО	HOH HO			
D	O HO HO	НО НО НО			

Answer: A



LiA*l*H₄ in dry ether can reduce:

- ketone / aldehyde
- carboxylic acid

H₂ (g), Pt can reduce:

- ketone / aldehyde
 - alkene





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

A voltaic cell is made up of Pb²⁺/Pb half-cell and the Fe^{3+}/Fe^{2+} half-cell. Which of the following statements are correct?

- 1 Adding excess solid potassium cyanide to the Fe³⁺/Fe²⁺ half-cell affects the direction of electron flow.
- 2 Adding water to the Pb²⁺/Pb half-cell increases the cell potential.
- 3 Increasing the size of the electrode decreases the cell potential.

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

Answer: D	
$E^{\Theta} Pb^{2+}/Pb = -0.13 V$	Oxidation, E_{oxid}^{Θ}
$E^{\Theta} Fe^{3+}/Fe^{2+} = + 0.77 V$	Reduction, E^{Θ}_{red}

Option 1 is wrong as the addition of CN^- ion results in the formation of $[Fe(CN)_6]^{3-}$ and $[Fe(CN)_6]^{4-}$ and the E^{Θ} $[Fe(CN)_6]^{3/}$ $[Fe(CN)_6]^{4-}$ = +0.36 V . As such,

 $E^{\Theta} Pb^{2+}/Pb = -0.13 V$ Oxidation, E^{Θ}_{oxid} $E^{\Theta} [Fe(CN)_6]^3/[Fe(CN)_6]^{4-} = +0.36 V$ Reduction, E^{Θ}_{red} Only the cell potential will be impacted but the direction of electron flow is still the same.

Option 2 is correct as it will decrease the concentration of Pb²⁺, causing the Pb²⁺ + 2e \Rightarrow Pb to shift left to counter the effect, making the E^{Θ}_{oxid} to be more negative. Thus, the E^{Θ}_{cell} will be more positive.

Option 3 is wrong as increasing the size of electrode will not have any impact on the cell potential even it is part of the involved partners.

28 Aluminium alloys undergo a process known as anodisation to increase corrosion resistance and surface hardness.

A possible set up for the process is shown below.



Which of the following statements about anodisation of aluminium is true?

- **A** Anodisation is a spontaneous reaction.
- **B** Hydrogen gas and oxygen gas are liberated.
- **C** The aluminium object will decrease in mass.
- **D** The reaction stops when the graphite electrode is replaced with gold.

Answer: B

Option A is wrong as anodisation requires electrical supplies, hence it is not a spontaneous reaction.

Option C is wrong as aluminium will react with oxygen to form aluminium oxide and this will result in the increase of the mass of the aluminum object.

Option D is wrong as replacing the graphite electrode (cathode) will not cause the reaction to cease as gold is a good conductor of electricity and is inert.



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

Which statement is true about the properties of transition metals?

- A Titanium has a higher density than copper.
- **B** Chromium in $[Cr(H_2O)_6]^{3+}$ has only one unpaired electron.
- **c** Scandium is not a transition metal as its atom does not contain partially filled d subshells.
- **D** Transition metal ion complexes are coloured due to the presence of ligands and splitting of d orbitals into different energy levels.

Answer: D

Option A is wrong as titanium has a smaller mass and a bigger atomic radius than copper.

Option B is wrong as Cr is in the +3 oxidation state and has 3 (instead of one) unpaired electrons.

Option C is wrong as the definition of TM is based on scandium metal ion and not the metal itself.

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

Peroxodisulfate, $S_2O_8^{2-}$, can oxidise tartrate ion, $C_4H_4O_6^{2-}$, to carbon dioxide and methanoate as shown in the following equation.

$$C_4H_4O_6{}^{2-} + 3S_2O_8{}^{2-} + 2H_2O \rightarrow 2CO_2 + 2HCO_2{}^{-} + 6H^+ + 6SO_4{}^{2-}$$

The electrode potential for the tartrate ion is

$$2CO_2 + 2HCO_2^- + 6H^+ + 6e \implies C_4H_4O_6^{2-} + 2H_2O$$
 $E^{\Theta} = +0.56 \text{ V}$

The rate of reaction can be increased with the addition of a metal ion as a catalyst. Which metal ion is **not** a suitable catalyst for this reaction?

A V²⁺

B Mn³⁺

C Fe²⁺

D Co³⁺

Answer: A $E^{\theta} S_2 O_8^{2^-} / SO_4^{2^-} = +2.01 \text{ V}$ E^{Θ}_{red} $E^{\theta} CO_2 / C_4 H_4 O_6^{2^-} = +0.56 \text{ V}$ E^{Θ}_{oxid} For the metal ion to function as the suital

For the metal ion to function as the suitable catalyst, its E^{θ} must be between +0.56 and +2.01 V to let $E^{\theta}_{cell} > 0$ V. V²⁺ is not a suitable catalyst as its $E^{\theta} V^{3+}/V^{2+}$ is -0.26V.



Answers:

1	2	3	4	5	6	7	8	9	10
Α	D	В	C	Α	В	Α	В	D	C
11	12	13	14	15	16	17	18	19	20
D	D	В	С	В	В	С	С	С	В
21	22	23	24	25	26	27	28	29	30
Α	D	В	D	D	Α	D	В	D	Α

[Turn over