



MERIDIAN JUNIOR COLLEGE  
**JC 2 Preliminary Examination**  
 H1 Chemistry Paper 2

1(a)  $\text{Zn obtained from daily feed} = 0.7 \times (180/100) \times 3 = 3.78 \text{ mg}$

It MEETS the recommended quantity for daily intake. There is no need for the child to supplement his / her diet with Zn from other sources.

(b) (i) Biggest increase is between 1<sup>st</sup> and 2<sup>nd</sup> ionization energy.

The 2<sup>nd</sup> electron is removed from the inner quantum shell. Hence, there is stronger electrostatic force of attraction between 2<sup>nd</sup> electron and nucleus.

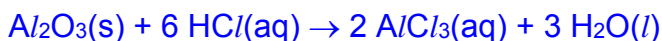
Thus the element has 1 valence electron. The element belongs to Group 1

(ii)  $1s^2 2s^2 2p^6 3s^1$

(iii) 1. Element M is Mg.  
 2.

	equations for reaction with water	pH of resultant solution
oxide of M	$\text{MgO(s)} + \text{H}_2\text{O(l)} \rightleftharpoons \text{Mg(OH)}_2\text{(s)}$	9
chloride of M	Hydration $\text{MgCl}_2\text{(s)} + 6\text{H}_2\text{O(l)} \rightarrow [\text{Mg(H}_2\text{O)}_6]^{2+}\text{(aq)} + \text{Cl}^-\text{(aq)}$  Slight Hydrolysis $[\text{Mg(H}_2\text{O)}_6]^{2+}\text{(aq)} \rightleftharpoons [\text{Mg(H}_2\text{O)}_5\text{(OH)}]^+\text{(aq)} + \text{H}^+\text{(aq)}$	6.5

(c) (i)  $\text{Al}_2\text{O}_3$  is amphoteric due to its ionic with partial covalent character. It reacts with both acids and bases.



$\text{SO}_3$  is acidic and reacts only with bases.



(ii) From aluminium to sulfur,

- Nuclear charge increases but shielding effect is relatively constant
- Effective nuclear charge increases.
- There is stronger electrostatic force of attraction between nucleus and valence electrons. More energy is required to remove the valence electron.
- Therefore, 1<sup>st</sup> I.E. of S is greater than Al.

2(a) (i)

$$\frac{(96)}{(4)} = 24.0$$

(ii)  $\text{HCO}_3^- + \text{H}^+ \rightarrow \text{H}_2\text{CO}_3$

The added  $\text{H}^+$  is removed as  $\text{H}_2\text{CO}_3$ .

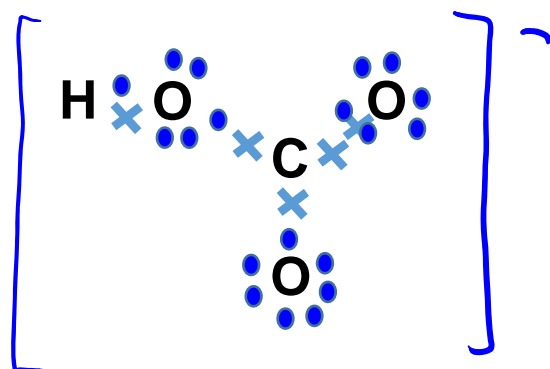
$[\text{H}^+]$  is slightly changed hence pH *remains* fairly constant.

$\text{H}_2\text{CO}_3 + \text{OH}^- \rightarrow \text{HCO}_3^- + \text{H}_2\text{O}$

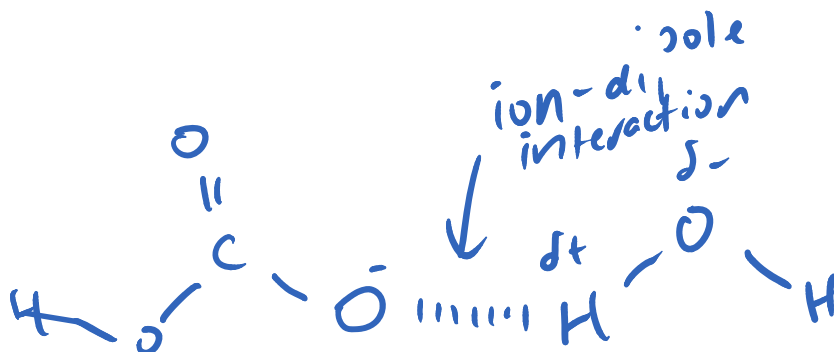
The added  $\text{OH}^-$  is removed as  $\text{HCO}_3^-$  and  $\text{H}_2\text{O}$ .

$[\text{OH}^-]$  is slightly changed hence pH *remains* fairly constant.

(b) (i)



(ii) There is the formation of ion-dipole interactions between  $\text{HCO}_3^-$  and water molecules.



(c) (i) No of mol of NaOH used =  $\frac{30}{1000} \times 0.25 = 7.50 \times 10^{-3}$  mol

No of mol of  $\text{H}^+$  present =  $7.50 \times 10^{-3} \text{ mol}$

$$\text{Concentration of } \text{H}^+ = \frac{7.5 \times 10^{-3}}{\frac{25}{1000}} = 0.300 \text{ mol dm}^{-3}$$

$$\text{pH} = 0.50$$

- (ii) Carbonic acid is a weak acid and it dissociates partially. Sulfuric acid is a strong acid and it dissociates completely. Concentration of  $\text{H}^+$  in the carbonic acid solution will be less than the concentration of  $\text{H}^+$  in sulfuric acid resulting in the pH to be higher

3(a)

	$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$		
Initial amount /mol	2	1	0
Change in amount /mol	-1.9	-0.95	+1.9
Amount at new equilibrium / atm	0.1	0.05	1.9

$$\text{Concentration of } \text{SO}_2 \text{ at equilibrium} = \frac{0.1}{5} = 0.02 \text{ mol dm}^{-3}$$

$$\text{Concentration of } \text{O}_2 \text{ at equilibrium} = \frac{0.05}{5} = 0.01 \text{ mol dm}^{-3}$$

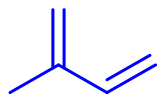
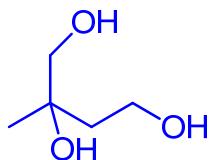
$$\begin{aligned} \text{(b)} \quad K_c' &= \frac{(0.02)^2 (0.01)}{(0.38)^2} \\ &= 2.77 \times 10^{-5} \text{ mol dm}^{-3} \end{aligned}$$

- (c) At  $t = 3 \text{ min}$ , concentration of  $\text{SO}_2$  is increased.

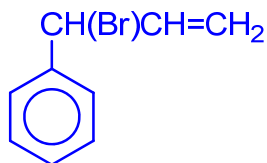
By *Le Chatelier's Principle*, when concentration of  $\text{SO}_2$  is increased, the equilibrium position shifts to the right to decrease the concentration of  $\text{SO}_2$ .

Overall, concentration of  $\text{SO}_2$  still increases while concentration of  $\text{O}_2$  is decreased as some  $\text{O}_2$  reacted with the added  $\text{SO}_2$  to form  $\text{SO}_3$ .

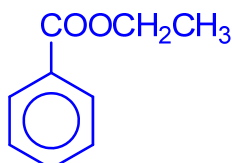
4(a)



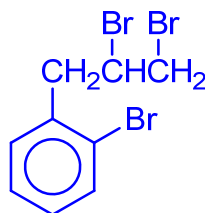
(b)



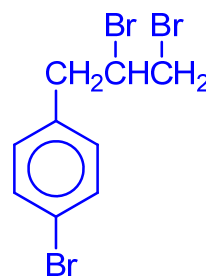
compound A



compound B



OR



compound C

(ii) Reaction I:  $\text{KMnO}_4$ ,  $\text{H}_2\text{SO}_4$  (aq), heatReaction III: limited  $\text{Br}_2$ , UV light

(iii) Substitution

5(a) disproportionation

(b) (i) Energy released when one mole of substance is completely burnt in excess oxygen under standard conditions.

(ii) Heat absorbed by water =  $200 \times 4.18 \times (40.6 - 27.9) = 10701 \text{ J}$ 

$$\text{Heat released by reaction} = \frac{10701}{\frac{30}{100}} = 35669 \text{ J}$$

$$\text{Amount of phenylmethanol burnt} = \frac{113.25 - 112.22}{108} = 9.538 \times 10^{-3} \text{ mol}$$

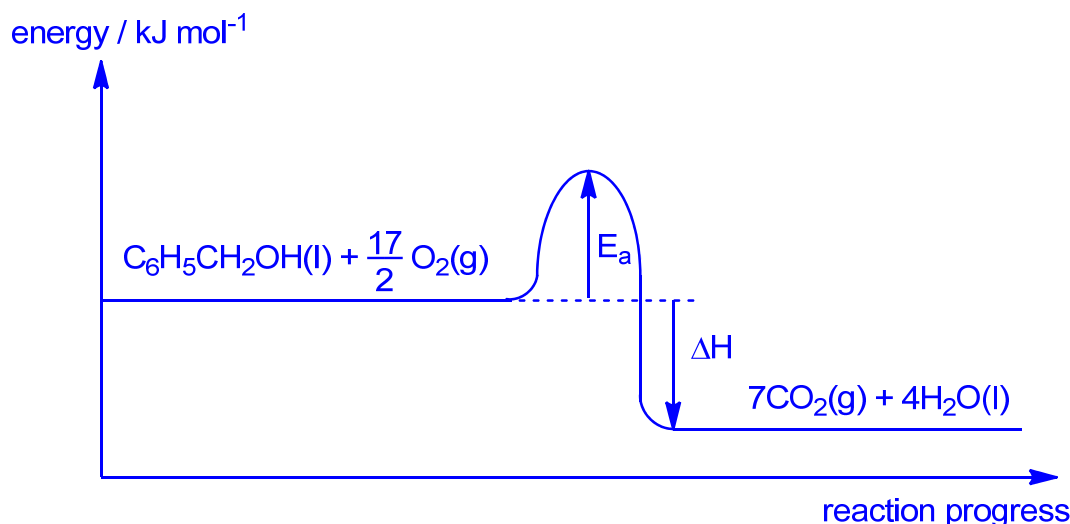
$$\begin{aligned} \Delta H^\circ_{\text{c}}(\text{C}_6\text{H}_5\text{CH}_2\text{OH}) &= - \frac{35669}{9.538 \times 10^{-3}} \\ &= -3.74 \times 10^6 \text{ J mol}^{-1} \text{ or } -3740 \text{ kJ mol}^{-1} \end{aligned}$$

(iii) density of water is  $1.0 \text{ g cm}^{-3}$  *other accurate reasons acceptable*

(c) (i)  $\Delta H_1 = 6(520) + 350 + 7(410) + 360 + 460 + 17/2(496) - 14(740) - 8(460)$   
 $= -2660 \text{ kJ mol}^{-1}$  (3 s.f.)

(ii)  $-2660 + 63 = 164 + \Delta H_4$   
 $\Delta H_4 = -2660 + 63 - 164 = -2761 \text{ kJ mol}^{-1}$

(iii)

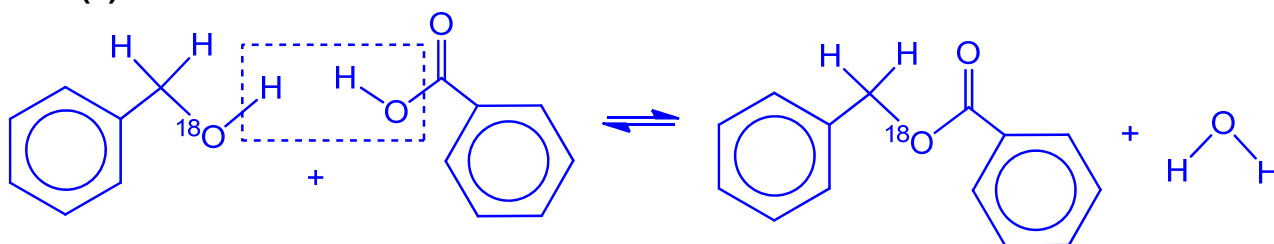


(d) (i) For alcohol / phenylmethanol: Electron-donating alkyl group increases the intensity of negative charge on oxygen atom of the alkoxide ion, destabilising the alkoxide ion.

For carboxylic acid / benzoic acid: Carboxylate ion is resonance stabilized; decreases intensity of negative charge on oxygen atom of the carboxylate ion, stabilising the carboxylate ion

Hence,  $K_a$  of carboxylic acid is higher because carboxylic acid is more acidic.

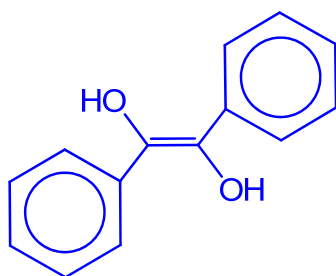
(ii)



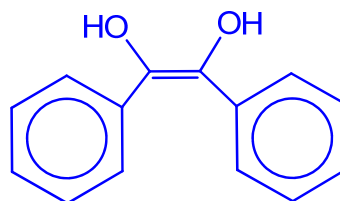
(e) (i)

Test (either one)	benzaldehyde	compound J
Tollens' reagent, heat	silver mirror formed	no silver mirror
PCl <sub>5</sub> , r.t.p.	no white fumes	white fumes of HCl formed

(ii)



trans-isomer



cis-isomer

6(a) (i) Order of reaction is the power to which the concentration of a reactant is raised in the rate equation.

(ii)  $\text{time taken} \propto \frac{1}{\text{initial rate of reaction}}$

(iii) Comparing Experiment 2 and 3,  
While keeping  $[\text{CH}_2=\text{CH}_2]$  and  $[\text{CO}]$  constant, when  $[\text{H}_2]$  doubles, rate of the reaction also doubles.

Hence it is 1<sup>st</sup> order of reaction with respect to  $\text{H}_2$ .

Comparing Experiment 1 and 3,

When  $[\text{CH}_2=\text{CH}_2]$  and  $[\text{CO}]$  doubles,  $[\text{H}_2]$  halves, rate of the reaction doubles.

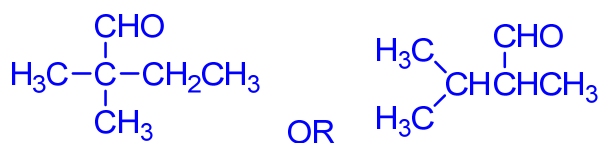
Since  $[\text{CO}]$  and  $[\text{H}_2]$  are 1<sup>st</sup> order, expected rate should be unchanged but doubling  $[\text{CH}_2=\text{CH}_2]$  doubles the rate of reaction.

Hence it is 1<sup>st</sup> order of reaction with respect to  $\text{CH}_2=\text{CH}_2$ .

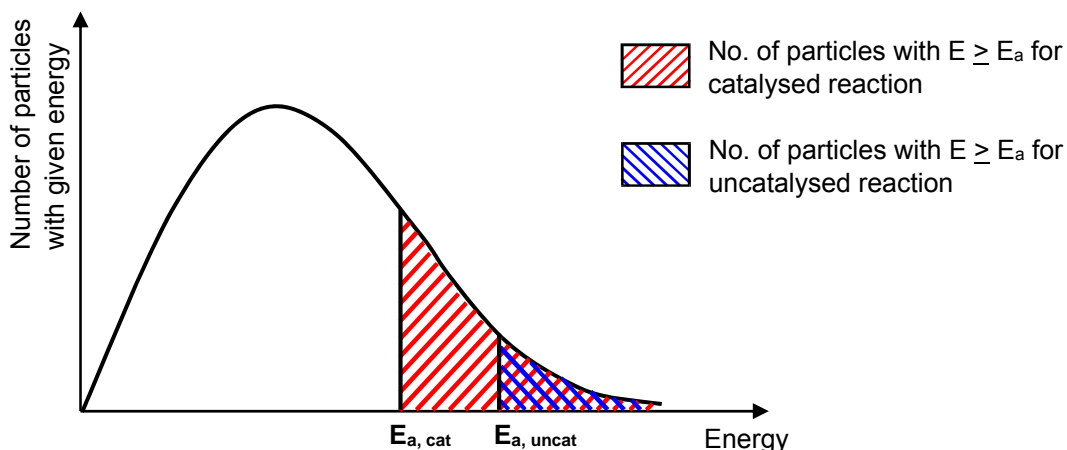
(iv)  $\text{rate} = k[\text{CH}_2=\text{CH}_2][\text{CO}][\text{H}_2]$

(v) The new rate will be  $\frac{3}{4}$  times the original rate

(vi)

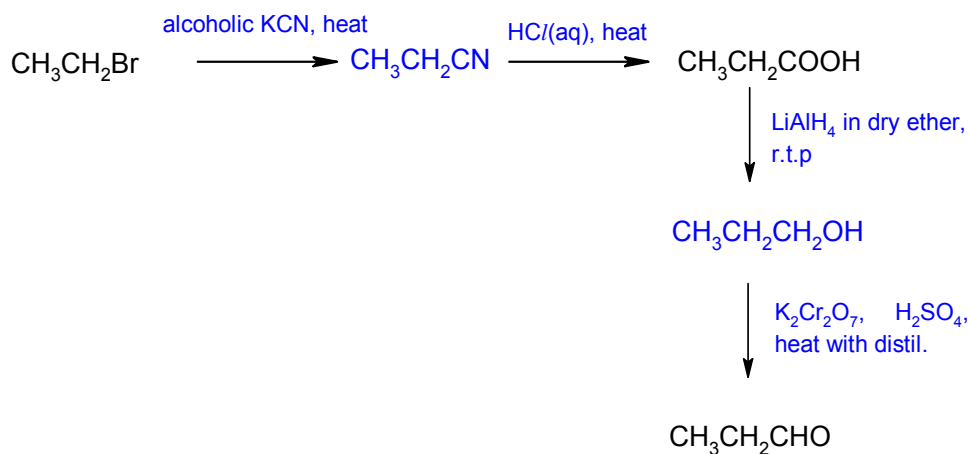


(vii)



Catalyst increases the rate of reaction by providing an alternative pathway of lower activation energy. Number of reactant particles with  $E \geq E_a$  increases. Frequency of effective collisions increases. Since rate of reaction is proportional to the frequency of effective collisions, rate of reaction increases.

(b)



(c) (i)

Test 1:

Add Tollens' reagent, heat.

Silver mirror is observed for compound Q and R.

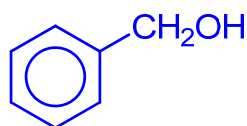
No silver mirror is observed for compound Q and R.

Test 2:

Add Fehling's solution, heat the mixtures.

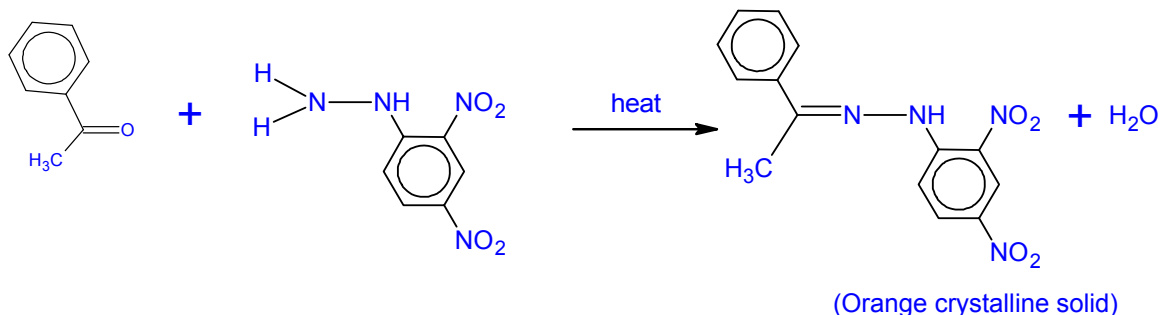
In the test tube containing compound R (the aliphatic aldehyde), a brick red ppt of  $\text{Cu}_2\text{O}$  is formed. In the test tube containing compound Q, no brick red ppt is formed.

(ii) Reduction



Compound D

(iii)

7(a) (i) *Endosulfan* has a simple molecular structure.

In water

- Strong hydrogen bonding between water molecules is not compatible to the weak van der Waals' forces between *endosulfan* molecules.
- *Endosulfan* is less soluble in H<sub>2</sub>O.

In hexane

- Weak van der Waals' forces of attraction between *endosulfan* molecules is similar in strength / compatible to the weak van der Waals' forces of attraction between hexane molecules.
- *Endosulfan* is more soluble in hexane.

(ii) There are 3 bond pairs and 1 lone pair around the S atom.

- To minimise repulsion and maximise stability, the 4 electron pairs are directed to the corners of a regular tetrahedron.
- But lone pair–bond pair repulsion > bond pair–bond pair repulsion,
- Bond angle is 107°.
- Shape about the sulfur atom in *endosulfan* is trigonal pyramidal.

(iii)

- One lone electron pair of C<sub>1b</sub> atom is delocalised with the adjacent C=C.
- This strengthens the carbon-chlorine bond in the alkene due to presence of partial double bond character, hence substitution is difficult under normal conditions.

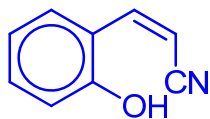
(b) (i) Structure of W:



Structure of X:

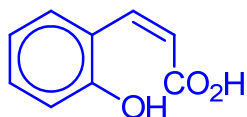


- Compound X undergoes addition with bromine.
- X contains alkene functional group.



Structure of Y:

- Compound Y undergoes acid-carbonate with solid sodium carbonate.
- Y contains carboxylic acid functional group.



(ii) Step I: KCN in ethanol, heat

Step II: Excess concentrated  $\text{H}_2\text{SO}_4$ ,  $170^\circ\text{C}$

Step III:  $\text{HCl}$  (aq), heat

(iii) Reagents and condition: Aqueous alkaline iodine, heat  
Compound A: Yellow precipitate of  $\text{CHI}_3$  observed  
Compound Z: No yellow precipitate of  $\text{CHI}_3$  observed