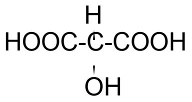
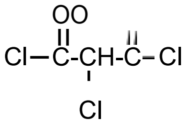
2012 Meridian JC H2 Chemistry Prelim P3 Suggested Answers

1 **(a)** Reaction I : $NaBH_4$ in ethanol , rtp
Reaction II : PCl_5 , rtp
Reaction III : $LiAlH_4$ in dry ether , rtp



$HOOC\text{-}CH(OH)\text{-}COOH$

A



$Cl\text{-}C(=O)\text{-}CH(Cl)\text{-}C(=O)\text{-}Cl$

B

(b) **(i)**1° and 2° alcohols

(ii) Hydrolysis

(c) **(i)**$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

(ii) ΔH_{rxn} = = [6(-394) + 6(-286)] – [-1275] = - 2805 kJ mol^{-1}

Energy released = 2801 x 0.0500 = 140 kJ

(iii) Energy released by combustion = 650 x 4.18 x 44 = 120 kJ

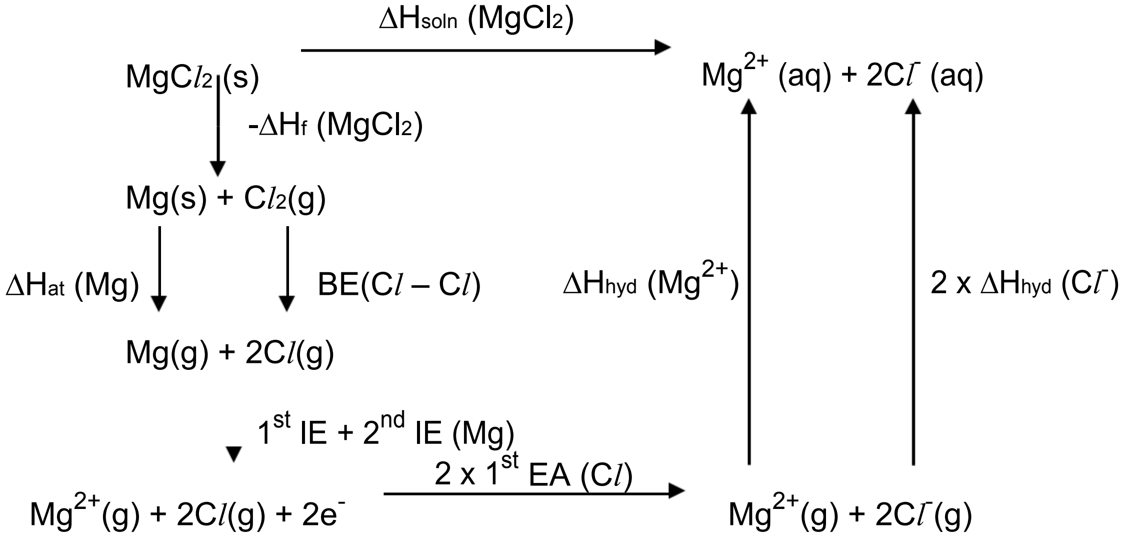
(iv) Some heat was lost to the surrounding.

(d) **(i)**$M(NO_3)_2 \rightarrow MO + 2NO_2 + ½O_2$

(ii) Each mole of Group II nitrates release the same amount of gaseous molecules.

(iii) Ionic size of cation: $Mg^{2+} < Ba^{2+}$
charge density hence polarizing effect of cation: $Mg^{2+} > Ba^{2+}$
Therefore $Ba(NO_3)_2$ has a higher decomposition temperature.

(e)



ΔH_{hyd} (Mg^{2+}) = - 148 - 244 - 736 - 1450 - 2 x (-364) - 2 x (-362) + (-642) + (-153) hence ΔH_{hyd} (Mg^{2+}) = -1921 kJ mol^{-1}

2(a) **(i)** Shine uv light on the mixture of hydrogen and chlorine gas.

(ii) Decolorisation of reddish brown bromine ; white fumes of HBr seen.

(iii) Reactivity of halogens with hydrogen *decreases* down the group.

The total bond energy released in forming H-X decreased down the group more significantly than the total bond energy absorbed in breaking X-X and H-H bonds. DH_{rxn} becomes more endothermic down the group, reactivity decrease down the group

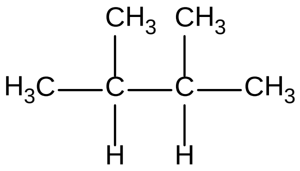
(b) **(i)** Limited Br_2 gas and uv light

(ii) $DH = 410 + 151 – 240 - 299 \quad = + 22.0$ kJ mol^{-1}

(iii) Endothermic due to the weak C-I bond formed.

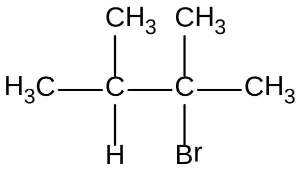
(iv)

W :



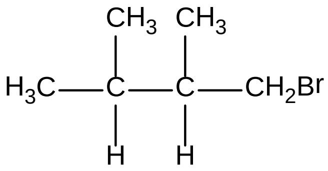
$H_3C-CH(CH_3)-CH(CH_3)-CH_3$

Y:



$H_3C-CH(CH_3)-CBr(CH_3)-CH_3$

Z:



$H_3C-CH(CH_3)-CH(CH_3)-CH_2Br$

(c) **(i)** Comparing experiments 1 & 3, when $[C_6H_{13}Br]$ was tripled, the initial rate of reaction increased by 3 times, order of reaction wrt $C_6H_{13}Br$ is 1.

Comparing experiments 1 & 2

$$Þ \ \frac{13.0}{26.0} = \frac{[1.30][2.60]^b}{[2.60][1.30]^b}$$

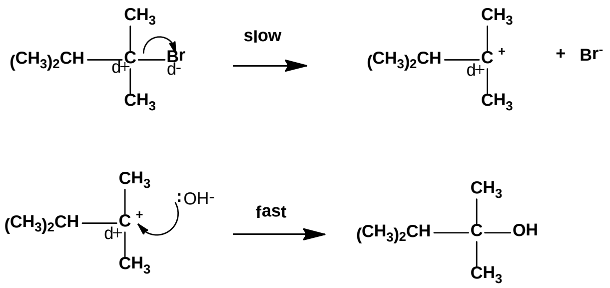
$$Þ \ 1 = \left(\frac{2.60}{1.30}\right)^b$$

$Þ \ b = 0$

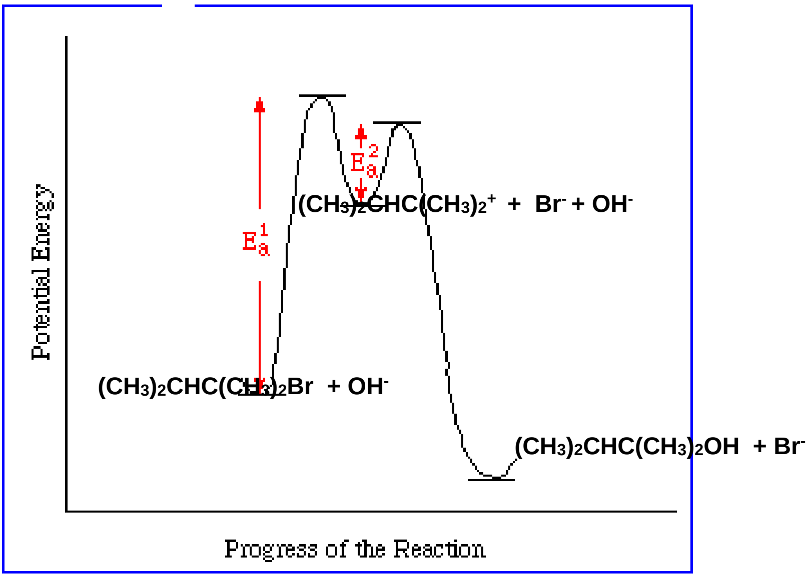
Rate = $k[C_6H_{13}Br]$

(ii) It should be isomer Y since it is a tertiary bromoalkane, it will form a stable carbocation in the slow step of the mechanism due to the presence of three electron donating alkyl group

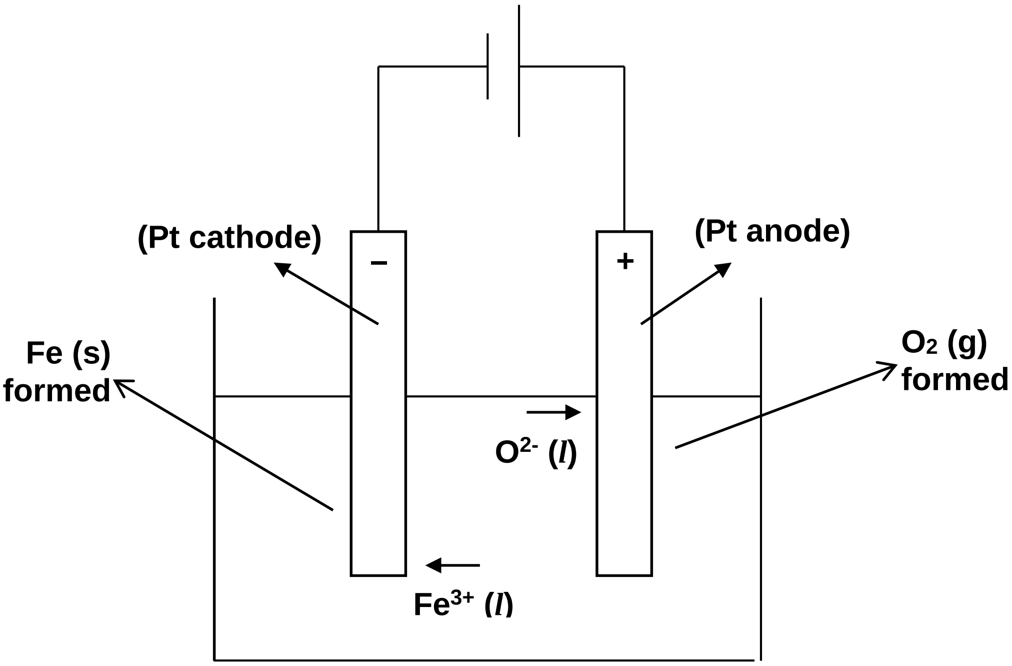
(iii) Mechanism : S_N1



(iv)



3(a) (i)



(ii) Cathode: Fe^{3+} (*l*) + 3e à Fe (s); Anode: $2O^{2-}$ (*l*) à O_2 (g) + 4e

(iii) $\frac{5´\ 1000}{55.8} = \frac{I´\ 24´\ 60´\ 60}{3´\ 96500}$; I = 300 A.

(iv) $C + O_2 \rightarrow CO_2$; $CO_2 + C \rightarrow 2CO$; $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(v) Less / no pollutants of CO or CO_2 are formed.

(b)(i) Fe(II) is stabilised with respect to Fe(III) in acidic medium compared to basic medium. Fe^{2+} in acidic medium is a weaker reducing agent compared to $Fe(OH)_2$ in basic medium.

(ii) Fe^{2+} acts as a homogeneous catalyst

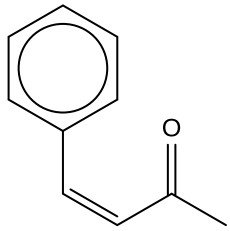
Step 1: $2Fe^{2+} + S_2O_8^{2-} \rightarrow 2SO_4^{2-} + 2Fe^{3+}$

Step 2: $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$

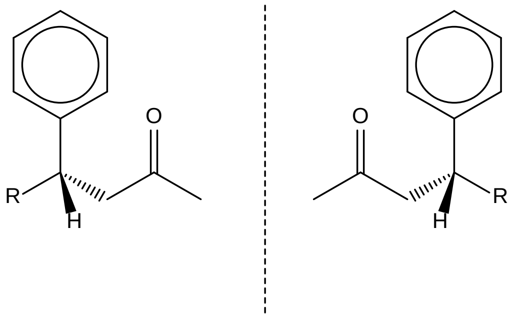
(c) **(i)** Ethoxide ion acts as a base

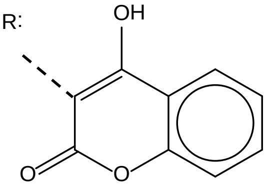
(ii) (Nucleophilic) Addition

(iii)

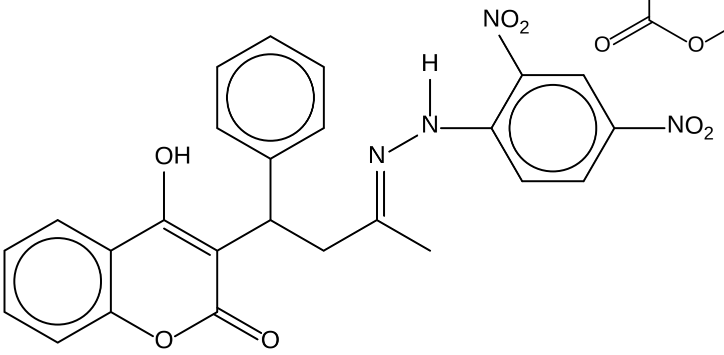


(iv) Optical isomerism





(v)



4(a) Element X : Sodium / Na
$Na_2O + H_2O \rightarrow 2NaOH$

Formula of the oxide of Element Y: SO_3

Upon addition of $Ca(OH)_2$, white ppt formed could be $CaSO_4$

No of mol of $CaSO_4$ = = 0.09 mol

$SO_3 + Ca(OH)_2 \rightarrow \underset{\text{white ppt}}{CaSO_4} + H_2O$

$SO_3 + H_2O \rightarrow H_2SO_4$

$H_2SO_4 + Na_2O \rightarrow Na_2SO_4 + H_2O$

(b) **(i)** $101 \times 1000 \times M = \frac{(1.345-0.298)}{average\ M_r} 1.60 \times 10^3 \times 8.31 \times (250+273)$

Molar mass of gas = 68.8 g $mol^{-1} \approx 67.5$ g mol^{-1}

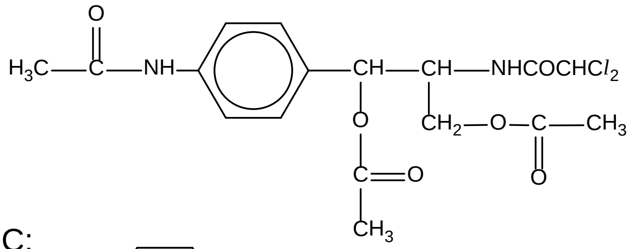
Hence m = 1, n = 2

(ii) There is significant van der Waals forces of attraction between the ClO_2 molecules.

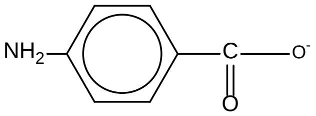
(c) **(i)** Al^{2+} (g) à Al^{3+} (g) + e

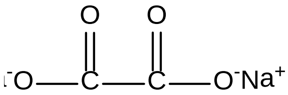
(ii) C is aluminium, as it has the lowest 3rd IE. The removal of the third electron will lead to the formation of the stable noble gas configuration hence a small amount of energy is required to remove the valence electron.

(d) **(i)** A:

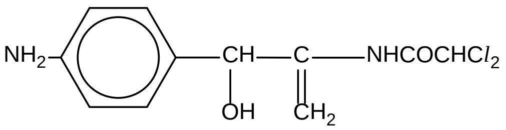


B, C:





D:

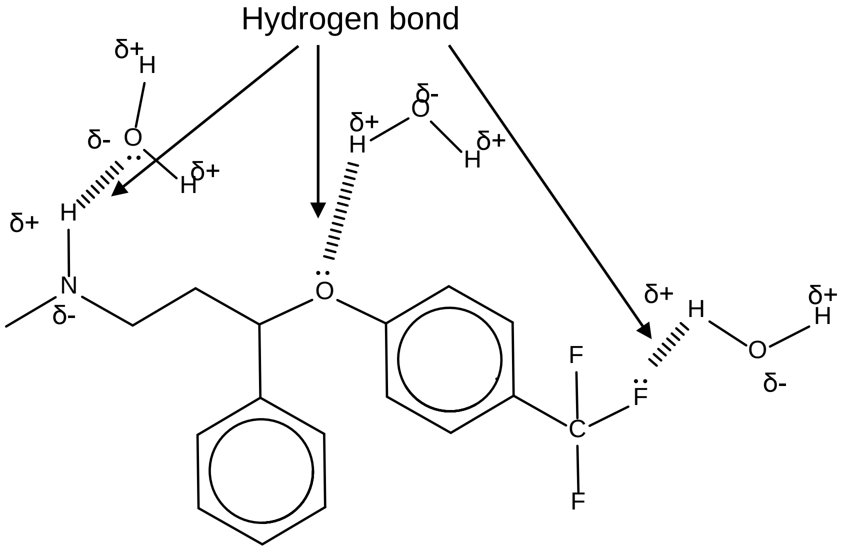


(ii) H_2O (g) or steam , conc. H_3PO_4, 65 atm , 300°C

Electrophilic Addition

(iii) Add 2,4-DNPH to each compound separately and heat. Chloramphenicol-X will not produce orange ppt of hydrazine;it's isomer will produce orange ppt of hydrazone.

5(a) **(i)**



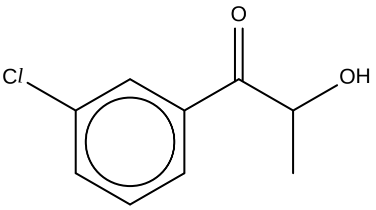
(ii) Due to the presence of a large hydrophobic benzene rings.

(iii) Formation of ion-dipole interaction with water molecules causes solvation hence drug is better is better absorbed.

(b) **(i)** Free radical substitution

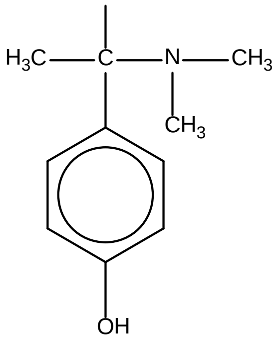
(ii) excess $(CH_3)_3CNH_2$, heat

(iii)



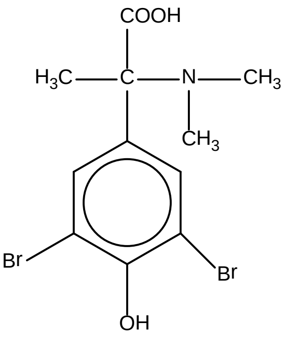
(c)

A:

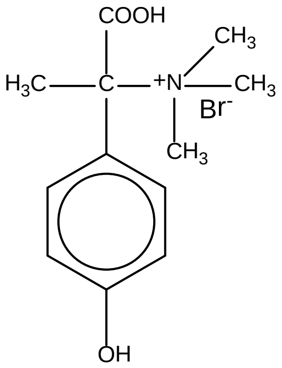


Or A can also be 1, 2 di-substituted isomer

B:



C:



(d)(i) Effective nuclear charge increases.The electrostatic force of attraction between nucleus and valence electrons increases hence energy required to remove the valence electrons increases.

(ii) Li^+ has the smallest ionic radius among the group I metal ion
Less H_2O ligands can be datively bonded to Li^+ cation, thus the coordination number is 4 and $Li(H_2O)_4^+$ ions is formed.