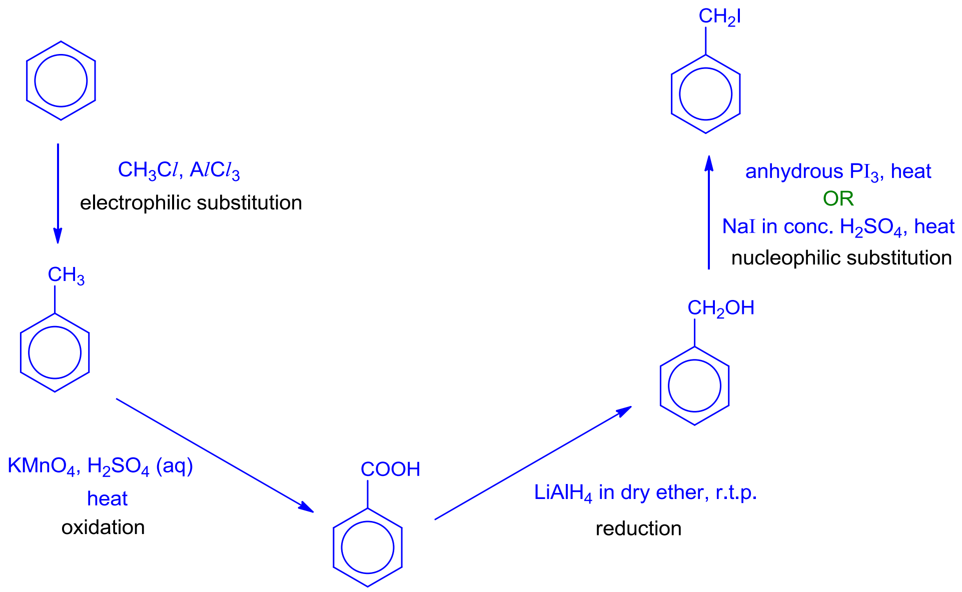
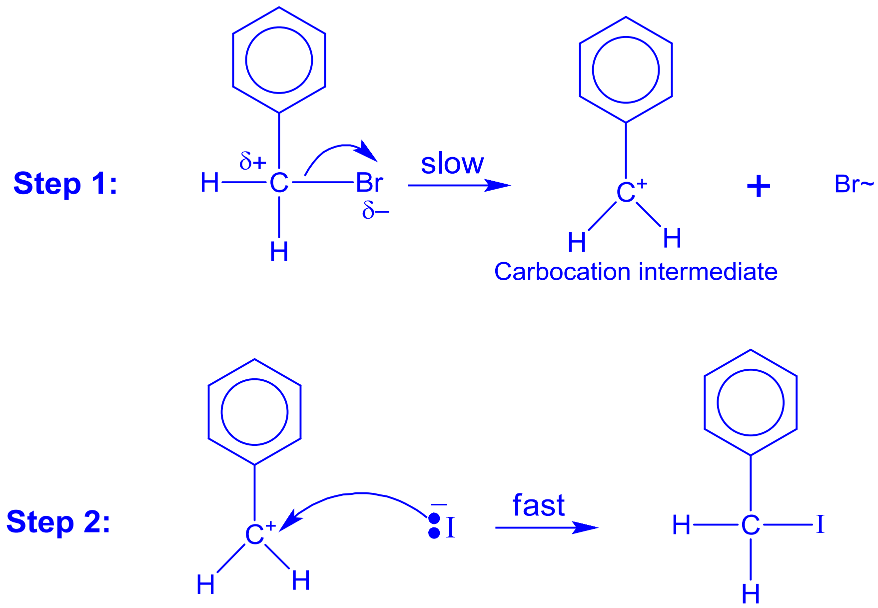
2016 MJC Prelim Paper 3 Suggested Answers

1(a)



(b)

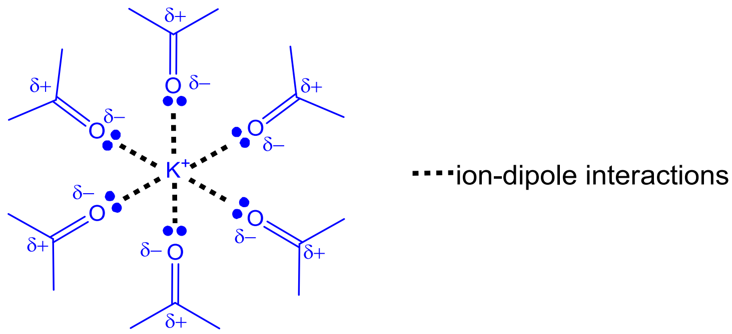


(i) Add $AgNO_3$(aq). Observation: No yellow precipitate observed.

(ii) The $C_6H_5CH_2^+$ carbocation is resonance stabilised

(ci) KBr is precipitated out as a solid. Position of equilibrium shifts to the right.

(ii)



(iii) Enthalpy change of solution for KI in propanone is more exothermic.

(di) As a base.

(ii) BE (C–I) = 240 kJ mol^{-1} ; BE (C–Br) = 280 kJ mol^{-1}

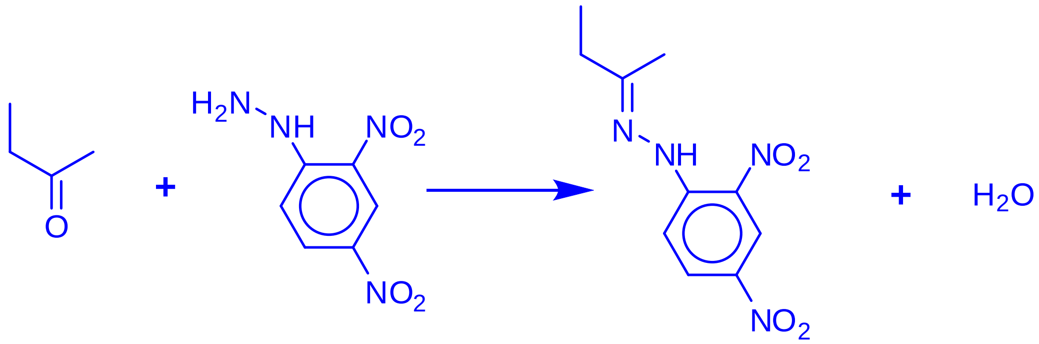
The C–Br bond is stronger than C–I bond hence rate is slower.

(iii) Step **III**: alkaline $KMnO_4$(aq), heat

Step **IV**: alkaline aq I_2, heat

Step **V:** hydrogen iodide

(iv)



2(ai) $Zn + 2\,OH^- \longrightarrow ZnO + H_2O + 2e^-$

$O_2 + 2H_2O + 4e^- \longrightarrow 4\,OH^-$

$2\ \ Zn + O_2 \longrightarrow 2\,ZnO$

(ii) $+1.59 = 0.40 - E^{\ominus}(ZnO / Zn)$

$E^{\ominus}(ZnO / Zn) = -1.19$ V

(iii) Prevent entry of O_2 so to minimise the battery's discharging process to prolong the shelf-life of the battery.

(iv) Partial pressure of O_2 hence the equilibrium position shifts left. $E^{\ominus}_{(O2/OH-)}$ will be less positive hence $E_{cell} < 1.59$ V.

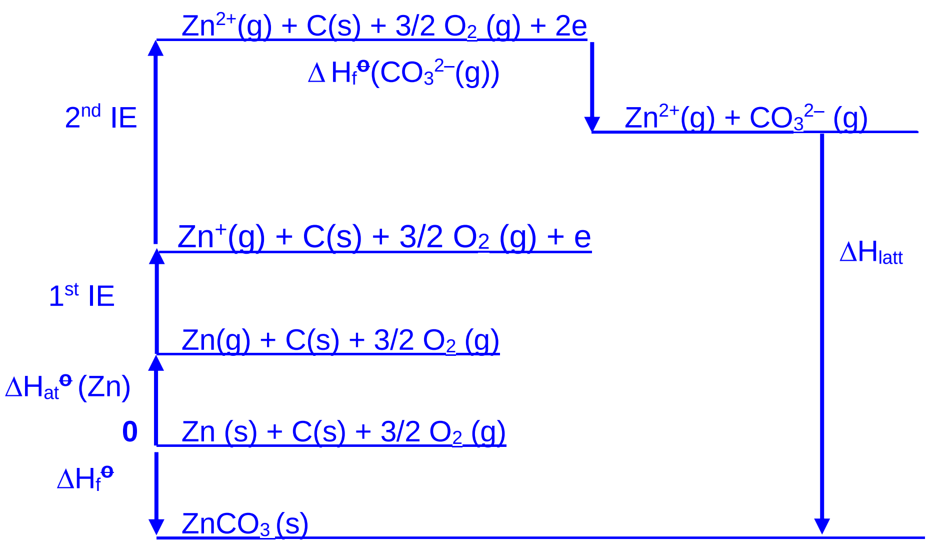
(v) No. of moles of $O_2 = \dfrac{I \times t}{n \times F} = \dfrac{I \times 60 \times 60}{4 \times 96500}$

Current output of battery = 0.188 A

(bi) $ZnCO_3\,(s) \longrightarrow CO_2\,(g) + ZnO\,(s)$

(ii) Zn^{2+} 0.074 nm; Ba^{2+}: 0.135 nm. Charge density: $Zn^{2+} > Ba^{2+}$. Zn^{2+} distorts the anion charge cloud to a greater extent, weakening and breaking the C–O bond in CO_3^{2-}. Hence, decomposition temperature of $ZnCO_3$ is lower than $BaCO_3$.

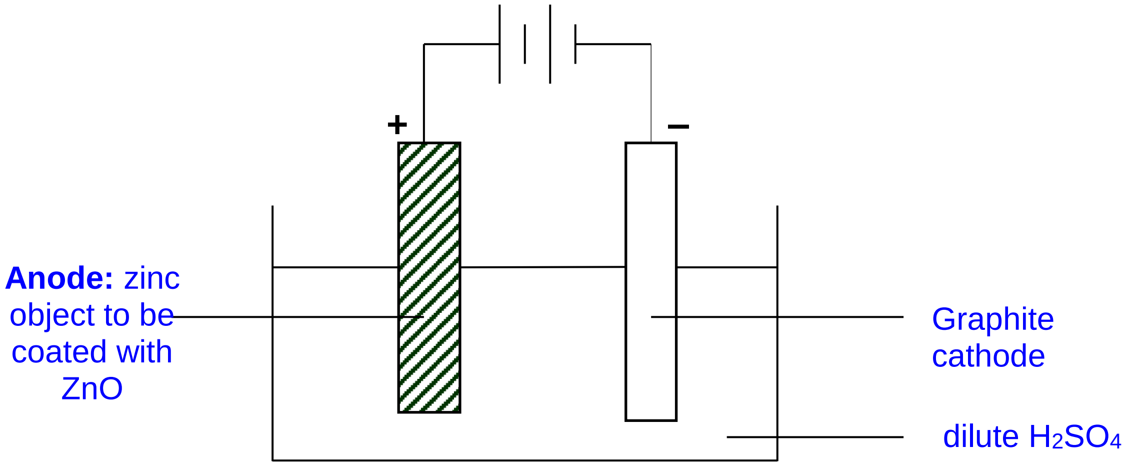
(iii)



By Hess' Law, $\Delta H_{latt}(ZnCO_3) = -3266$ kJ mol^{-1}

(c) Zn is a heterogeneous catalyst because of the availability of 3d & 4s electrons for temporary bond formation with reactants. Reactant molecules are adsorbed onto the Zn catalyst surface. This adsorption increases the surface concentration of the reactants and weakens the covalent bonds lowering the activation energy such that molecules are brought close for reaction to take place easily. Products formed diffuse away from the surface of the catalyst.

(d)



Anode : $2H_2O\ (l) \rightarrow O_2\ (g) + 4H^+\ (aq) + 4e$

Overall : $2\ Zn\ (s) + O_2\ (g) \rightarrow 2\ ZnO\ (s)$

3(ai) No of moles of NO_2 gas produced = $\frac{PV}{RT} = \frac{1.01\times10^{5}\times103.7\times10^{-6}}{8.31\times353}$

M_r of *atorvastatin* = $\frac{1}{1.785\times10^{-3}} = 560$

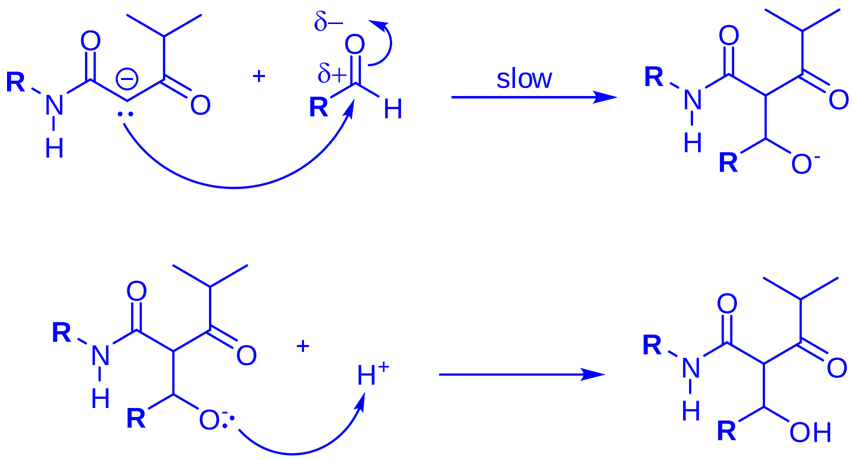
(ii) NO_2 is a real gas with significant intermolecular forces of attraction.

(bi) No of tablets required in year = 2 x 365.

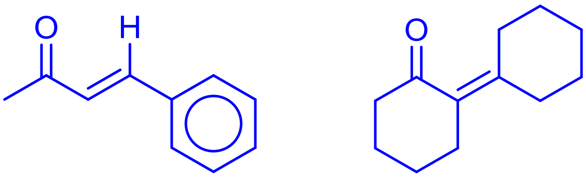
No of bottles needed = $\frac{730}{90} = 8.11 \approx 9$

(ii) The weak van der Waal's forces between the *atorvastatin* molecules is compatible with that between CCl_4 molecules. The *atorvastatin* calcium cannot form ion–dipole interaction with the CCl_4 molecules, hence it will not dissolve.

(i)



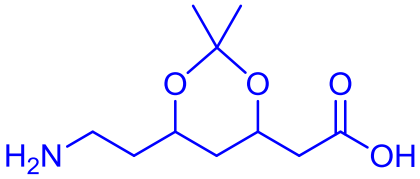
(ii)



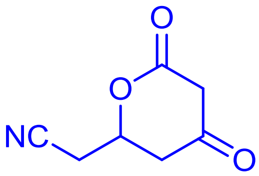
(di) NaBH4 in ethanol

(ii) Nucleophilic substitution

(iii)

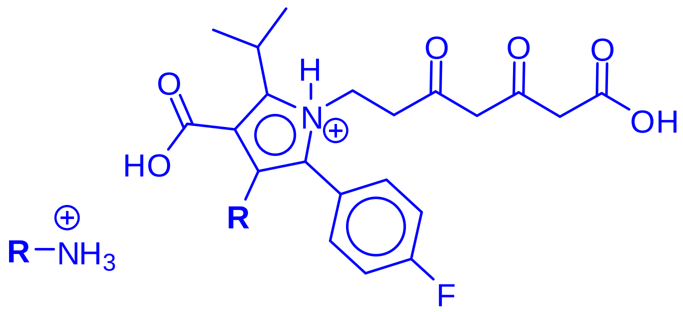


(iv)



(ei) The carboxylic acid group has higher K_a.The carboxylate anion is resonance stabilised.The alcohol has lower K_a. The electron donating alkyl group increases the intensity of the negative charge on the oxygen atom of the alkoxide anion hence destabilising it.

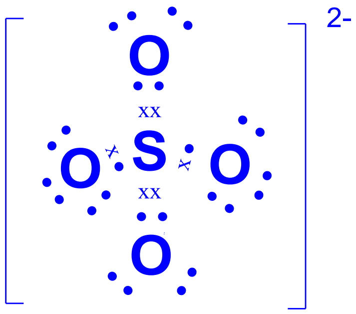
(ii)



4(ai) ΔH_{rxn} =2(1079) + 4(460) + 1(350) + 2(610) + 6(410) **–** [5(350) + 2(740) + 2(360) + 2(460) + 8(410) = – 122 kJ mol^{-1}

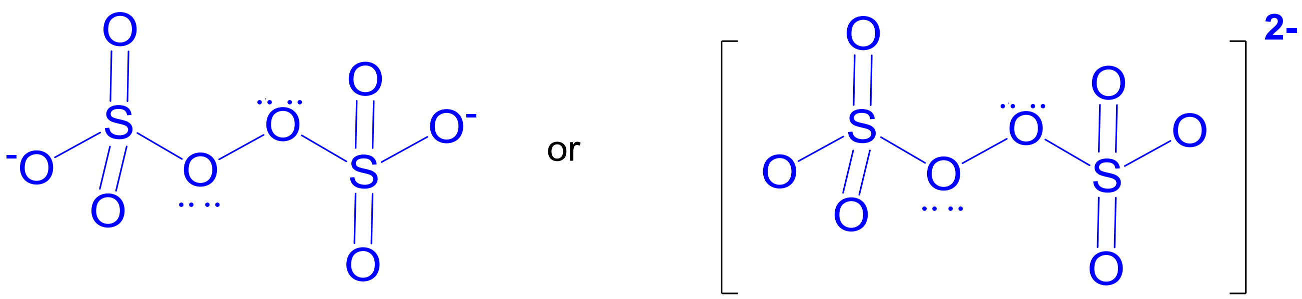
(ii) The difference is due to ΔH_{fusion} plus vaporisation of adipic acid. *Accept other answers*.

(iii) For adipoyl dichloride, the carbonyl C atom is bonded to electronegative atoms hence the electron deficient carbonyl C atom is very susceptible to hydrolysis. For compound A, the lone electron pair of the chlorine atom is delocalised with the adjacent C=C double bond hence rendering partial double bond character.



(bi)

(ii)



The shape with respect to S is tetrahedral.
The shape with respect to O is bent

(iii) Let **y** dm^3.= vol of base added.

No. of mole of HA^- = 0.2**y**

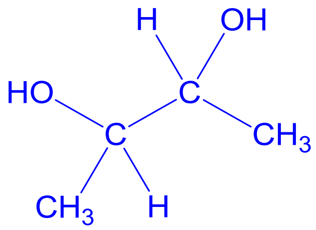
Final no. of mole of H_2A = 5×10^{-3} – 0.2**y**

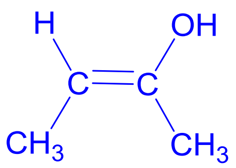
$$4.6 = 4.4 + \lg \frac{0.2y/(0.5+y)}{(5 \times 10^{-3} - 0.2y)/(0.5+y)}$$

y = 0.0153 dm^3

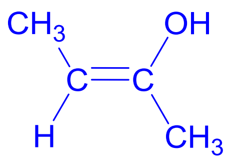
(ci) **B** undergoes acidic hydrolysis ➔ B is an ester.
C does not undergo condensation with 2,4–dinitrophenylhydrazine.
➔ **C** does not contain aldehyde or ketone
C undergoes elimination with hot Al_2O_3.➔ **E** to **G** contains alkene
E and **F** are cis-trans isomers and **G** contains chiral carbonand is a structural isomer of **E** & **F**.
D undergoes oxidation with Fehling's ➔ **D** contains aliphatic aldehyde.
D is ethanedioic acid and it undergoes further oxidation to form carbon dioxide.

Structure of **C** is

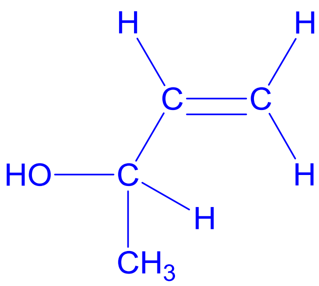




E



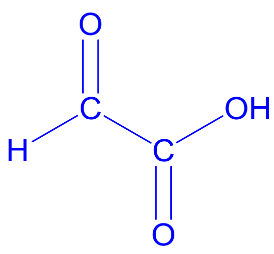
F



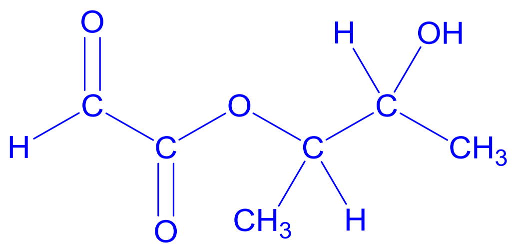
G

E and F (can interchange)

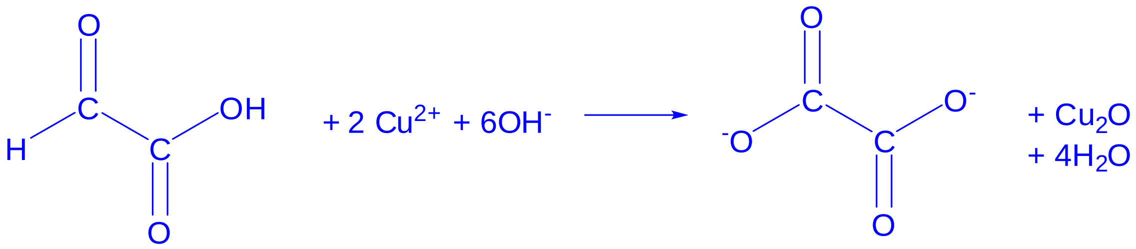
Structure of **D** is



Structure of **B** is



(i)



5(a) Quaternary structure is the combination of two or more polypeptide chains interacting to form a more complex structure. The sub–units in the structure interact via van der Waals' forces, ionic bonds and hydrogen bonds.

(bi) $[O_2] = \frac{(0.13 \times 1.01 \times 10^5)}{(8.31)(298)}$ = **=** 5.30×10^{-3} mol dm^{-3} . *Accept answer in mol m*$^{-3}$

$K_c = 0.33 \times \frac{1}{5.30 \times 10^{-3}} = 62.3$

(ii) $\Delta G = -(8.31)(298) \ln(62.3) = -10.2$ kJ mol^{-1}

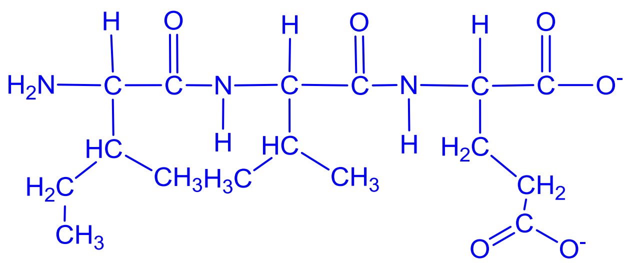
(iii) ΔS is negative since there is a decrease is disorder as there is a decrease in number of moles of gas. ΔH is negative .When temperature is high, $|\Delta H| < |-T\Delta S|$, hence ΔG is positive hence oxygenation of squid is not supported leading to death.

(iv) Cu(II) has partially-filled d orbitals. The d orbitals are split into two groups by ligands. The d electron is promoted to the *higher* d orbital. During the transition, the d electron absorbs red/ orange/yellow wavelength light from the visible region of the electromagnetic spectrum and the remaining wavelengths (blue) not absorbed will appear as the colour observed.

(c) *gly – ile – val – glu – gln – cys – cys – ala – ser – val – cys – ser – leu*

(d) van der Waals' attraction between *val* and *leu*; hydrogen bond between *gln* and *ser* ; disulfide bond between side chains of cys.

(e)



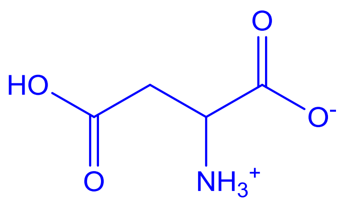
(fi) The plot is a straight line graph. [NaOH] is kept constant hence the rate is independent of [NaOH]

(ii) $-k' = = -8.21 \times 10^{-10}$ Allow range of $8.0 - 8.4 \times 10^{-10}$

(iii) $8.21 \times 10^{-10} = k\,[1.5]$

$k = 5.47 \times 10^{-10}$

(g) *pH 2.4* *pH 7.0*



and