Name of Student	Roll No.

Problem 1 — 17 Marks

1.1

X = 1.34 V

Y = –0.408 V

1.2

$\Delta G = -222915\ J < 0$

$\Rightarrow$ Cr (IV) disproportionates.

Correct E calculation and inference also awarded marks

1.3

$Cr_2O_7^{2-} + 14\ H^+ + 6\ e^- \rightleftharpoons 7\ H_2O + 2\ Cr^{3+}$

1.4

– 0.27V is the change in potential.

1.5

$E_{sy} = 1.140\ V$

1.6

$CrO_4^{2-} + 8\,H^+ + 6e^- \rightarrow Cr + 4\,H_2O$

% Efficiency = 6.87 %

1.7

The reaction at the cathode is $2\,H_3O^+ + 2\,e^- \rightarrow 2\,H_2O + H_2$

The reaction at the anode is $6\,H_2O \rightarrow 4\,H_3O^+ + 4\,e^- + O_2$.

$v(H_2) = 6.69\ m^3$ of hydrogen.

$v(O_2) = 3.50\ m^3$ of oxygen.

1.8

% of $Cu(C_{18}H_{33}O_2)_2 = 23\,\%$

Problem 2 11 Marks

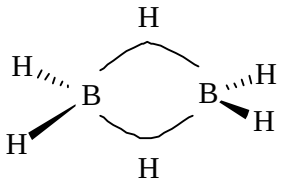
2.1

B_2O_3 acidic

Al_2O_3 amphoteric

Tl_2O_3 basic

2.2



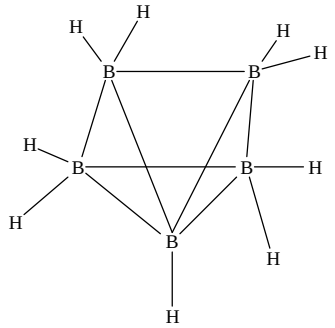
X

b) Three centered $2e^-$ bond

2.3

$B_2H_6 + 6H_2O \rightarrow 2\ B(OH)_3 + 6\ H_2$ or $2H_3BO_3 + 6H_2$

2.4



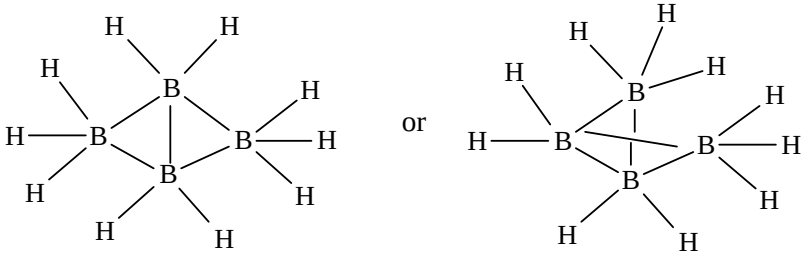
Y

2.5

B_nH_{n+6} or $B_nH_{n+4}^{2-}$ or $B_nH_{n+2}^{4-}$ or $B_nH_n^{6-}$

2.6

B_4H_{10}



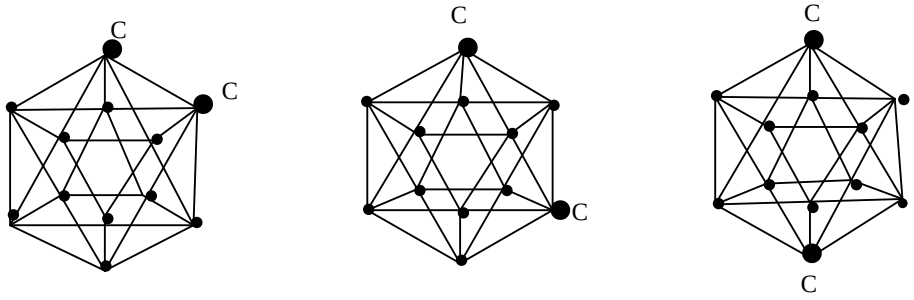
or

2.7

$C_2B_{10}H_{12}$

Z

2.8



Problem 3 18 Marks

Thermodynamics of a sustainable bio process

3.1

Efficiency = 32.6%

3.2

Decrease in the level of CO_2 (in ppm) = 2.56×10^5 ppm

3.3

$\Delta H_f = -1271.4$kJ

3.4

$C_6H_{12}O_6 + O_2 \rightarrow H_2O_2 + C_6H_{10}O_6$

3.5

Change in current produced= 0.672×10^{-3} mA

3.6

$C_6H_{12}O_6 + 6H_2O \rightarrow 24e^- + 24H^+ + 6CO_2$

$6O_2 + 24H^+ + 24e^- \rightarrow 12H_2O$

3.7

E = 1.24V

3.8

$dE/dT = 7.82 \times 10^{-5}$ VK^{-1}

3.9

Time = 5.597 or 6 .0 min

3.10

$dU_S = T_S dS \quad dG_S = 0$

3.11

$(\Delta U)_S = -60N_A hc/\lambda$. $(\Delta U)_{PO} = 60N_A hc/\lambda$
Or $(\Delta U)_S = -60hc/\lambda$. $(\Delta U)_{PO} = 60hc/\lambda$

3.12

$(\Delta S)_{step1} = 60N_A hc/\lambda\,(1/T_{PO} - 1/T_S)$

or $(\Delta S)_{step1} = 60hc/\lambda\,(1/T_{PO} - 1/T_S)$

3.13

$(\Delta S)_{step2} = -\Delta G_{PO}/T$

3.14 Show that $\Delta S_{step3} = 0$

In step 3 sun does not participate.
ΔU_{Po} in step 3 = (ΔU_{Po} in step 1 – ΔU_{Po} in step 2) = the energy transmitted to the earth
$(\Delta U_{PO}$ (step1) $- \Delta G_{Po})/T_{Po}$ is the change in entropy of PO
Change in entropy of earth = $-(\Delta U_{PO}$ (step1) $-\Delta G_{Po})/T_E$
Adding ΔS_E and ΔS_{PO} and since $T_E = T_{PO}$ $\Delta S_{step3} = 0$

3.15

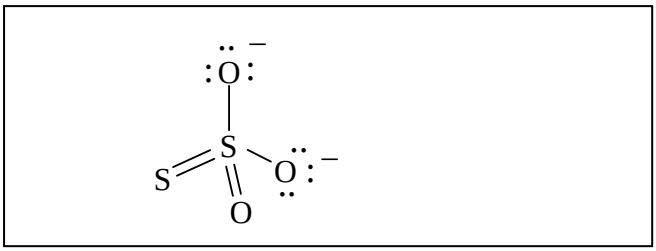
ΔS (overall) $= (60N_A hc/\lambda - \Delta G_{PO})/T_{PO}$

or ΔS (overall) $= (60hc/\lambda - \Delta G_{PO})/T_{PO}$

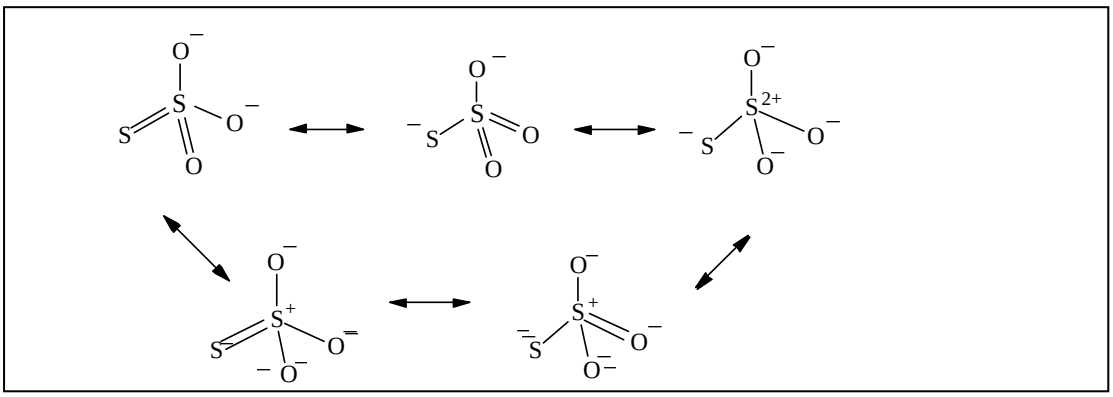
Problem 4 23 marks

Organosulphur Compounds

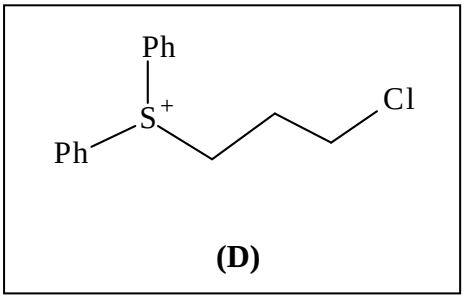
4.1



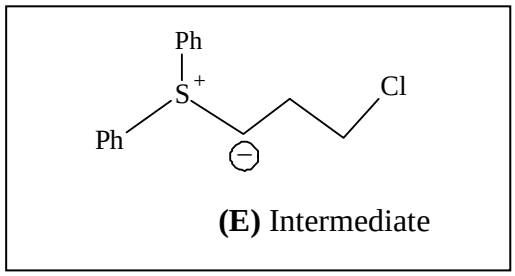
4.2



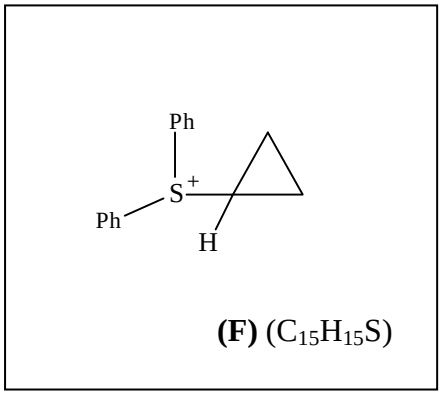
4.3



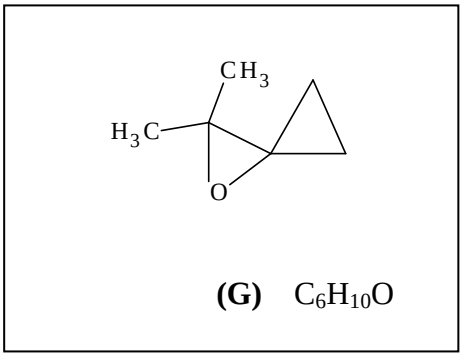
(D)



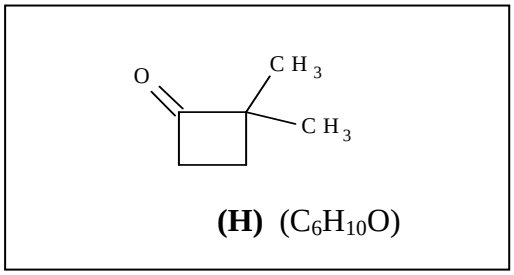
(E) Intermediate



(F) ($C_{15}H_{15}S$)

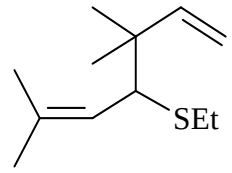


(G) $C_6H_{10}O$



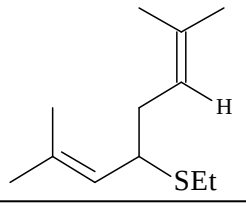
(H) ($C_6H_{10}O$)

4.4

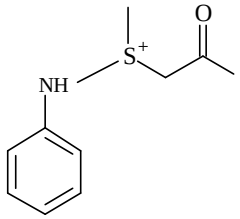


(J)

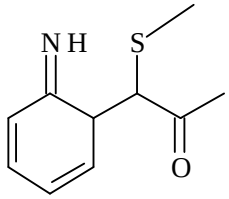
4.5



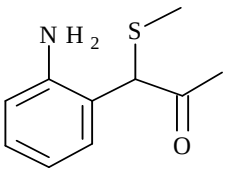
4.6



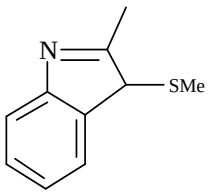
K



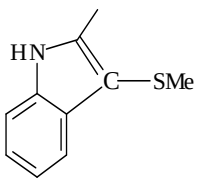
(an intermediate) **L**



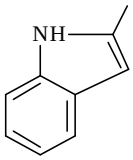
M ($C_{10}H_{13}NSO$)



N

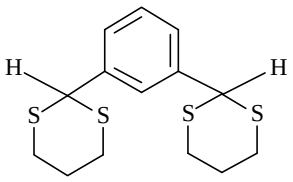


O

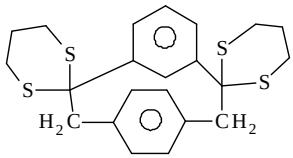


P(C_9H_9N)

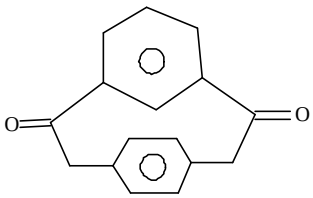
4.7



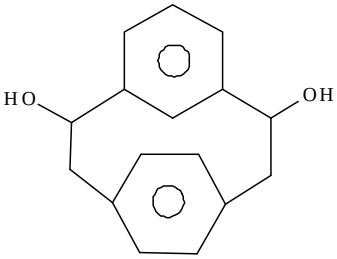
Q ($C_{14}H_{18}S_4$)



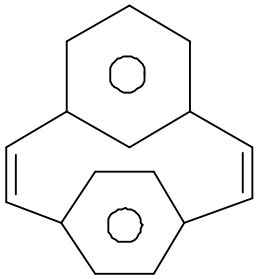
R ($C_{22}H_{24}S_4$)



S ($C_{16}H_{12}O_2$)



T ($C_{16}H_{16}O_2$)

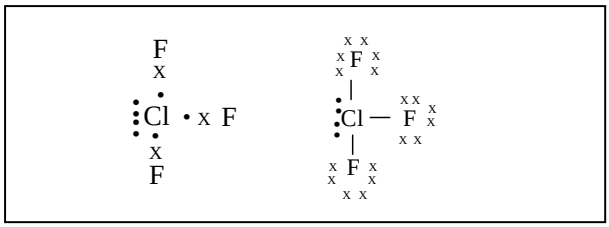


U ($C_{16}H_{12}$)

Problem 5 17 marks

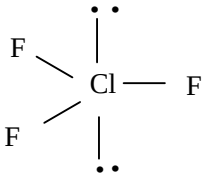
A. Chemistry of Main Group Elements

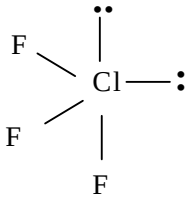
5.1 a)



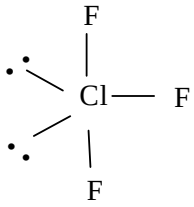
b)

Lone pairs in the axial position



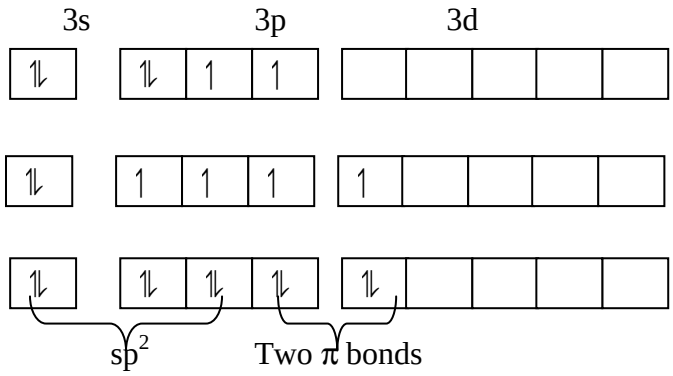


Lone pairs in the Equatorial position



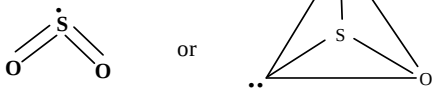
c). T-Shaped

5.2 a)



(having gained four electrons from two oxygen atoms)

b) Bent /V shaped



c) No X

5.3 i) b) Sn^{4+} is more stable than Sn^{2+} X

c) Pb^{2+} is more stable than Pb^{4+} X

ii) oxidizing agent X

iii) **This sub part was found to be Ambiquous – Hence Omitted**

B. Chemistry of d and f- block elements

5.4

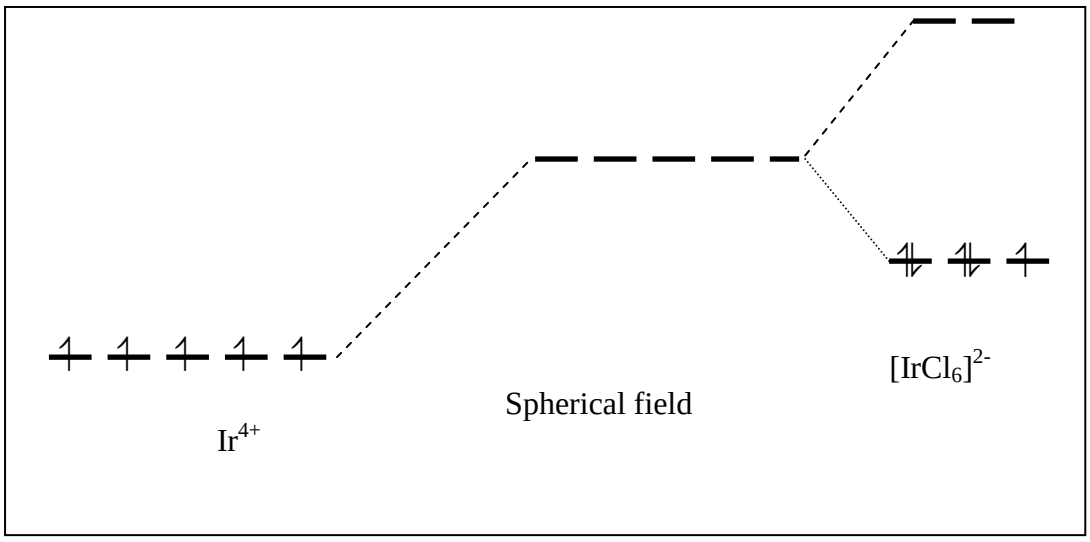
Complex	No of unpaired electrons	Spin state
$[Fe(CN)_6]^{4-}$	0	Diamagnetic/low spin
$[Fe(CN)_6]^{3-}$	1	Low spin
$[FeCl_4]^{-}$	5	High spin
$[Fe(H_2O)_6]^{2+}$	4	High spin

5.5 0.0 B.M

5.6 i) a) the central metal ion is in higher oxidation state. X

b) Ir belongs to third transition series. X

ii)



5.7

$2Ln + 6H_2O \rightarrow 2\ Ln(OH)_3 + 3H_2$

$2Ln + 6H^+ \rightarrow 2\ Ln^{3+} + 3H_2\uparrow$

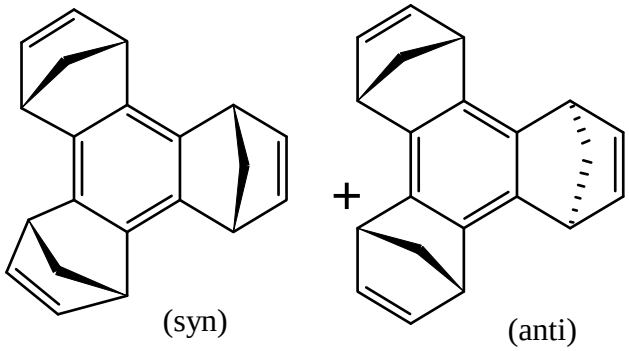
$Ce + O_2 \rightarrow CeO_2$

$Ce + 2F_2 \rightarrow 2\ CeF_4$

Problem 6 16 Marks

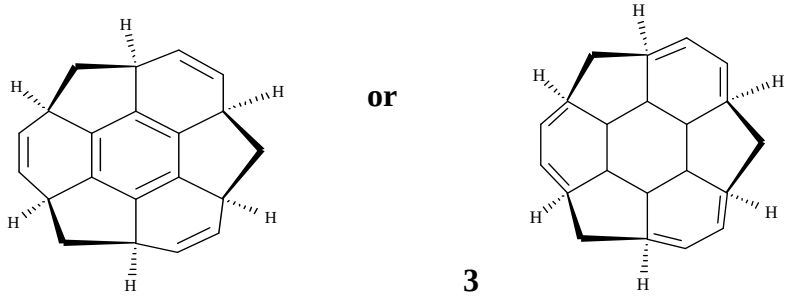
Chemistry of unusual organic compounds

6.1



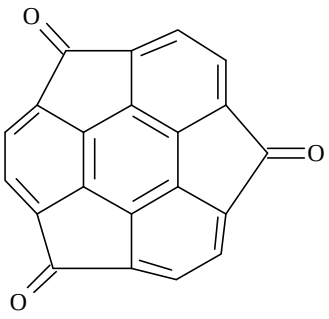
2

6.2



3

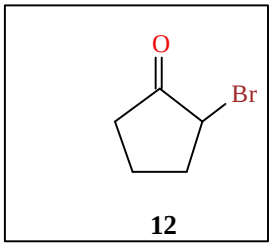
6.3



5

6.4 (i) carbonyl group (**b**) has conjugated double bond [X]

6.5



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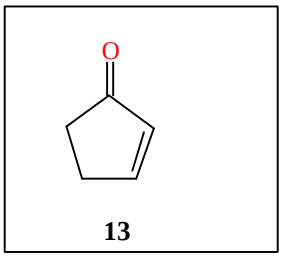

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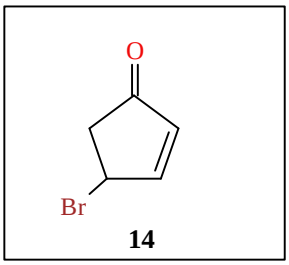

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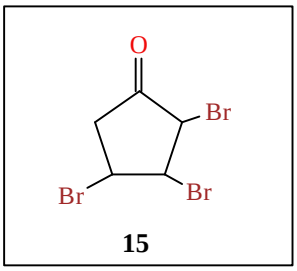

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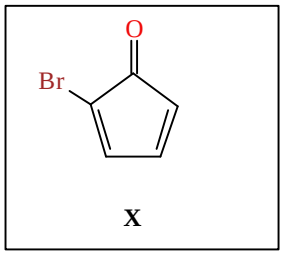
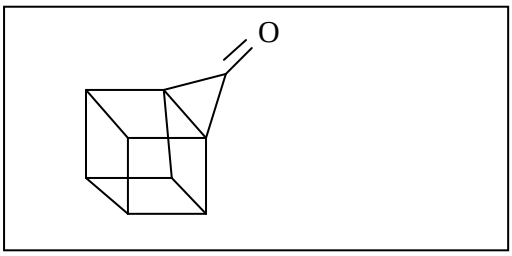
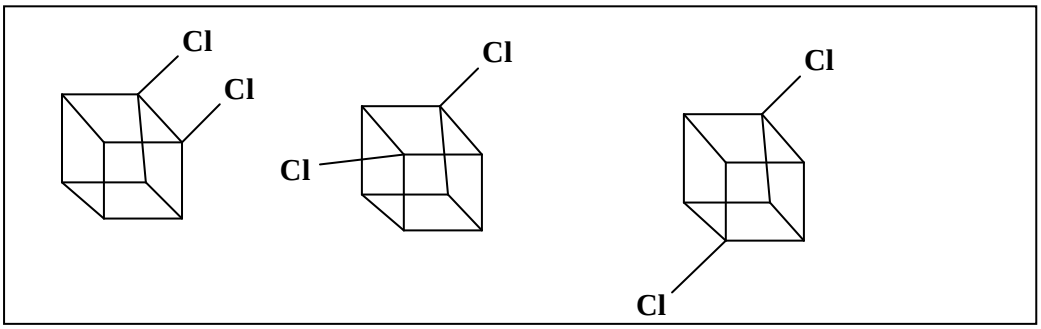


X

6.6



6.7



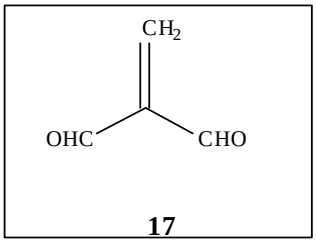
6.8 (ii) pentacyclic compound X

6.9

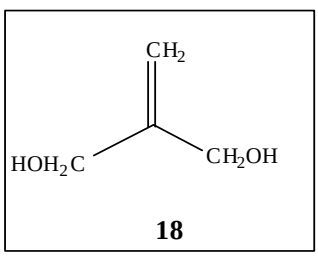
$CHBr_3 + NaOH \rightarrow :CBr_2 + NaBr + H_2O$

(**16**)

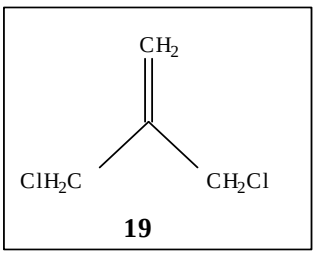
6.10



17

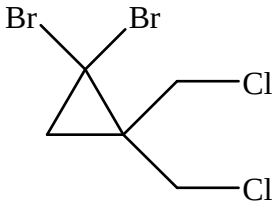


18



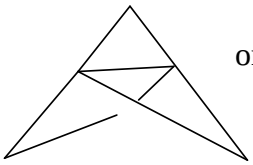
19

6.11

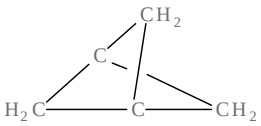


20

6.12



or



Propellane