

Indian Olympiad Qualifier in Chemistry (IOQC) 2021-2022

conducted jointly by

Homi Bhabha Centre for Science Education (HBCSE-TIFR)

and

Association of Chemistry Teachers (ACT)

Part II: Indian National Chemistry Olympiad (INChO)

Homi Bhabha Centre for Science Education (HBCSE-TIFR)

Date of Exam- March 20, 2022

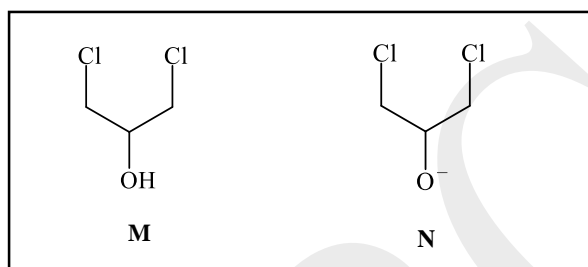
Solutions March 21, 2022

Problem 1

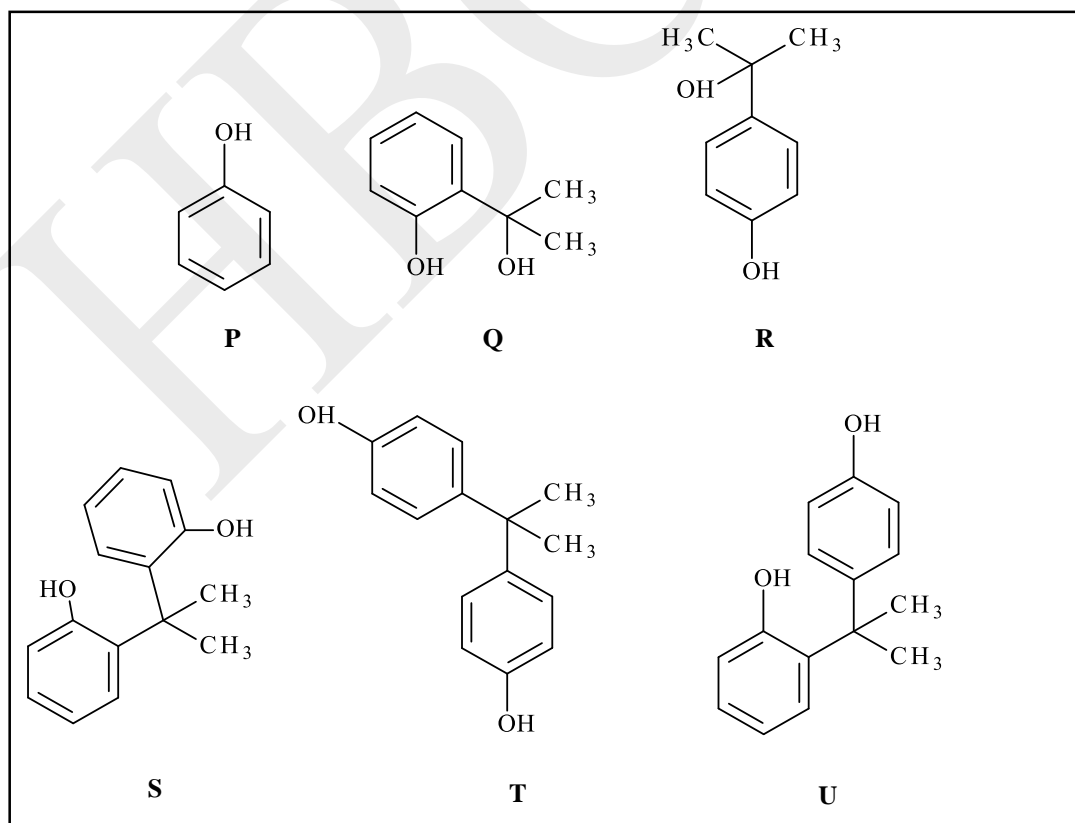
20 marks

A journey into epoxy resins

1.1



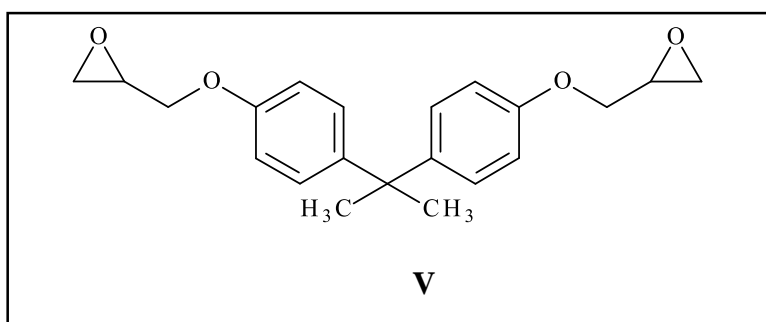
1.2 i)



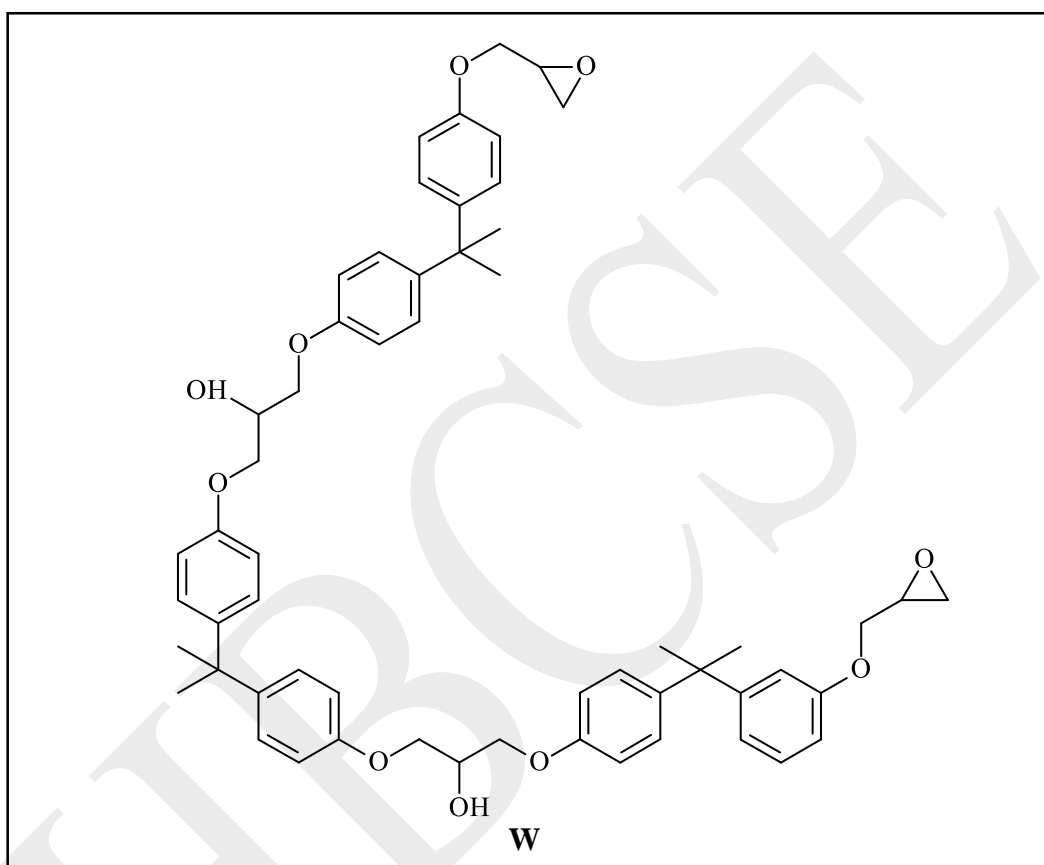
1.2 ii)

T (isomer with the two –OH groups at para position of benzene rings)

1.3 i)



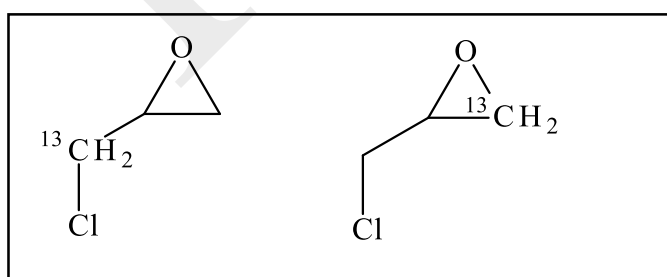
1.3 ii)



1.3 iii)

b) **X**c) **X**d) **X**

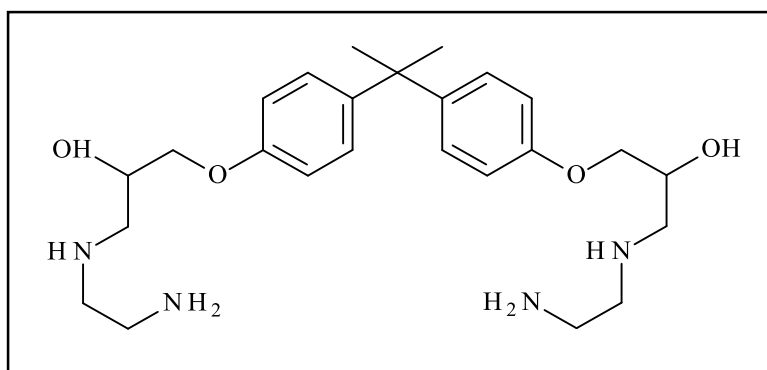
1.3 iv)



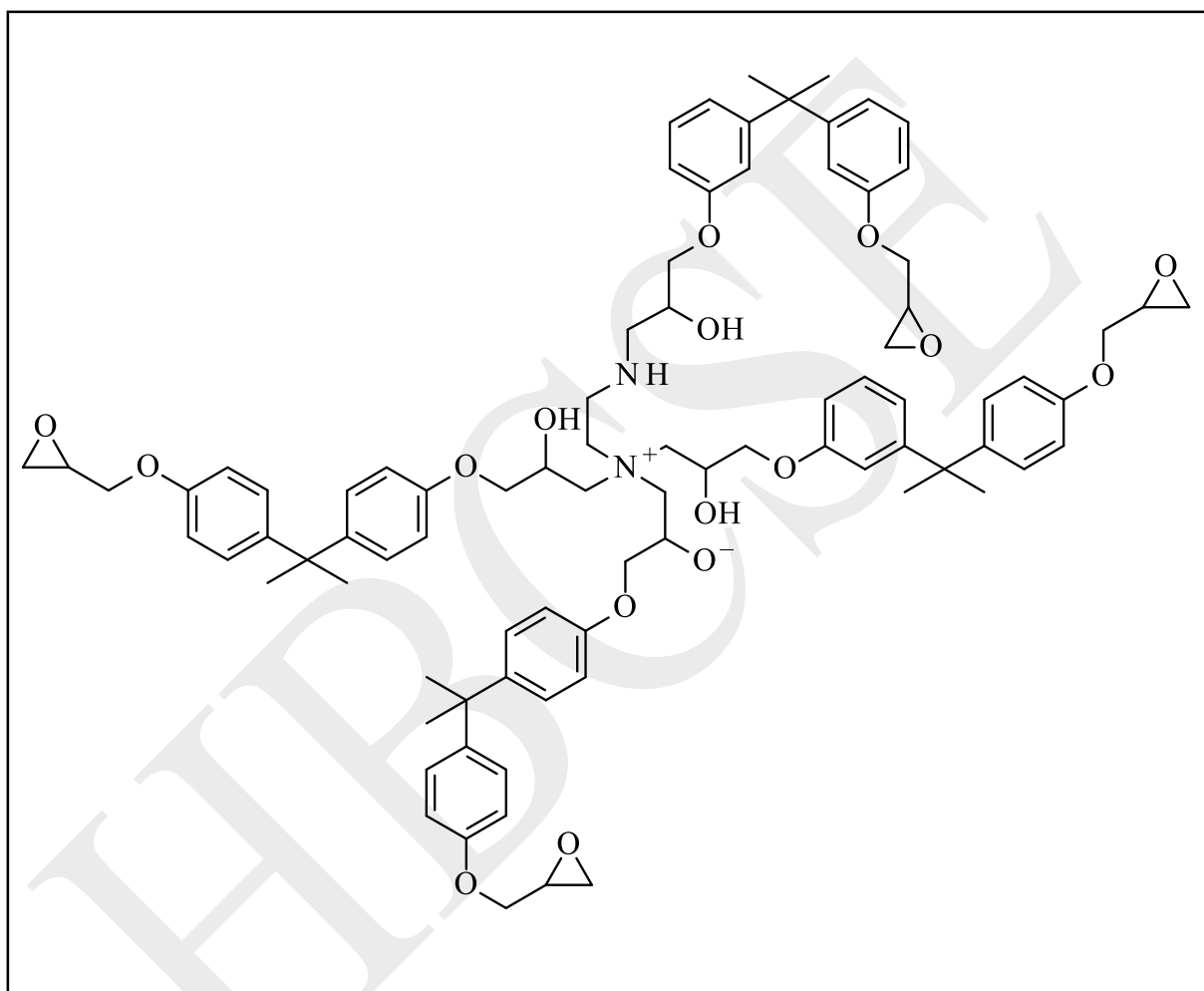
1.3 v)

NaCl, increase tensile strength

1.4 i)



1.4 ii)

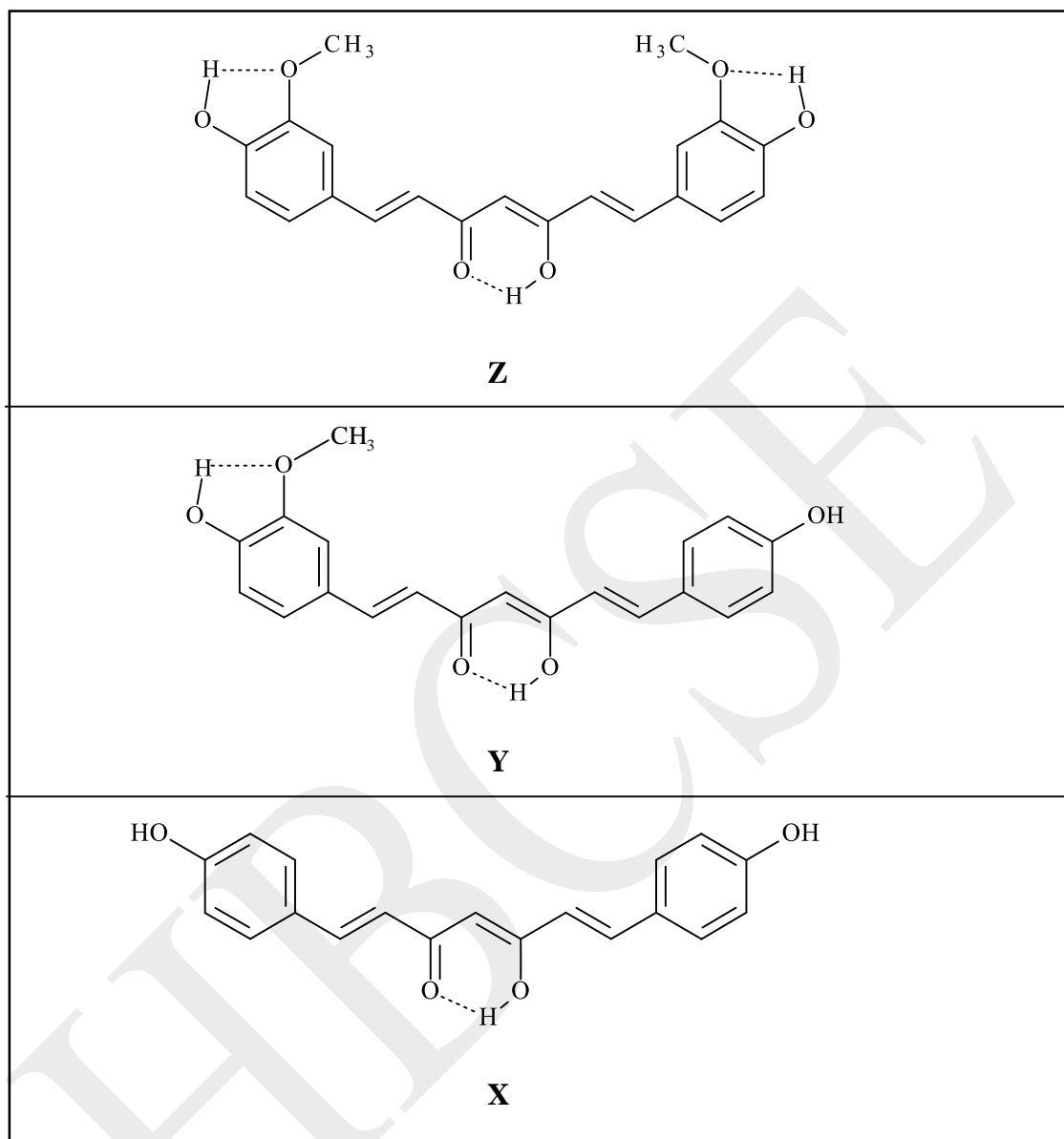
1.4 iii) c) 1.5 ii) iii) iv)

Problem 2

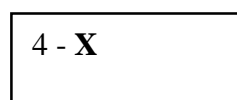
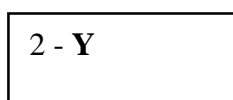
19 marks

An edible compound and a colouring agent

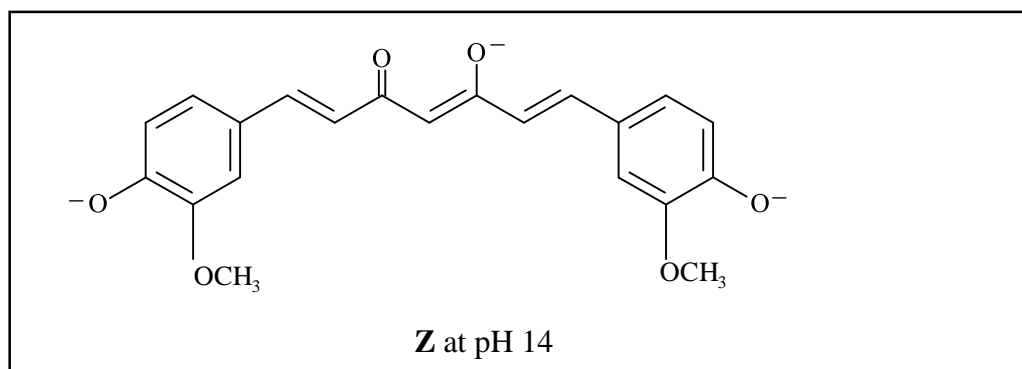
2.1



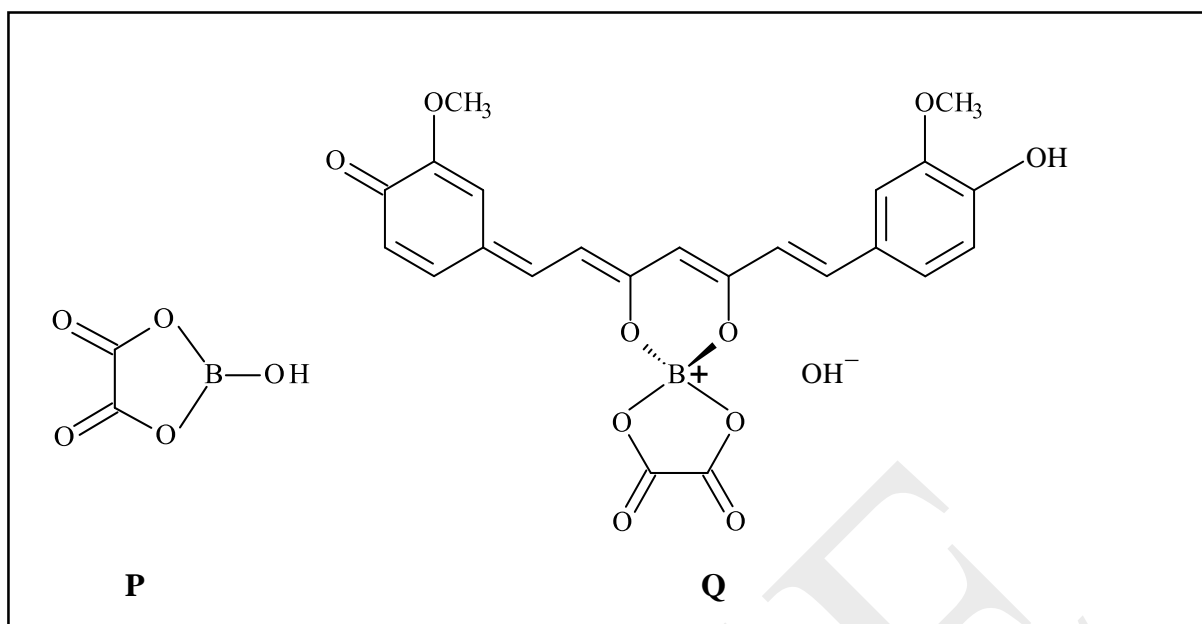
2.2



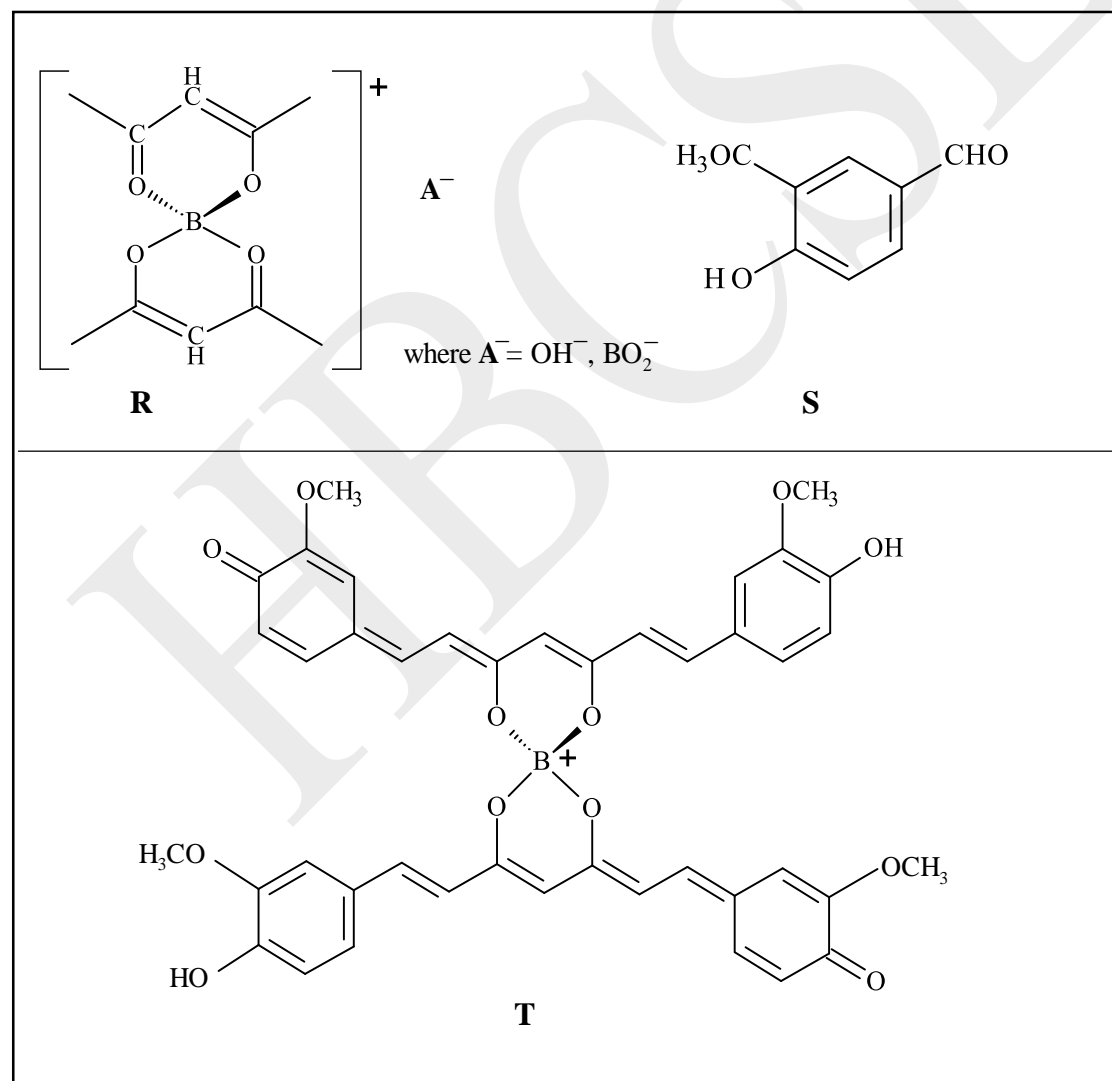
2.3



2.4

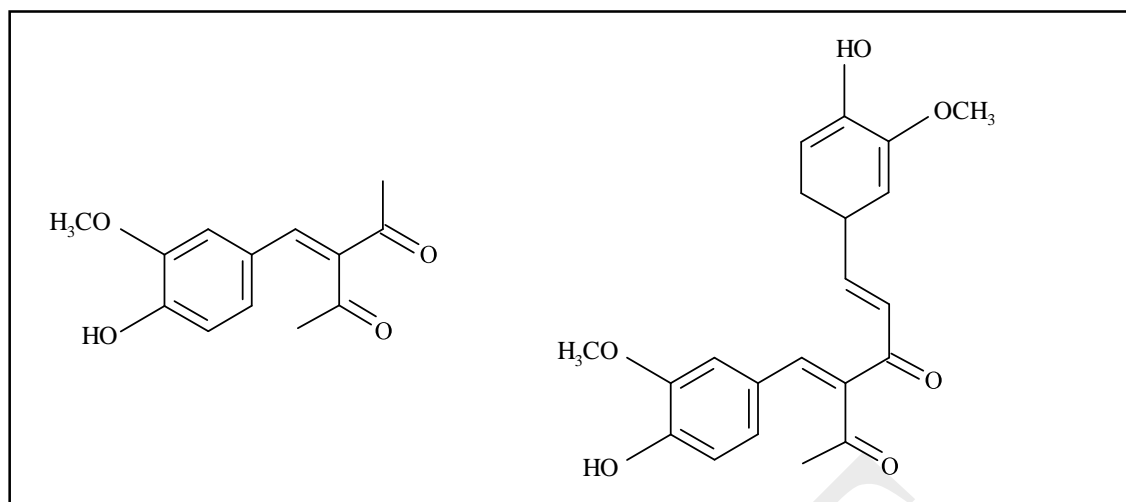
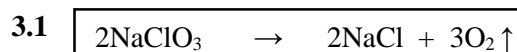


2.5



2.6 Methanol, boric acid, butyl ammonium borate

2.7

**Problem 3****31 marks****Chemical Oxygen Generation and Oxygen safety**

or

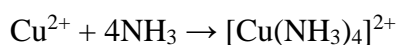
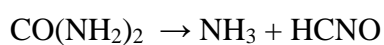


3.4 $x = 2$ $y = 3$

3.5 1 mol of peroxide produces 0.5 moles of oxygen

Molar mass of **G** = 60.1 g mol^{-1}

3.6 **G** : Urea; **H**: Copper sulphate



3.7 Amount of ethanol vapour in whole room = 255.5 g

Temperature rise = 28.1 K

- 3.8 Average mole fraction of ethanol in the air space = 0.043
 Decrease in oxygen mole fraction = 0.009
 Thus, average mole fraction of oxygen = 0.201

- 3.9 i) Moles of ethanol in 1.5 m³ of air space = 2.64 mol
 Mass of air undergoing combustion = 1884 g
 $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
 Increase in moles of gases during combustion = 1 mol per mol of ethanol.
 Increase in temperature before expansion = 1902 K
 Final temperature after expansion = 1394 °C
- ii) Oxygen initially = 12.3 moles
 Oxygen consumed = 7.92 moles
 Average mole fraction of oxygen left = 4.38/64.14 = 6.82 %

3.10

- i)
- ii)
- iv)
- v)

3.11

- i)
- iii)
- iv)

Problem 4

19 marks

Polyoxometallates

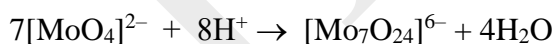
4.1

- ii)
- iv)

4.2

- i)
- ii)
- iv)

4.3



4.4

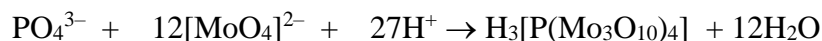
i) x = 13

ii) y = 40

4.4

iii) O_a = 12 O_b = 12 O_p = 4

4.5



4.6

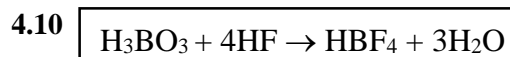
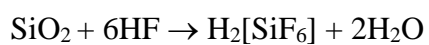
- ii)

4.7

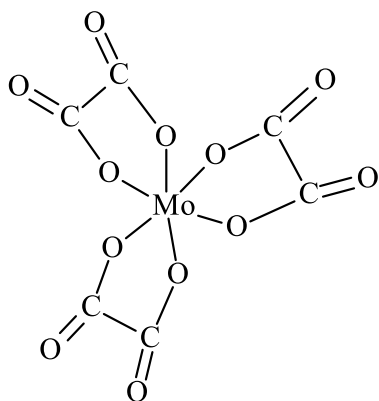
- iii)



R



4.11



or $[\text{Mo(C}_2\text{O}_4)_2(\text{H}_2\text{O})_2]^{2+}$ or $[\text{Mo(C}_2\text{O}_4)(\text{H}_2\text{O})_4]^{4+}$

4.12

ii)

X

iii)

X