polymer. They follow chain reaction mechanism i.e. successive steps of initiation, propagation and termination, so they are also called as **chain growth polymerisations**—

$$CH_3 - CH = CH_2 \longrightarrow -(-CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} -)_n-$$

Propene — Polypropene

Such polymers and monomers have the same empirical formula.

2. **Condensation polymerisations** involve a condensation between two polyfunctional molecules usually with the elimination of small molecules. These are associated with a stepwise process, so they are also called as **step growth polymerisation**. In such polymerisations, reaction continues until all of one type of reactant is consumed—

$$H_2N - (CH_2)_6 - NH_2 + HOOC - (CH_2)_4 - COOH \xrightarrow[-H_2O]{}$$

Hexamethylene diammine — Adipic acid

$$-NH - (CH_2)_6 - NH - CO - (CH_2)_4 - CO -$$

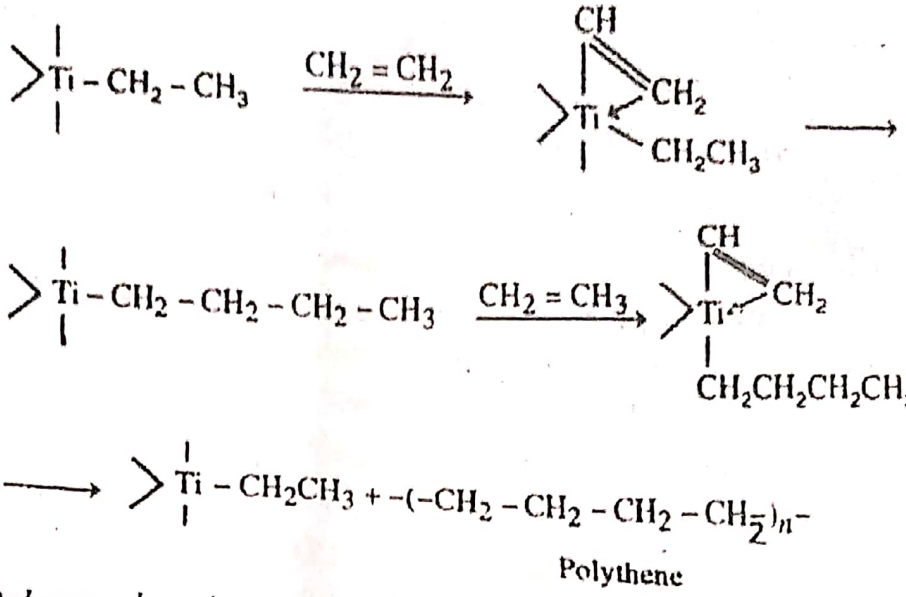
Nylon-6, 6

Such polymers & monomers differ in their empirical formula.

Q.33. What is Ziegler-Natta catalyst ? What are the advantages of using Ziegler-Natta catalyst in a polymerisation reaction ?

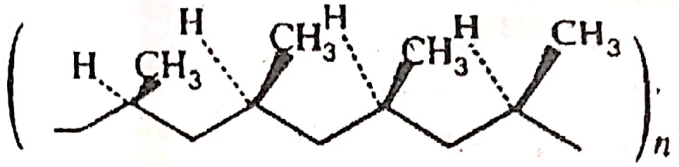
Ans. : The **catalysic system** discovered by **Ziegler** and developed by **Natta** (both Noble Laureates, 1963) has a bimetallic co-ordination complex. These catalysts consist of a transition metal salt particularly $TiCl_3$ & a metal alkyl e.g. triethylaluminium ($Et_3Al : TiCl_4$).

The essence of the coordination polymerisation is the insertion of the alkene into the C – Ti bond of growing polymer which leads to stereoregular isotactic polymers of terminal olefins of high density and high crystallinity. Chain termination is by hydrogenation. Long chains of linear polythene thus produced lie together in a regular manner in the solid without defects in regularity imposed by random branches of high temperature polymer. In addition to polymerisation which goes exclusively in head to tail manner with such catalyst, the polymer obtained has CH_3– groups entirely on one side of the zig-zag backbone. This isomeric form is called *isotactic*, where there is significant steric hindrance between methyl appendages. Thus the backbone twists regularly to give a helical shape to the polymer. Unlike this, polymers obtained from free radical polymerisation have a random (atactic) orientation of substituents—

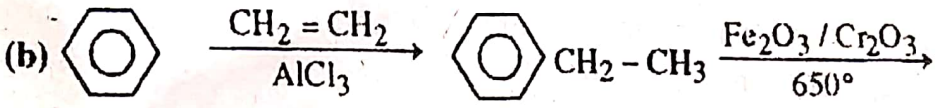


Polythene

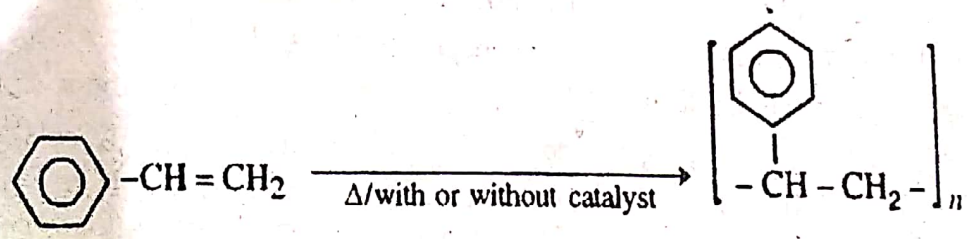
Polypropylene isotactic is shown as—



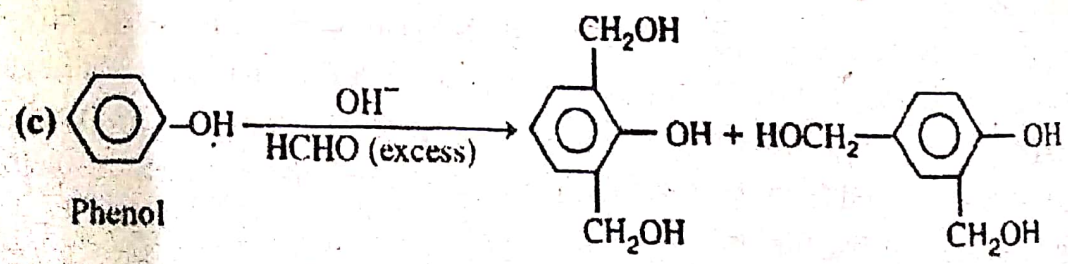
Q.34. Give the synthesis of the following industrially important polymers.
(a) Polyester (b) Polystyrene (c) Bakelite
Ans. : (a) See Q. 35.



Benzene.



Styrene Polystyrene



Phenol