

## Answer on Question #76168, Chemistry / Inorganic Chemistry

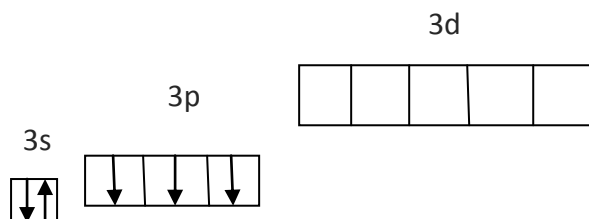
Q. Explain the type of hybridization in phosphorus pentafluoride.

### Solution

Atom P needs five orbitals to form five P-Cl bonds in  $\text{PCl}_5$ .

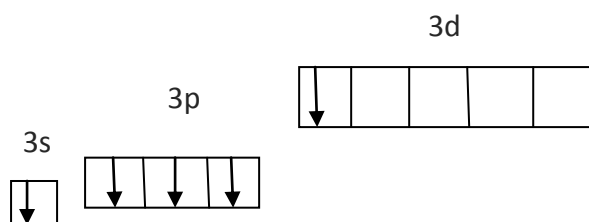
Electron structure of P atom is:

$_{15}\text{P} [\text{Ne}]3s^23p^33d^0$  (ground state)



In ground state atom P has three unpaired electrons and can form three bonds. To form 5 bonds atom P goes into an excited state, where atom P has five unpaired electrons:

$_{15}\text{P} [\text{Ne}]3s^13p^33d^1$  (excited state)



Five orbitals (one s, three p and one d) are hybridized to form five P-Cl bonds, therefore hybridization of P in  $\text{PCl}_5$  is  $sp^3d$ .

Hybridization can be calculated by using a formula:

$$H = \frac{1}{2} \cdot (V + M - C + A),$$

V – number of free electrons of central atom (P has 5 free electrons);

M – number of monovalent atoms linked to the central atoms ( 5 monovalent atoms of Cl)

C – cationic charge of the compound ( C=0)

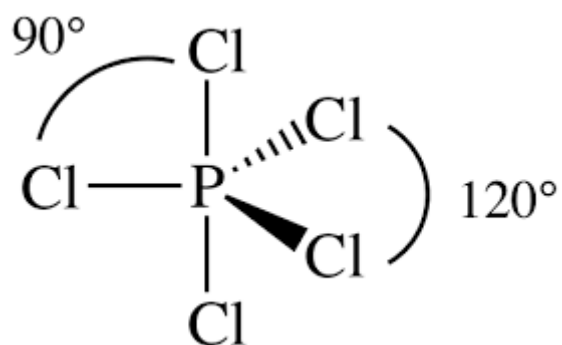
A – anionic charge of the compound (A= 0)

$$H = \frac{1}{2} (5+5-0+0) = 5$$

H	2	3	4	5	6
Type of hybridization	sp	$sp^2$	$sp^3$	$sp^3d$	$sp^3d^2$

For  $\text{PCl}_5$   $H = 5$  therefore hybridization of P atom is  $sp^3d$ .

A molecule of  $\text{PCl}_5$  has trigonal bipyramidal structure (VSEPR theory):



Answer provided by AssignmentExpert.com