Hybridization

Predicting type of hybridisation & The shape of the molecule :

Number of electron pairs in central atom = $\frac{\text{Group number of central atom + number of bonded pairs}}{2}$

$BeCl_2$	number of e^- pairs=	$\frac{2+2}{2} = 2$	sp	linear
BCl_3	number of e^- pairs =	$\frac{3+3}{2} = 3$	sp^2	Trigonal planar
SO_2	number of e^-pairs =	$\frac{6+0}{2} = 3$	sp^2 (2b.p + 1*l.p*)	Angular
SO_3	number of e^- pairs =	$\frac{6+0}{2} = 3$	sp^2 (3b.p + O *l.p*)	Trigonal planar
NH_3	number of e^- pairs =	$\frac{5+3}{2} = 4$	sp^3 (3b.p + I *l.p*)	Pyramidal
H_3O^+	number of e^- pairs =	$\frac{6+3-1}{2} = 4$	sp^3	Pyramidal

No. of electron pairs	Bond pairs	lone pairs	Hybridi-sation	*Shape*	Angle	Examples
2	2	-	sp	Linear	180^0	$BeCl_2$, CO_2, HCN
3	3	-	sp^2	Trigonal planar	120^0	BCl_3,BF_3, SO_2
	2	1	sp^2	Angular	-	SO_2, $SnCl_2$
4	4	-	sp^3	Tetrahedral	109^0	CH_4, CCl_4,CF_4
	3	1	sp^3	Pyramidal	107^0	NH_3, H_3O^+ (Hydronium ion)
	2	2	sp^3	Angular	-	H_2O, H_2S, Cl_2O, OF_2
5	5	-	sp^3d	Trigonal bipyramidal	90°, 120° 180°	PCl_5, PF_5
	4	1	sp^3d	Distorted tetrahedral	-	SCl_4, SF_4
	3	2	sp^3 d	T	90^0, 180^0	ClF_3, BrF_3,ICl_3
	2	3	sp^3 d	Linear	180^0	XeF_2, ICl_2⍰
6	6	-	sp^3d^2	Octahedral	90^0	SF_6
	5	1	sp^3 d^2	Distorted octahedral	-	ClF_5, IF_s
	4	2	sp^3 d^2	Square planar	90^0	XeF_4
7	7	-	sp^3 d^3	Pertagonal bipyramidal	72^0, 90^0	IF_7
	6	1	sp^3 d^3	Distorted octahedral	-	XeF_6

CCl_4 number of e^- pairs $=\frac{4+4}{2} = 4$ tetrahedral

PCl_5 number of e^- pairs $=\frac{5+5}{2} = 5$ sp^3d trigonal bipyramidal

SF_6 number of e^- pairs $=\frac{6+6}{2} = 6$ sp^3 d^2 octahedral

IF_7 number of e^- pairs $=\frac{7+7}{2} = 7$ sp^3d^3 pentagonal bipyramidal

H_2O	number of e^- pairs=	$\frac{6+2}{2} = 4$	(2 b.p + 2 l.p) sp^3	Angular
NH_3	number of e^- pairs	$= \frac{5+3}{2} = 4$	(3 b.p + 1 l.p) sp^3	Pyramidal
NF_3	number of e^- pairs	$=\frac{5+3}{4} = 4$	sp^3(3b.p + 1l.p)	Pyramidal
PCl_3	number of e^- pairs	$=\frac{5+3}{2} = 4$	sp^3(3b.p + 1 l.p)	Pyramidal
$POCl_3$	number of e^- pairs	$=\frac{5+3}{2} = 4$	sp^3(4b.p + o l.p)	Tetrahedral
$SOCl_2$	number of e^- pairs	$=\frac{6+2}{2} = 4$	sp^3(3b.p + 1 l.p)	Pyramidal
XeF_2	number of e^- pairs	$=\frac{8+2}{2} = 5$	sp^3d (2b.p + 3 l.p)	Linear
XeF_4	number of e^- pairs	$=\frac{8+4}{2} = 6$	sp^3d^2 (4b.p + 2 l.p)	Square planar
XeF_6	number of e^- pairs	$=\frac{8+6}{2} = 7$	sp^3d^3(6b.p + 1 l.p)	distorted octahedral
ClF_3	number of e^- pairs	$=\frac{7+3}{2} = 5$	sp^3d (3b.p + 2 l.p)	T shape
ICl_3	number of e^- pairs	$=\frac{7+3}{2} = 5$	sp^3d (3 b.p + 2 l.p)	T shape
ICl_5	number of e^- pairs	$=\frac{7+5}{2} = 6$	sp^3d^2(5 b.p + 1 l.p)	Square pyramidd
NO_2^-	number of e^- pairs	$=\frac{5+1}{2} = 3$	sp^2(2 b.p + 1l.p)	Angular
NO_3^-	number of e^- pairs	$=\frac{5+1}{2} = 3$	sp^2(3 b.p + 0 l.p)	Triagonal planar
BrF_5	number of e^- pairs	$=\frac{7+5}{2} = 6$	sp^3d^2(5 b.p + 1l.p)	Square pyramidal
SO_3^{2-}	number of e^- pairs	$=\frac{6+2}{2} = 4$	sp^3(3 b.p + 1l.p)	Pyramidal
SO_4^{2-}	number of e^- pairs	$=\frac{6+0+2}{2} = 4$	sp^3 (4 b.p + 0 l.p)	Tetrahedral
ClO^-	number of e^- pairs	$=\frac{7+1}{2} = 4$	sp^3 (1b.p + 3l.p)	Linear
ClO_2^-	number of e^- pairs	$=\frac{7+1}{2} = 4$	sp^3(2 b.p + 2l.p)	Angular
ClO_3^-	number of e^- pairs	$=\frac{7+1}{2} = 4$	sp^3 (3 b.p + 1l.p)	Pyramidal
ClO_4^-	number of e^- pairs	$=\frac{7+1}{2} = 4$	sp^3 (4 b.p + 0l.p)	Tetrahedral
NH_4^+	number of e^- pairs	$=\frac{5+4-1}{2} = 4$	sp^3 (4 b.p + 0l.p)	Tetrahedral
CH_3^+	number of e^- pairs	$=\frac{4+3-1}{2} = 3$	sp^2(3 b.p + 0l.p)	Trigonal planar
NH_2^-	number of e^- pairs	$=\frac{5+2+1}{2} = 4$	sp^3(2 b.p + 2l.p)	Angular
I_3^-	number of e^- pairs	$=\frac{7+2+1}{5} = 5$	sp^3 d (2 b.p + 3l.p)	Linear
OF_2	number of e^- pairs	$=\frac{6+2}{2} = 4$	sp^3(2b.p + 2l.p)	Angular
Cl_2O	number of e^- pairs	$=\frac{6+2}{2} = 4$	sp^3 (2b.p + 2l.p)	Angular
$SnCl_2$	number of e^- pairs	$=\frac{4+2}{2} = 3$	sp^2(2b.p + 1l.p)	Angular
$SnCl_4$	number of e^- pairs	$=\frac{4+4}{2} = 4$	sp^3(4 b.p + 0l.p)	Tetrahedral
SCl_2	number of e^- pairs	$=\frac{6+2}{2} = 4$	sp^3(2b.p + 2l.p)	Angular
SCl_4	number of e^- pairs	$=\frac{6+4}{2} = 5$	sp^3d (4b.p + 1l.p)	Distorted tetrahedral

SF_4 number of e^- pairs $= \frac{6+4}{2} = 5$ sp^3d (4b.p + 1l.p) Distorted tetrahedral

The above formula to calculate e^- pairs is applicable only for simple molecules or ions mentioned above.
It is not applicable for

- Polycentred molecules like C_2H_6, C_2H_4, C_2H_2, etc
- Polymeric substances like diamond (SP^3) graphite (SP^2); polyethene (SP^2); SiC (SP^3),

It is also not applicable for odd electronic species like NO, NO_2, ClO_2, etc.