Crystal Systems & Their Symmetries

Crystal System	**Lattice & point symmetries**	**Metric Constraints** NOTE: "≠" means "doesn't have to be" rather than "not equal to"
Triclinic	**$\bar{1}$**, 1	$a \neq b \neq c$; $\alpha \neq \beta \neq \gamma$
Monoclinic	**2/m**, 2, m	$a \neq b \neq c$; $\alpha = \gamma = 90^o$, $\beta \neq 90^o$
Orthorhombic	**mmm**, mm2, 222	$a \neq b \neq c$; $\alpha = \beta = \gamma = 90^o$
Tetragonal	**4/mmm**, $\bar{4}$2m, 4mm, 422, 4/m, $\bar{4}$, 4	$a = b \neq c$; $\alpha = \beta = \gamma = 90^o$
Trigonal rhombohedral setting hexagonal setting	**$\bar{3}$m**, 3m, 32, $\bar{3}$, 3	 $a = b = c$; $\alpha = \beta = \gamma \neq 90^o$ $a = b \neq c$; $\alpha = \beta = 90^o$, $\gamma = 120^o$
Hexagonal	**6/mmm**, $\bar{6}$m$\bar{2}$, 6mm, 622, 6/m, $\bar{6}$, 6	$a = b \neq c$; $\alpha = \beta = 90^o$, $\gamma = 120^o$
Cubic	**m$\bar{3}$m**, $\bar{4}$3m, 432, m$\bar{3}$, 23	$a = b = c$; $\alpha = \beta = \gamma = 90^o$

Understanding Hermann-Mauguin Notation for Point Groups

Crystal System	1st Position	2nd Position	3rd Position	Point Groups
Triclinic	Only one position, denoting all directions in crystal			**$\bar{1}$**, 1
Monoclinic	Only 1 symbol: 2 or $\bar{2}$ ‖ to Y (*b* is principal axis)			**2/m**, 2, m
Orthorhombic	2 and/or $\bar{2}$ ‖ to X	2 and/or $\bar{2}$ ‖ to Y	2 and/or $\bar{2}$ ‖ to Z	**mmm**, mm2, 222
Tetragonal	4 and/or $\bar{4}$ ‖ to Z	2 and/or $\bar{2}$ ‖ to X and Y	2 and/or $\bar{2}$ ‖ to [110]	**4/mmm**, $\bar{4}$2m, 4mm, 422, 4/m, $\bar{4}$, 4
Trigonal	3 and/or $\bar{3}$ ‖ to Z	2 and/or $\bar{2}$ ‖ to X, Y, U		**$\bar{3}$m**, 3m, 32, $\bar{3}$, 3
Hexagonal	6 and/or $\bar{6}$ ‖ to Z	2 and/or $\bar{2}$ ‖ to X, Y, U	2 and/or $\bar{2}$ along [1$\bar{1}$0]	**6/mmm**, $\bar{6}$m$\bar{2}$, 6mm, 622, 6/m, $\bar{6}$, 6
Cubic	2 and/or $\bar{2}$ ‖ to X, Y, Z	3 and/or $\bar{3}$ ‖ to [111]		m$\bar{3}$, 23
	4 and/or $\bar{4}$ ‖ to X, Y, Z		2 and/or $\bar{2}$ along face diagonals	**m$\bar{3}$m**, $\bar{4}$3m, 432