

Point Groups

- Combinations of operators are often identical to other operators or combinations – there are 13 standard, unique operators
- $i, m, 1, 2, 3, 4, 6, 3, 4, 6, 2/m, 4/m, 6/m$
- These combine to form 32 unique combinations, called point groups
- Point groups are subdivided into 6 crystal systems

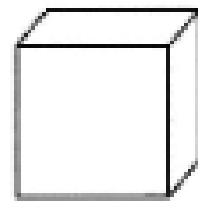
3-D Symmetry

The 32 3-D Point Groups

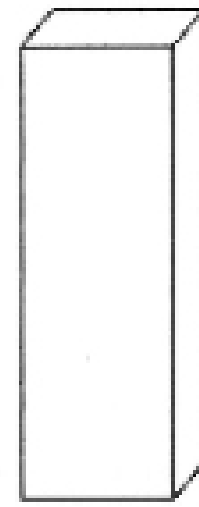
Regrouped by **Crystal System**

(more later when we consider *translations*)

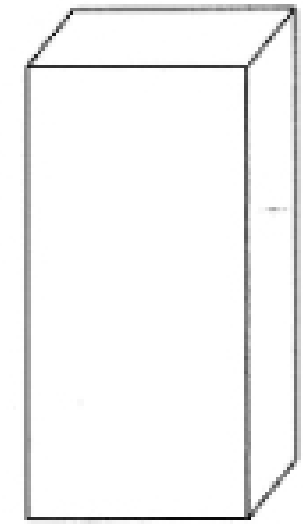
Crystal System	No Center	Center
Triclinic	1	$\bar{1}$
Monoclinic	2, $\bar{2}$ (= m)	2/m
Orthorhombic	222, 2mm	2/m 2/m 2/m
Tetragonal	4, $\bar{4}$, 422, 4mm, $\bar{4}2m$	4/m, 4/m 2/m 2/m
Hexagonal	3, 32, 3m	$\bar{3}$, $\bar{3}$ 2/m
	6, $\bar{6}$, 622, 6mm, $\bar{6}2m$	6/m, 6/m 2/m 2/m
Isometric	23, 432, $\bar{4}3m$	2/m $\bar{3}$, 4/m $\bar{3}$ 2/m



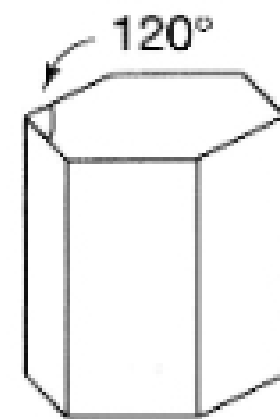
(a) cubic



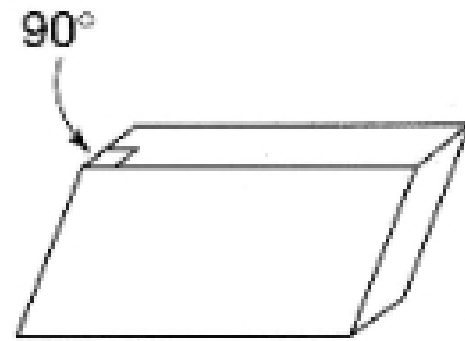
(b) tetragonal



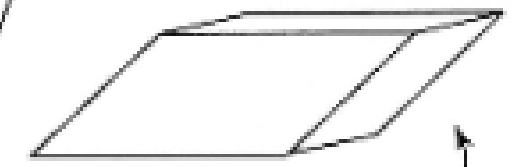
(c) orthorhombic



(d) hexagonal

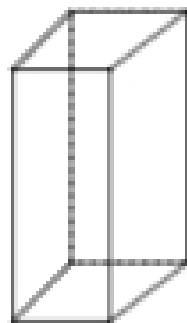


(e) monoclinic

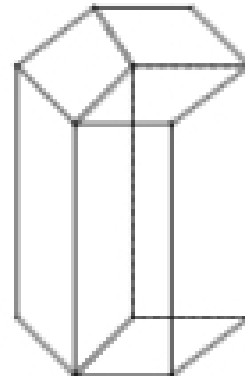


(f) triclinic

Hexagonal class



Rhombohedral form



Hexagonal form

Unit Cell Shape	Crystal System	Unit Cell Symmetry
cubic	cubic (isometric)	$4/m\bar{3}2/m$
tetragonal	tetragonal	$4/m2/m2/m$
hexagonal	hexagonal	$6/m2/m2/m$
orthorhombic	orthorhombic	$2/m2/m2/m$
monoclinic	monoclinic	$2/m$
triclinic	triclinic	$\bar{1}$