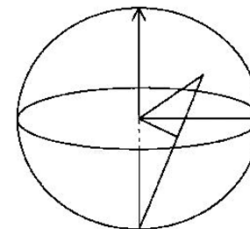


## *Point Groups*

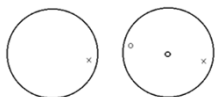
*(Crystal Classes)*

## Stereographic Projections

- Used to display crystal morphology.
- X for upper hemisphere.
- O for lower.



## Stereographic Projections



- We will use stereographic projections to plot the perpendicular to a general face and its symmetry equivalents (general form  $hkl$ ).
- Illustrated above are the stereographic projections for Triclinic point groups 1 and  $\bar{1}$ .

## *32 Point Groups:* *Hermann-Mauguin Symbols*

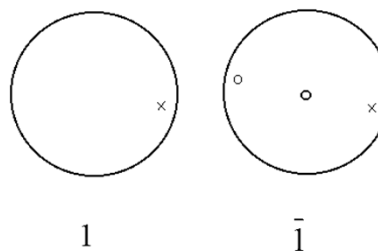
- *Three positions in H-M symbol*
- *Triclinic: No unique axis Only 1 or -1*
- *Monoclinic: (b-unique) [010]*
- *Orthorhombic: [100], [010], [001]*
- *Tetragonal: [001], [100], [110]*
- *Trigonal: [001], [100],*
- *Hexagonal: [001], [100], [210]*
- *Cubic: [100], [111], [110]*

## *32 Point Groups*

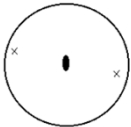
*(Crystal Classes)*

- *Triclinic: 1,  $\bar{1}$*
- *Monoclinic: 2,  $\bar{2}=m$ ,  $2/m$*
- *Orthorhombic:  $222$ ,  $2mm$ ,  $2/m2/m2/m$  (=mmm)*
- *Tetragonal: 4,  $\bar{4}$ ,  $4/m$ ,  $\bar{4}2m$ ,  $422$   $4mm$   $4/m2/m2/m$*
- *Trigonal: 3,  $3m$ ,  $\bar{3}2$ ,  $\bar{3}$ ,  $\bar{3}2/m$*
- *Hexagonal: 6,  $\bar{6}$ ,  $6/m$ ,  $\bar{6}m2$ ,  $622$ ,  $6mm$ ,  $6/m2/m2/m$*
- *Cubic:  $23$ ,  $2/m3$ ,  $432$ ,  $43m$ ,  $4/m32/m$*

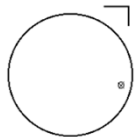
## Triclinic System



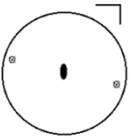
### Monoclinic System



2

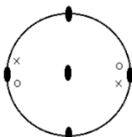


$\bar{2} = m$

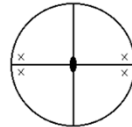


2/m

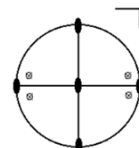
### Orthorhombic System



222

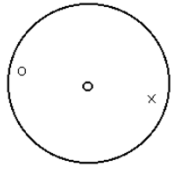


2mm



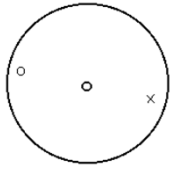
2/n2/n2/m

### Crystal System ?



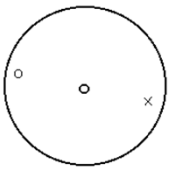
A. Triclinic  
 B. Monoclinic  
 C. Orthorhombic  
 D. Tetragonal  
 E. Trigonal

### Crystal System ?



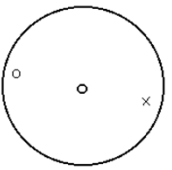
A. Triclinic  
 B. Monoclinic  
 C. Orthorhombic  
 D. Tetragonal  
 E. Trigonal

### Point Group ?



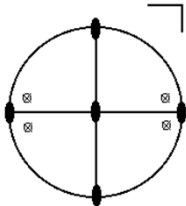
A. -1  
 B. 2  
 C. m  
 D. 2/m  
 E. 1

### Point Group ?



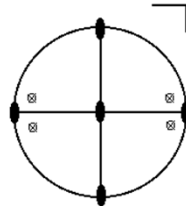
A. -1  
 B. m  
 C. 2/m  
 D. 1

Crystal System



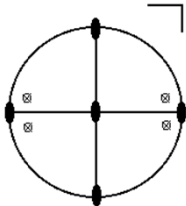
A. Triclinic  
 B. Monoclinic  
 C. Orthorhombic  
 D. Tetragonal  
 E. Trigonal

Crystal System



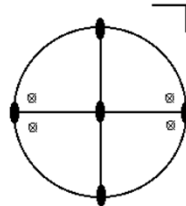
A. Triclinic  
 B. Monoclinic  
 C. Orthorhombic  
 D. Tetragonal  
 E. Trigonal

Point Group



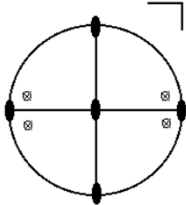
A. -1  
 B. 2  
 C. *m*  
 D.  $2/m \ 2/m \ 2/m$   
 E.  $2/m$

Point Group



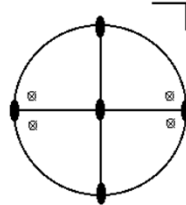
A. -1  
 B. 2  
 C. *m*  
 D.  $2/m \ 2/m \ 2/m$   
 E.  $2/m$

Order

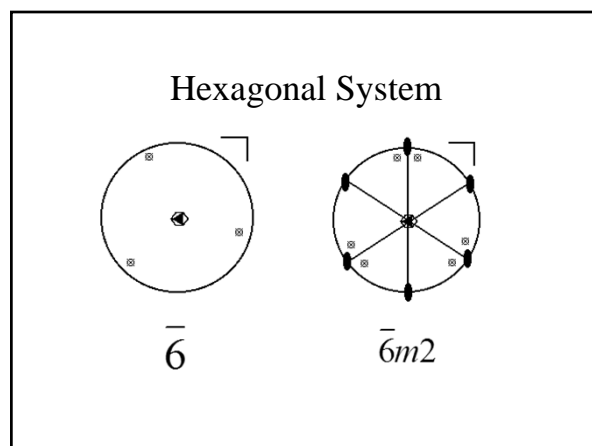
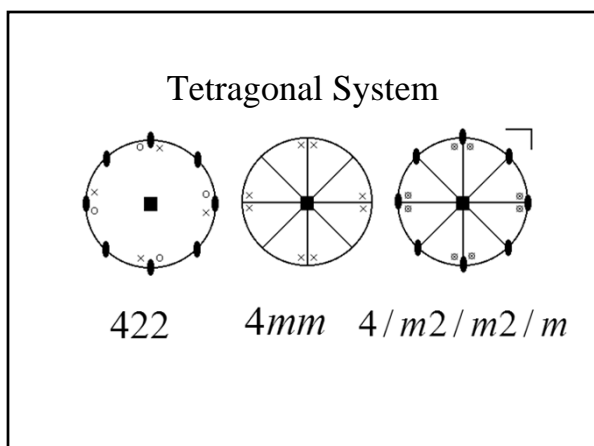
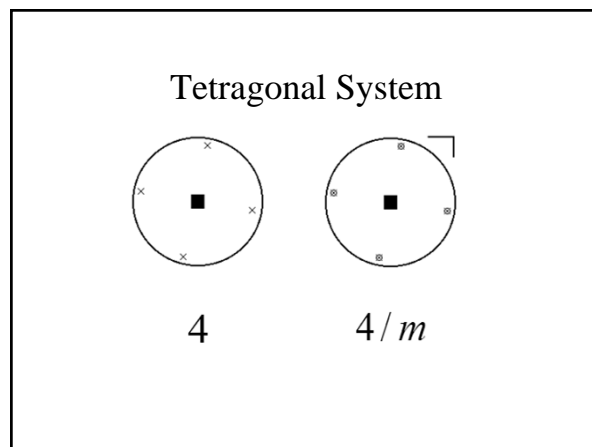
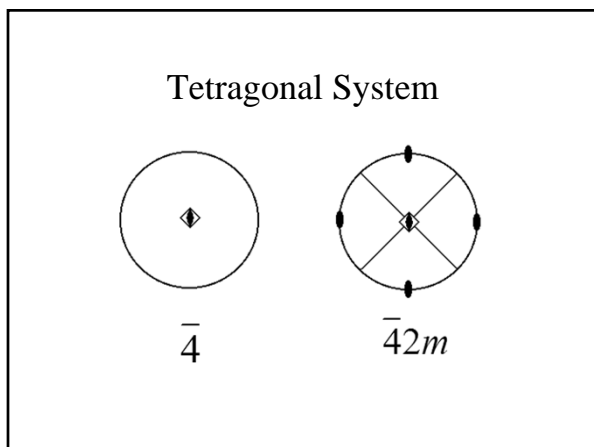
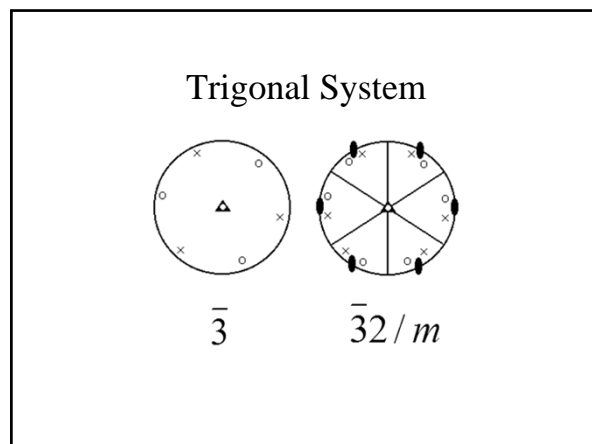
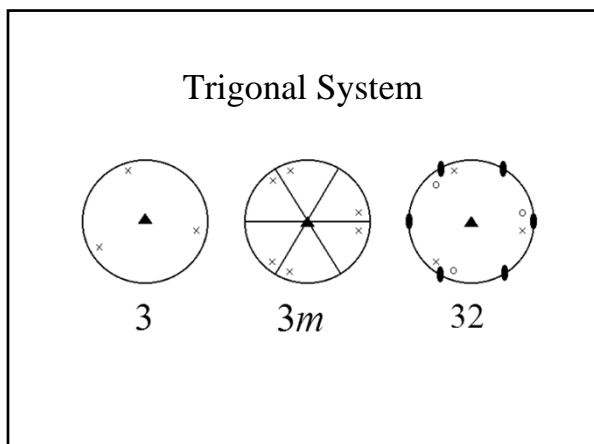


A. 1  
 B. 2  
 C. 4  
 D. 8  
 E. 16

Order



A. 1  
 B. 2  
 C. 4  
 D. 8  
 E. 16



Hexagonal System

6                   $6/m$

Hexagonal System

$622$                    $6mm$                    $6/m2/m2/m$

Cubic System

23                   $2/m\bar{3}$

Cubic System

$432$                    $\bar{4}3m$                    $4/m\bar{3}2/m$

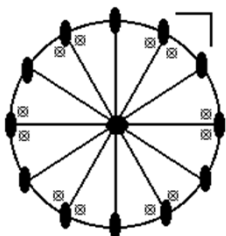
Crystal System ?

A. Orthorhombic  
B. Tetragonal  
C. Isometric (cubic)  
D. Hexagonal  
E. Trigonal

Crystal System ?

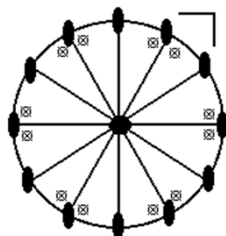
A. Orthorhombic  
B. Tetragonal  
C. Isometric (cubic)  
D. Hexagonal  
E. Trigonal

Point Group



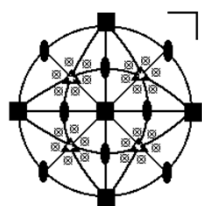
- A. 4mm
- B. 432
- C. 6/m 2/m 2/m
- D. 4/m -3 2/m
- E. 2/m -3

Point Group



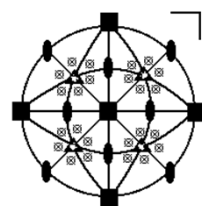
- A. 4mm
- B. 432
- C. 6/m 2/m 2/m
- D. 4/m -3 2/m
- E. 2/m -3

Crystal System ?



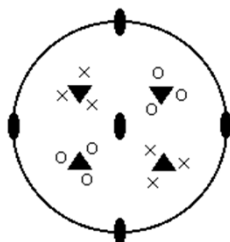
- A. Orthorhombic
- B. Tetragonal
- C. Isometric (cubic)
- D. Hexagonal
- E. Trigonal

Crystal System ?



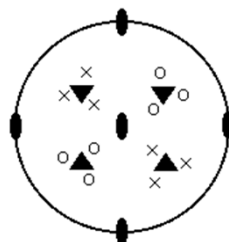
- A. Orthorhombic
- B. Tetragonal
- C. Isometric (cubic)
- D. Hexagonal
- E. Trigonal

Point Group ?



- A. 4mm
- B. 432
- C. 23
- D. 4/m -3 2/m
- E. 2/m -3

Point Group ?



- A. 4mm
- B. 432
- C. 23
- D. 4/m -3 2/m
- E. 2/m -3

## 32 Point Groups (Crystal Classes)

- *Triclinic*:  $1, \bar{1}$
- *Monoclinic*:  $2, 2=m, 2/m$
- *Orthorhombic*:  $222, 2mm, 2/m2/m2/m (=mmm)$
- *Tetragonal*:  $4, \bar{4}, 4/m, \bar{4}2m, 422, 4mm, 4/m2/m2/m$
- *Trigonal*:  $3, 3m, \bar{3}2, \bar{3}, \bar{3}2/m$
- *Hexagonal*:  $6, \bar{6}, 6/m, \bar{6}m2, 622, 6mm, 6/m2/m2/m$
- *Cubic*:  $23, 2/m3, 432, 43m, 4/m\bar{3}2/m$