Atlas des formes cristallographiques

Les formes cristallines (ensemble des faces équivalentes de notation {hkl}) des 32 **classes** de symétrie ponctuelles sont regroupées dans cet atlas. Les classes sont regroupées dans les 7 **systèmes** cristallins. Chaque système commence par sa classe holoèdre (celle qui possède la symétrie du réseau). On envisage la forme *générale* puis les formes *particulières* (pôle de la face confondu avec un élément de symétrie). Si pour les classes holoèdres toutes les projections stéréographiques et toutes les représentations des solides correspondants sont données, pour les classes mériédres seules figurent les formes qui diffèrent des formes holoèdres.

Les traits pointillés qui figurent sur les projections stéréographiques sont de simples guides pour les yeux et ne doivent pas être confondus avec la projection d'éléments de symétrie. Les faces cachées des solides ne sont représentées que si la lisibilité du dessin le permet. Certaines formes ne ferment pas l'espace ; dans un cristal réel ces formes ne peuvent exister seules. Afin de mieux mettre en évidence leurs symétries et aussi pour faciliter le dessin, les représentations des solides sont tracées en donnant le même développement à toutes les faces. La forme des cristaux réels est souvent très différente de celle des solides idéaux représentés dans l'atlas. Les cristaux comportent en général plusieurs formes associées et les faces ont fréquemment des développements différents fonction des conditions de croissance.

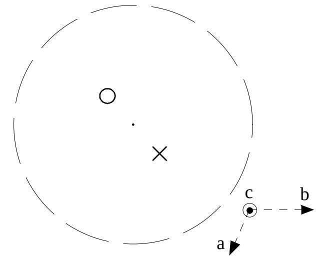
La **nomenclature** des formes utilise les noms du langage courant pour les formes usuelles comme le prisme, la pyramide, le cube, le tétraèdre, l'octaèdre ou le rhomboèdre. Le pinacoïde correspond à deux plans parallèles. Pour les formes cubiques, on utilise la systématique suivante : Le suffixe « èdre » (face) est précédé du préfixe numérique (racine grecque et non latine) qui correspond au nombre de faces. On obtient ainsi le tétraèdre, l'hexaèdre (cube), l'octaèdre, le dodécaèdre. A ce radical on ajoute les préfixes bi, tri, tétra, hexa… indiquant que le nombre de faces est doublé, triplé… Un trioctaèdre est un solide dans lequel chacune des faces d'un octaèdre est remplacée par une pyramide triangulaire. Un second préfixe précise la forme des faces. Par exemple pour le pentagonotrioctaèdre les faces que l'on vient d'évoquer sont des pentagones.

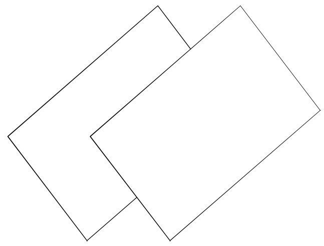
Sur la première projection de chaque système figure le repère utilisé. Les axes qui sont en dehors du plan de projection sont en pointillés, l'axe normal au plan est représenté par un point cerclé.

Système triclinique

Classe $\bar{1}$ (C_i) Élément : C

{hkl}

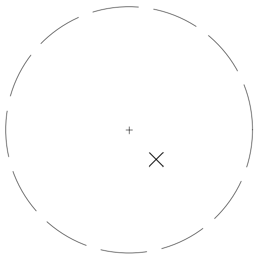


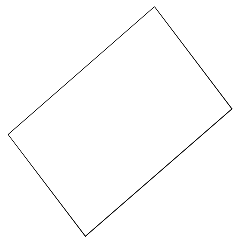


Pinacoïde

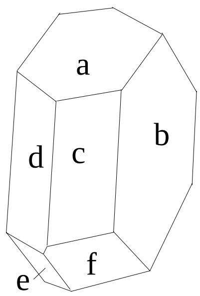
Classe 1 (C1) Élément : néant

{hkl}





Monoèdre

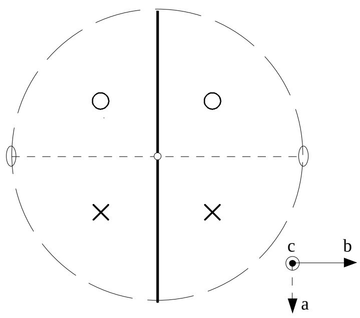


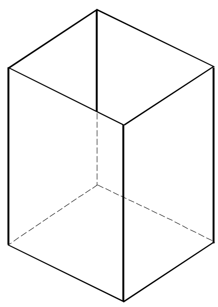
Cristal d'albite $NaAlSi_3O_8$
Classe $\bar{1}$
a : {001} Pinacoïdes
b : {010}
c : {110}
d : {1$\bar{1}$0}
e : {1$\bar{1}\bar{1}$}
f : {11$\bar{1}$}

Système monoclinique

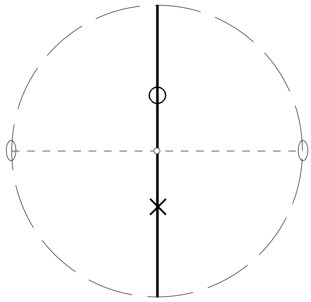
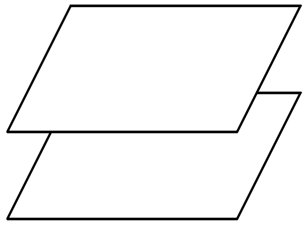
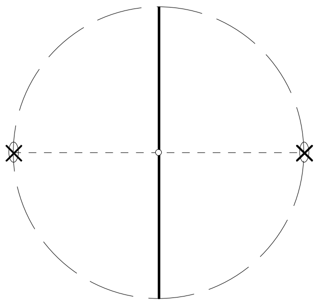
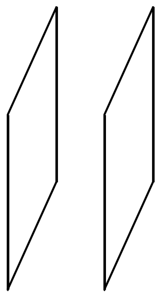
Classe 2/m (C_{2h}) Éléments : $\frac{A_2}{M}$C

{hkl}

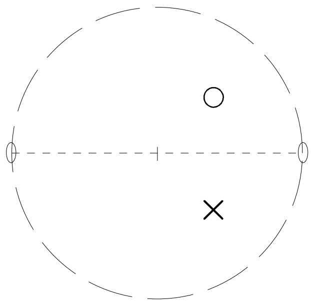
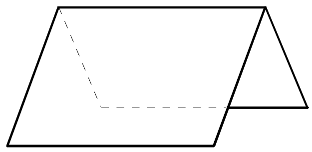
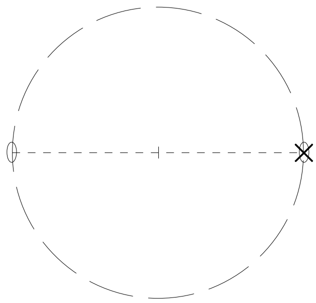
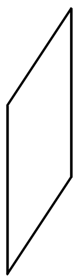




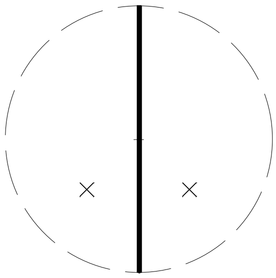
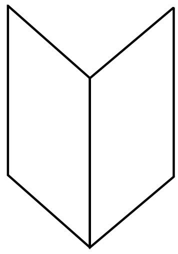
Prisme monoclinique

{h0l}		 Pinacoïde
{010}		 Pinacoïde

Classe 2 (C_2) Élément : A_2

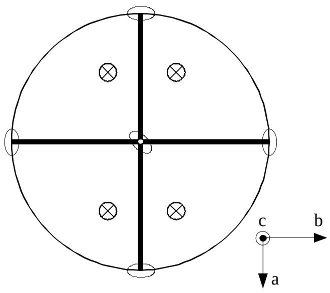
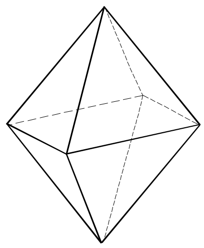
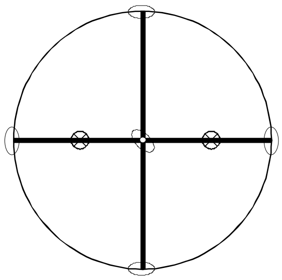
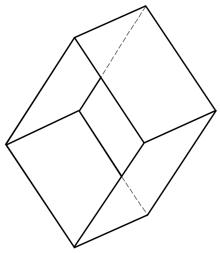
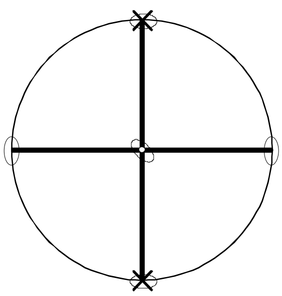
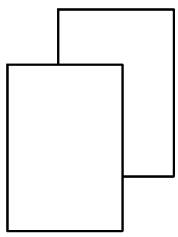
{hkl}		 Dièdre
{h0l}		Pinacoïde
{010}		 Monoèdre

Classe m (C_s) Élément : M

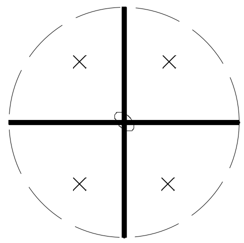
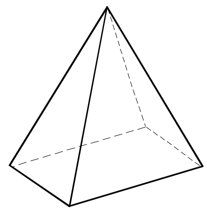
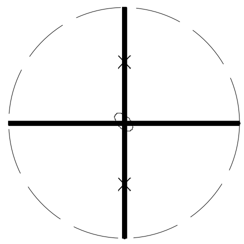
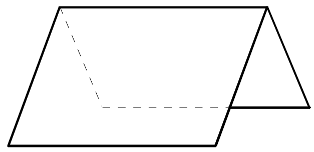
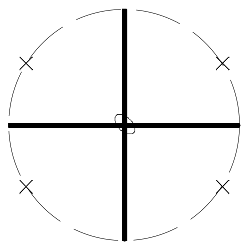
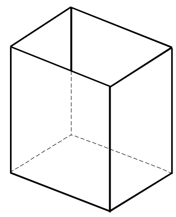
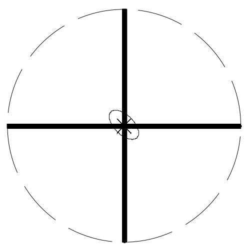
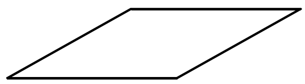
m **{hkl}**		 Dièdre
{h0l}		Monoèdre
{010}		Pinacoïde

Système orthorhombique

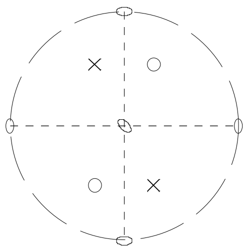
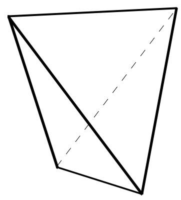
Classe mmm (D_{2h}) Éléments : $\frac{3A_2}{3M}C$

{hkl}	 	 Octaèdre orthorhombique
{0kl} {h0l} {hk0}		 Prismes orthorhombiques
{100} {010} {001}		 Pinacoïdes

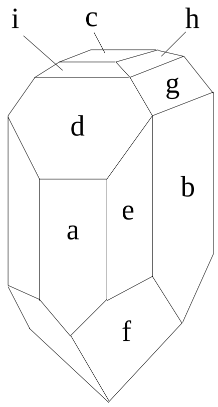
Classe mm2 (C_{2v}) Éléments : A_2 M' M''

{hkl}		 Pyramide orthorhombique
{h0l} {0kl}		 Dièdre
{hk0}		 Prisme orthorhombique
{100} {010}		Pinacoïdes
{001}		 Monoèdre

Classe 222 (D_2) Éléments : $3A_2$

{hkl}		 Tétraèdre orthorhombique

{0kl} {h0l} {hk0}		Prismes orthorhombiques
{100} {010} {001}		Pinacoïdes



Cristal de calamine : $Zn_4(OH)_2Si_2O_7,H_2O$

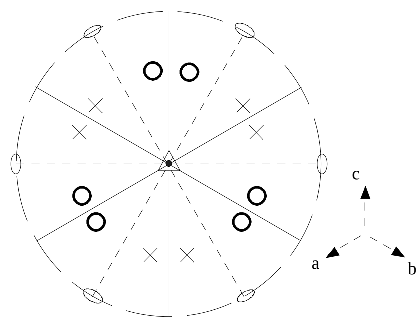
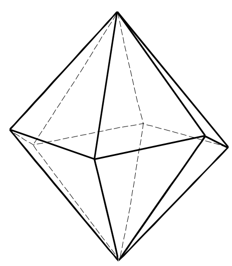
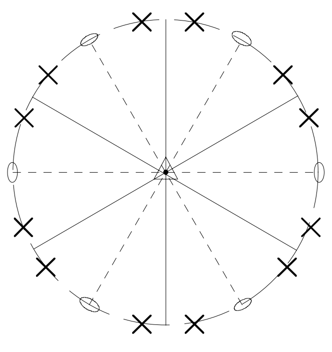
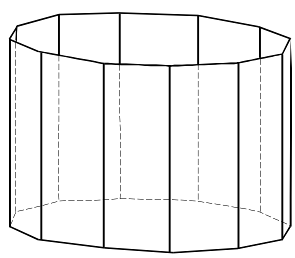
Classe mm2

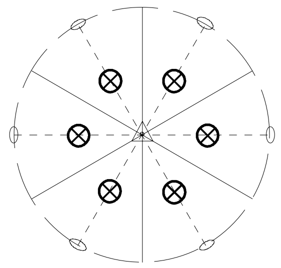
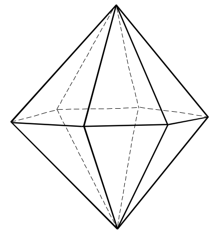
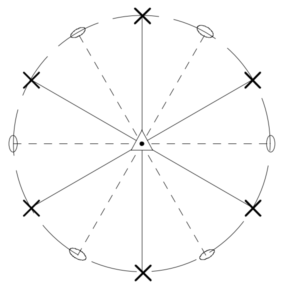
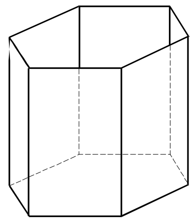
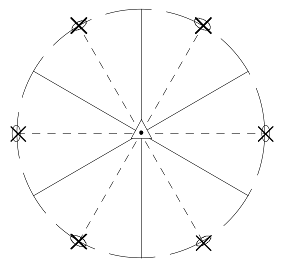
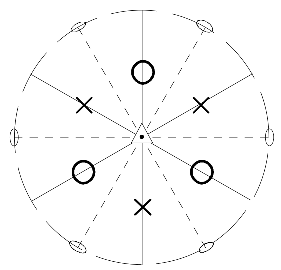
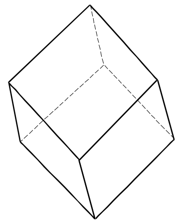
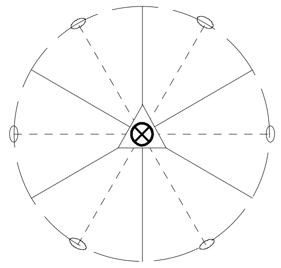
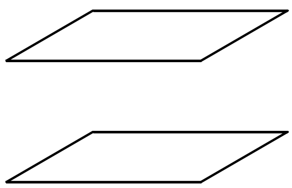
a : {100} Pinacoïde
b : {010} Pinacoïde
c : {001} Monoèdre
d : {301} Dièdre
e : {110} Prisme
f : {$12\bar{1}$} Pyramide
g : {031} Dièdre
h : {011} Dièdre
i : {101} Dièdre

Système trigonal

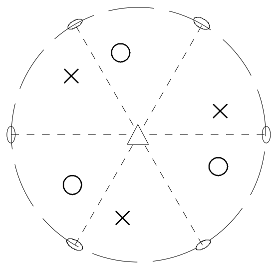
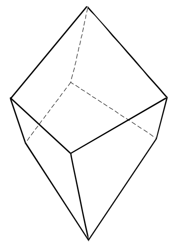
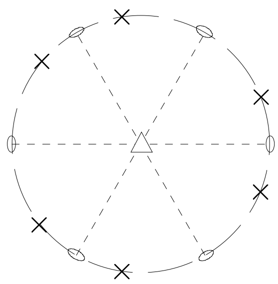
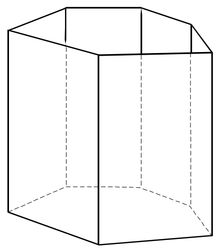
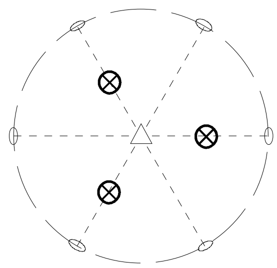
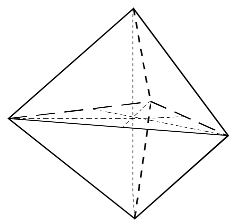
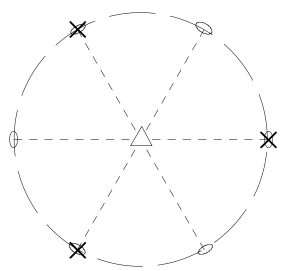
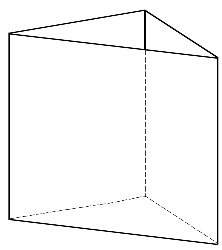
Les classes du système trigonal sont compatibles avec un réseau hexagonal.

Classe $\bar{3}$m (D_{3d}) Éléments : $A_3 \frac{3A'_2}{3M'} C$

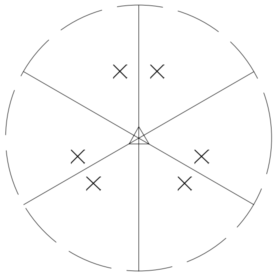
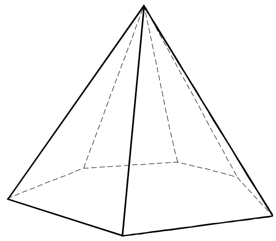
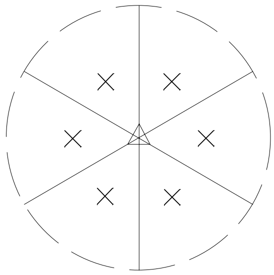
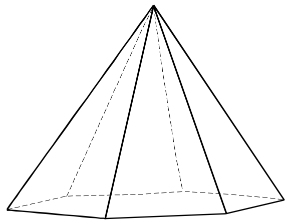
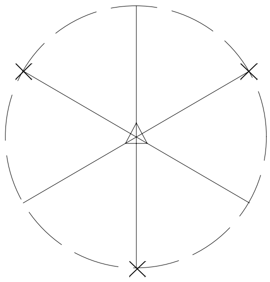
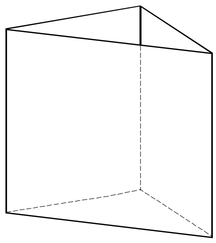
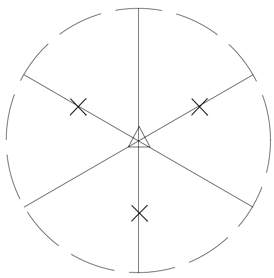
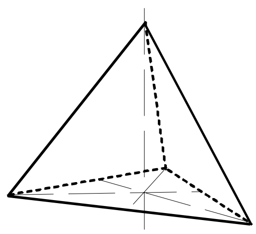
{hkl}		 Scalénoèdre trigonal
{hkl} h+k+l = 0		 Prisme dihexagonal

{hkl} $h+l = 2k$		 Dipyramide hexagonale
{11$\bar{2}$}		 Prisme hexagonal
{10$\bar{1}$}		Prisme hexagonal
{hhl}		 Rhomboèdre
{111}		 Pinacoïde

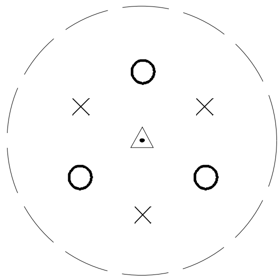
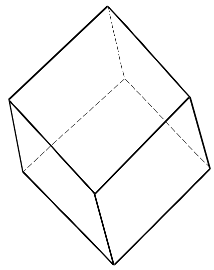
Classe 32 (D_3) Éléments : $A_3 3A'_2$

{hkl}		 Trapèzoèdre trigonal
{hkl} h+k+l = 0		 Prisme ditrigonal
{hkl} h+l = 2k		 Dipyramide trigonale
$\{11\bar{2}\}$		Prisme hexagonal
$\{10\bar{1}\}$		 Prisme trigonal
{hhl}		Rhomboèdre
{111}		Pinacoïde

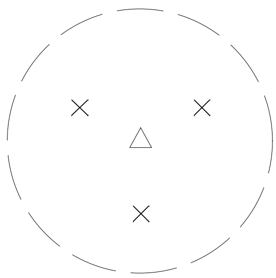
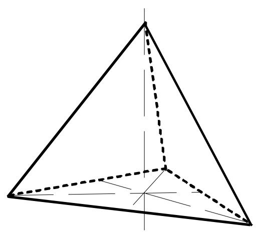
Classe 3m (C_{3v}) Éléments : $A_3\,3M'$

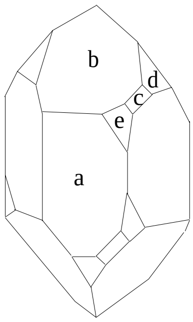
{hkl}		 Pyramide ditrigonale
{hkl} h+k+l = 0		Prisme ditrigonal
{hkl} h+l = 2k		 Pyramide hexagonale
{11$\bar{2}$}		 Prisme trigonal
{10$\bar{1}$}		Prisme hexagonal
{hhl}		 Pyramide trigonale
{111}		Monoèdre

Classe $\bar{3}$ (S_6)   Éléments : A_3C

{hkl}		 Rhomboèdre
{hkl} h+k+l = 0		Prisme hexagonal
{hkl} h+l = 2k		Rhomboèdre
$\{11\bar{2}\}$		Prisme hexagonal
$\{10\bar{1}\}$		Prisme hexagonal
{hhl}		Rhomboèdre
{111}		Pinacoïde

Classe 3 (C_3)   Élément : A_3

{hkl}		 Pyramide trigonale
{hkl} h+k+l = 0		Prisme trigonal
{hkl} h+l = 2k		Pyramide trigonale
$\{11\bar{2}\}$		Prisme trigonal
$\{10\bar{1}\}$		Prisme trigonal
{hhl}		Pyramide trigonale
{111}		Monoèdre



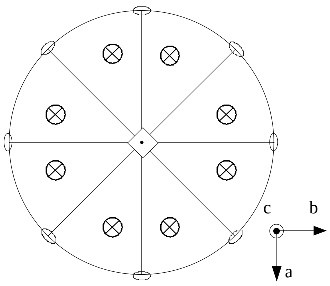
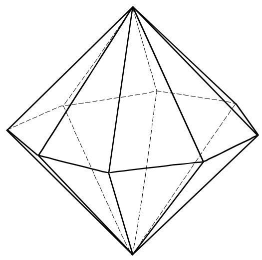
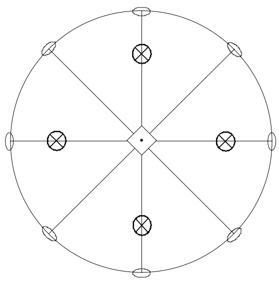
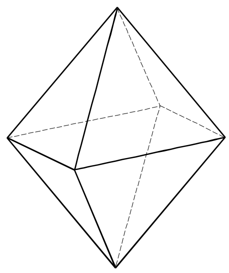
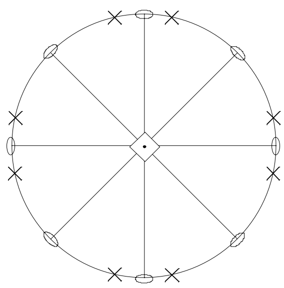
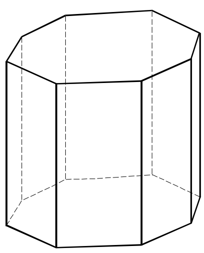
Cristal de quartz droit.

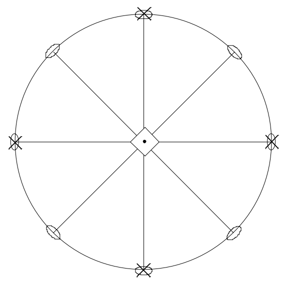
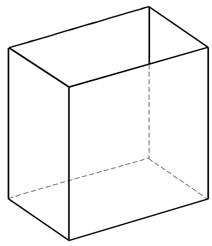
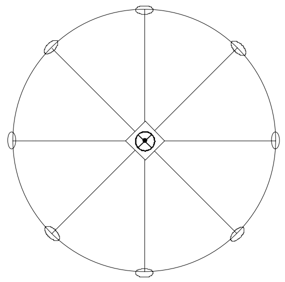
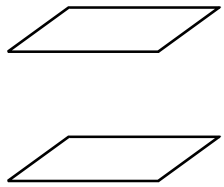
Classe 32 (réseau hexagonal)

	Hexag.	Trig.	Formes
a :	{10.0}	{$11\bar{2}$}	Prisme hexagonal.
b :	{10.1}	{100}	Rhomboèdre.
c :	{11.1}	{$41\bar{2}$}	Dipyramide trigonale.
d :	{01.1}	{$22\bar{1}$}	Rhomboèdre.
e :	{51.1}	{$4\bar{1}\bar{2}$}	Trapézoèdre.

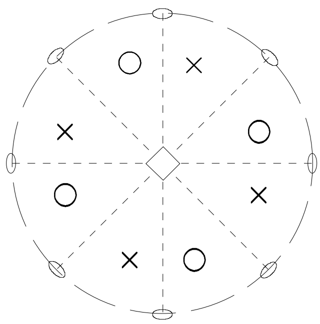
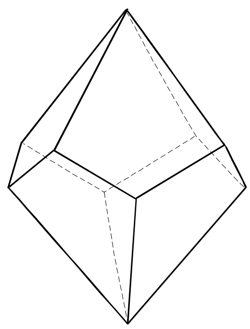
Système tétragonal

Classe 4/mmm (D_{4h}) Éléments : $\frac{A_4}{M}\,\frac{2A'_2}{2M'}\,\frac{2A''_2}{2M''}\,C$

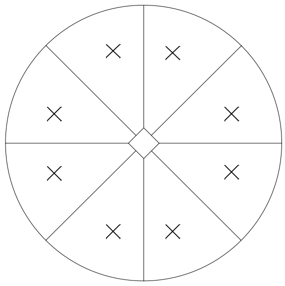
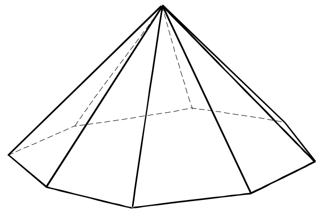
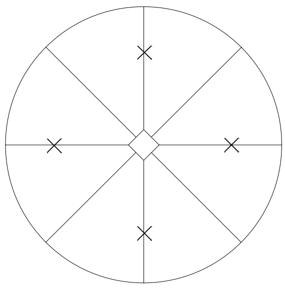
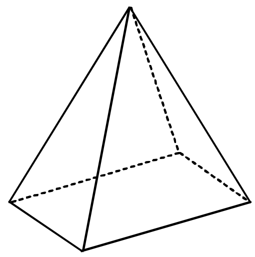
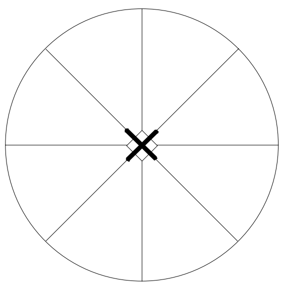
{hkl}		 Dipyramide ditétragonale
{h0l} {hhl}		 Dipyramide tétragonale
{hk0}		 Prisme ditétragonal

4/mmm **{100}** {110}		 Prisme tétragonal
{001}		 Pinacoïde

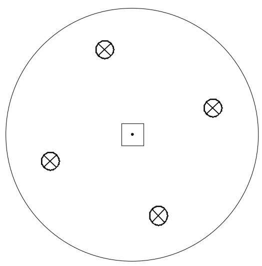
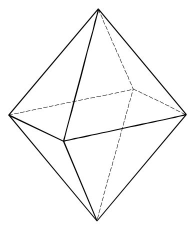
Classe 422 (D_4) Éléments : A_4 $2A'_2$ $2A''_2$

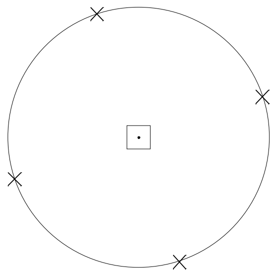
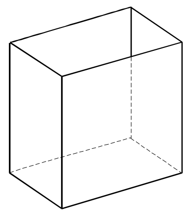
{hkl}		 Trapèzoèdre tétragonal
{h0l} {hhl}		Dipyramide tétragonale
{hk0}		Prisme ditétragonal
{100} {110}		Prisme tétragonal
{001}		Pinacoïde

Classe 4mm (C_{4v}) Éléments : A_4 2M' 2M"

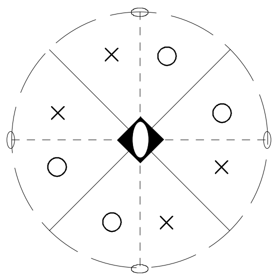
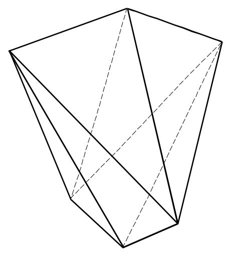
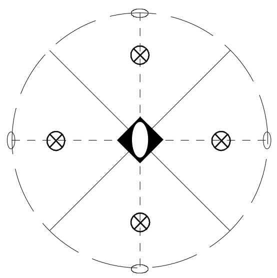
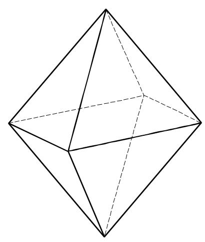
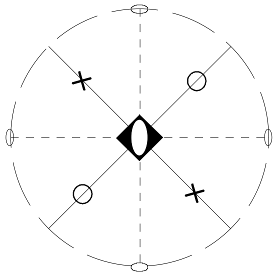
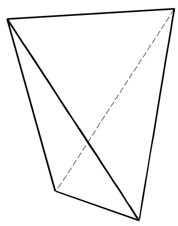
4mm **{hkl}**		 Pyramide ditétragonale
{h0l} {hhl}		 Pyramide tétragonale
{hk0}		Prisme ditétragonal
{100} {110}		Prisme tétragonal
{001}		Monoèdre

Classe 4/m (C_{4h}) Éléments : $\frac{A_4}{M}C$

{hkl}		 Dipyramide tétragonale
{h0l} {hhl}		Dipyramide tétragonale

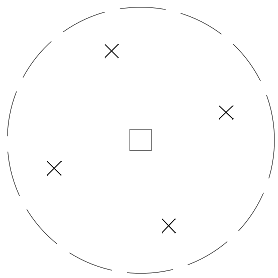
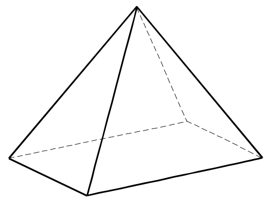
4/m **{hk0}**		 Prisme tétragonal
{100} {110}		Prisme tétragonal
{001}		Pinacoïde

Classe $\bar{4}$2m (D_{2d}) Éléments : $\bar{A}_4$ $2A'_2$ $2M''$

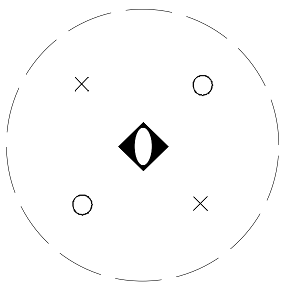
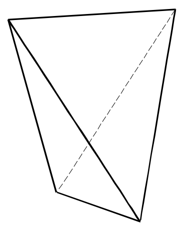
{hkl}		 Scalénoèdre tétragonal
{h0l}		 Dipyramide tétragonale
{hhl}		 Tétraèdre tétragonal
{hk0}		Prisme ditétragonal
{100} **{110}**		Prisme tétragonal

{001}		Pinacoïde

Classe 4 (C_4) Élément : A_4

{hkl}		 Pyramide tétragonale
{h0l} **{hhl}**		Pyramide tétragonale
{hk0}		Prisme tétragonal
{100} **{110}**		Prisme tétragonal
{001}		Monoèdre

Classe $\bar{4}$ (S_4) Élément : $\bar{A}_4$

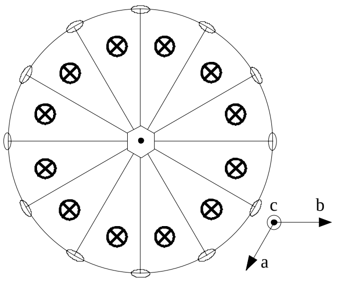
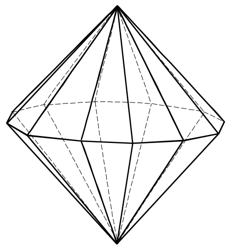
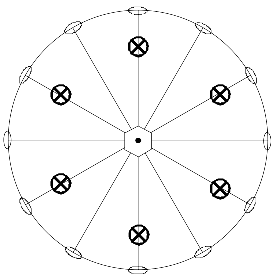
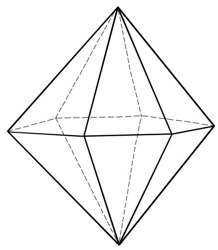
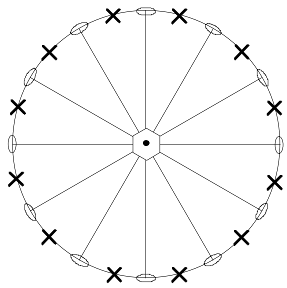
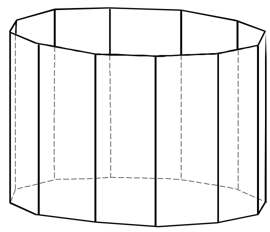
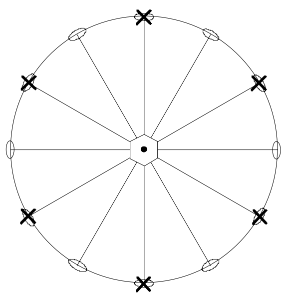
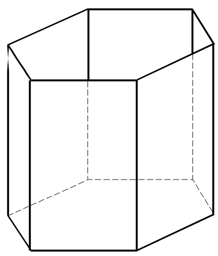
{hkl}		 Tétraèdre tétragonal
{h0l} **{hhl}**		Tétraèdre tétragonal
{hk0}		Prisme tétragonal
{100} **{110}**		Prisme tétragonal
{001}		Pinacoïde

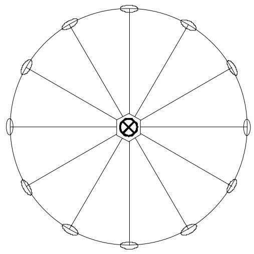
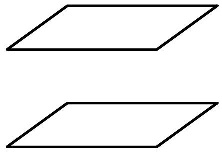
Système hexagonal

Pour les cristaux dont le réseau est hexagonal, les 5 classes du système trigonal doivent être rattachées au système hexagonal.

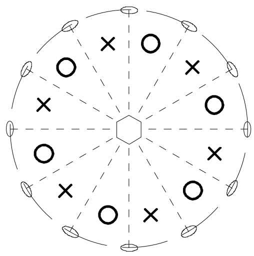
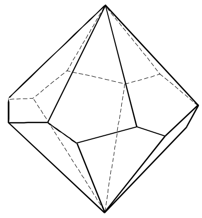
Classe 6/mmm (D_{6h})

Éléments : $\frac{A_6}{M}\frac{3A'_2}{3M'}\frac{3A''_2}{3M''}C$

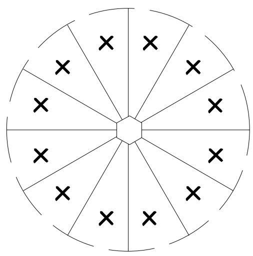
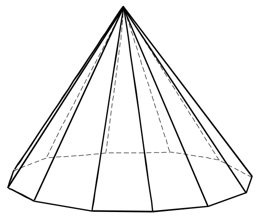
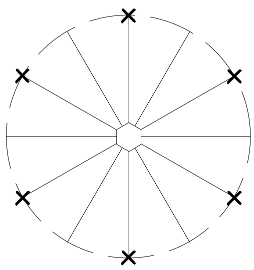
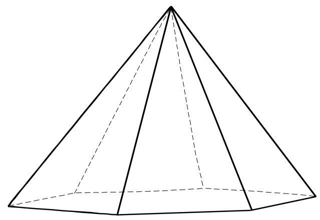
{hk.l}		 Dipyramide dihexagonale
{h0.l} {hh.l}		 Dipyramide hexagonale
{hk.0}		 Prisme dihexagonal
{10.0} {11.0}		 Prisme hexagonal

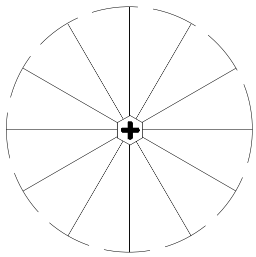
{00.1}		 Pinacoïde

Classe 622 (D_6) Éléments : $A_6\ 3A'_2\ 3A''_2$

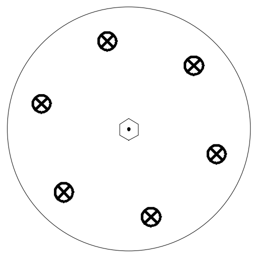
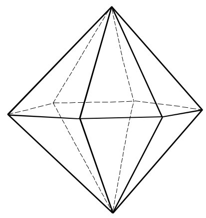
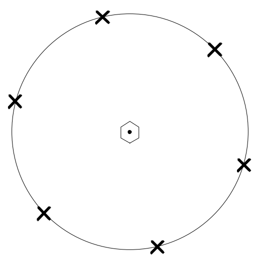
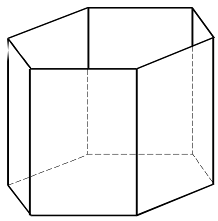
{hk.l}		 Trapèzoèdre hexagonal
{h0.l} {hh.l}		Dipyramide hexagonale
{hk.0}		Prisme dihexagonal
{10.0} {11.0}		Prisme hexagonal
{00.1}		Pinacoïde

Classe 6mm (C_{6v}) Éléments : $A_6\ 3M'\ 3M''$

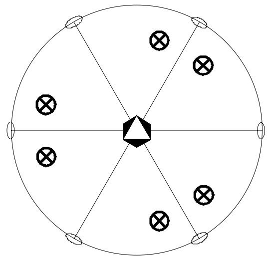
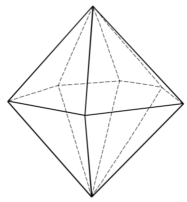
{hk.l}		 Pyramide dihexagonale
{h0.l} {hh.l}		 Pyramide hexagonale
{hk.0}		Prisme dihexagonal

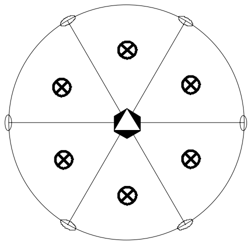
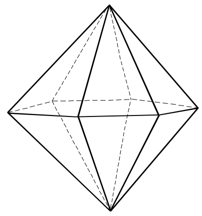
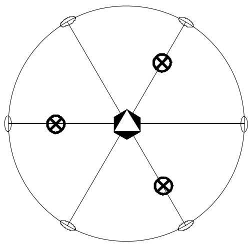
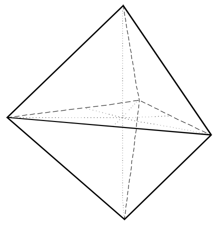
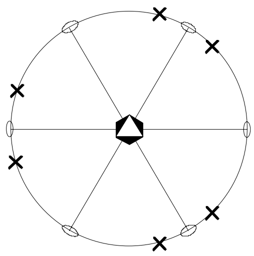
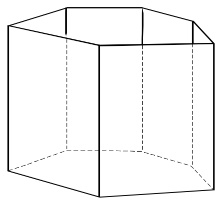
{10.0} {11.0}		Prisme hexagonal
{00.1}		Monoèdre

Classe 6/m (C_{6h}) Éléments : $\frac{A_6}{M}C$

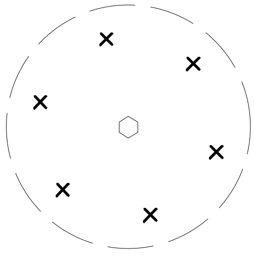
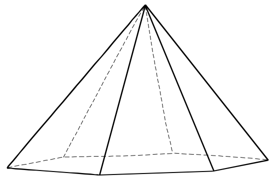
{hk.l}		 Dipyramide hexagonale
{h0.l} {hh.l}		Dipyramide hexagonale
{hk.0}		 Prisme hexagonal
{10.0} {11.0}		Prisme hexagonal
{00.1}		Pinacoïde

Classe $\bar{6}2m$ (D_{3h}) Éléments : $\frac{A_3}{M}\,3A'_2\,3M''$

{hk.l}		 Dipyramide ditrigonale

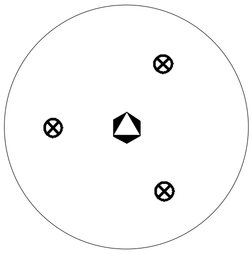
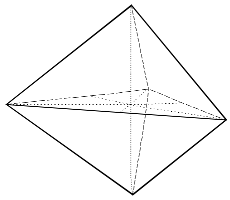
{h0.l}		 Dipyramide hexagonale
{hh.l}		 Dipyramide trigonale
{hk.0}		 Prisme ditrigonal
{10.0}		Prisme hexagonal
{11.0}		Prisme trigonal
{00.1}		Pinacoïde

Classe 6 (C_6) Élément : A_6

{hk.l}		 Pyramide hexagonale
{h0.l} **{hh.l}**		Pyramide hexagonale
{hk.0}		Prisme hexagonal

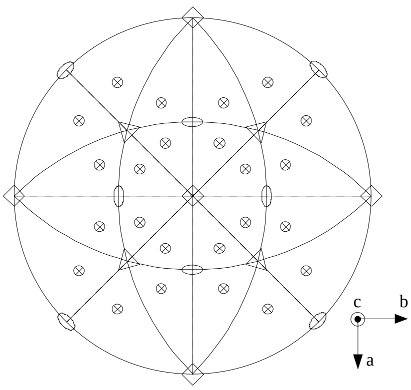
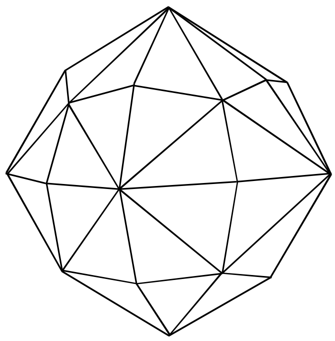
{10.0} **{11.0}**		Prisme hexagonal
{00.1}		Monoèdre

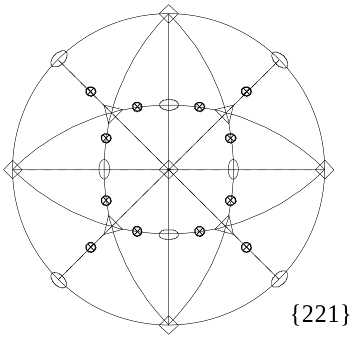
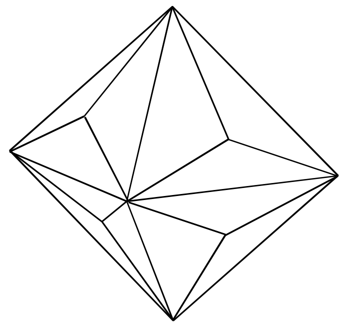
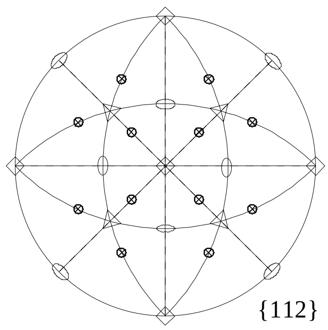
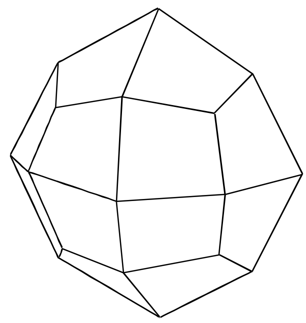
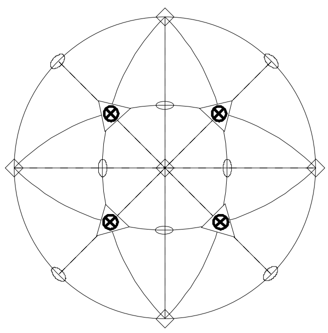
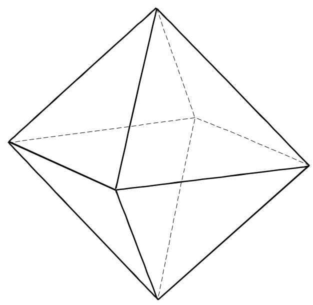
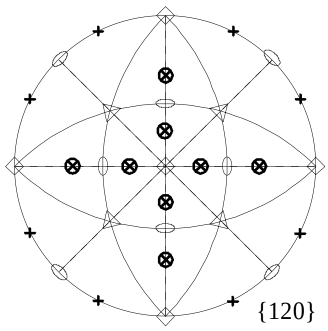
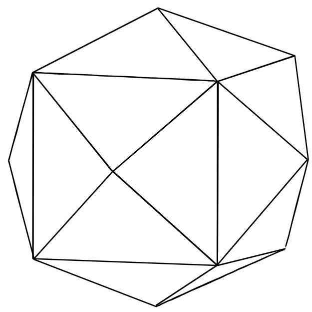
Classe $\overline{6}$ (C_{3h}) Éléments : $\frac{A_3}{M}$

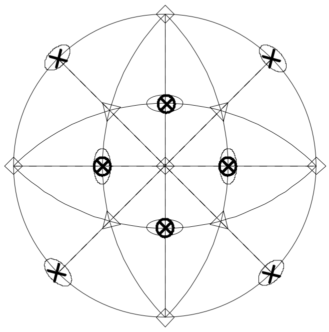
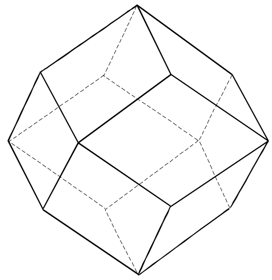
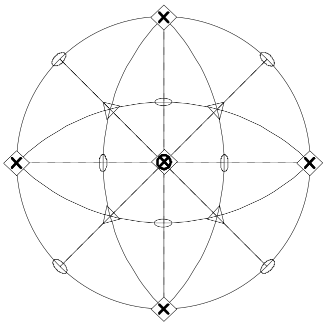
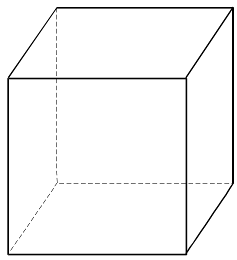
{hk.l}		 Dipyramide trigonale
{h0.l} **{hh.l}**		Dipyramide trigonale
{hk.0}		Prisme trigonal
{10.0} **{11.0}**		Prisme trigonal
{00.1}		Pinacoïde

Système cubique

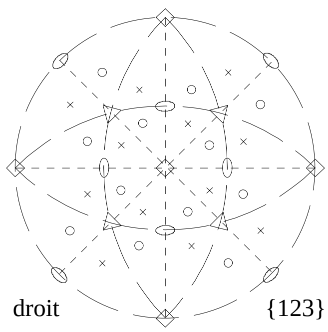
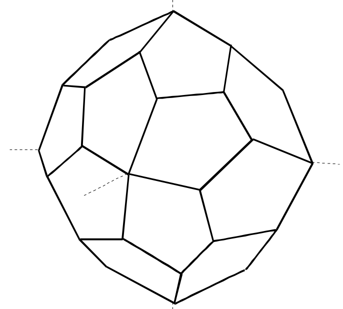
Classe m3m (O_h) Éléments : $\frac{3A_4}{3M}$ $4A_3$ $\frac{6A_2'}{6M'}$ C

{hkl}		 Hexaoctaèdre

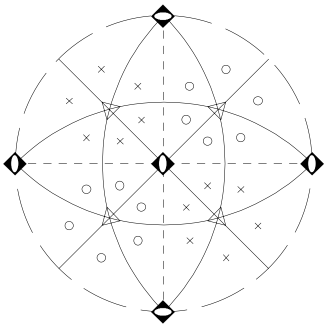
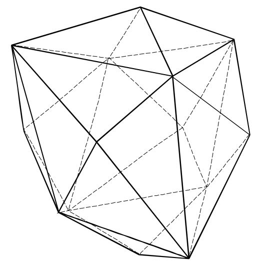
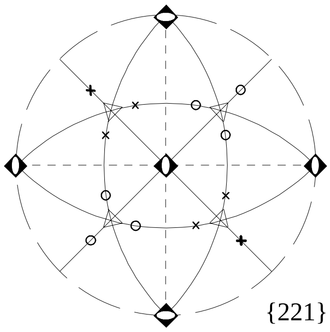
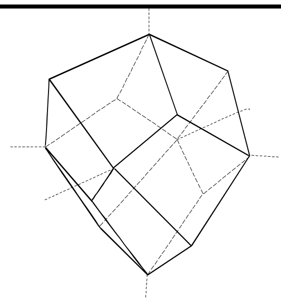
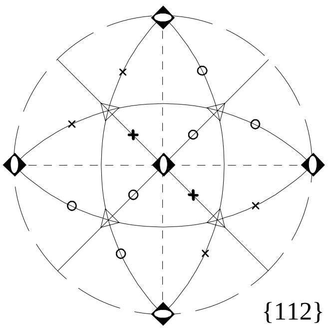
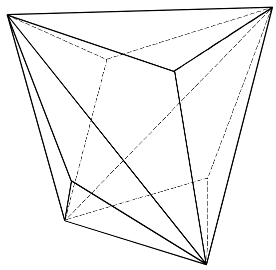
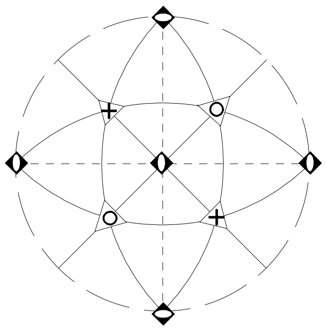
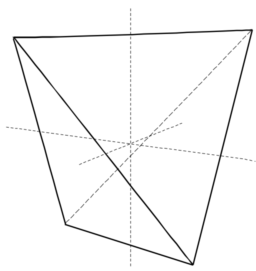
{hhl} h > ℓ		 Trigonotrioctaèdre
{hhl} h < ℓ		 Tétragonotrioctaèdre
{111}		 Octaèdre
{hk0}		 Tétrahexaèdre

{110}		 Dodécaèdre rhomboïdal
{100}		 Cube (Hexaèdre)

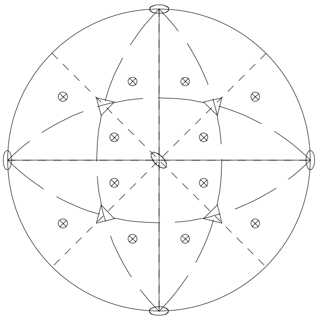
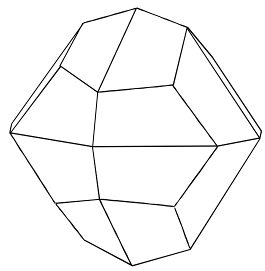
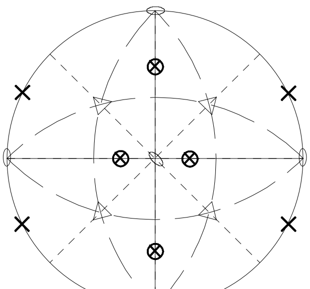
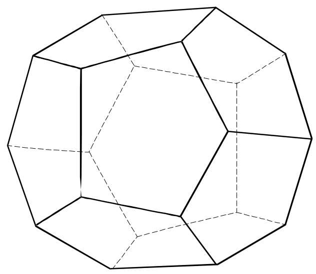
Classe 432 (O) Éléments : $3A_4\ 4A_3\ 6A'_2$

{hkl}		 Pentagonotrioctaèdre (droit)
{hhl} h > ℓ		Trigonotrioctaèdre
{hhl} h < ℓ		Tétragonotrioctaèdre
{111}		Octaèdre
{hk0}		Tétrahexaèdre
{110}		Dodécaèdre rhomboïdal
{100}		Cube

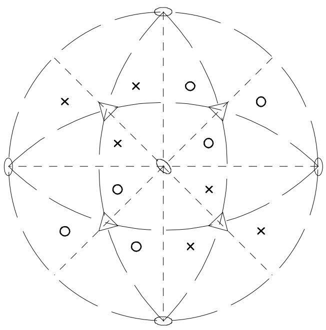
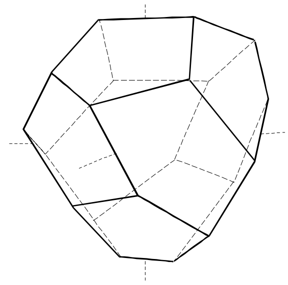
Classe $\bar{4}3m$ (T_d) Éléments : $3\bar{A}_4$ $4A_3$ $6M'$

{hkl}		 Hexatétraèdre
{hhl} h > ℓ	 {221}	 Tétragonotritétraèdre
{hhl} h < ℓ	 {112}	 Trigonotritétraèdre
{111}		 Tétraèdre
{hk0}		Tétrahexaèdre
{110}		Dodécaèdre rhomboïdal
{100}		Cube

Classe m3 (T_h) Éléments : $\frac{3A_2}{3M}$ $4A_3$ C

{hkl}		 Didodécaèdre
{hhl} h > ℓ		Trigonotrioctaèdre
{hhl} h < ℓ		Tétragonotrioctaèdre
{111}		Octaèdre
{hk0}	 {120}	 Dodécaèdre pentagonal
{110}		Dodécaèdre rhomboïdal
{100}		Cube

Classe 23 (T) Éléments : $3A_2$ $4A_3$

{hkl}		 Pentagonotritétraèdre (gauche)
{hhl} h > ℓ		Tétragonotritétraèdre

{hhl} h < ℓ		Trigonotritétraèdre
{111}		Tétraèdre
{hk0}		Dodécaèdre pentagonal
{110}		Dodécaèdre rhomboïdal
{100}		Cube

Groupes ponctuels non cristallographiques

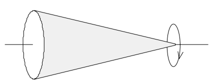
Leur dénombrement s'effectue avec la méthode utilisée pour les groupes ponctuels cristallographiques en supprimant les contraintes liées au réseau.

Groupes cycliques	n	5, 7, 8, 9, 10... , ∞
Groupes diédraux	n2	52, 72, 822, 92, 10 2 2... , ∞2
Groupes impropres	$\bar{n}$	$\bar{5}$, $\bar{7}$, $\bar{8}$, $\bar{9}$, $\overline{10}$…
	n/m	8/m, 10/m... , ∞/m (n pair)
	nm	5m, 7m, 8mm, 9m, 10mm... , ∞m
	$\bar{n}2$	$\bar{5}2$, $\bar{7}2$, $\bar{8}2m$, $\bar{9}2$, $\overline{10}m2$…
	$\frac{n}{m}m$	$\frac{8}{m}mm$, $\frac{10}{m}mm$… , $\frac{\infty}{m}m = \frac{\infty}{m}\frac{2}{m}$ (n pair)
Groupes icosaédriques		532, $\bar{5}\bar{3}\frac{2}{m}$ (plusieurs axes principaux)

Les groupes *continus* ont un axe d'isotropie (∞). Il existe également les groupes sphériques (avec plusieurs axes d'isotropie) ∞ ∞ et ∞/m ∞/m. La symétrie des objets du groupe ∞ ∞ est celle d'une sphère remplie de liquide doué de pouvoir rotatoire et celle d'une sphère pour ceux du groupe ∞/m ∞/m.

Les 5 groupes continus avec un axe d'isotropie peuvent être représentés par les objets suivants (utilisables pour l'application des lois de Curie) :

∞

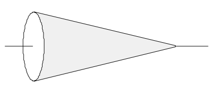


Cone tournant avec une vitesse uniforme.

∞/m

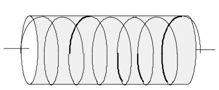
Cylindre tournant avec une vitesse uniforme. Vecteur axial (tenseur antisymétrique loi de transformation : $r'_i = \pm a_{ij} r_j$)

∞m



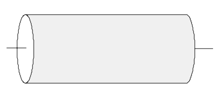
Cone de révolution. Vecteur polaire (tenseur, loi de transformation : $r'_i = a_{ij} r_j$)

∞2



Hélice droite infinie ou cylindre rempli d'un liquide doué de pouvoir rotatoire.

$\frac{\infty}{m}\frac{2}{m}$



Cylindre de révolution.