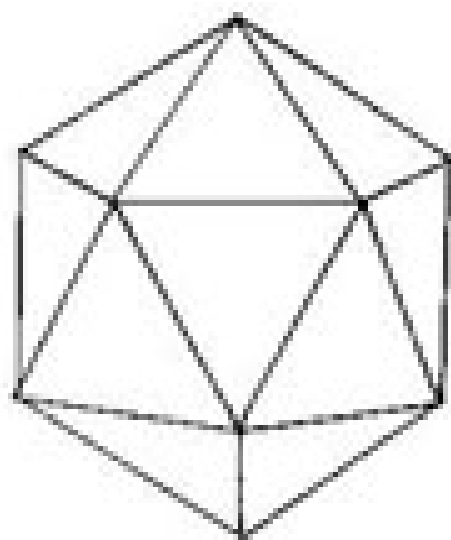




Seleção europeia, campeã pela primeira vez jogando em casa, com uma nação estreante terminando em terceiro e com o artilheiro da Copa, Eusébio de Portugal

Seleção europeia, campeã pela primeira vez jogando em casa, com uma nação estreante terminando em terceiro e com o artilheiro da Copa, Suker da Croácia

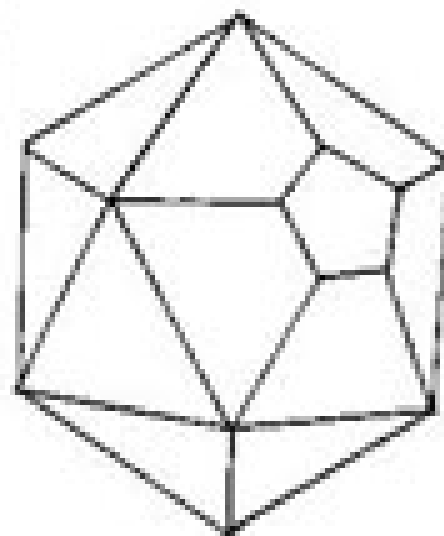
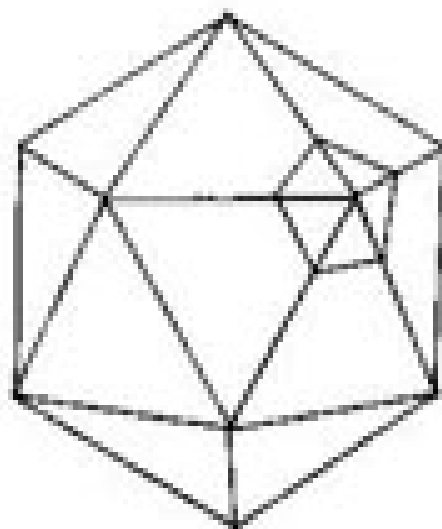


Icosaedro:

12 cantos

20 faces triangulares

30 bordas



**Icosaedro
Truncado:**

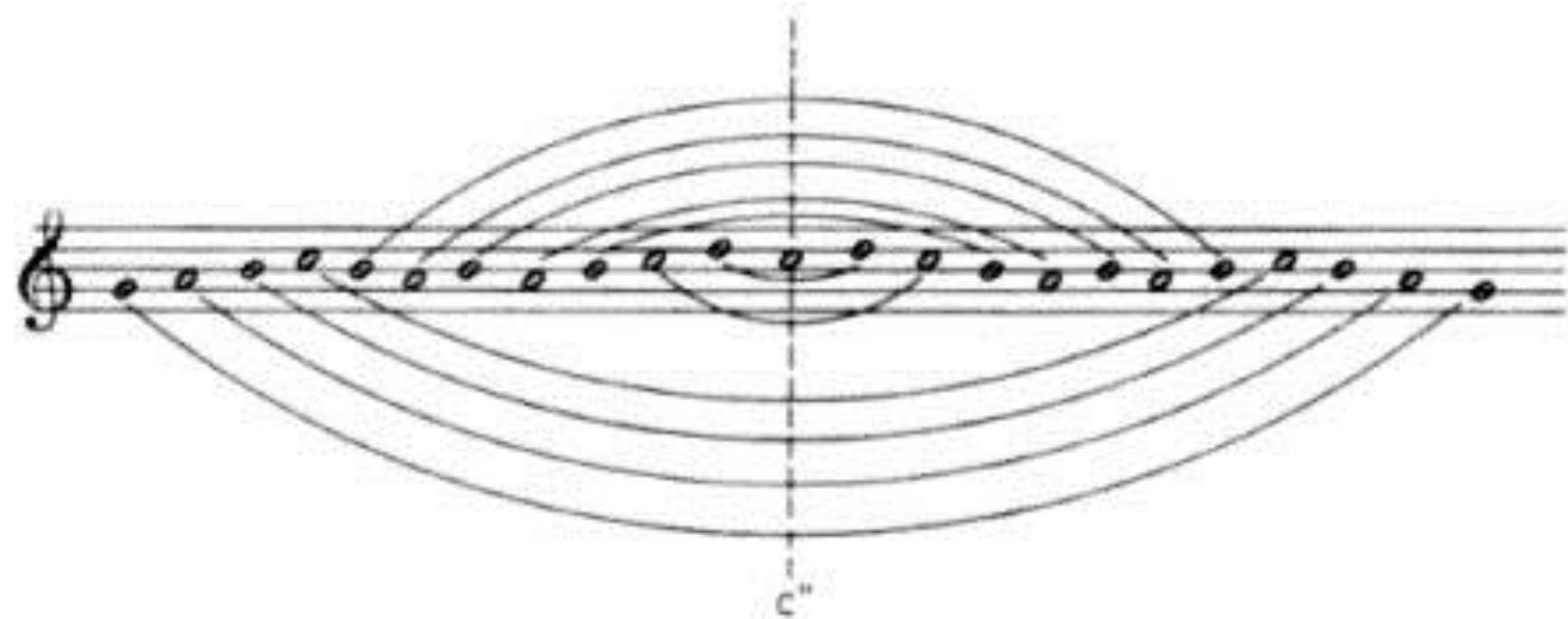
60 cantos

12 pentágonos

20 hexágonos

90 bordas

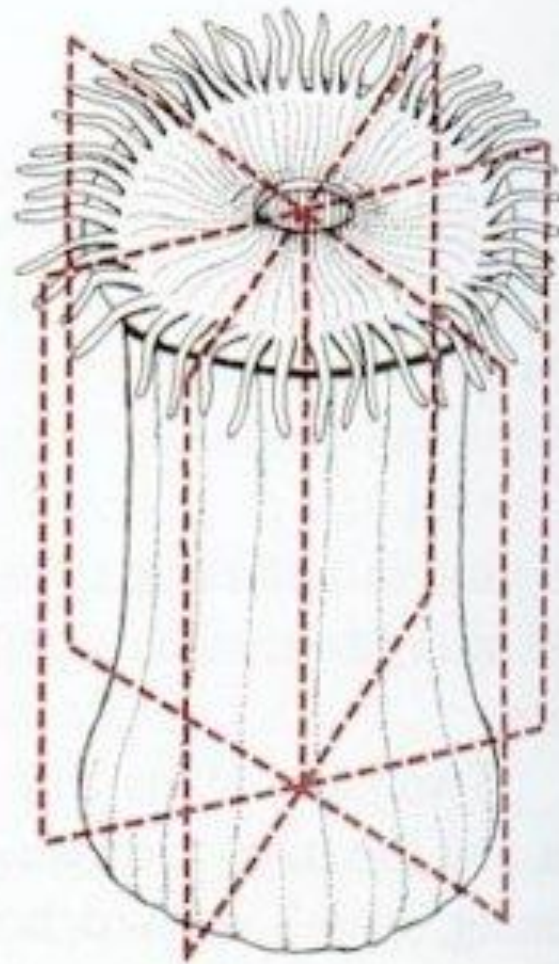








a. Bilateral symmetry



b. Radial symmetry

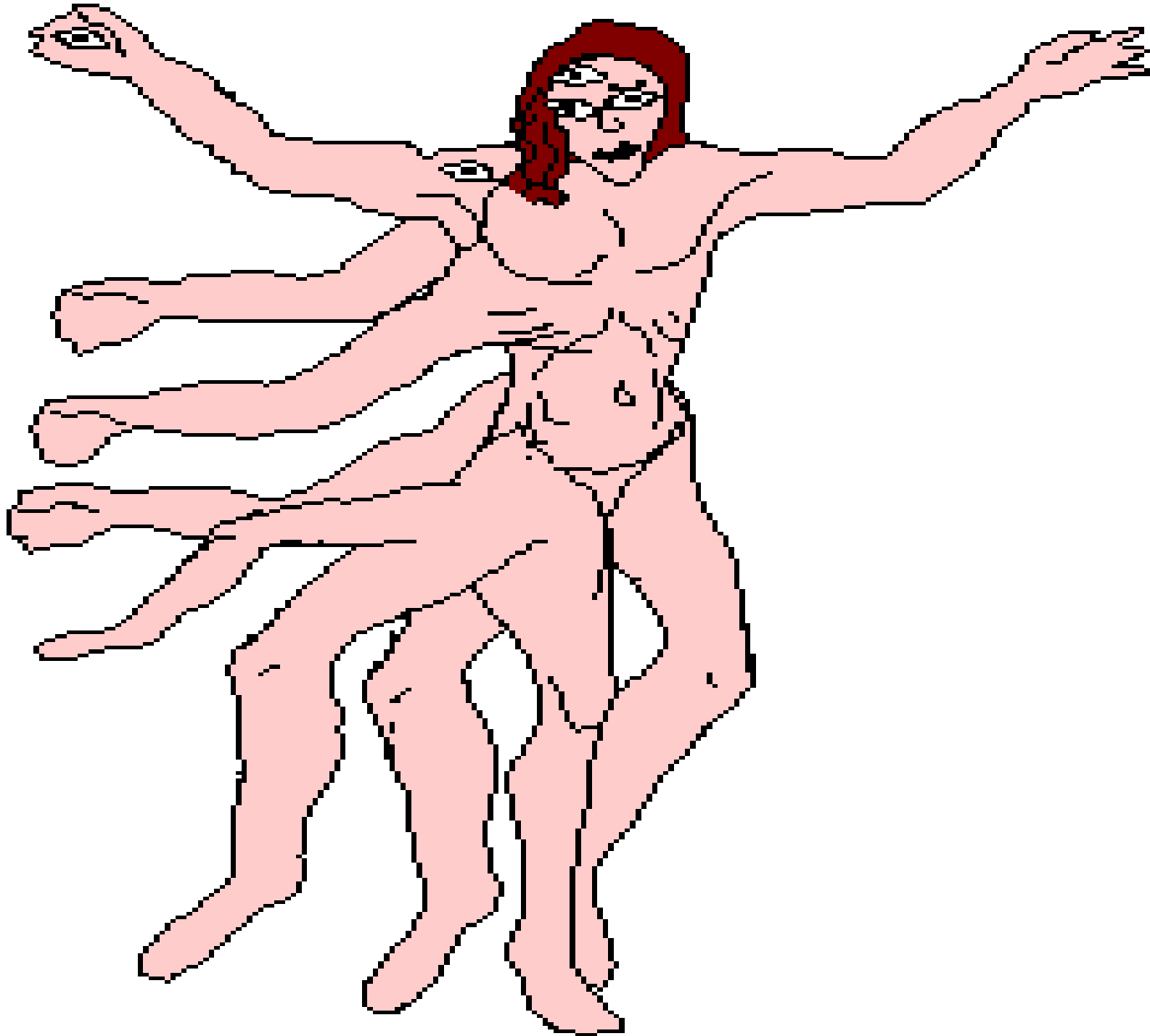


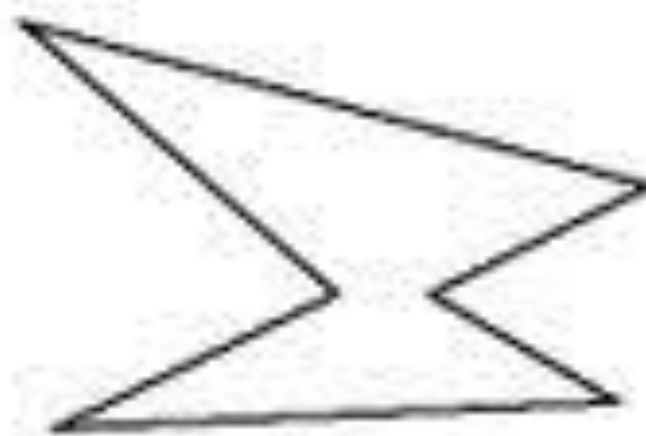
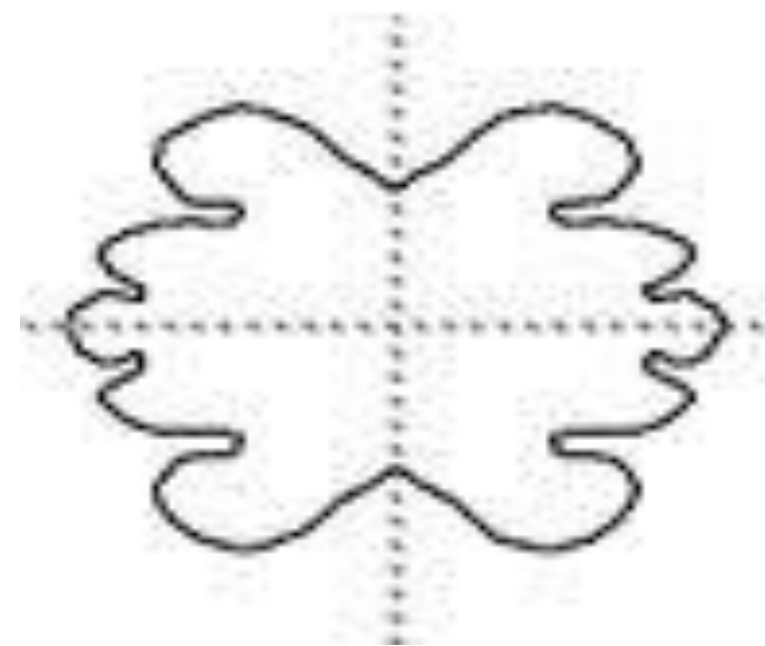
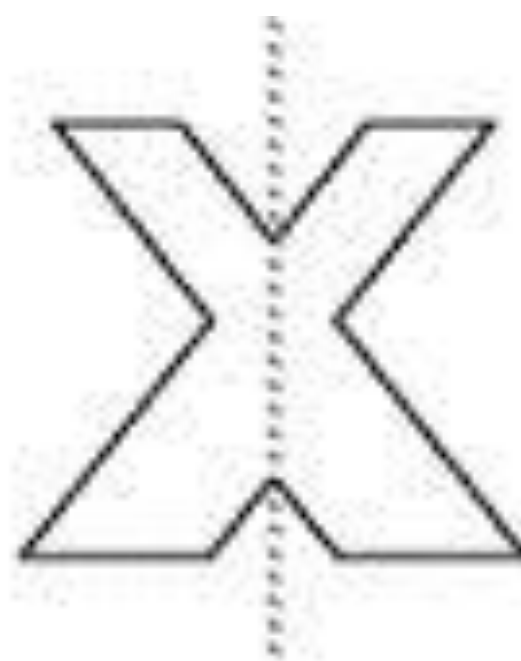
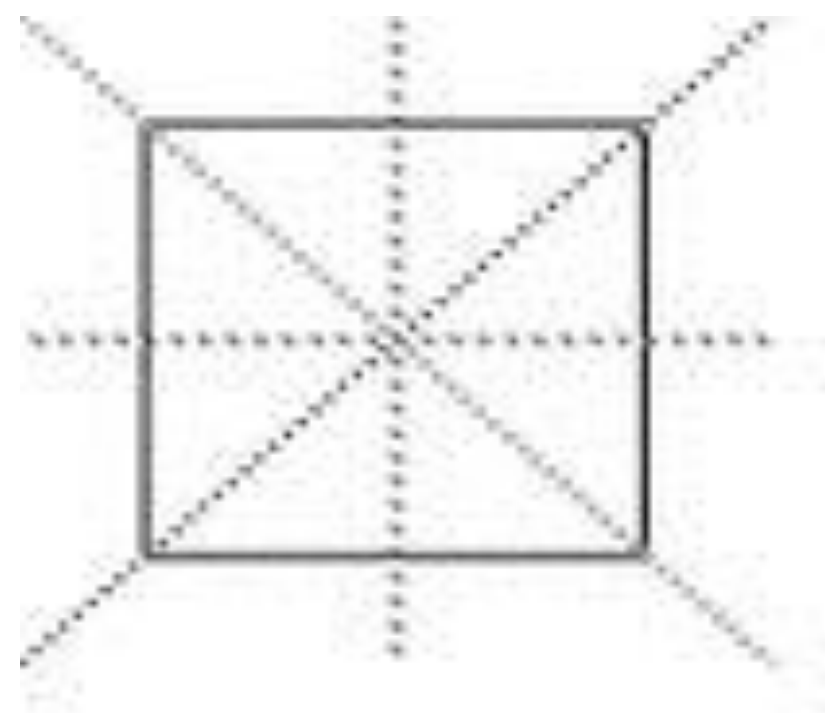




qualidade de vida !!!

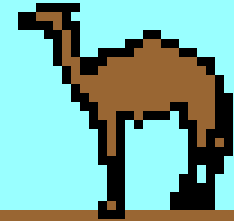






***Dábale arroz a la zorra el
Abad***

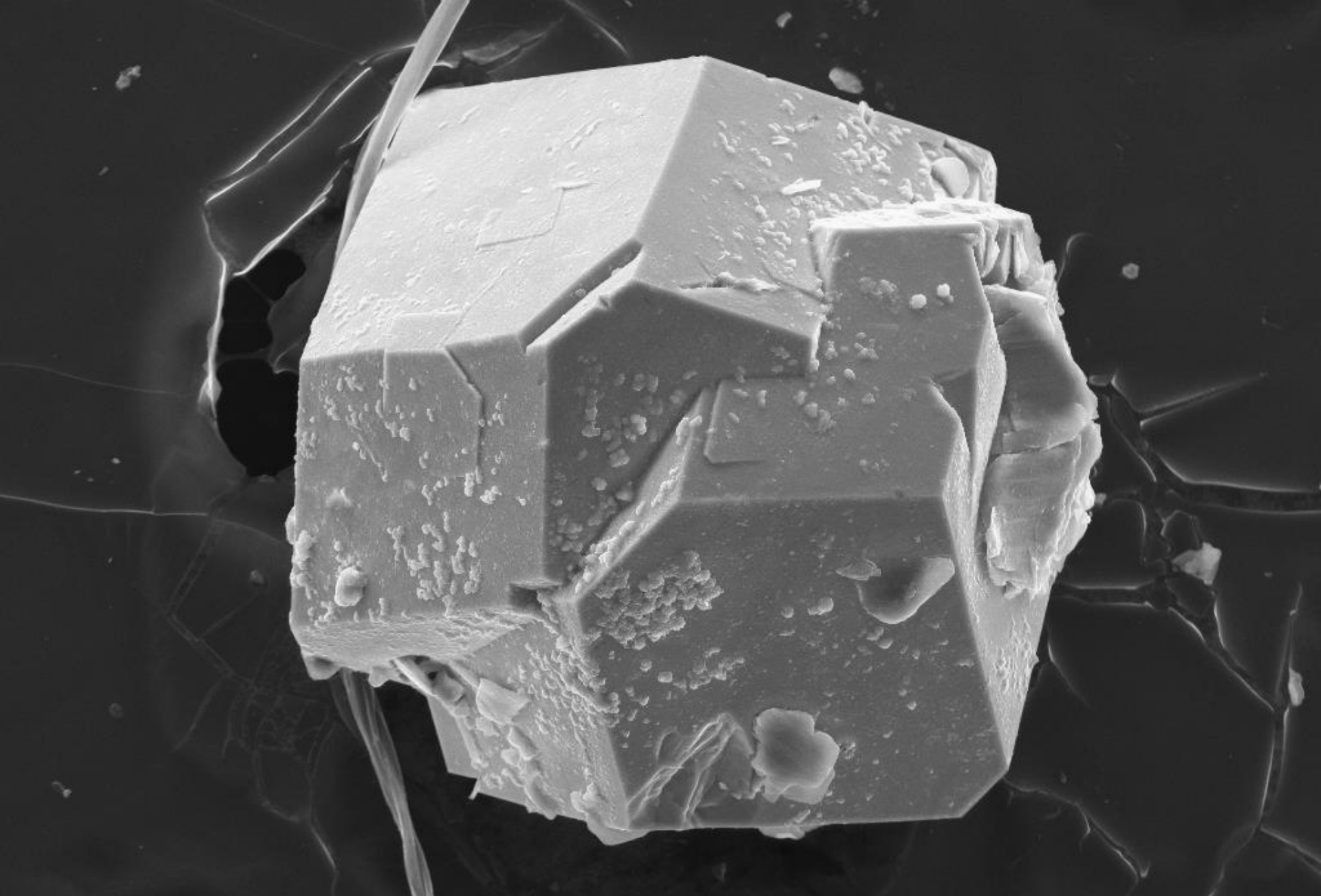
Perfil:
Pliegue simétrico





SIMETRIA EXTERNA DOS CRISTAIS

Daniel Atencio

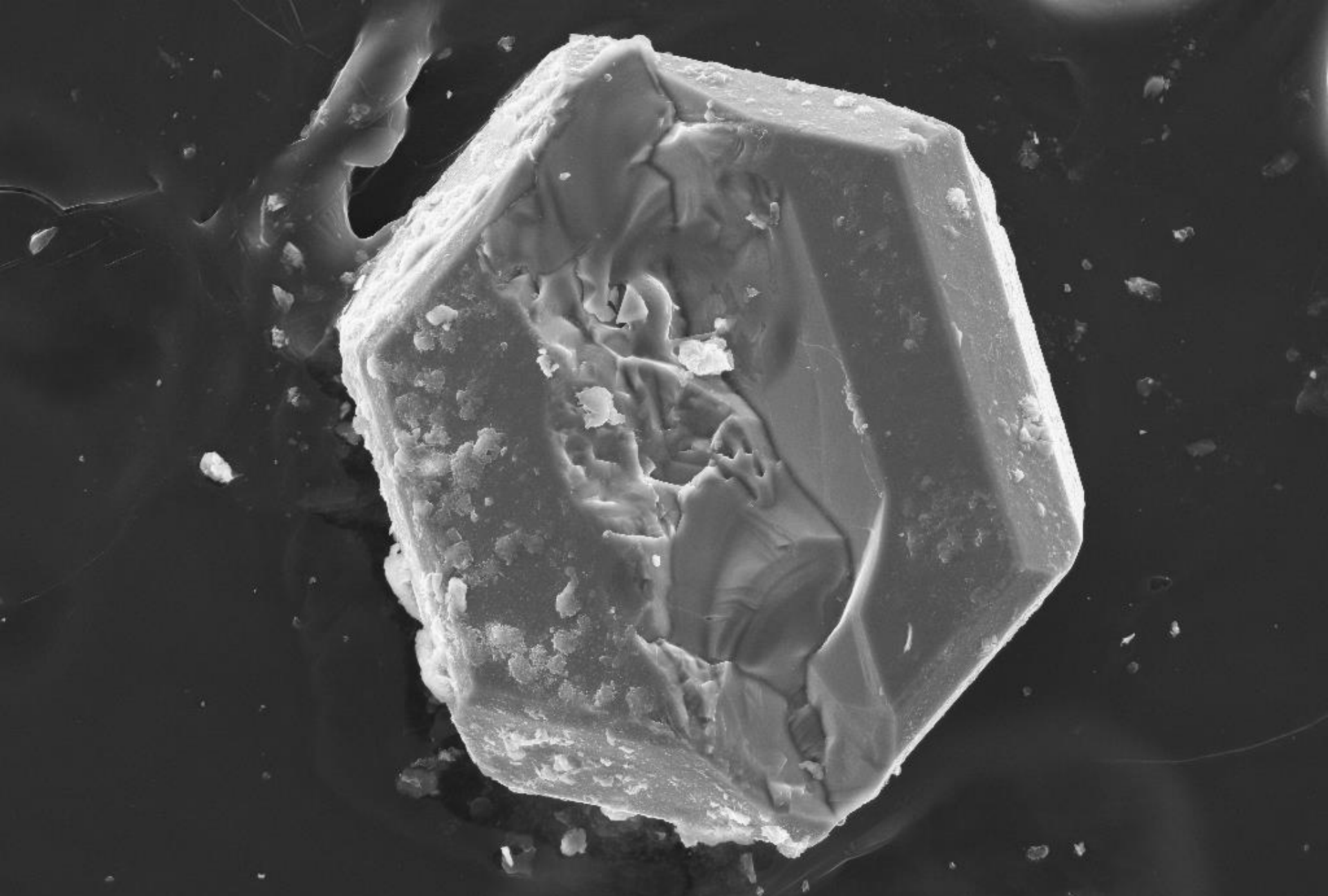


IGc-USP EHT=30.00 kV
30µm

WD= 25 mm
Photo No.=5

Mag= 700 X
Detector= SE1

14405



IGc-USP EHT=30.00 kV
100µm

WD= 25 mm
Photo No.=9

Mag= 600 X
Detector= SE1

3VID305

Elementos de Simetria

Plano de simetria – m – *reflexão*

Eixos de simetria

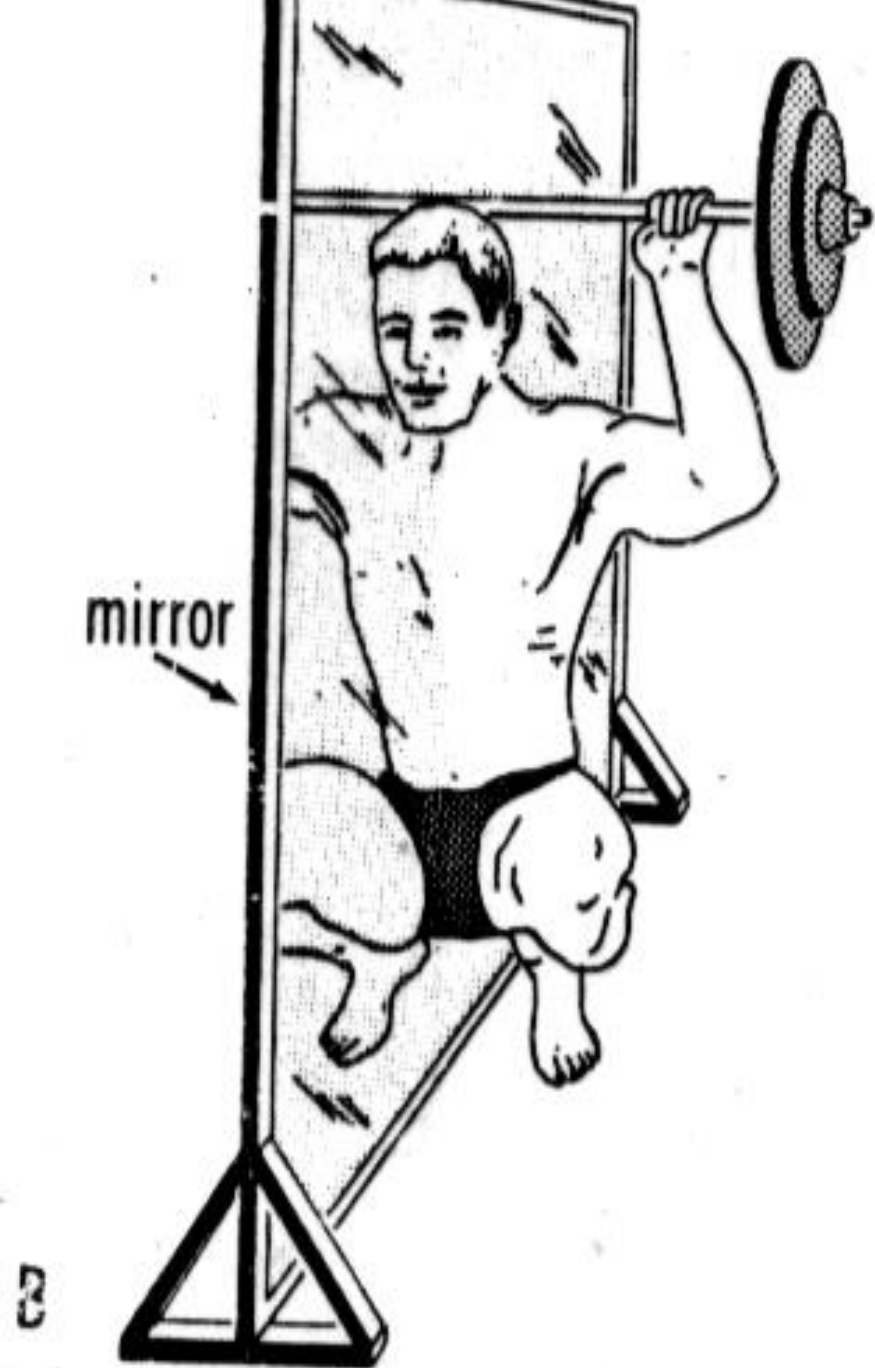
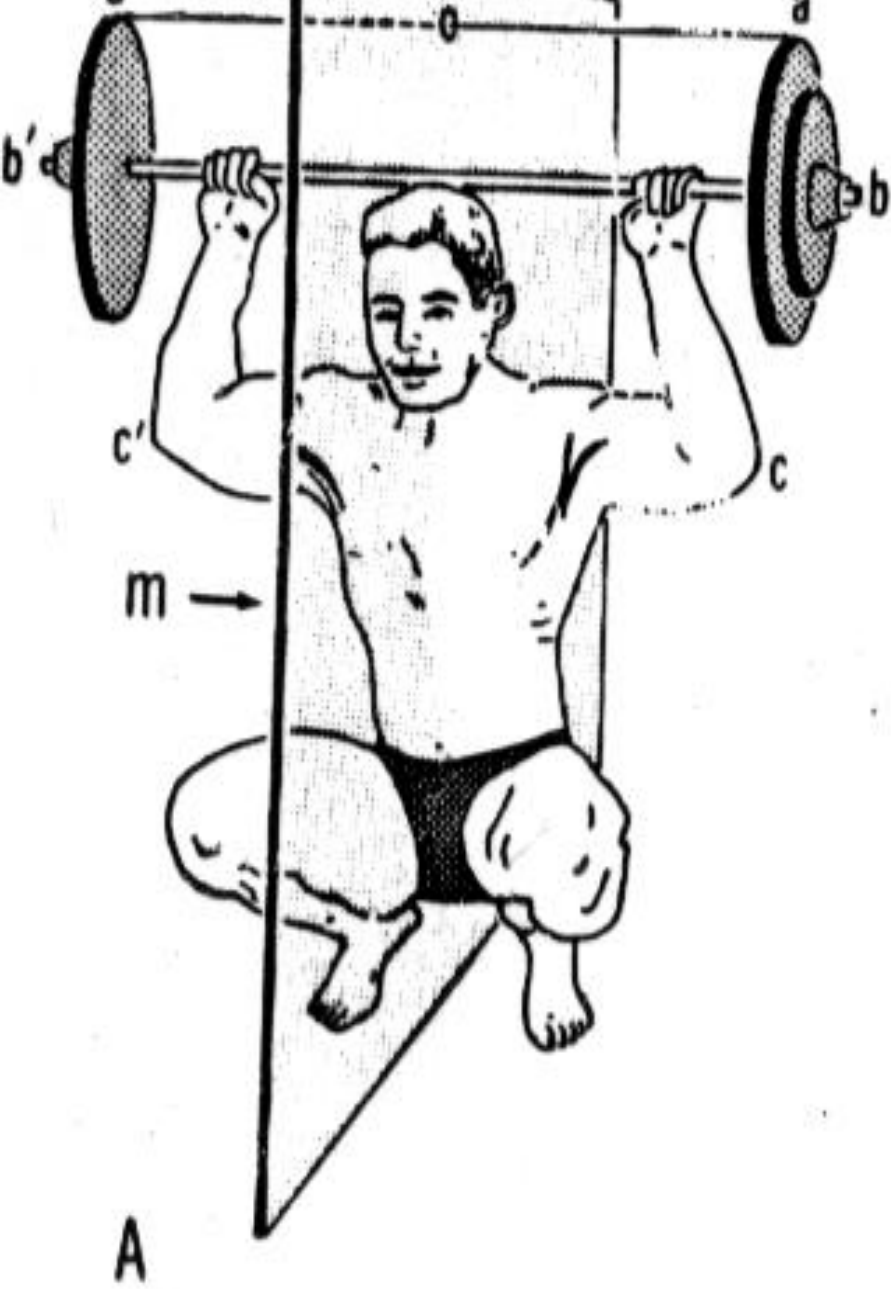
próprios: 1, 2, 3, 4, 6 – *rotação*

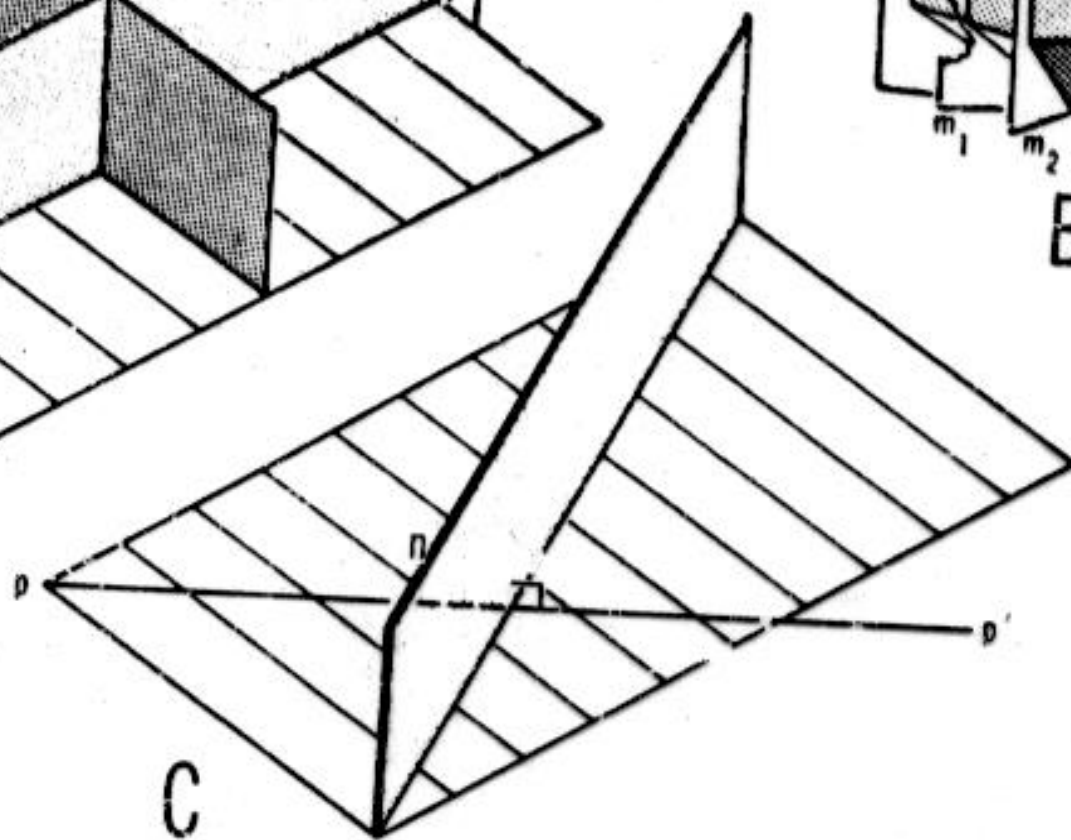
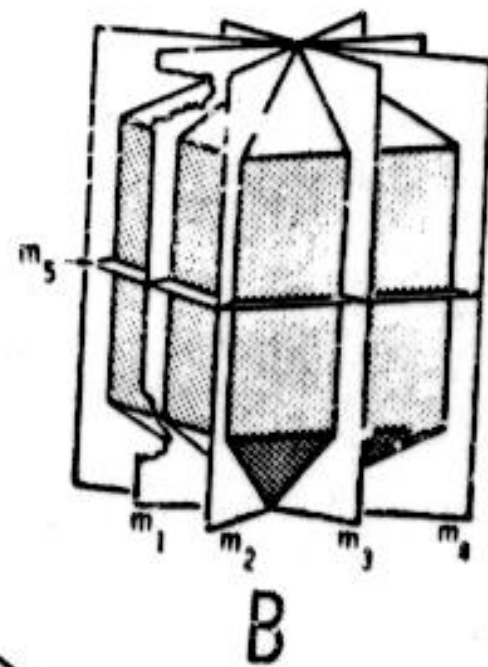
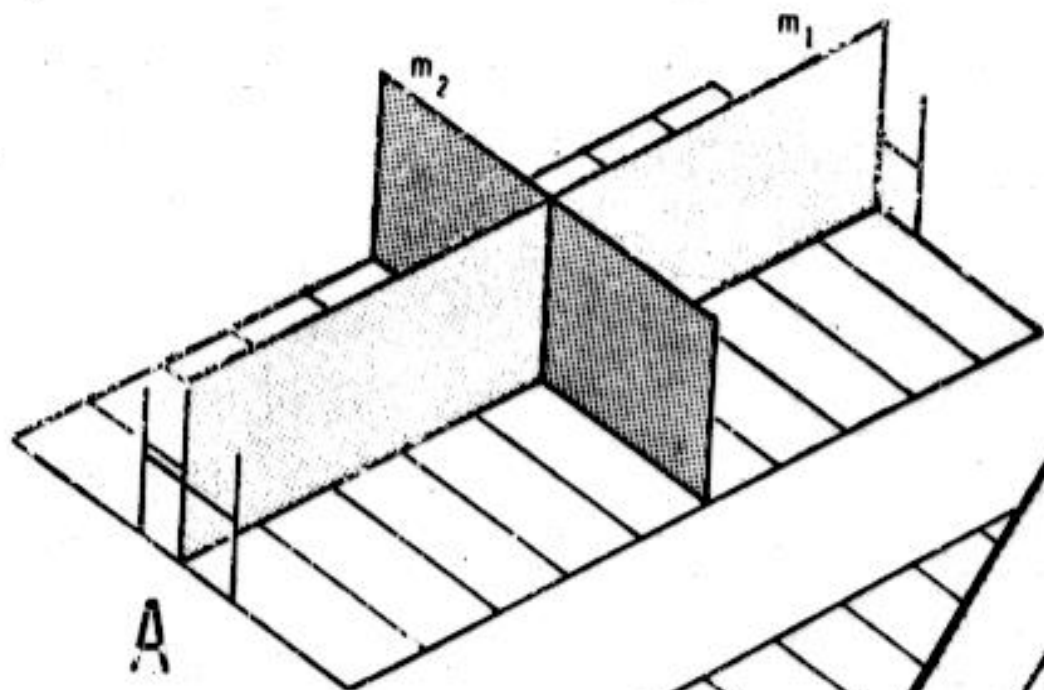
impróprios – *rotação + inversão*

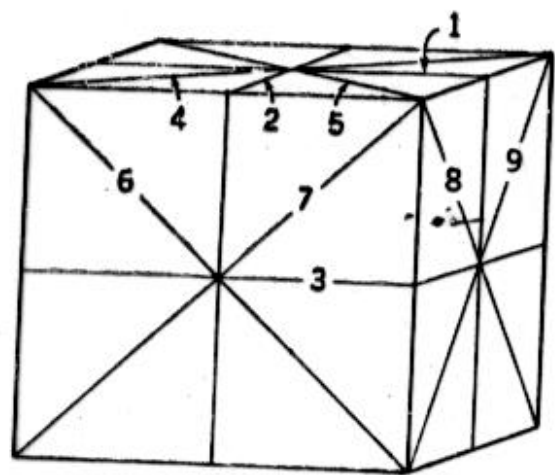
Centro de simetria – i - *inversão*

Plano de simetria – m – *reflexão*

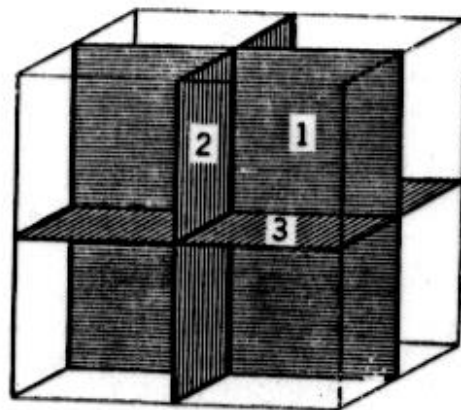




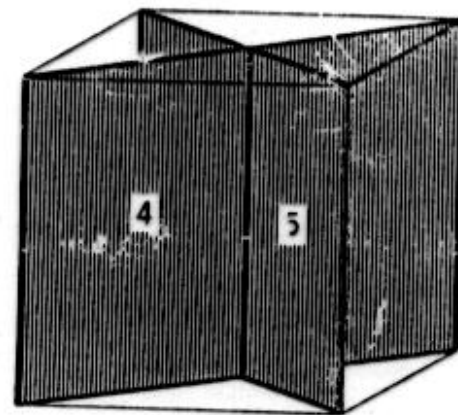




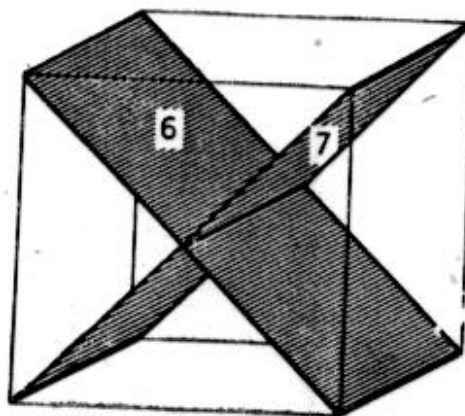
(a)



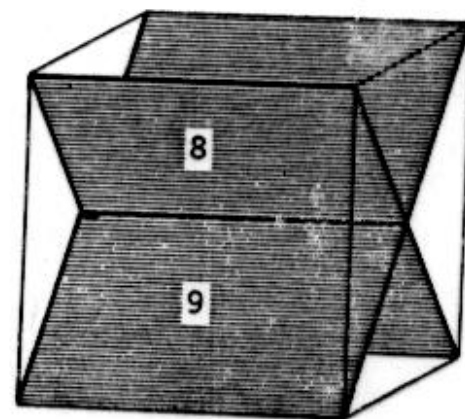
(b)



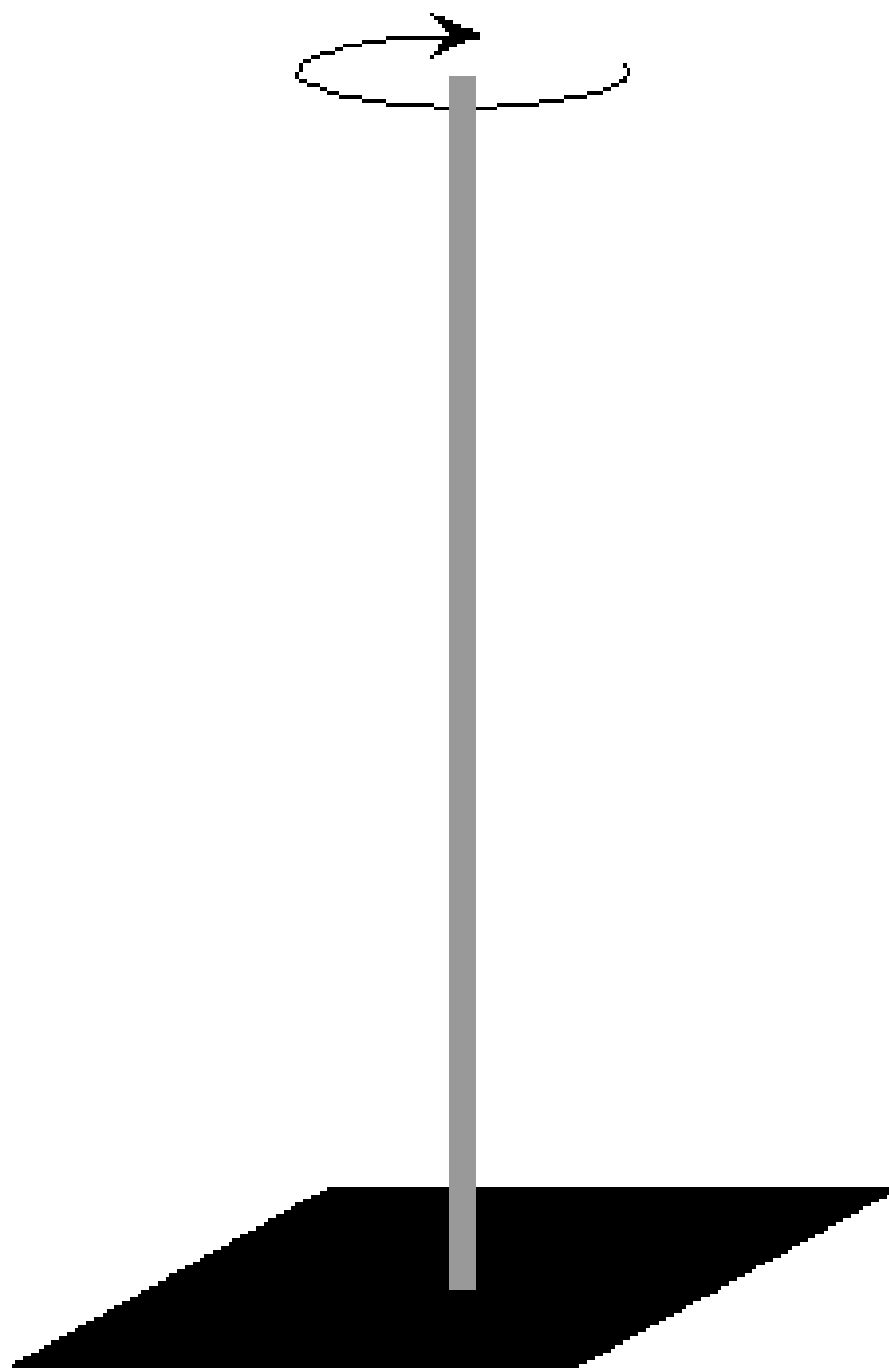
(c)

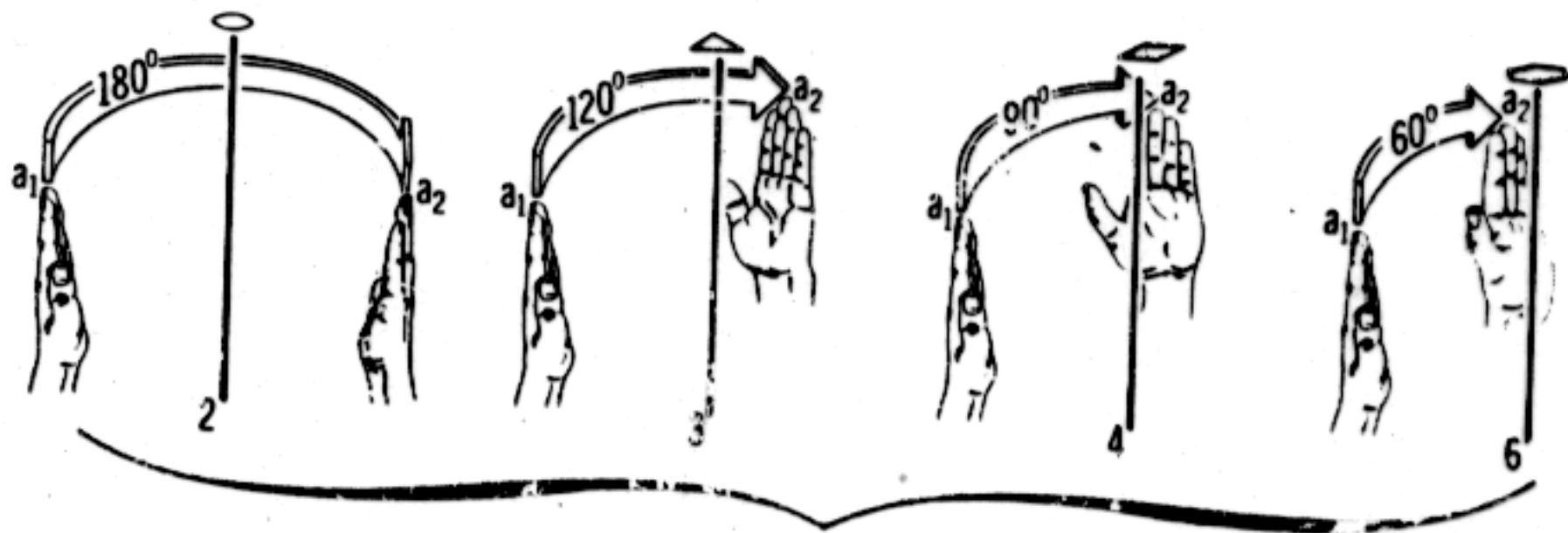


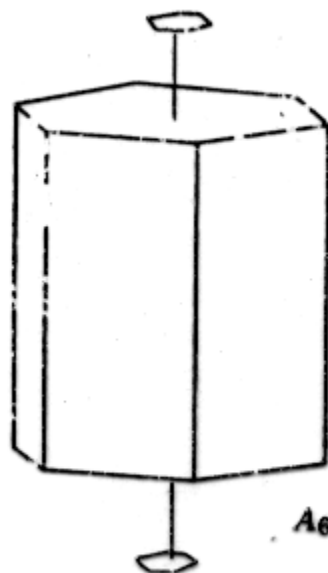
(d)



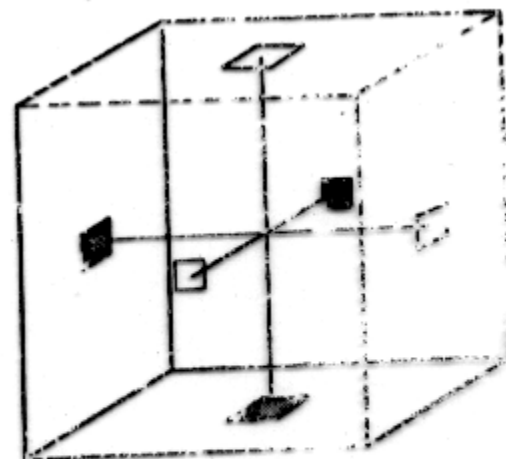
Eixos de simetria
próprios: 1, 2, 3, 4, 6
rotação

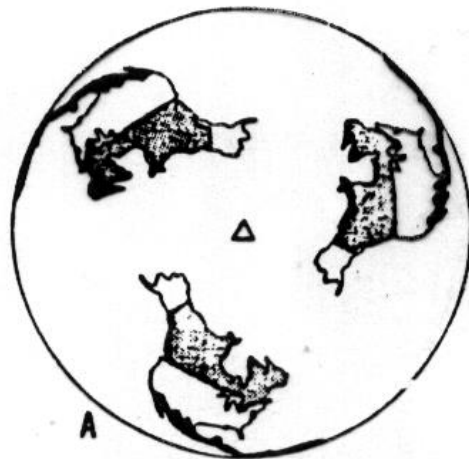


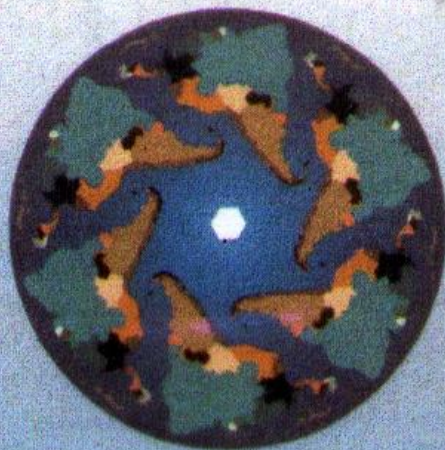




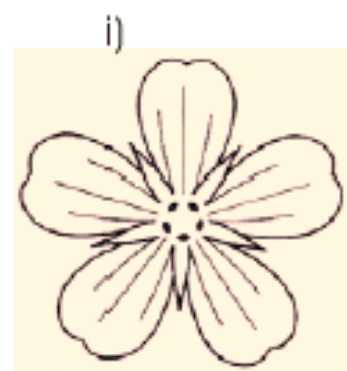
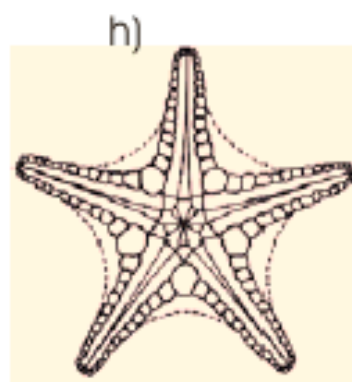
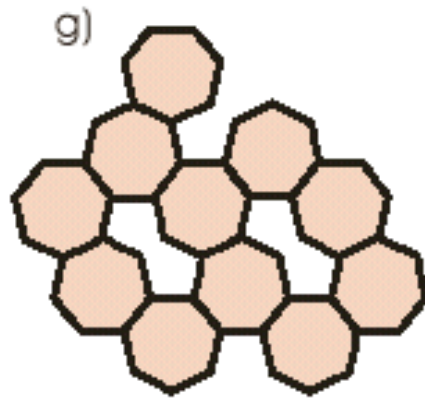
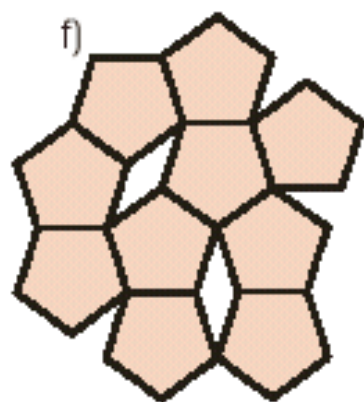
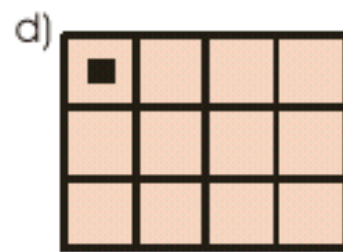
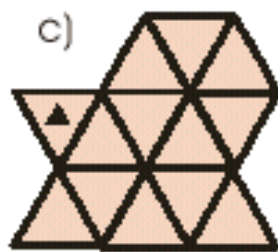
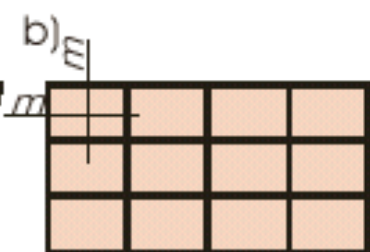
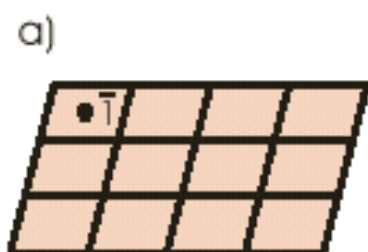
A6



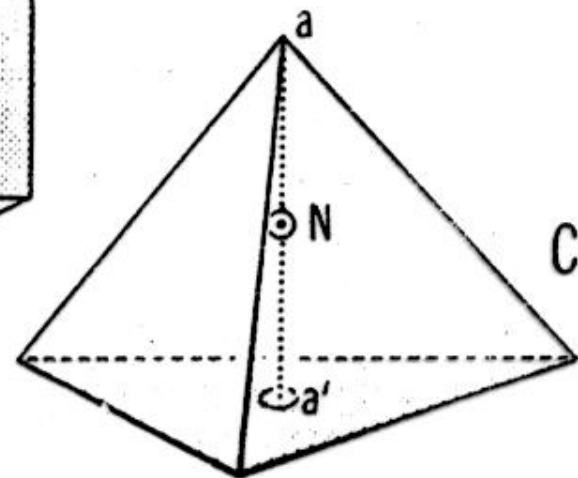
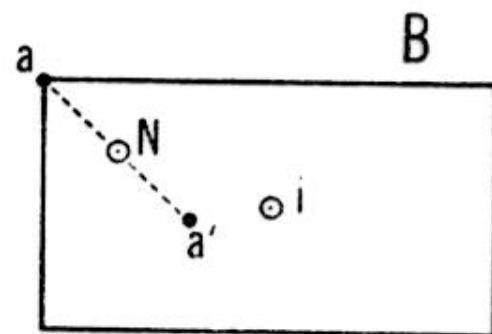
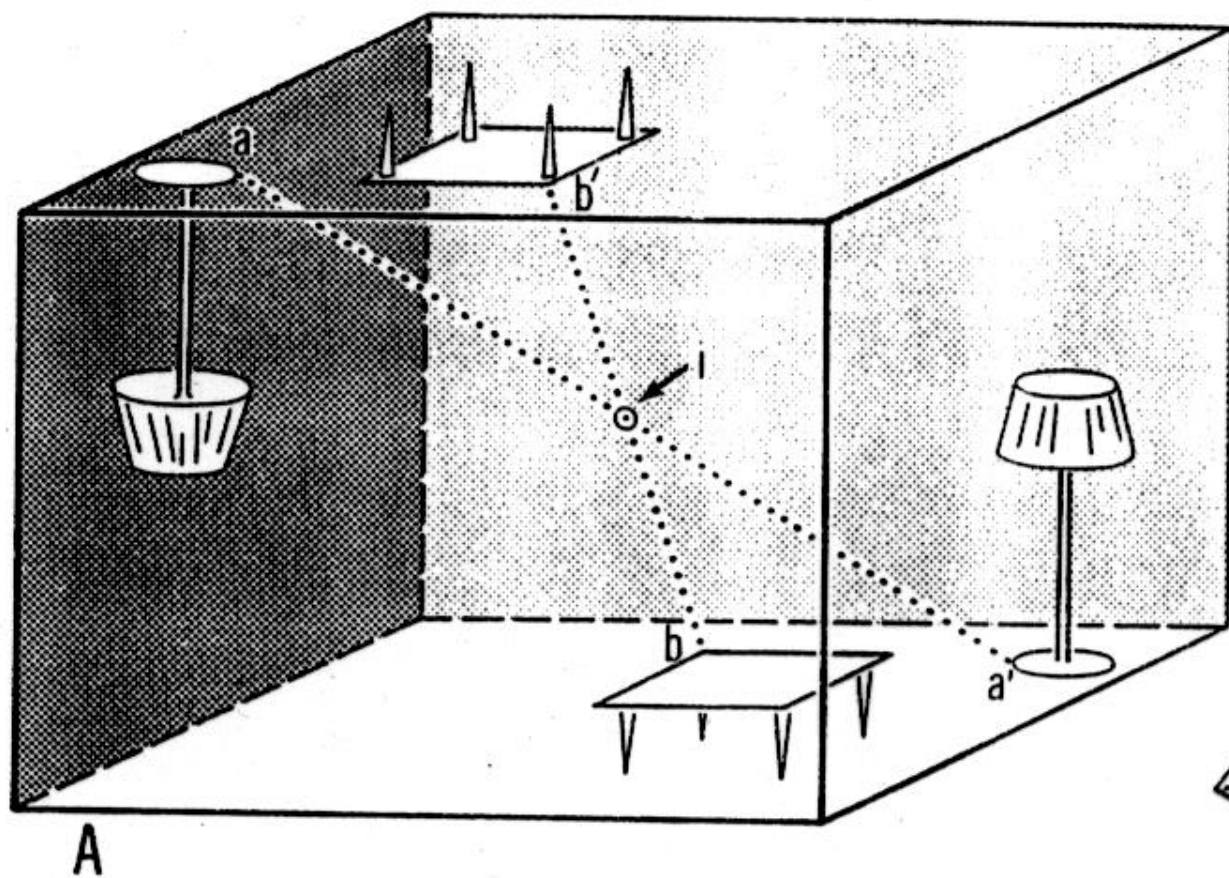


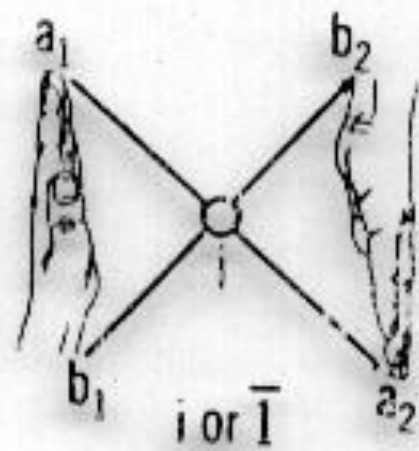
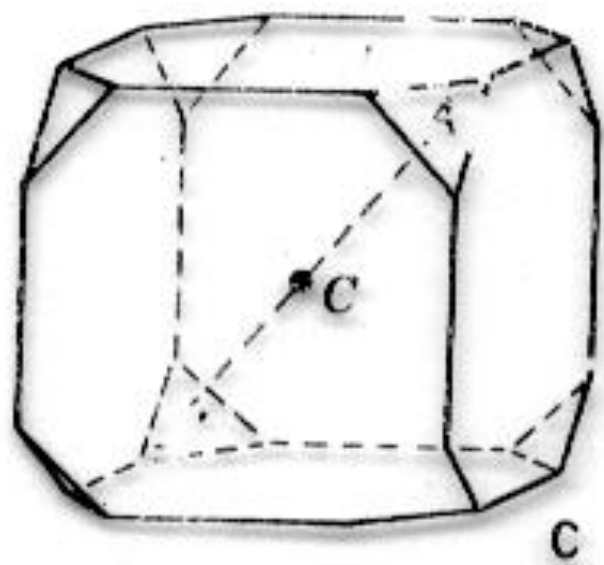


Eixos de simetria
próprios: 1, 2, 3, 4, 6
rotação

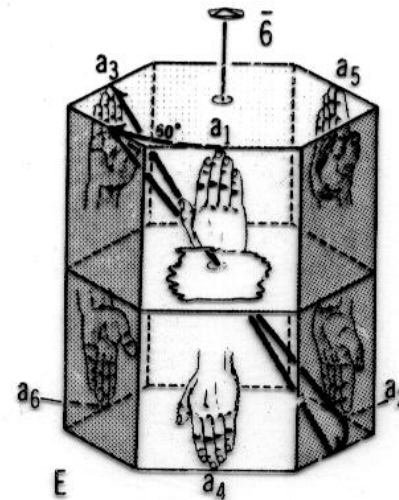
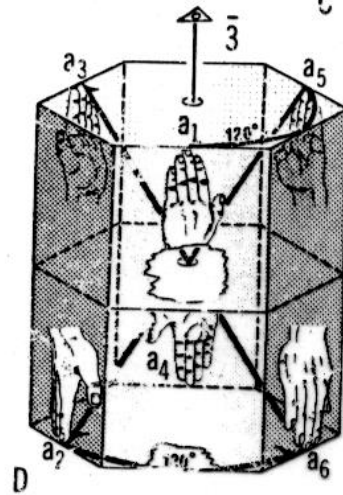
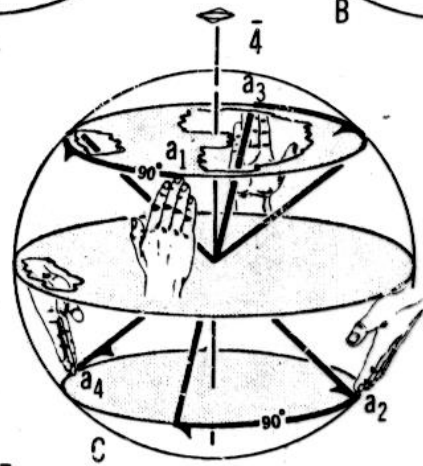
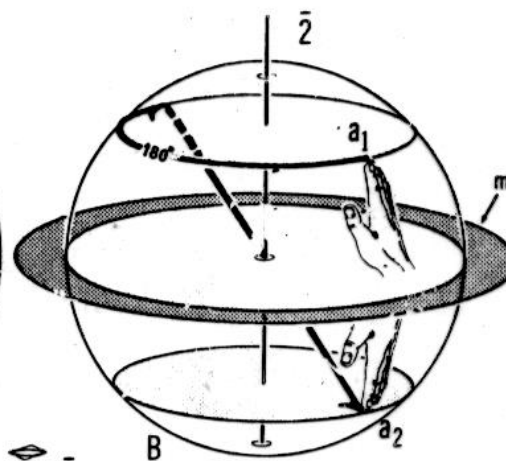
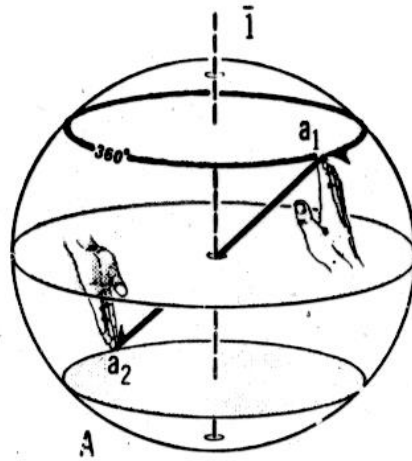


Centro de simetria – i - *inversão*





Eixos de simetria
impróprios
rotação + inversão



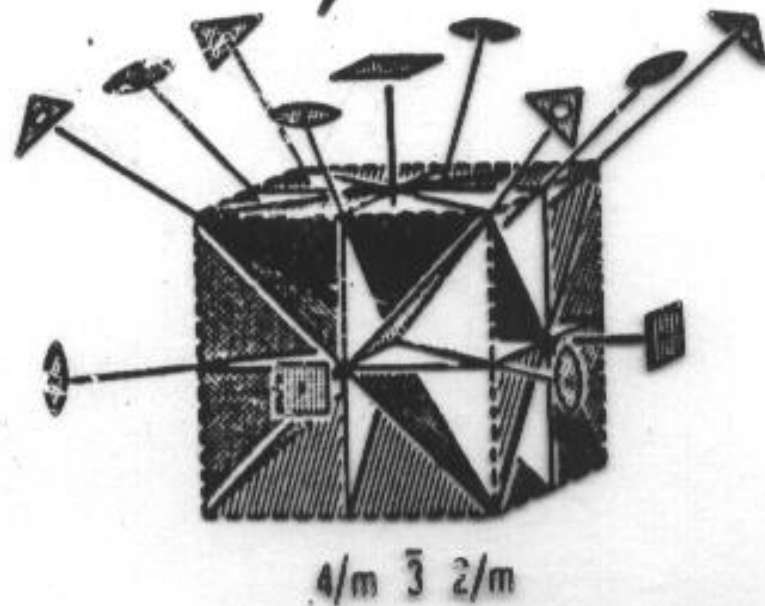
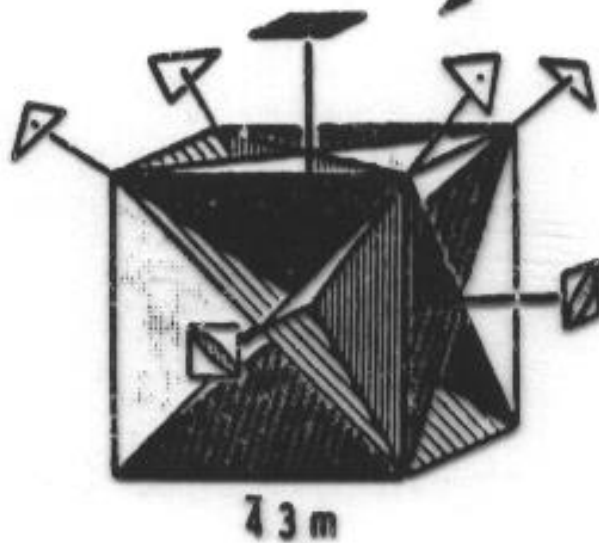
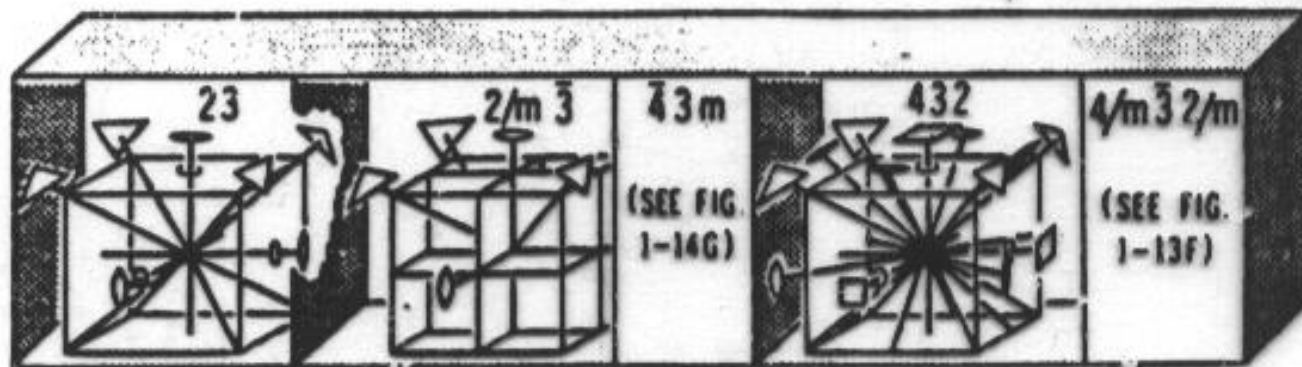
Associações de elementos de
simetria externa:
32 possibilidades
(Grupos Pontuais/Classes de
Simetria).

AS 32 CLASSES CRISTALINAS

Sistema Cristalino	Classe Cristalina	Grau de Simetria	Nome da Classe
Triclínico	1	Sem simetria	Pedial
	$\bar{1}$	i	Pinacoidal
Monoclínico	2	1E2	Esfenoédrica
	m	1m	Domática
	2/m	1E2, 1m, i	Prismática
Ortorrômbico	222	3E2	Biesfenoédrica-rômbica
	mm2	1E2, 2m	Piramidal rômbica
	2/m2/m2/m	3E2, 3m, i	Bipiramidal rômbica
Tetragonal	4	1E4	Piramidal tetragonal
	$\bar{4}$	1E $\bar{4}$	Biesfenoédrica tetragonal
	4/m	1E4, 1m, i	Bipiramidal tetragonal
	422	1E4, 4E2	Trapezoédrica tetragonal
	4mm	1E4, 4m	Piramidal ditetragonal
	$\bar{4}2m$	1E $\bar{4}$, 2E2, 2m	Escalenoédrica tetragonal
	4/m2/m2/m	1E4, 4E2, 5m, i	Bipiramidal ditetragonal
Trigonal (Classe Hexagonal - Divisão Romboédrica)	3	1E3	Piramidal trigonal
	$\bar{3}$	1E $\bar{3}$	Romboédrica
	32	1E3, 3E2	Trapezoédrica trigonal
	3m	1E3, 3m	Piramidal ditrigonal
	$\bar{3}2/m$	1E $\bar{3}$, 3E2, 3m, i	Escalenoédrica hexagonal
Hexagonal (Classe Hexagonal - Divisão Hexagonal)	6	1E6	Piramidal hexagonal
	$\bar{6}$	1E $\bar{6}$	Bipiramidal trigonal
	6/m	1E6, 1m, i	Bipiramidal hexagonal
	622	1E6, 6E2	Trapezoédrica hexagonal
	6mm	1E6, 6m	Piramidal dihexagonal
	$\bar{6}m2$	1E $\bar{6}$, 3E2, 3m	Bipiramidal ditrigonal
	6/m2/m2/m	1E6, 6E2, 7m, i	Bipiramidal dihexagonal
Isométrico (Cúbico)	23	4E3, 3E2	Tetartoédrica
	2/m $\bar{3}$	4E $\bar{3}$, 3E2, 3m, i	Diploédrica
	432	4E3, 3E4, 6E2	Giroédrica
	$\bar{4}3m$	4E3, 3E $\bar{4}$, 6m	Hexatetraédrica
	4/m $\bar{3}2/m$	4E $\bar{3}$, 3E4, 6E2, 9m, i	Hexaoctaédrica

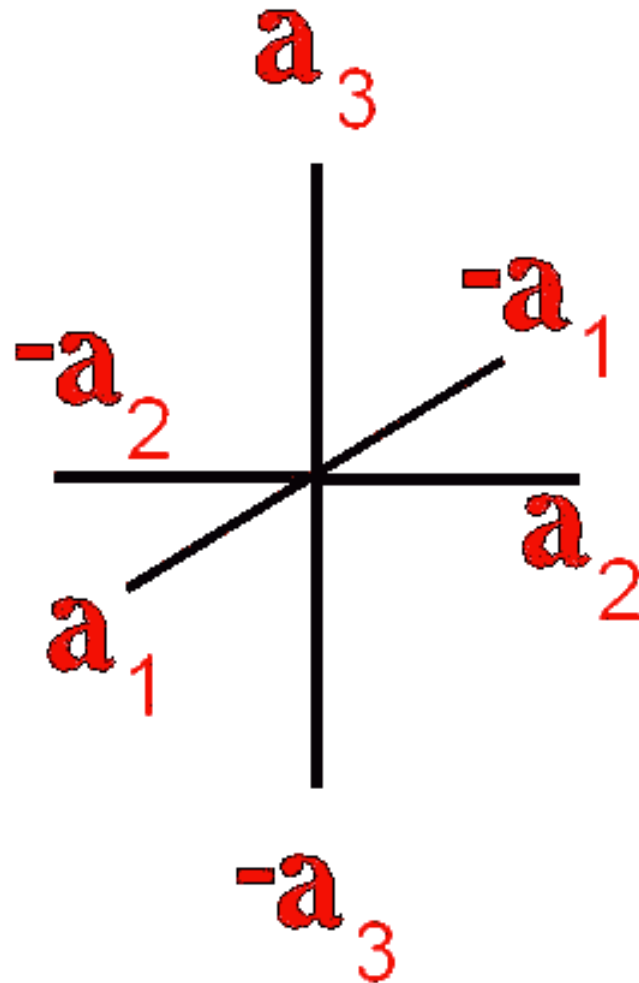
X					
$\bar{X}$					
X/m	$1/m = m = \bar{2}$	$2/m$	$3/m = \bar{6}$	$4/m$	$6/m$
$Xm(m)$	$1m = m = \bar{2}$	$2mm$	$3m$	$4mm$	$6mm$
$X2(2)$	$12 = 2$	222	32	422	622
$\bar{X}2$ or $\bar{X}m$	$\bar{1}2 = 2/m$ $\bar{1}m = 2/m$	$\bar{2}2 = 2mm$ $\bar{2}m = 2mm$	$32/m$	$42m$	$6m2$
$X/m2/m2/m$	$1/m 2/m 2/m$ $=$ $2/m 2/m 2/m$	$2/m 2/m 2/m$	$3/m 2/m 2/m$ $=$ $6/m 2/m 2/m$	$4/m 2/m 2/m$	$6/m 2/m 2/m$

Combinações referíveis ao cubo - guia

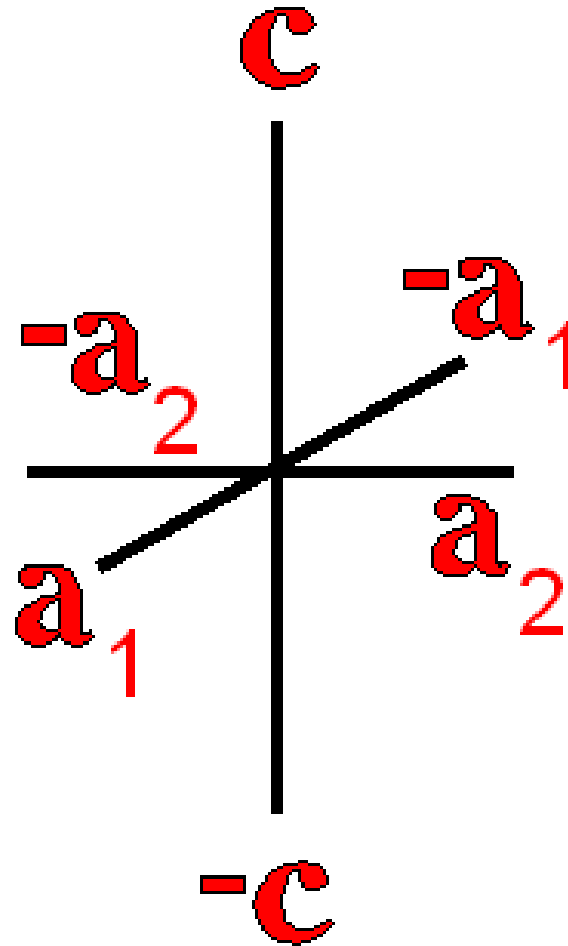


Eixos cristalográficos: orientação espacial

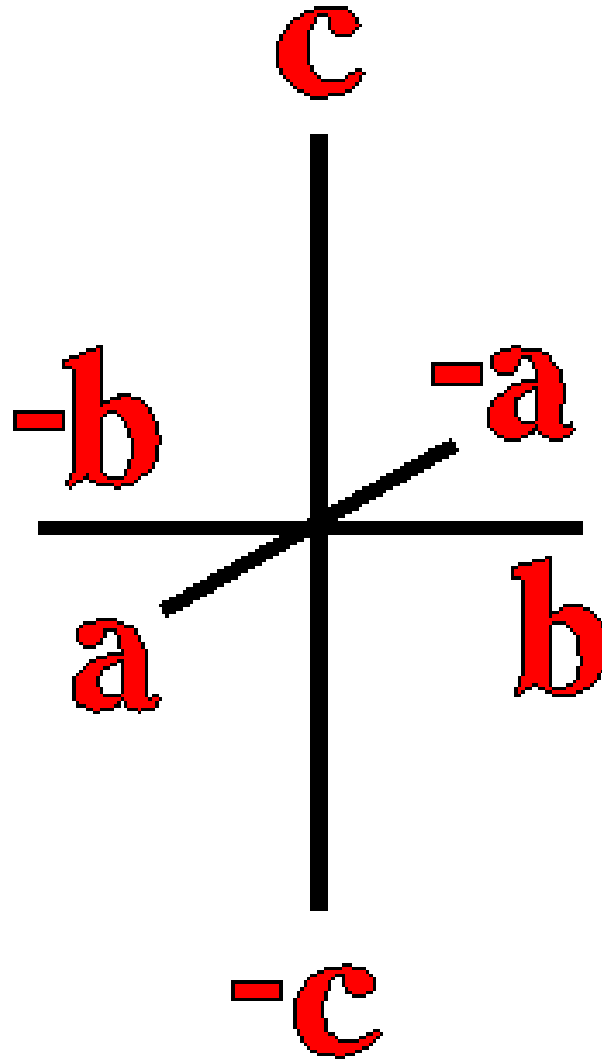
Isométrico



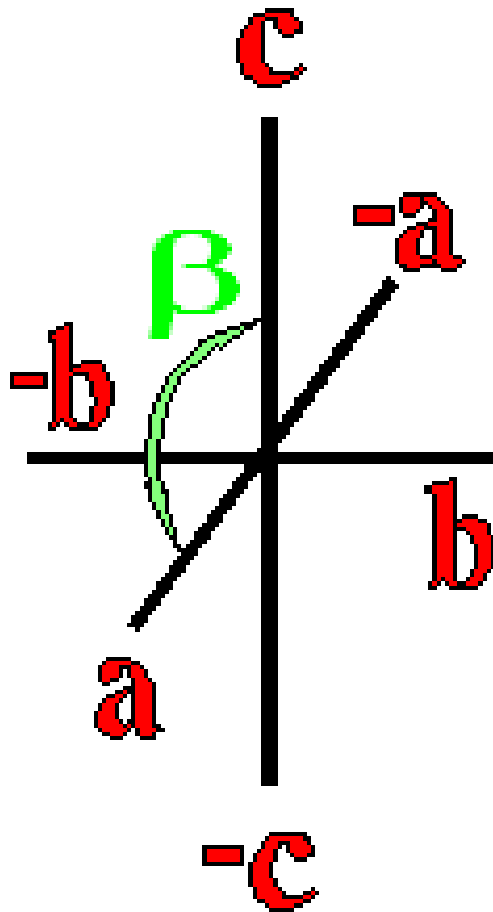
Tetragonal



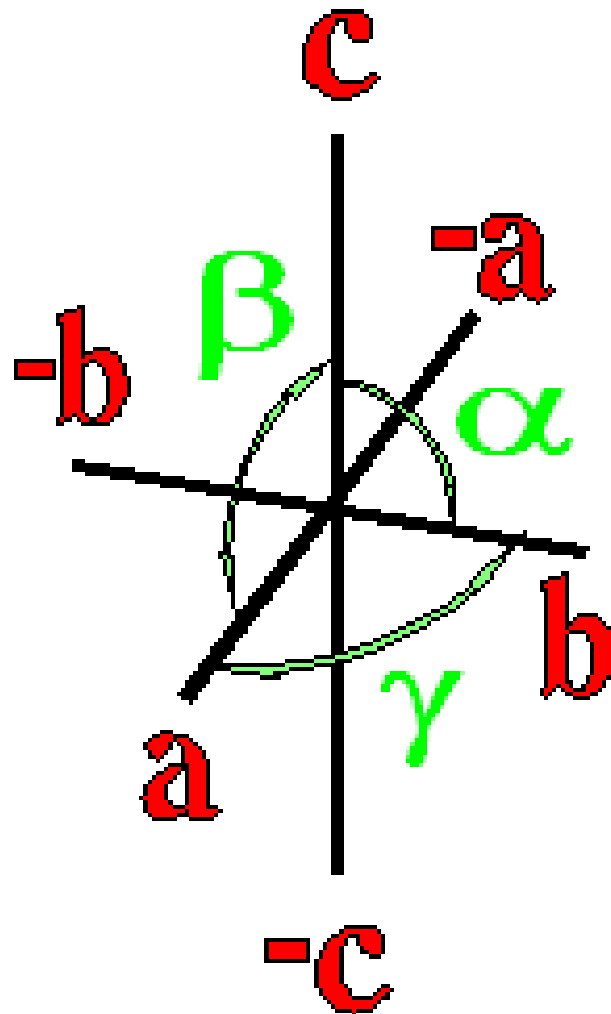
Ortorrômbico



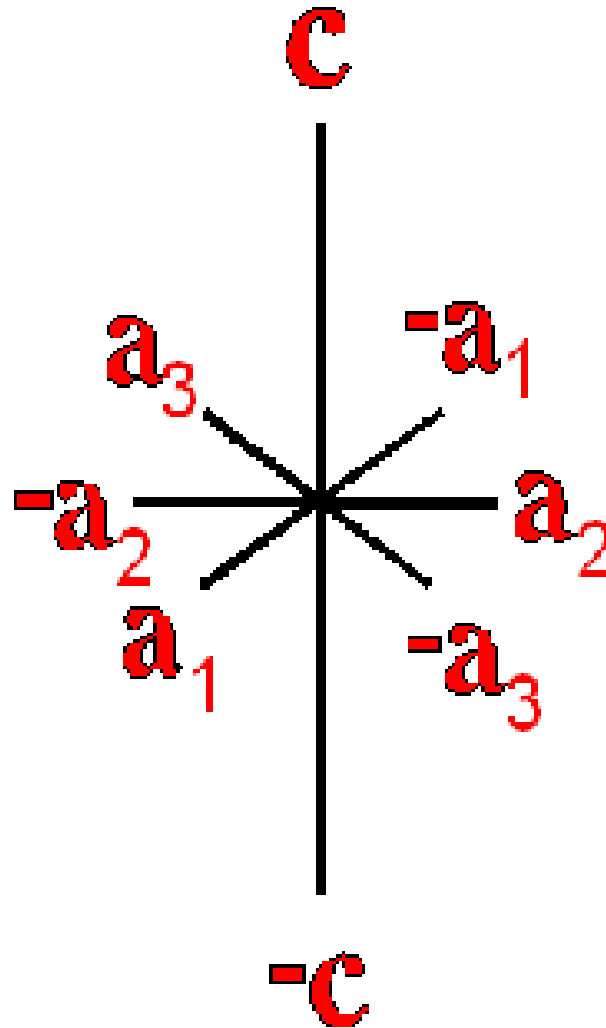
Monoclínico



Triclínico



Trigonal e hexagonal



AS 32 CLASSES CRISTALINAS

Sistema Cristalino	Classe Cristalina	Grau de Simetria	Nome da Classe
Triclínico	1	Sem simetria	Pedial
	$\bar{1}$	i	Pinacoidal
Monoclínico	2	1E2	Esfenoédrica
	m	1m	Domática
	2/m	1E2, 1m, i	Prismática
Ortorrômbico	222	3E2	Biesfenoédrica-rômbica
	mm2	1E2, 2m	Piramidal rômbica
	2/m2/m2/m	3E2, 3m, i	Bipiramidal rômbica
Tetragonal	4	1E4	Piramidal tetragonal
	$\bar{4}$	1E $\bar{4}$	Biesfenoédrica tetragonal
	4/m	1E4, 1m, i	Bipiramidal tetragonal
	422	1E4, 4E2	Trapezoédrica tetragonal
	4mm	1E4, 4m	Piramidal ditetragonal
	$\bar{4}2m$	1E $\bar{4}$, 2E2, 2m	Escalenoédrica tetragonal
	4/m2/m2/m	1E4, 4E2, 5m, i	Bipiramidal ditetragonal
Trigonal (Classe Hexagonal - Divisão Romboédrica)	3	1E3	Piramidal trigonal
	$\bar{3}$	1E $\bar{3}$	Romboédrica
	32	1E3, 3E2	Trapezoédrica trigonal
	3m	1E3, 3m	Piramidal ditrigonal
	$\bar{3}2/m$	1E $\bar{3}$, 3E2, 3m, i	Escalenoédrica hexagonal
Hexagonal (Classe Hexagonal - Divisão Hexagonal)	6	1E6	Piramidal hexagonal
	$\bar{6}$	1E $\bar{6}$	Bipiramidal trigonal
	6/m	1E6, 1m, i	Bipiramidal hexagonal
	622	1E6, 6E2	Trapezoédrica hexagonal
	6mm	1E6, 6m	Piramidal dihexagonal
	$\bar{6}m2$	1E $\bar{6}$, 3E2, 3m	Bipiramidal ditrigonal
	6/m2/m2/m	1E6, 6E2, 7m, i	Bipiramidal dihexagonal
Isométrico (Cúbico)	23	4E3, 3E2	Tetartoédrica
	2/m $\bar{3}$	4E $\bar{3}$, 3E2, 3m, i	Diploédrica
	432	4E3, 3E4, 6E2	Giroédrica
	$\bar{4}3m$	4E3, 3E $\bar{4}$, 6m	Hexatetraédrica
	4/m $\bar{3}2/m$	4E $\bar{3}$, 3E4, 6E2, 9m, i	Hexaoctaédrica

Símbolos para classes cristalinas

Hermann-
Mauguin

	1º.	2º.	3º.
cúbico	a_1, a_2, a_3	vértices do cubo-guia	centro das arestas do cubo-guia
tetragonal	c	a_1, a_2	bissetrizes de a_1 e a_2
ortorrômbico	a	b	c
monoclínico	b	-	-
triclínico	-	-	-
hexagonal	c	a_1, a_2, a_3	bissetrizes de a_1, a_2 e a_3
trigonal	c	a_1, a_2, a_3	

AS 32 CLASSES CRISTALINAS

Sistema Cristalino	Classe Cristalina	Grau de Simetria	Nome da Classe
Triclínico	1	Sem simetria	Pedial
	$\bar{1}$	i	Pinacoidal
Monoclínico	2	1E2	Esfenoédrica
	m	1m	Domática
	2/m	1E2, 1m, i	Prismática
Ortorrômbico	222	3E2	Biesfenoédrica-rômbica
	mm2	1E2, 2m	Piramidal rômbica
	2/m2/m2/m	3E2, 3m, i	Bipiramidal rômbica
Tetragonal	4	1E4	Piramidal tetragonal
	$\bar{4}$	1E $\bar{4}$	Biesfenoédrica tetragonal
	4/m	1E4, 1m, i	Bipiramidal tetragonal
	422	1E4, 4E2	Trapezoédrica tetragonal
	4mm	1E4, 4m	Piramidal ditetragonal
	$\bar{4}2m$	1E $\bar{4}$, 2E2, 2m	Escalenoédrica tetragonal
	4/m2/m2/m	1E4, 4E2, 5m, i	Bipiramidal ditetragonal
Trigonal (Classe Hexagonal - Divisão Romboédrica)	3	1E3	Piramidal trigonal
	$\bar{3}$	1E $\bar{3}$	Romboédrica
	32	1E3, 3E2	Trapezoédrica trigonal
	3m	1E3, 3m	Piramidal ditrigonal
	$\bar{3}2/m$	1E $\bar{3}$, 3E2, 3m, i	Escalenoédrica hexagonal
Hexagonal (Classe Hexagonal - Divisão Hexagonal)	6	1E6	Piramidal hexagonal
	$\bar{6}$	1E $\bar{6}$	Bipiramidal trigonal
	6/m	1E6, 1m, i	Bipiramidal hexagonal
	622	1E6, 6E2	Trapezoédrica hexagonal
	6mm	1E6, 6m	Piramidal dihexagonal
	$\bar{6}m2$	1E $\bar{6}$, 3E2, 3m	Bipiramidal ditrigonal
	6/m2/m2/m	1E6, 6E2, 7m, i	Bipiramidal dihexagonal
Isométrico (Cúbico)	23	4E3, 3E2	Tetartoédrica
	2/m $\bar{3}$	4E $\bar{3}$, 3E2, 3m, i	Diploédrica
	432	4E3, 3E4, 6E2	Giroédrica
	$\bar{4}3m$	4E3, 3E $\bar{4}$, 6m	Hexatetraédrica
	4/m $\bar{3}2/m$	4E $\bar{3}$, 3E4, 6E2, 9m, i	Hexaoctaédrica

Table 1

Distribution of forms in the triclinic, monoclinic, and orthorhombic systems

Number of faces	Name	Point group					Unique in		
		1	$\bar{1}$	2	m	$\frac{2}{m}$		2 2 2	$m m 2$
1	pedion	+		+	+			+	
2	pinacoid		+	+	+	+		+	
	sphenoid			+	+			+	
4	prism					+	+	+	+
	disphenoid						+		2 2 2
	pyramid							+	$m m 2$
8	dipyramid							+	$\frac{2}{m} \frac{2}{m} \frac{2}{m}$

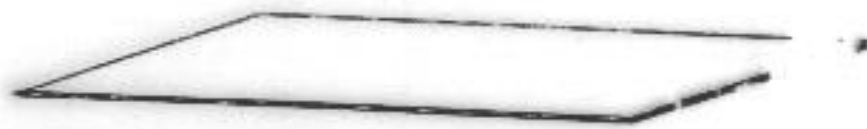


Fig. 2. Pediton (or monohedron, a form consisting of a single plane surface).



Fig. 3. Pinacoid (a form consisting of a pair of parallel plane surfaces).

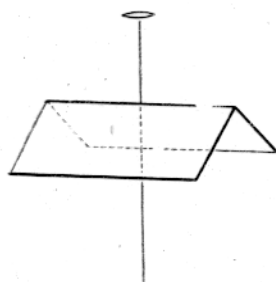


Fig. 4i. Sphenoid (or dihedron) of class 2.

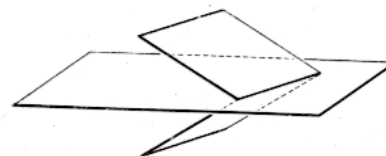


Fig. 4ii. Sphenoid (or dihedron) of class m .

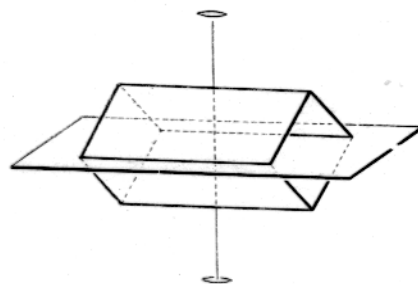


Fig. 5. Prism.

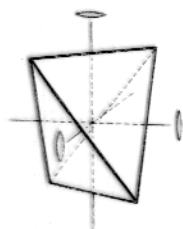


Fig. 6. Rhombic disphenoid.

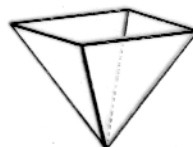


Fig. 7. Rhombic pyramid.

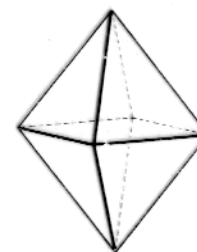


Fig. 8. Rhombic dipyramid.

Table 2
Distribution of forms in the tetragonal system

Number of faces	Name	Point group							Unique in
		4	$\bar{4}$	$\frac{4}{m}$	4 2 2	4 m m	$\bar{4} 2 m$	$\frac{4}{m} \frac{2}{m} \frac{2}{m}$	
1	pedion	+				+			
2	pinacoid		+	+	+		+	+	
4	tetragonal prism	+	+	+	+	+	+	+	
	tetragonal pyramid	+				+			
	tetragonal disphenoid		+				+		
8	ditetragonal prism				+	+	+	+	
	tetragonal dipyramid			+	+		+	+	
	tetragonal trapezohedron				+				4 2 2
	ditetragonal pyramid					+			4 m m
	tetragonal scalenohedron						+		$\bar{4} 2 m$
16	ditetragonal dipyramid							+	$\frac{4}{m} \frac{2}{m} \frac{2}{m}$

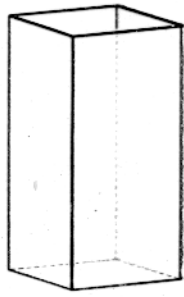


Fig. 9. Tetragonal prism.

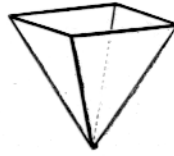


Fig. 10. Tetragonal pyramid.



Fig. 11. Tetragonal disphenoid.

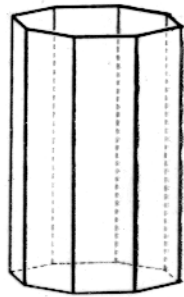


Fig. 12. Ditetragonal prism.

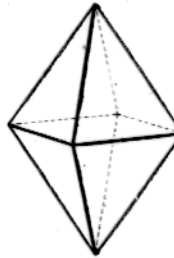


Fig. 13. Tetragonal dipyramid.



Fig. 14. Tetragonal trapezohedron.

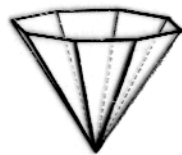


Fig. 15. Ditetragonal pyramid.



Fig. 16. Tetragonal scalenohedron.

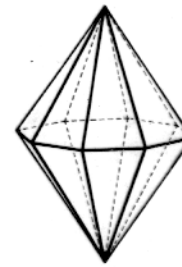


Fig. 17. Ditetragonal dipyramid.

Table 3
Distribution of forms in the hexagonal system

Number of faces	Name	Point group												Unique in
		3	$\bar{3}$	3 2	3 m	$\bar{3} \frac{2}{m}$	6	$\bar{6}$	$\frac{6}{m}$	6 2 2	6 m m	$\bar{6} m 2$	$\frac{6}{m} \frac{2}{m} \frac{2}{m}$	
1	pedion	+			+		+				+			
2	pinacoid		+	+		+		+	+	+		+	+	
3	trigonal prism	+		+	+		+					+		
	trigonal pyramid	+			+									
6	hexagonal prism		+	+	+	+	+		+	+	+	+	+	
	rhombohedron		+	+		+								
	ditrigonal prism			+	+							+		
	trigonal dipyramid			+			+					+		
	hexagonal pyramid				+		+				+			
	trigonal trapezohedron			+										3 2
	ditrigonal pyramid				+									3 m
12	hexagonal dipyramid					+		+	+			+	+	
	dihexagonal prism					+			+	+			+	
	hexagonal scalenohedron					+								$\bar{3} \frac{2}{m}$
	hexagonal trapezohedron								+					6 2 2
	dihexagonal pyramid										+			6 m m
	ditrigonal dipyramid											+		$\bar{6} m 2$
24	dihexagonal dipyramid												+	$\frac{6}{m} \frac{2}{m} \frac{2}{m}$

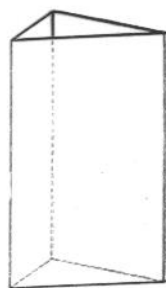


Fig. 18. Trigonal prism.

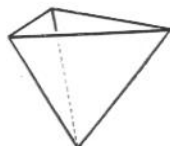


Fig. 19. Trigonal pyramid.

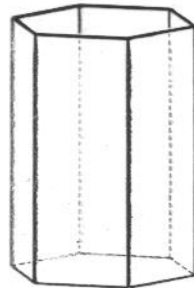


Fig. 20. Hexagonal prism.

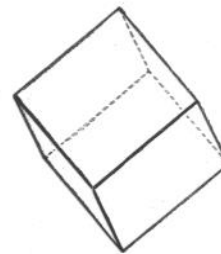


Fig. 21. Rhombohedron.

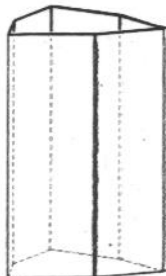


Fig. 22. Ditrigonal prism.

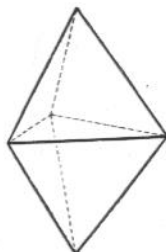


Fig. 23. Trigonal dipyramid.

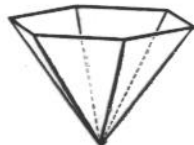


Fig. 24. Hexagonal pyramid.

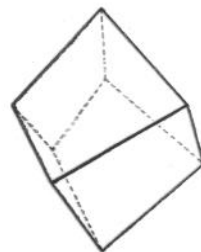


Fig. 25. Trigonal trapezohedron.

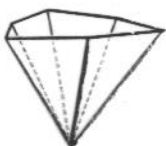


Fig. 26. Ditrigonal pyramid.

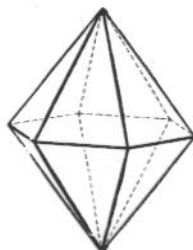


Fig. 27. Hexagonal dipyramid.

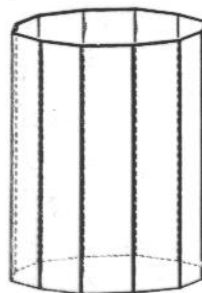


Fig. 28. Dihexagonal prism.

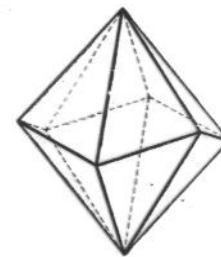


Fig. 29. Hexagonal scalenohedron.

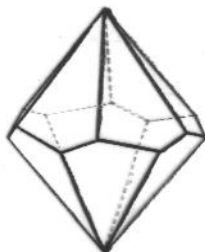


Fig. 30. Hexagonal trapezohedron.

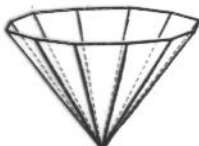


Fig. 31. Dihexagonal pyramid.

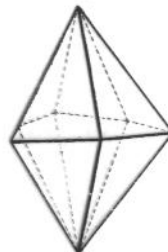


Fig. 32. Ditrigonal dipyramid.

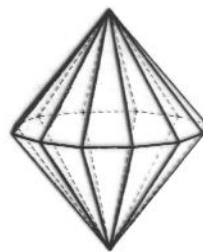


Fig. 33. Dihexagon dipyramid.

Table 4
Distribution of forms in the isometric system

Number of faces	Name	Point group					Unique in
		$2\ 3$	$\frac{2}{m}\ \bar{3}$	$\bar{4}\ 3\ m$	$4\ 3\ 2$	$\frac{4}{m}\ \bar{3}\ \frac{2}{m}$	
4	tetrahedron	+		+			
6	cube	+	+	+	+	+	
8	octahedron		+		+	+	
12	dodecahedron	+	+	+	+	+	
	pyritohedron	+	+				
	deltohedron	+					
	tristetrahedron	+					
	tetartoid	+					$2\ 3$
24	trisoctahedron		+		+	+	
	trapezohedron		+		+	+	
	tetrahexahedron				+	+	
	diploid		+				$\frac{2}{m}\ \bar{3}$
	hextetrahedron			+			$\bar{4}\ 3\ m$
	gyroid				+		$4\ 3\ 2$
48	hexoctahedron					+	$\frac{4}{m}\ \bar{3}\ \frac{2}{m}$

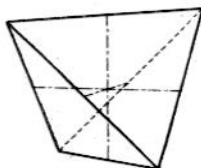


Fig. 34. Tetrahedron.

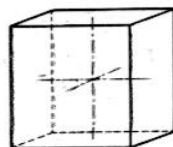


Fig. 35. Cube.

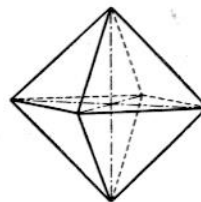


Fig. 36. Octahedron.

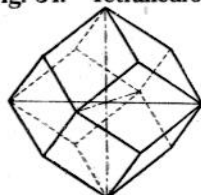


Fig. 37. Dodecahedron.

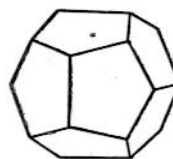


Fig. 38. Pyritohedron.

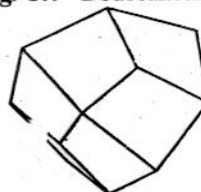


Fig. 39. Deltohedron.

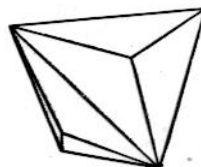


Fig. 40. Tristetrahedron.

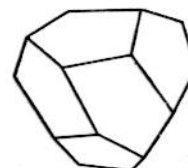


Fig. 41. Tetartoid.

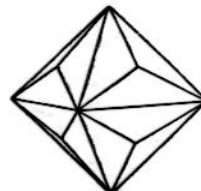


Fig. 42. Trisoctahedron.

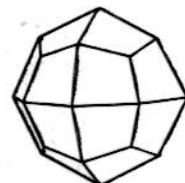


Fig. 43. Trapezohedron.

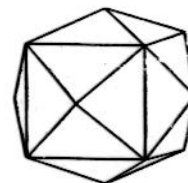


Fig. 44. Tetrahexahedron.

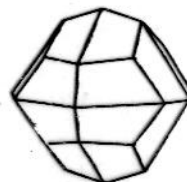


Fig. 45. Diploid.

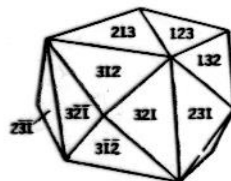


Fig. 46. Hextetrahedron.



Fig. 47. Gyroid.



Fig. 48. Hexoctahedron.