Miller Indices for directions

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Miller Indices (MI)

- Atoms are periodically arranged in a crystalline materials.
- Hence can be designated by a vector.
- Miller introduced a system to designate atoms, directions and planes in a unit cell.
- A set of three numbers is used and called as Miller Indices.

Remember

- Indices is plural of index.
- Negative values are indicated by bar over the number.
  e. g. $[10\overline{1}]$
- Miller Indices are never in a fractions.
- Miller Indices don't have comma unless double integer.

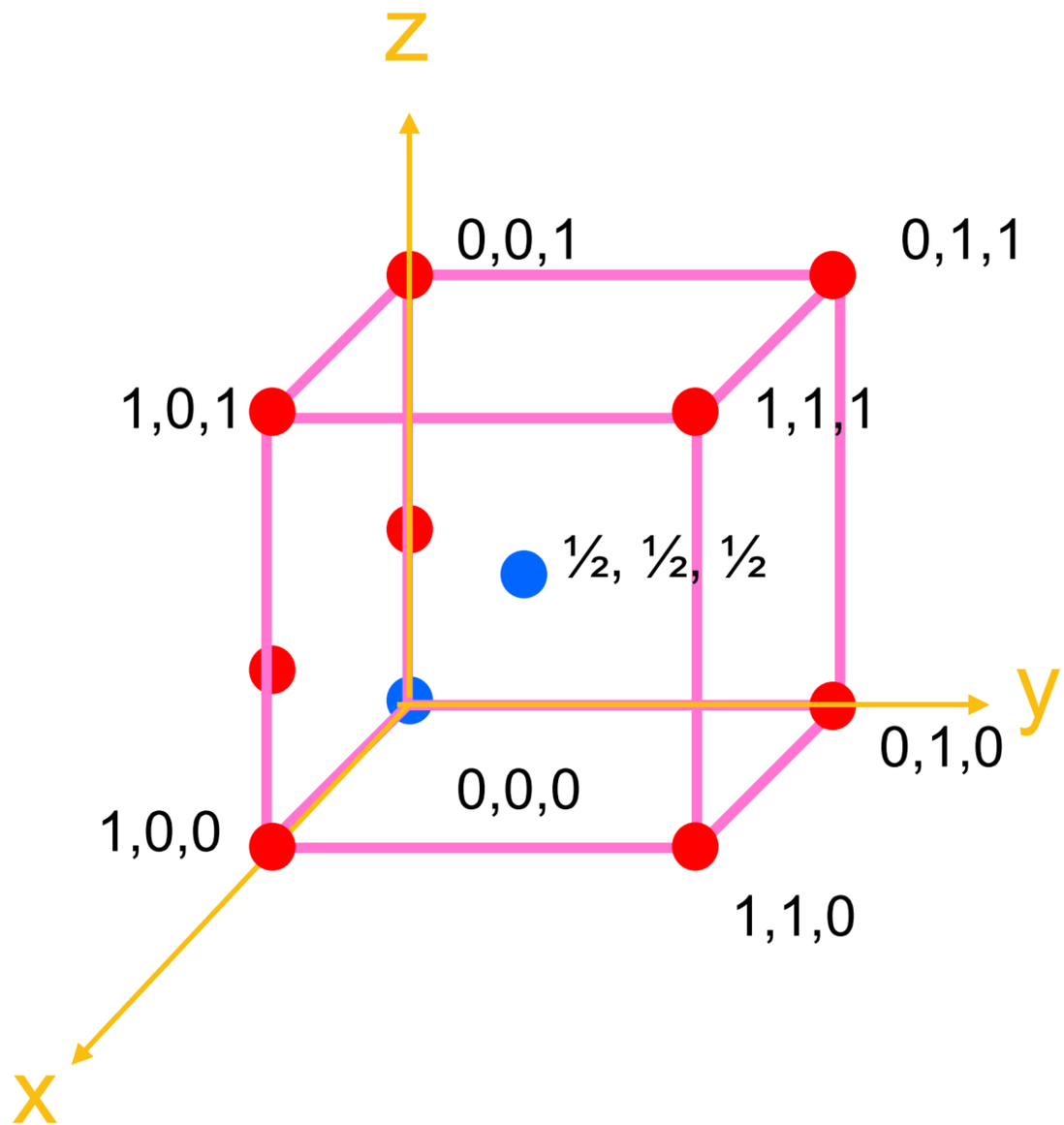
Miller Indices notations

Family is the collection of atoms, directions or planes having same magnitude but in different directions

Entity	Symbol for single entity	Symbol for family
Atoms	.xyz.	:xyz:
Direction	[uvw]	<uvw>
Plane	(hkl)	{hkl}

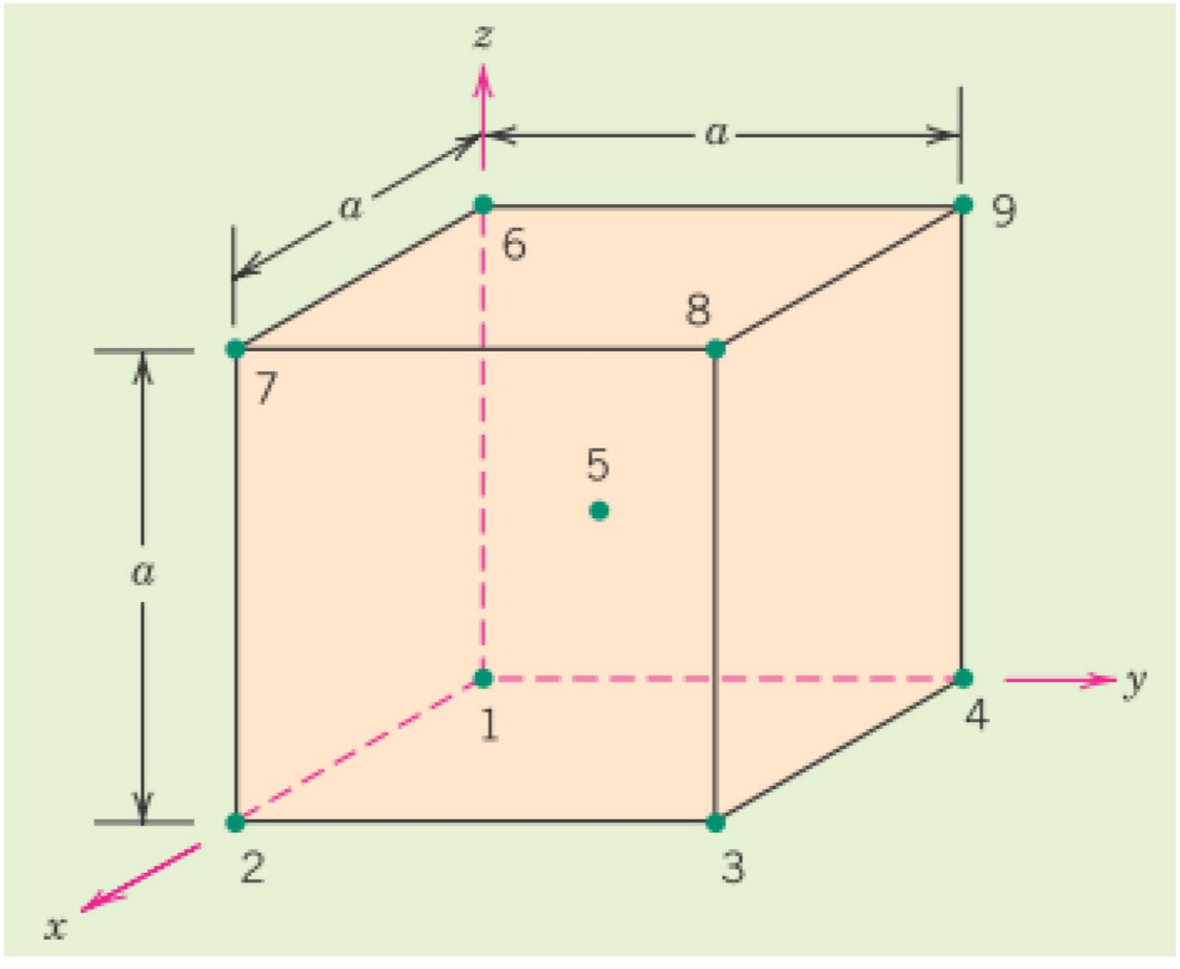
Position co-ordinates of atoms

a=b=c=1



Miller indices for atoms

Find out MI for the given points mentioned. Consider length as unit distance.



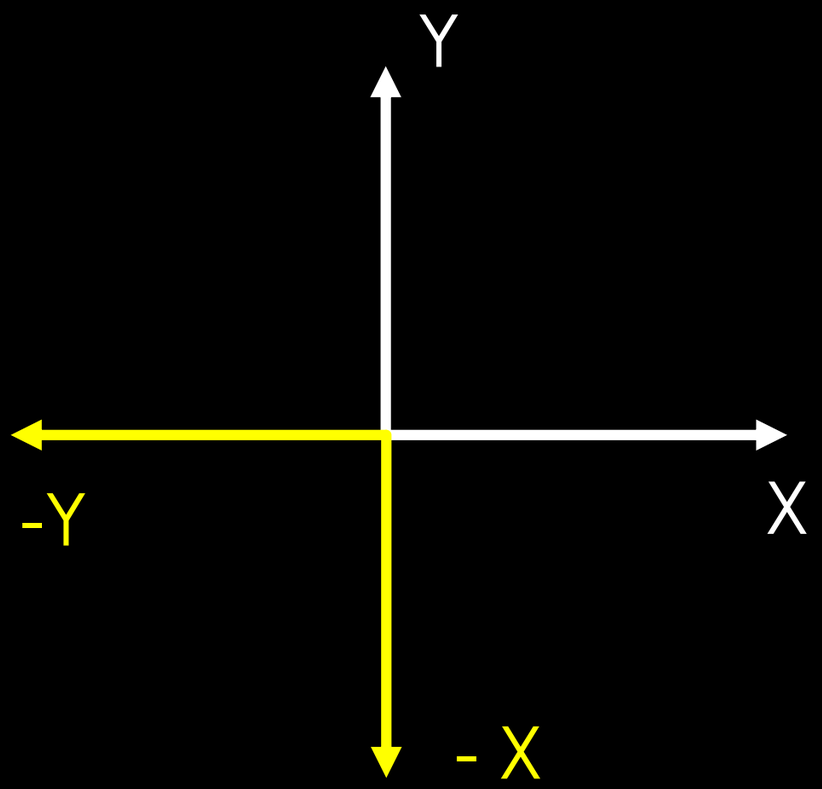
Miller indices for directions

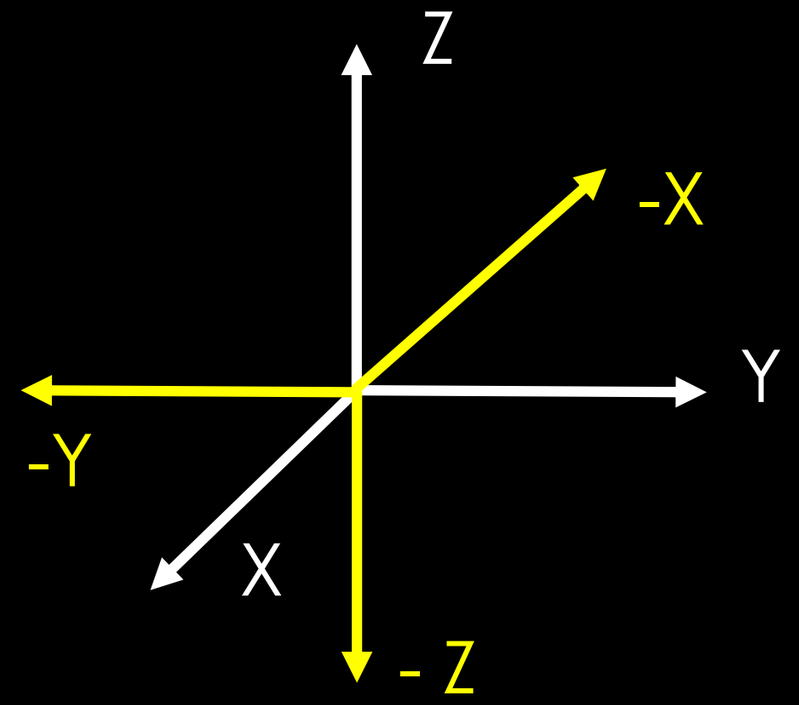
Procedure when direction is given

1. Find out co-ordinates for head and tail
2. Subtract tail from the head
3. Clear the fractions/Reduce to lowest integer
4. Enclose numbers in [] and write a bar over negative integers.

Note about negative co-ordinates

- x, y and z axis can be represented by a negative sign.
- It represented direction in opposite to the original direction.



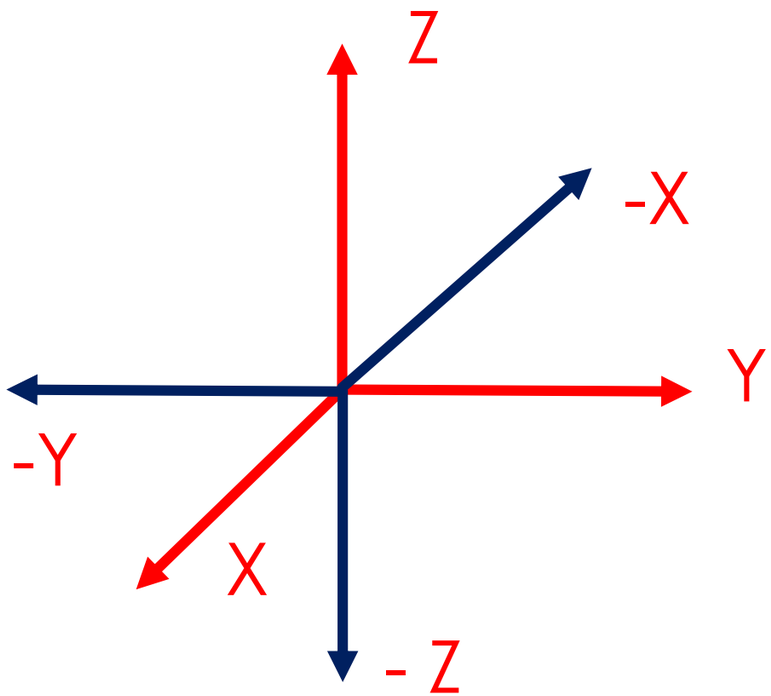


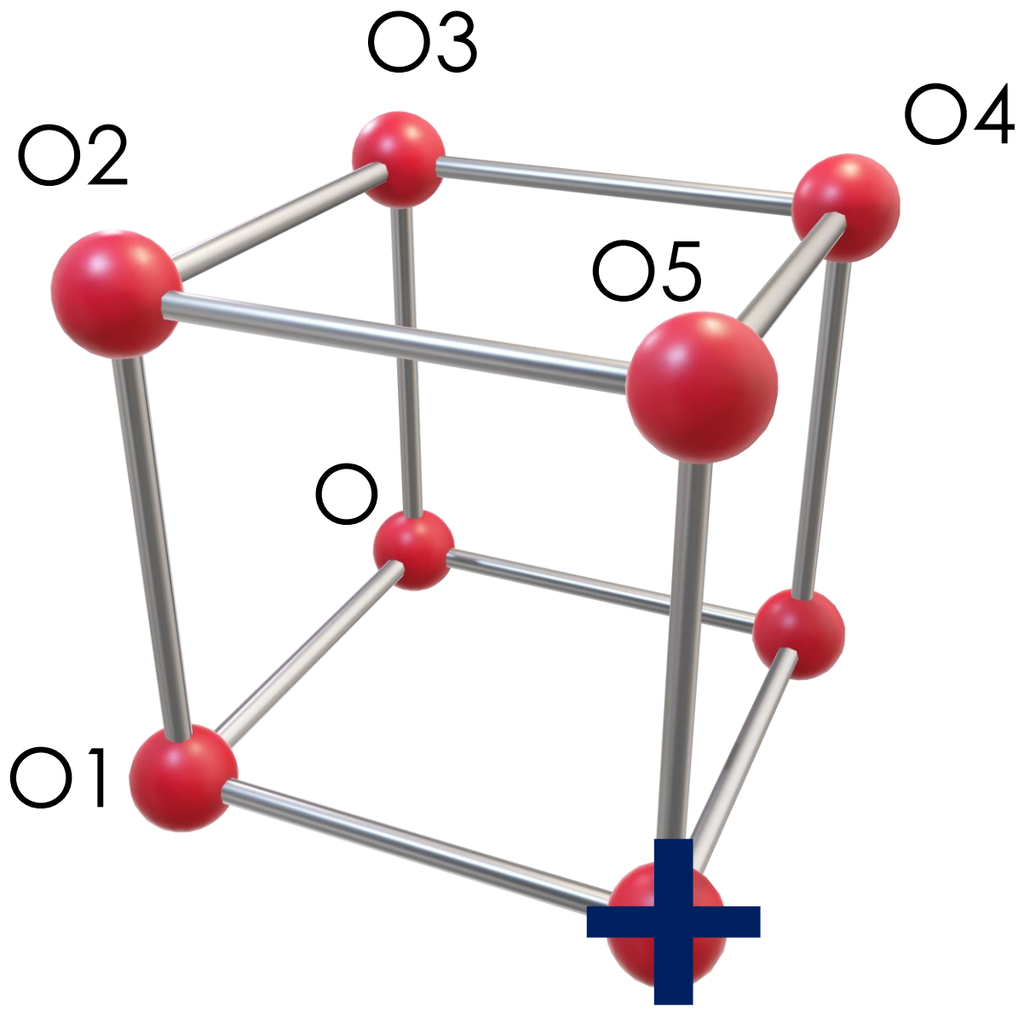
How to choose negative co-ordinates?

- The cubic unit cell has 8 corners. Any corner can be taken as a origin.
- Move the origin while choosing such that the negative co-ordinate should lie inside the unit cell.
- This will save our efforts to draw more than one unit cells to show negative Miller indices.

Utility of origin shifting

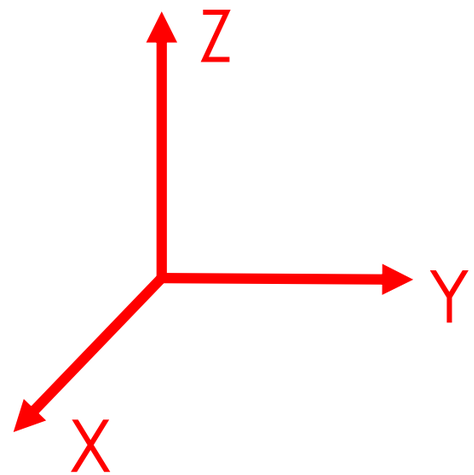
Find out the point co-ordinates of the plus symbol at different origins. The co-ordinate system is given.

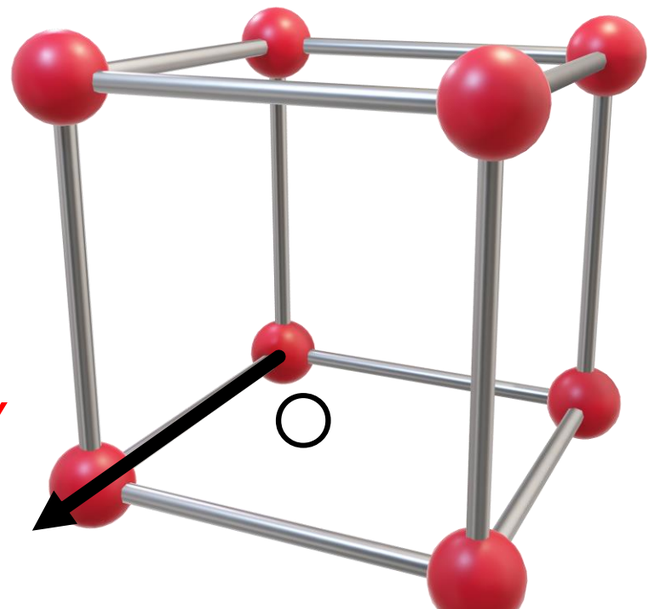




MI for directions

Find out the MI of the following direction.

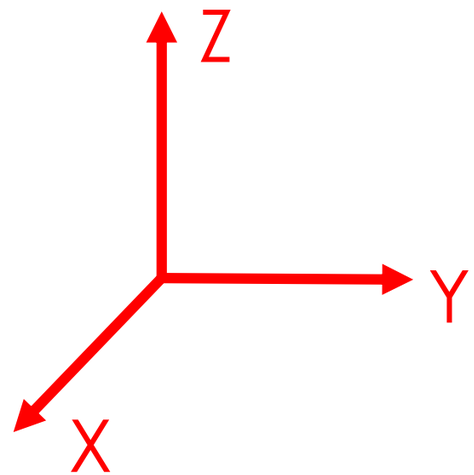


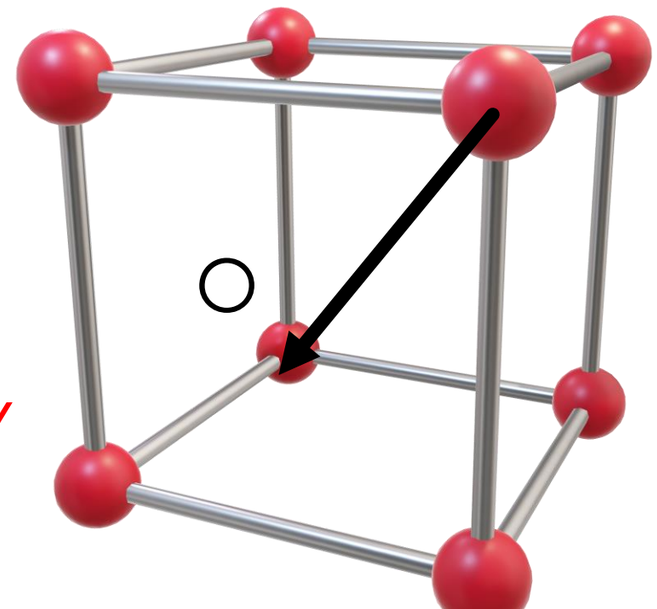


1	Co-ordinates of tail	0,0,0
2	Co-ordinates of head	1,0,0
3	Head-tail	1,0,0 - 0,0,0
4	Clear fractions	--
5	Enclose in []	[100]

MI for directions

Find out the MI of the following direction.

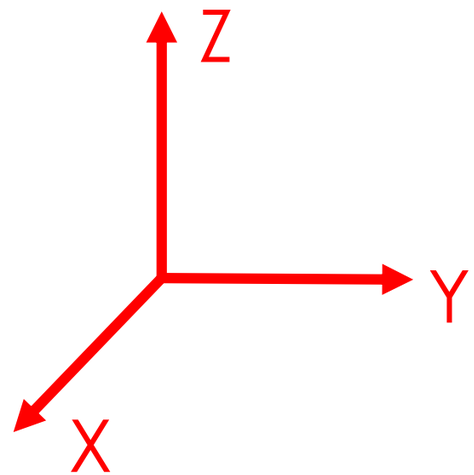


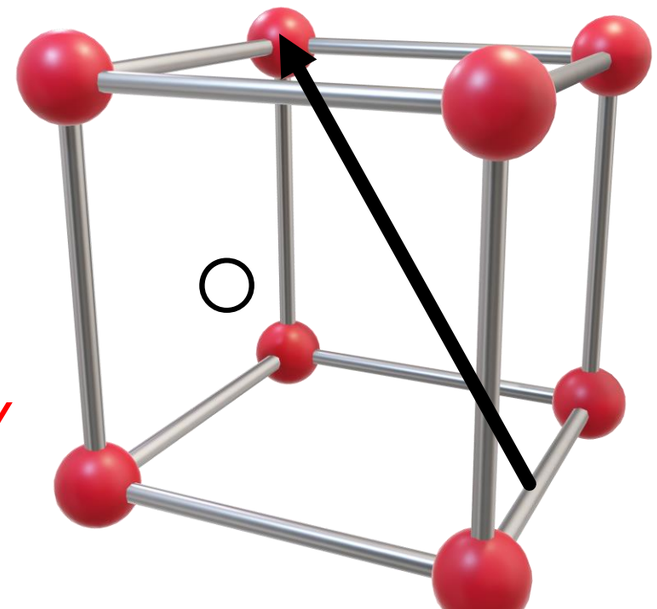


1	Co-ordinates of tail	1,1,1
2	Co-ordinates of head	0,0,0
3	Head-tail	0,0,0 -1,1,1
4	Clear fractions	--
5	Enclose in []	$[\bar{1}\bar{1}\bar{1}]$

MI for directions

Find out the MI of the following direction.





1	Co-ordinates of tail	1/2,1,0
2	Co-ordinates of head	0,0,1
3	Head-tail	0,0,1 -1/2,1,0
4	Clear fractions	-1,-2,2
5	Enclose in []	$[\bar{1}\bar{2}2]$

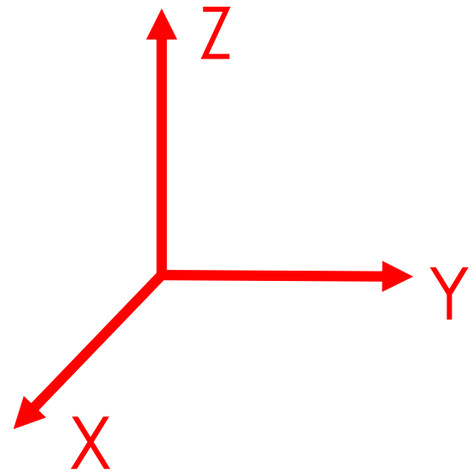
Procedure when MI is given

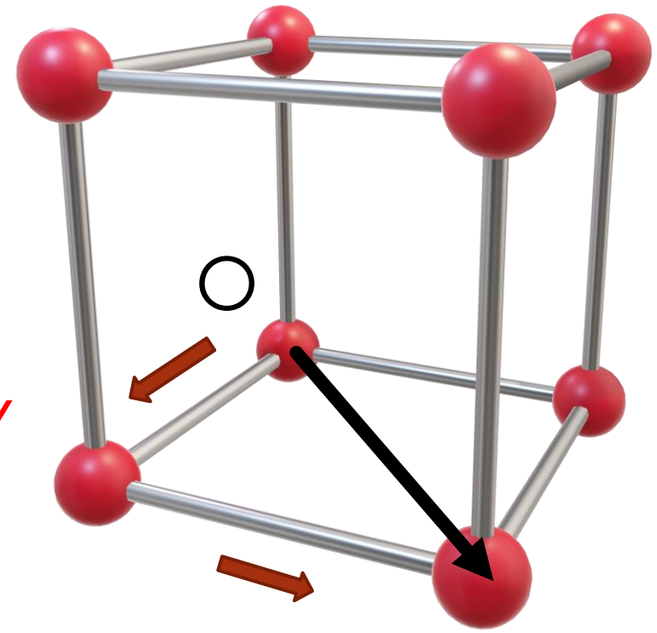
1. Choose origin according to the MI given
2. Mark the points on respective axis
3. Join the origin and the last marked point
4. Show a vector representation

MI for directions

Show [110] direction

1	Choose the origin
2	Mark the respective axis
3	Join origin and marked point
4	Show vector

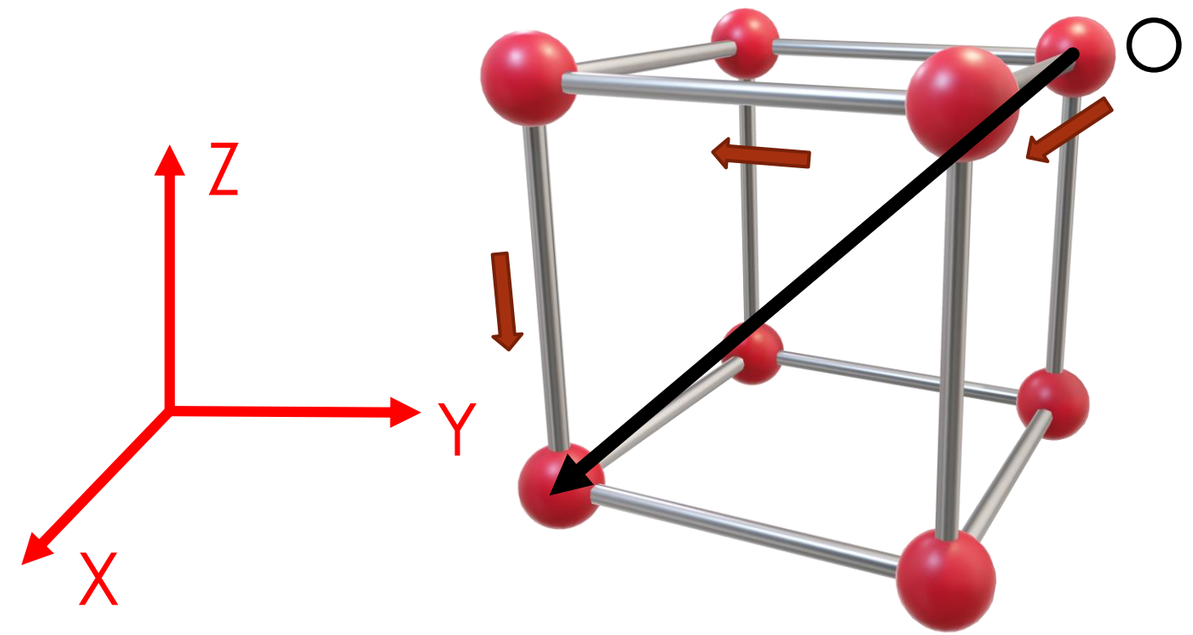




MI for directions

Show [$1\bar{1}\bar{1}$] directions

1	Choose the origin
2	Mark the respective axis
3	Join origin and marked point
4	Show vector



Remember: If any indices is more than1divide by the largest number to smaller numbers and then show the direction

e.g. [112] ➔ 1/2,1/2,1

Summary

1. Miller indices are the notations to designate atoms, directions and planes.
2. You can choose any of the corner of unit cell as a origin. This is necessary to draw/show the MI with negative indices.

Assignments

1. Draw the following directions in cubic unit cell

(a) $[1\bar{1}\bar{1}]$ (b) $[\bar{1}\bar{1}3]$ (c) $[1\bar{1}0]$ (d) [110] (e) [101] (f) [102]