Miller Indices Questions

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Question 1 View this Question Online >

In a Triclinic crystal, a lattice plane makes intercepts at a length a, 2b and $-\frac{3c}{2}$. The Miller indices of the plane are

1. 3 : 6 : 4
2. 6 : 3 : 4
3. 6 : 3 : - 4
4. 6 : 3 : -2

Answer (Detailed Solution Below)

Option 3 : 6 : 3 : - 4

Miller Indices Question 1 Detailed Solution

Concept:

Miller Indices:

- Miler indices is a symbolic representation of vector for the orientation of an atomic plane in the crystal lattice.
- It is defined as the reciprocal of fractional intercept which the plane makes with the crystallographic axes.

Procedure to find Miller Indices:

1. Determine the intercept of the plane along each of three crystallographic directions.
2. Taking reciprocal of intercept.
3. Taking LCM of the fraction and multiply it by reciprocal of intercept.

Calculation:

Given,

Intercepts of plane = (a, 2b, $-\frac{3c}{2}$)

Intercept = (1, 2, $-\frac{3}{2}$)

Reciprocal of intercept = 1, $\frac{1}{2}$, $-\frac{2}{3}$)

LCM = 6

Miller indicates of the plane = LCM × Reciprocal of intercept

∴ Miller indicates of the plane = (6, 3, - 4)

Question 2 View this Question Online >

A plane intersects the coordinate axes at $x = \frac{2}{3}, y = \frac{1}{3}\ and\ z = \frac{1}{2}$ what is the Miller index of this plane?

1. 9,3,2
2. 4,3,2
3. 4,2,3
4. 3,6,4

Answer (Detailed Solution Below)

Option 4 : 3,6,4

Miller Indices Question 2 Detailed Solution

Explanation:

Miller indices are rationalized reciprocal of fractional intercepts taken along the crystallographic directions.

Calculation:

Given:

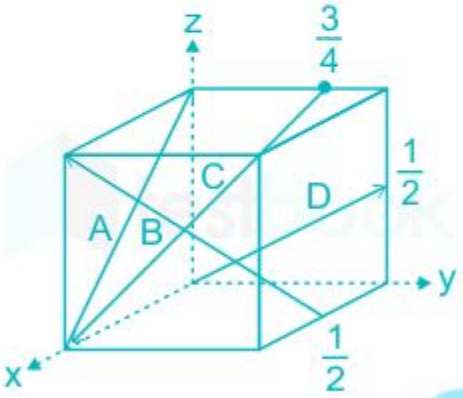
Plane intercepts are $x = \frac{2}{3}, y = \frac{1}{3} and\ z = \frac{1}{2}$

Plane ABCD	x	y	Z
Intercept	$x = \frac{2}{3}$	$x = \frac{1}{3}$	$x = \frac{1}{2}$
Reciprocal	$\frac{3}{2}$	$\frac{3}{1}$	$\frac{2}{1}$
Rationalization	$x = \frac{3}{2} \times \frac{2}{3} = 1$	$x = \frac{3}{1} \times 2 = 6$	$x = \frac{2}{1} \times 2 = 4$
Indices	3	6	4

∴ Miller index of this plane will be 3,6,4

Question 3 View this Question Online >

In the figure shown below, Miller indices [0 2 1] have the direction of



1. B

2. A

3. D

4. C

Answer (Detailed Solution Below)

Option 3 : D

Miller Indices Question 3 Detailed Solution

Concept:

Miller Indices:

Miller Indices are used to specify **directions** and **planes**.

These directions and planes could be in a lattice or in crystals.

If two points **M** (x_1, y_1, z_1) and **N** (x_2, y_2, z_2) then the direction is given by $[(x_2 - x_1)\ (y_2 - y_1)\ (z_2 - z_1)]$

- **Negative numbers** can be represented by a **bar sign**.
- The **common factor** can be **ignored**.

Calculation:

Given:

A_1 (1, 0, 0) and A_2 (0, 0,1)

Direction of A $[(0 - 1)\ (0 - 0)\ (1 - 0)] \Rightarrow [-1\ 0\ 1]$

$\therefore A\ [\bar{1}\ 0\ 1]$

$B_1\left(\frac{1}{2}, 1, 0\right)\ and\ B_2\ (1, 0, 1)$

Direction of $B\ \left[\left(1 - \frac{1}{2}\right)(0 - 1)(1 - 0)\right] \Rightarrow \left[\frac{1}{2}\ -1\ 1\right]$

$\therefore B\left[\frac{1}{2}\ \bar{1}\ 1\right] \Rightarrow B\ [1\ \bar{2}\ 2]$

$C_1\left(0, \frac{3}{4}, 1\right)\ and\ C_2(1,\ 0,\ 0)$

Direction of $C\left[(1 - 0)\left(0 - \frac{3}{4}\right)(0 - 1)\right] \Rightarrow \left[1\ -\frac{3}{4}\ -1\right]$

$\therefore C\left[1\ \bar{\frac{3}{4}}\ \bar{1}\right] \Rightarrow \left[4\ \bar{3}\ \bar{1}\right]$

$D_1\ (0,\ 0,\ 0)\ and\ D_2\ \left(0,\ 1,\ \frac{1}{2}\right)$

Direction of $D\left[(0 - 0)(1 - 0)\left(\frac{1}{2} - 0\right)\right] \Rightarrow \left[0\ 1\ \frac{1}{2}\right]$

$\therefore$ D [0 2 1]

∴ D [0 2 1]

Question 4

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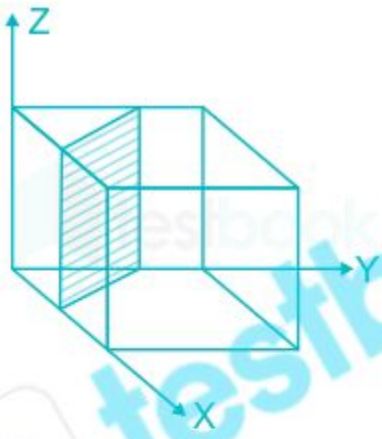
The Miller indices for the plane in the figure shown below are:



1. [120]
2. [210]
3. [220]
4. [002]

Answer (Detailed Solution Below)

Option 3 : [220]

Miller Indices Question 4 Detailed Solution

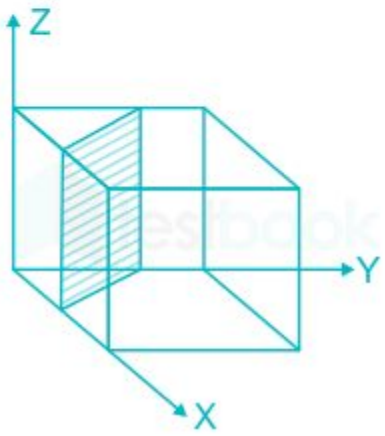
Concept:

Crystallographic plane:

- It is a **plane located within the unit cell,** the crystallographic planes are represented in terms of Miller indices.
- Representation of a **single plane is [xyz].**
- Representation of a family of a plane is ={xyz}

Calculation:

Given:



Now, let, 'a' be the side of the given cube and plane intersects in the middle of the x and y-axis.

So, the plane fractions are = $\frac{a}{2}, \frac{a}{2}, \infty$

Reciprocal of plane fraction = $\frac{2}{a}, \frac{2}{a}, 0$

To convert reciprocal into least integer, multiply by a

∴ Miller indices = [220]

Question 5 View this Question Online >

A plane in a unit cell is described by its miller indices a (632). The plane intersects x, y

and z respectively at a point whose distances from origin are

1. 6, 3 and 2 units
2. $\frac{1}{6}, \frac{1}{3}\ and\ \frac{1}{2}$ units
3. $\frac{2}{3}, \frac{1}{3}\ and\ 1$ units
4. $\frac{1}{2}, 1\ and\ \frac{2}{3}$ units

Answer (Detailed Solution Below)

Option 2 : $\frac{1}{6}, \frac{1}{3}\ and\ \frac{1}{2}$ units

Miller Indices Question 5 Detailed Solution

Concept:

- **Miller indices** are the styles to **designate the planes and directions in the unit cells and crystals.**
- Miller indices (hkl) are expressed as a reciprocal of intercepts p, q, and r made by the plane on the three rectangular axes x, y, and z respectively.
- These are the unit distances from the origin along the three axes. Thus

$h = \frac{1}{p}, k = \frac{1}{q}, l = \frac{1}{r}$

Where p = intercept of the plane on the x-axis, q = intercept of the plane on the y-axis, and r = intercept of the plane on the z-axis.

Calculation:

Given:

Miller indices of a plane = (632)

Since, Miller indices are obtained by reciprocal of intercept p, q, and r made by the plane on the three rectangular axes x, y, and z respectively. Hence the reciprocal of miller indices will give the intercepts.

Distances from the origin to points at which the plane intersects = $\frac{1}{6}, \frac{1}{3}\ and\ \frac{1}{2}$ units

Question 6 View this Question Online >

Miller indices are same for:

1. Crystal planes
2. Parallel planes
3. Perpendicular planes
4. Three crystallographic planes.

Answer (Detailed Solution Below)

Option 2 : Parallel planes

Miller Indices Question 6 Detailed Solution

CONCEPT:

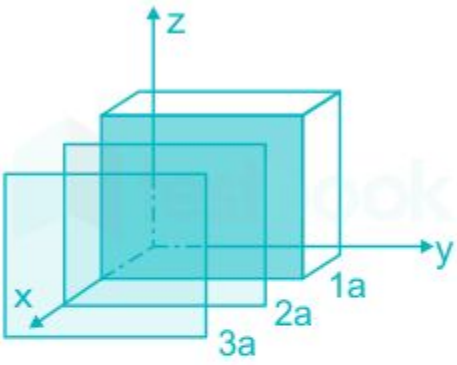
- **Miller indices** are the styles to **designate the planes and directions in the unit cells and crystals.**
- Miller indices (hkl) are expressed as a reciprocal of intercepts p, q, and r made by the plane on the three rectangular axes x, y, and z respectively.
- These are the unit distances from the origin along the three axes. Thus

$h = \frac{1}{p}, k = \frac{1}{q}, l = \frac{1}{r}$

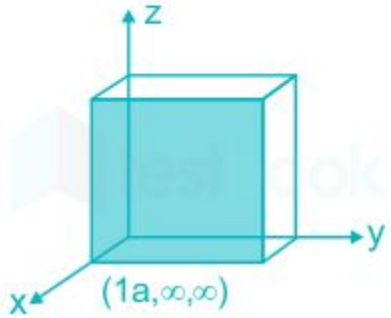
Where p = intercept of the plane on the x-axis, q = intercept of the plane on the y-axis, and r = intercept of the plane on the z-axis.

EXPLANATION:

- Consider the plane in pink, which is one of an infinite number of the parallel plane each a consistent distance (“a”) away from the origin (purple planes)

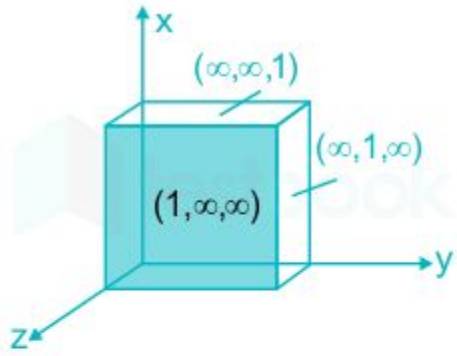


- The plane intersects the x-axis at point a.
- It runs parallel along y and z axes.
- Thus, this plane can be designated as (1,∞,∞)



1) Likewise, the yellow plane can be designated as (∞,1,∞)

And the green plane can be written as (∞,∞,1)



Miller Indices are the reciprocals of the parameters of each crystal face. Thus:

- Pink Face = (1/1, 1/∞, 1/∞) = (100)
- Green Face = (1/∞, 1/∞, 1/1) = (001)
- Yellow Face = (1/∞, 1/1, 1/∞) = (010)

Procedure for Miller indices

Step 1: locate the origin ‘O’, and axis x, y, z

Step 2: find the plane fractions (plane dimensions) = P, Q, R

Step 3: Calculate the reciprocals of plane fractions = $\frac{1}{P}, \frac{1}{Q}, \frac{1}{R}$

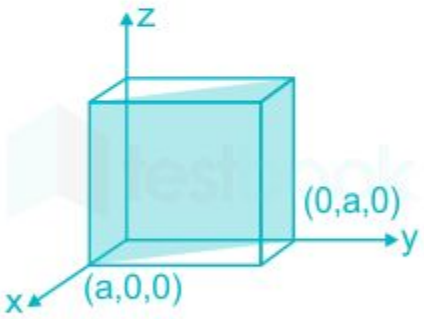
[h, k, l] is the miller indices.

For parallel planes

The distance will be the **same** for **all directions** from the origin. So, reciprocals of those also will be the same.

For parallel planes, miller indices will be the same

Example:



Here plane is intersecting x and y axes at a and a respectively and extending along the z-direction.

Plane fractions [P, Q, R] = [a, a, ∞]

Plane fractions [P, Q, R] = [1, 1, ∞]

Reciprocals of plane fractions:

$$\left[\frac{1}{P}, \frac{1}{Q}, \frac{1}{R} = \frac{1}{1}, \frac{1}{1}, \frac{1}{\infty}\right]$$

[h, k, l] = [1, 1, 0]

Question 7

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The Miller indices of a material in a plane are proportional to

1. The reciprocal of numerical parameters of the intercepts

2. The square of unit cell dimensions

3. The intercepts of the planes on the coordinate axes

4. The interplanar spacing

Answer (Detailed Solution Below)

Option 1 : The reciprocal of numerical parameters of the intercepts

Miller Indices Question 7 Detailed Solution

Concept:

Miller indices are the styles to designate the planes and directions in the unit cells and crystals.

Miller indices (hkl) are expressed as a reciprocal of intercepts p, q, and r made by the plane on the three rectangular axes x, y and z respectively. These are the unit distances from the origin along the three axes. Thus

$h = \frac{1}{p}, \ k = \frac{1}{q}, \ l = \frac{1}{r}$

where, p = intercept of the plane on the x-axis, q = intercept of the plane on the y-axis, and r = intercept of the plane on the z-axis.

Reciprocal of these intercepts are then converted into whole numbers. This can be done by multiplying each reciprocal by a number obtained after taking LCM of the denominator.

This gives the Miller indices of the required plane. The Miller indices are expressed by three smallest integers.

Question 8 View this Question Online >

If (3 2 6) are the Miller indices of a plane the intercepts made by the plane on the three

crystallographic axes are

1. (a, b, c)
2. (2a, 3b, c)
3. (a, 2b, 3c)
4. (2a, b, 3c)

Answer (Detailed Solution Below)

Option 2 : (2a, 3b, c)

Miller Indices Question 8 Detailed Solution

Concept:

Miller indices are the styles to designate the planes and directions in the unit cells and crystals.

Miller indices (h, k, l) are expressed as a reciprocal of intercepts p, q, and r made by the plane on the three rectangular axes x, y, and z respectively.

These are the unit distances from the origin along the three axes. Thus

$h = \frac{1}{p},\ k = \frac{1}{q},\ l = \frac{1}{r}$

where, p = intercept of the plane on the x-axis, q = intercept of the plane on the y-axis, and r = intercept of the plane on the z-axis.

Reciprocal of these intercepts are then converted into whole numbers. This can be done by multiplying each reciprocal by a number obtained after taking LCM of the denominator.

This gives the Miller indices of the required plane. The Miller indices are expressed by the three smallest integers.

Calculation:

Given:

Miller indices (3 2 6) = (h, k, l)

$h = \frac{1}{p},\ k = \frac{1}{q},\ l = \frac{1}{r}$

$p = \frac{1}{h},\ q = \frac{1}{k},\ r = \frac{1}{l}$

$(p, q, r) \Rightarrow \left(\frac{1}{h}, \frac{1}{k}, \frac{1}{l}\right)$

$(p, q, r) \Rightarrow \left(\frac{1}{3}, \frac{1}{2}, \frac{1}{6}\right)$

Taking LCM = 6 and multiplying with all the terms

$(p, q, r) \Rightarrow (2, 3, 1) \Rightarrow (2a, 3b, 1c)$

Question 9:

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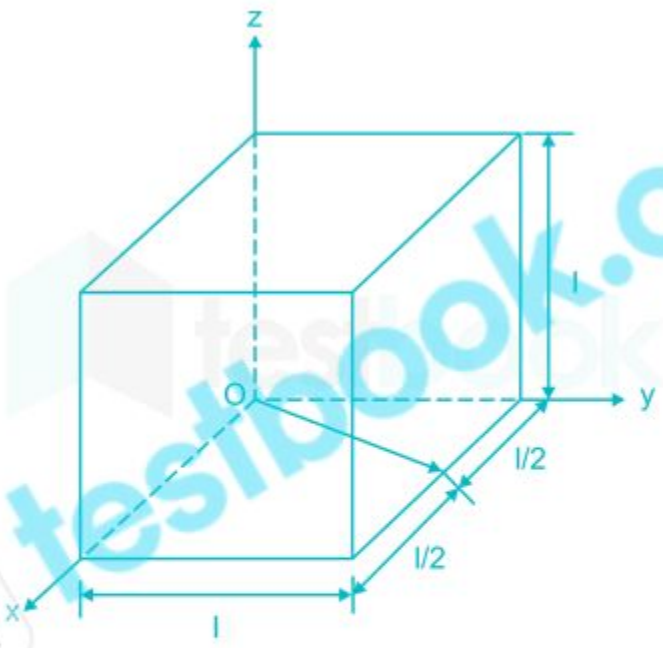
A unit cell of a crystal is shown in the figure. The miller indices of the direction (arrow) shown in the figure is



1. [1 2 0]
2. [0 2 1]
3. [0 1 2]

4. [2 1 0]

Answer (Detailed Solution Below)

Option 1 : [1 2 0]

Miller Indices Question 9 Detailed Solution

Concept:

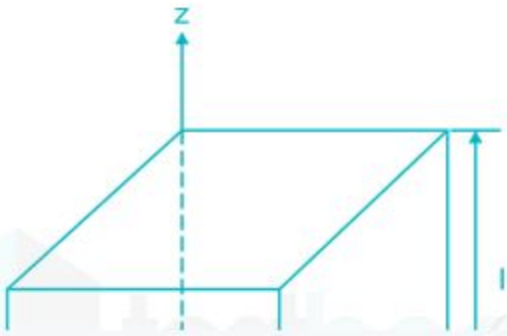
Procedure To find Miller Indices:

To find miller indices of direction, take the given direction vector as resultant and **find its component along the x, y and z-axis.**

If components are in fraction, then **convert** it to an **integer.**

Calculation:

Given:



Question 10:

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In a Triclinic crystal, a lattice plane makes intercepts at a length a, 2b and $-\frac{3c}{2}$. The Miller indices of the plane are

1. 3 : 6 : 4
2. 6 : 3 : 4
3. 6 : 3 : - 4
4. 6 : 3 : -2

Answer (Detailed Solution Below)

Option 3 : 6 : 3 : - 4