GROUP ACTIVITY 1
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HISTORY AND DISCRIPTION

- Developed by William Hallowes Miller
- Describes the orientation of planes in a lattice
- Helps to investigate events in material science
Continued

- The position of the planes or the direction of a vector in the lattice are usually described by three integers.
MAIN GOALS

• To avoid infinite intercepts.
• Miller indices correspond to the xyz coordinate
• Since crystal lattice structures are periodic structures, the whole structure can be constructed as the multiple of the unit cell structure.
HOW TO FIND MILLER INDICES

• Determine the intercepts of the plane intersecting the xyz coordinate.
  a1 – x direction, a2 – y direction, and a3 – z direction.

• Take the reciprocals of the intercepts.
  h = 1/a1, l = 1/a2, and m = 1/a3.

• Reduce the result to the smallest integer.

• (hkl) – for single plane and {hkl} for a group of planes.
Negative Miller values are denoted by a bar on top. Example - (hk l).

Planes without an intersecting intercept are taken as infinite planes (∞).
DIRECTION

- The direction of a lattice plane is usually normal to the plane, but not necessarily always.
- Directions are represented by vector components that are integer multiples of the basis vector.
- Directions are denoted by [def], and <def> for a family of directions.
PROCEDURE

• Determine the coordinated of the vector.
• Reduce the coordinate in to the smallest integer values.
• Present the resulting integers as [def].
• Family of directions as <def>.
• Example – [100], [010], and [001]
  - As a family <100>
EXAMPLES

1 – For the intercepts $x$, $y$, and $z$ with values of 3, 1, and 2 respectively, find the Miller indices.
SOLUTION

• Intercepts: \(x=3\), \(y=1\), and \(z=2\)
• Take the reciprocal of the intercepts
  \(h = 1/x\), \(k=1/y\), and \(l=1/z\)
  \(h=1/3\)
  \(k = 1/1\)
  \(l = ½\).
  Multiply \(h\), \(k\), and \(l\) by 6 to find the smallest integer.
  \((hkl) = (263)\)
EXAMPLE

- 2 – Determine the Miller indices of the given plane

- $X -$  
- $Y -$  
- $z -$  

Diagram:
- Axes labeled $a$, $b$, and $z$.
SOLUTION

• Notice that the plane does not intersect the $y$–axis. Therefore, take the intercept as $\infty$.

• Assume the intercepts of the $x$ and $z$ are $a$ and $b$.

• Take the reciprocals of the intercepts
  
  $h = 1/a$, $k = 1/\infty$, and $l= 1/b$

Multiply by $a*b$ to reduce to an integer value

$(hkl) = (b0a)$

In cubic structures, where the intercepts $x = z = a$

Then, $h=1/a$, $k=1/\infty$, and $z=1/a$

$a*(hkl) = (101)$
In what direction is the line segment shown above oriented?
SOLUTION

• In cubic lattice, the length of each plane is the same. Therefore, in our problem we have \{100\} planes.
• Find the distance the line traveled from each plane.

From the x-axis – 1 unit

   y-axis - 1 unit
   z-axis - 1 unit

So, the line intersects and travels in the direction of \(<111>\)
1. Answer the following multiple choice problems:

   Which statement below is false about \((1_{21})\) and \((1_{21})\)?

A. They are in the same set of planes
B. They are in the same family of planes
C. They are parallel with each other
D. They are perpendicular with each other
PROBLEM

2. What miller index plane is shown below?

A. (0 2 1)  B. (0 1 2)  C. (0 4 1)  D. (0 0 0)
PROBLEM

3. What six miller indices does the set \( \{100\} \) include? Can this set be written another way?

4. Find the Miller indices for the plane below? Assume a 1by 1 by cube.