# Ask The Oracle

## Question - to be answered in the next issue

I am new to faceting and would like to know more about Spirit lamps, heat sources and Dops: what they are -•what sizes -what shapes - where to buy -•how to avoid breaking stones.

**Q:** Some textbooks, when dealing with crystallography, use a system comprising of four numbers with a bar over the third number enclosed within curly brackets to describe and identify crystal faces. For example, {1 0 1 0} and {14 14 2 8 3}. I have also come across an alpha notation for example {h o h l} and symmetry classes described, for example, as 3 2 /m. None of the text books that I have seen that use this system take the trouble to explain it. Can anyone in the Guild enlighten me on how this system works?

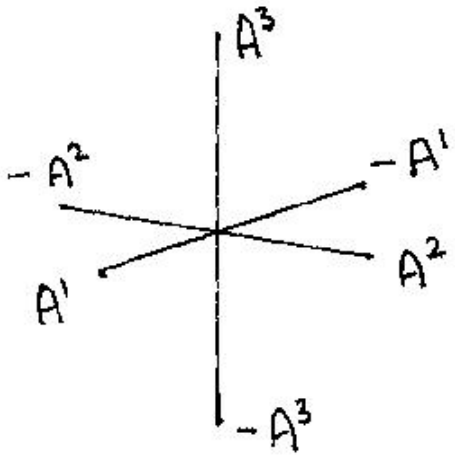
**You can find the original four page article covering this subject, written by Jim Finlayson, in the very first issue of Faceters Stonechat in October 1994, so it is well worth purchasing the CD of the back issues of the Guild newsletter, there is a wealth of information in there.**

## Answer by Jim Finlayson

**Miller Indices – introduced.**

A question has come in from a member for response by the "Oracle". The question relates to the use and meaning of Miller Indices in Crystallography. For my sins, and because I wrote a short article on this subject, for our magazine, in 1996 I drew the short straw to respond to this one. I must point out that after publication of the 1996 article I was mildly rebuked by a ***real*** mineralogist that I was living in the nineteenth century (which was true) and while the article was accurate it was even at that time, out dated. Thus, since my references are still from the nineteenth century, and really even a basic description of Miller Indices is beyond the scope of this magazine, I will try to explain the principles without going into the nitty-gritty.

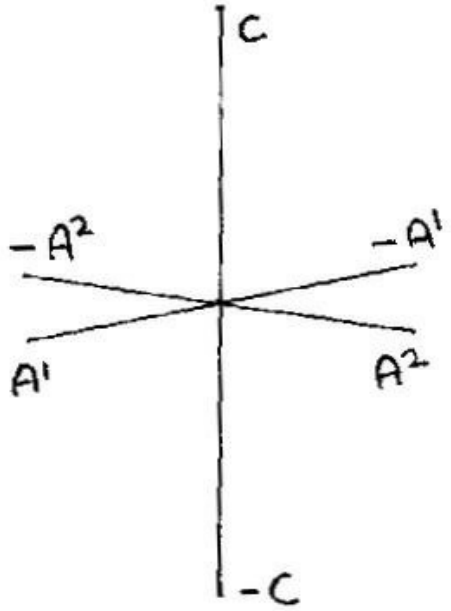
First, since Miller Indices are a property of crystals and crystals are divided into seven crystal systems (for simplicity we'll say six, as the hexagonal system can be divided into the hexagonal and trigonal systems), it is necessary to define the basics of these crystal systems before looking at Miller Indices.




Cubic FIG. 1

All crystals are allocated a crystal system depending on the shape of the crystal as it forms in nature and specifically how the natural faces of the crystal relate to each other and to the axes

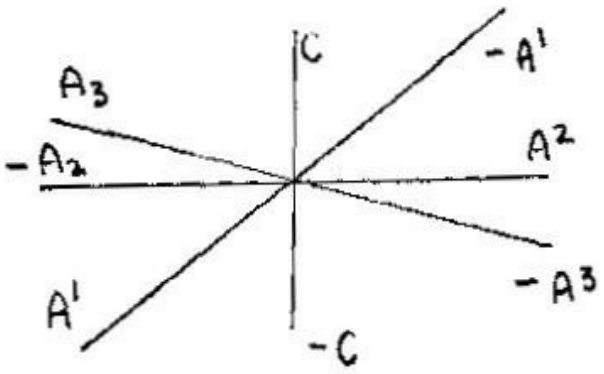
of the crystal. It must be emphasised here that this is absolute basic information required to give you a feel for what Millar Indices are for – nothing more. It must also be emphasised that even this lowly level of information is not essential to become a good, or even excellent faceter, it is of interest only if you wish to expand your interest in faceting into crystallography and mineralogy.




Tetragonal FIG. 2

The six systems are named as follows;

1. **Cubic**, also referred to a Isometric. Each axis is at 90° to the other axes and all axes are the same length. See Fig.1
2. **Tetragonal**. As the cubic but the vertical axis is either longer or shorter than the two horizontal axes, which are of equal length. See Fig.2
3. **Hexagonal (includes Trigonal).** Has three horizontal axes (all the same length) at 120° to each other and one vertical axis at 90° to the plane of the three horizontal axes. The vertical axis is not the same length as the horizontal axes. See Fig.3.
4. **Orthorhombic.** As the cubic system but all three axes are of different lengths.
5. **Monoclinic.** Two horizontal axes at 90° to each other and one vertical axis which is not at 90°to the plane of the two horizontal axes. All axes lengths are different.
6. **Triclinic.** Two "horizontal" axes not at right angles with each other, and the one vertical axis not at right angles to the plane of the horizontal axes. All three axes have different lengths.




Hexagonal FIG. 3

As the purpose of this article is to give an insight to Miller Indices I will now restrict my explanation to the simplest system, i.e. the Cubic system. The cubic system can take on seven forms, but for the sake of brevity I will restrict this article to two, i.e. the **cube** and the **octahedron.** See Figs. 4a and 4b resp.. Note: The accepted notation for naming the axes is to give all axes having the same length the same letter – in this case "a". To distinguish between them a superscript as attached e.g. "$a^1$". Where an axis has a different length it is given a different letter. See Figs. 2 and 3.

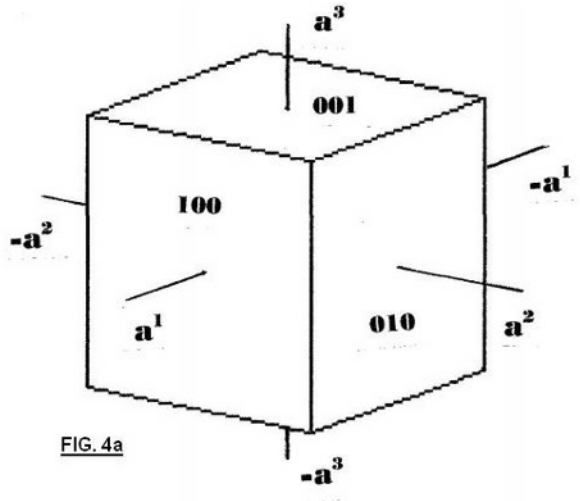



FIG. 4a

Refer to Fig.4a. The Miller indices on each face of the cube indicate which axes are cut by that face, e.g. the face to the right (**0 1 0**) indicates that that face cuts axis $a^2$ only, at distance one unit from the centre of that axis. Similarly, the face on the left (**1 0 0**) indicates that that face cuts axis $a^1$ only, at a distance one unit from the centre of that axis.

Refer to Fig. 4b. The Miller indices on each face of the octahedron indicate which axes are cut by that face, e.g. the face at top right (**1 1 1**) cuts each of the three axes ($a^1$, $a^2$, $a^3$) at distance one unit from the centre of each axis.

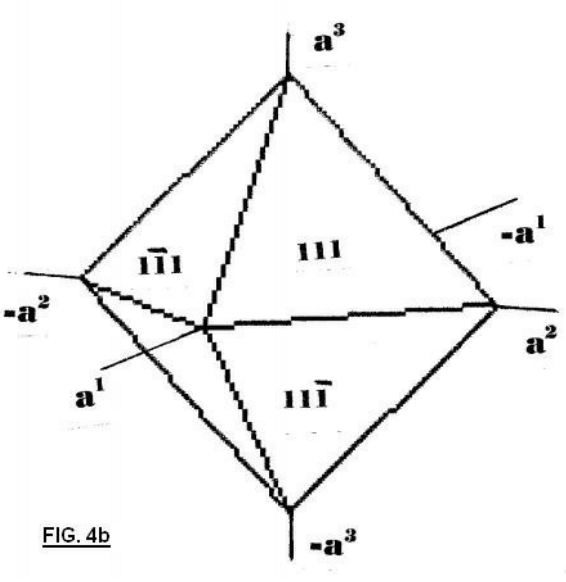


FIG. 4b

Similarly, the face at top left (**1 1 1**) cuts each of the three axes at distance one unit from the centre of each axis. However, in this case the $a^2$ axis is cut at the negative side of that axis therefore the $a^2$ indicator has a bar over the **1** (which refers to $a^2$).

As I have already indicated, this is a complex subject which is only touched upon here. It might however give you some idea whether you wish to proceed to learn more. There are many tutorials on the internet which will take you much further than this "toe in the water" sketch.

The following two should prove useful;

"http://www.doitpoms.ac.uk/tlplib/miller_indices/lattice.php"

"http://www.rockhounds.com/rockshop/xtal/index.shtml"

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**Q:** I have been having some problems with stones exploding while I am faceting them, especially Tourmaline. Can someone please shed some light on why this might be happening and how to stop it?

**Answer** by Mike Richardson

Some rough material is riddled with latent cracks which may not be easily visible. Tourmaline is one of these materials and is rated as moderately heat sensitive. A latent crack is a stress concentration which is basically a crack waiting to happen. All it needs is a bit of additional stress to to set it off.

This can be imparted during the dopping process (thermal shock), grinding process (vibration induced), or polishing process (usually thermal again).

Often the cracks are sensitised during hot dopping and whilst the stone may be still in one piece, it takes just a small amount of further load to trigger rapid crack propagation.
Whilst hot wax dopping is an essential faceter's skill to be learned and if done properly is quick and reliable, I rarely use it now and since I started cold dopping I have never lost a stone due to crack propagation. My preferred method is superglue on lapped wax for the table and rapid araldite for the pavilion. This is adequately described in previous issues of Faceters Stonechat.