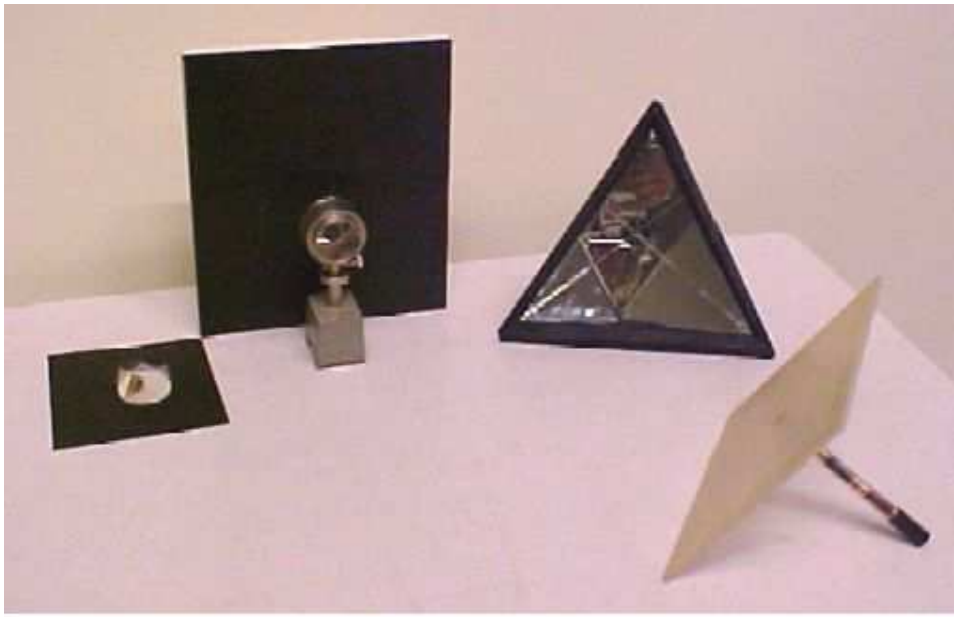
Corner cube

Aim: To show that the reflecting light ray in a corner cube is always parallel to the entering ray.

Subjects: 6A10 (Reflection From Flat Surfaces)

Diagram:



Equipment:

- Prism corner cube, glass.
- Prism corner cube in fitting.
- Three planar mirrors arranged as corner cube.
- Laserpointer fitted in transparant ground perspex.

Corner cube

Presentation: The objects are presented to the students. They are invited to look with one eye closed into the corner cube and move their head. They will notice that their eye remains caught in the center of the corner cube and that up-down and left-right are reversed.
Directng a laserbeam towards a cornercube produces a reflection back to the laserpointer as reflection on the ground screen shows: the reflection is always parallel to the incident beam on the corner cube, It does not matter from which direction the laserbeam is coming as long as it "sees" the three mirrors.

Explanation: In a planar mirror the image and object are equidistant from the mirror surface. But there is also inversion:
a right-handed coordinate system is converted into a left-handed one (see Figure1).

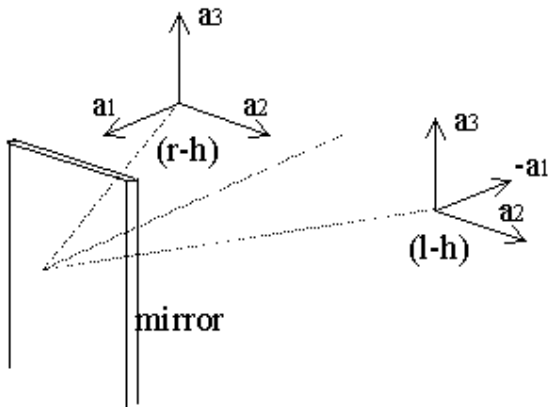


Figure 1

We see that after reflection a1 has changed into -a1, while a2 and a3 remain the same. Vectornotation is applied to treat this.
Figure 2 shows that reflection in three mutually perpendicular mirrors (xz, xy, yz) will produce ray (vector) inversion. Three reflections occur:

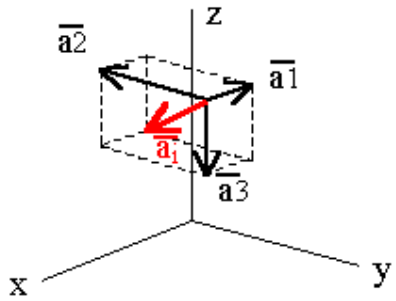


Figure 2

-against xz-plane, a2 changes into -a2,
-against xy-plane, a3 changes into -a3 and
-against yz-plane, a1 changes into -a1.
So the finally reflected ray is a_r=<-a1,-a2,-a3>=-a_i. So the reflected ray is parallel to the incident ray.

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Remarks:

- The principle that the resulting reflection is always perpendicular to the initial ray is used in an array of corner cubes on the moon. Together with a laser beam from earth the measurement of the reflection is used to calculate very precisely the distance from Earth to the Moon.

Sources:

- Hecht, Eugene, Optics, pag. 178-180 and 195
- Stewart, J, Calculus, pag. 791 and 796