LU4: LAB 1-4C: Law of Reflection

REFERENCES:

- *Fundamentals of Light & Lasers* (OPTEC), 3rd edition
- Module 4, Laboratory 1-4C, page 49-51
- http://optecvideo.opteccrm.org, Video 15: Read these instructions and watch the videos before doing the lab.
  - Course 1: Fundamentals of Light and Lasers
  - Lab Activity Video
  - Choose Video #

THEORY:

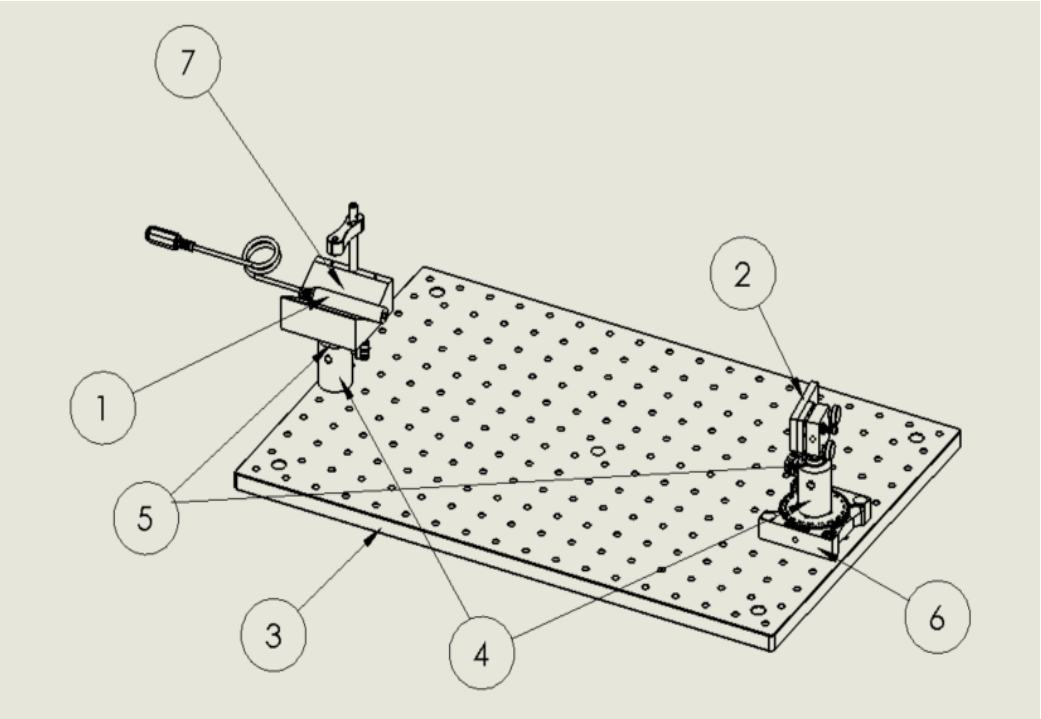
The Law of Reflection states that when a beam is reflected, the angle of incidence will equal the angle of reflection. Both angles are typically measured between a normal to the surface (a line perpendicular to the surface at the point of incidence) and the beam. The angle of incidence is the angle between the incoming beam and the normal. The angle of reflection is the angle between the reflected beam and the normal. Since these angles are equal, the angle between the incident beam and the reflected beam is twice (2x) the angle of incidence.

OBJECTIVE:

Demonstrate the Law of Reflection by measuring angles for incident and reflected beams.
To do a comprehensive and precise Lab Write-up.
Take appropriate pictures (5 or more) to prove/show lab work.

EQUIPMENT:

Laser Diode Module (key 1)
Laser Diode Power Supply
Mirror assembly (key 2)
Optical Breadboard (key 3)
(2) Post Holder (key 4)
(2) Post (key 5)
Rotational Stage (key 6)
V-Clamp (key 7)
Observation screen
Misc hardware

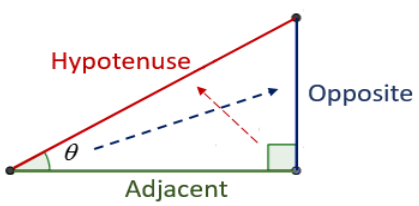


EQUATIONS:

tan θ = (side opposite/side adjacent)
θ = tan^{-1} (side opposite/side adjacent)

NOTE: If tan θ = X, then θ = tan^{-1} X
θ is an angle in a right triangle
Side opposite is the length of the side opposite θ
Side adjacent is the length of the side next to θ (not the hypotenuse)

SOHCAHTOA



SOH $\sin\theta = \frac{\text{Opposite}}{\text{Hypotenuse}}$

CAH $\cos\theta = \frac{\text{Adjacent}}{\text{Hypotenuse}}$

TOA $\tan\theta = \frac{\text{Opposite}}{\text{Adjacent}}$

SET-UP: Read the entire SET-UP and PROCEDURE before starting the lab.

1. Mount a post holder near the center of the short edge of the breadboard.
2. Mount the V-clamp on a post and insert it into the holder
3. Mount the rotational stage at the opposite end of the breadboard.
    a. Locate the center of the stage on the same line of holes as the V-clamp post holder.
4. Mount a post holder in the center of the rotational stage
5. Mount the mirror (M1) on a post and insert it into the holder on the rotational stage
6. Place a non-reflecting beam block behind the mirror to contain the laser beam.
7. Place the laser diode module in the V-clamp and adjust the assembly so the laser points along the line of holes in the breadboard to the mirror.
8. Adjust the laser mount and/or the mirror mount so a horizontal beam from the laser will be reflected back to the laser aperture by the mirror
9. Create an observation screen (8.5" x 11" white paper, landscape on a book, piece of cardboard, etc.) and position it behind the laser. This is where the laser beam spots will be marked.

PROCEDURE: Read this complete procedure before following it.

Always contain the laser beam. Keep direct and reflected beams away from yourself and others.

1. Adjust the rotational stage so that it is set to 0°.
2. Turn on the laser.
3. Reposition the mirror assembly in the post holder (keep rotational stage set at 0°) and use the adjustment screws on the back of the mirror to reflect the laser beam directly back to the center of the laser aperture.
4. Use the vertical adjustment screw on the back of the mirror to move the laser beam straight upward.
    a. Adjust the beam until it is projected directly vertical above the laser and V-clamp and is visible within 2.54 cm of a vertical edge of the observation screen.
5. **Mark** the laser beam with a dot on the observation screen. Label it LB_0 (laser beam zero spot)
    a. A fine point, wet tip marker is best for this.
6. **Measure** the horizontal distance from the mirror to LB_0. **Record** the number in a table (like the one below) in the Lab Write-Up in each of the five cells in the column labeled "X".
7. **Take a picture of this set up to include observation screen and include in Lab Write-up.**
8. **Rotate** the rotational stage to a setting of 4°. Laser beam should move horizontally from LB0.
9. **Mark** the laser beam with a dot on the observation screen. Label it LB1
10. **Measure and record** the distance from LB_0 to LB_1 in the 4° row at column Y.
11. **Repeat** steps 9 and 10 at four additional equally spaced rotational stage settings. **Measure & record** the rotational stage setting and the corresponding distances from LB_0 in the appropriate columns
12. **Include a picture of the observation screen with all appropriate labels in the Lab Write-Up**.

Rotational Stage Angle (deg)	Screen Distance, X (mm)	Spot Distance, Y (mm)	Calculated Total Angle, θ (deg)	Expected Total Angle (deg)	(%) Difference
4°	M1 to LB0	LB0 to LB1:			
	M1 to LB0	LB0 to LB2:			
	M1 to LB0	LB0 to LB3:			
	M1 to LB0	LB0 to LB4:			
	M1 to LB0	LB0 to LB5:			

CALCULATIONS:

1. Calculated Total Angle, θ can be found from: $\theta = \tan^{-1}$ (side opposite/side adjacent) $= \tan^{-1}(Y/X)$.
    a. **Calculate** θ for each rotational stage angle and **record** the result. **Show** your work.
2. The Rotational Stage Angle is the angle of incidence of the beam. The Law of Reflection states that the angle of reflection equals the angle of incidence so the Expected Total Angle is just twice the angle of incidence (double the Rotational Stage Angle). **Record** the Expected Total Angle for each rotational stage angle.
    a. **Calculate** the % Difference & **record**. **Show** your work.
3. Explain why the difference **and** why or why not acceptable. **THINK.**

DISCUSSION:

- The Law of Reflection has two parts:
    - 1) The angle of incidence equals the angle of reflection
    - 2) The incident beam, the reflected beam, and normal all lie in the same plane.
- The Law of Reflection applies at the point on the reflecting surface where the beam is incident regardless of the shape of the rest of the surface.