As a team at your table, you will carry out 2 experiments. For these experiments you have:

1. A flashlight
2. A metre stick
3. A protractor

First, decide on your roles in the experiments, e.g., experimentalist, note taker, calculations, number checker, graphing, etc. Once you've decided as a team, write down your members and roles on the Lab 6 Table Worksheet. Make sure everyone participates in observation at some point in experiment 1 or 2.

N.B.: Be sure to mark your table number on the end-of-lab quiz or you may not receive credit!

-1.0.1 Power vs. Distance

In this experiment, you will measure how distance and angle affect the intensity of sunlight, and corresponding energy, that falls on the ground.

1. For this experiment, push the sleeve on the front part of the flashlight all the way **in**, i.e., make the total length of the flashlight as **short** as possible.
2. Shine it at the whiteboard straight on from 0.5 ft away. As a group, find and agree on the position of the edge of the beam.

   You can use markers to outline the dimensions a and b of the flashlight beam. They should be about the same, i.e., the beam should be circular.
3. Next, shine the flashlight at the whiteboard and measure the height a and width b of the beam from several different distances. Make measurements with the light bulb at 0.5, 1, 1.5, and 2 ft.
4. Fill in a and b in the table. Then, carry out the calculations to find the area the light is spread over, i.e., calculate the number of watts per square centimetre at each distance.

   To simplify the calculations, assume that the flashlight produces 10,000 watts (W) of light output. Measure a and b in centimetres, and then use area $= 0.79\,ab$. Next, calculate 10,000 watts/area to find the intensity in watts per square centimetre.
5. Plot your results of intensity versus distance between the board and the flashlight's light bulb. Pick one other distance to fill in any gap in your graph, or to check one of the first measurements if it seems inconsistent with the others.

-1.0.2 Power vs. Angle

For this experiment, we will measure the effect of changing the angle while keeping the flashlight bulb at a constant distance of 1 ft from the whiteboard.

1. Change your role in this experiment, and write down your new role on the table worksheet.

2. For this experiment, pull the sleeve on the front part of the flashlight all the way **out**, i.e., make the total length of the flashlight as **long** as possible.

3. Use the yardstick to keep the flashlight's light bulb at a fixed distance of 1 ft from the board, and use a protractor to measure the angle.

   As before, you can use markers to outline the dimensions a and b of the flashlight beam. It will elongate into an ellipse at smaller angles. Try to keep the ellipse of the beam centered on the base of the yardstick, so the width b stays about the same.

4. Make measurements at 90°, 71°, 47°, and 24°. Assume that these smaller angles correspond to the altitude of the Sun in Amherst at noon on the summer solstice, the equinoxes, and the winter solstice respectively.

   As before, use area $= 0.79\,ab$ to find the area of the flashlight beam.

5. As before, divide 10,000 watts by the area you measured at each angle. Determine your y-axis scale based on the range of values you obtain, and fill in the table with your measurements and calculations. Then, plot the data.

6. From your plot, at what angle does the intensity of light match the intensity at 1.5 ft (50% farther away than 1 ft)? Try to estimate what that angle would be, then carry out one last measurement at that angle and fill it out in your table.

-1.0.3 Distance vs. Angle

The angle you measure relative to the whiteboard is like the "altitude" of the Sun. So when the flashlight is shining straight at the board, it is like having the Sun at the zenith, 90° from the horizon.

At noon on the winter solstice in Amherst, the Sun has an altitude of about 24°. By comparing your graphs, estimate the distance where the light intensity (in watts per square centimetre), shining at 90°, is the same as the light intensity (in watts per square centimetre) at a distance of 1 ft and an angle of 24°.

What is your estimate? _____ (Record this for the next section.)

-1.0.4 Moodle Lab Quiz

Go to the section for this lab on the Moodle page and complete the End-of-Lab Quiz. Write your name on the Table Worksheet, take a picture of it, and hand it in.