Physics in light-intensity

Science, Physics

Investigations in Light Intensity Change through Angular Displacement Guiding Question How does the intensity of light change as the angle of incidence to the light source increases? Prediction of Results Predict what you think will happen and what type of equation and graph might best fit the data representing the intensity of a light as the angle of incidence increases. Objective After completing this lesson, a student should be able to analyze light intensity striking a surface at varying angles of incidence.

Materials CBL, TI-83 Plus calculator, light sensor, lamp with light bulb (60 to 100 watts), tape measure, Scotch tape (or similar), protractor, sheet of paper, ANGLE program, daily log Vocabulary the normal angle of incidence periodic sinusoidal regression Introduction You have completed an investigation of light intensity changes with varying distance. You will continue investigating intensity changes, but now you will note the change of intensity as light strikes a surface through increasing angles of incidence.

As Figure 1 indicates, the angle of incidence is the angle at which light strikes a surface. The normal is an imaginary line perpendicular to the plane on which light strikes. The angle of incidence is the angle between the normal and an incident (that is, an incoming) light ray. Angle of incidence Normal Incident Light Ray Figure 1 As the angle of incident light increases, is it more reasonable to think that its intensity increases or decreases? As you think about this question, consider whether you are more likely to get a sunburn in the late evening when the sun is low on the horizon greater incidence angle) or at noon time when the sun is more overhead (smaller incidence angle), as sketched below? Is it usually hotter at noon or in the late evening? Evening Sunlight Noon Sunlight If you suspect that intensity

decreases with increasing angle of incidence, you are on the right track. Assuming for the moment, then, that the light intensity (I) decreases as the angle of incidence (a) increases, we can say the relationship between intensity and incidence angle are inversely proportional over the angles involved.

But you may note that as the sun rises through the morning and then sets toward the evening, its angle of incidence decreases, reaches a minimum at noon, and then begins to increase again into the evening. That is, the incidence angle starts at sunrise at a maximum of 90°, decreases to a minimum until noon (near the equator it decreases to 0°, but not in Alaska), and then increases back to a maximum to 90° at sunset.

You can see that this cycle repeats itself time and again: the incidence angle begins at a maximum, then decreases to a minimum, increases to a maximum, and so forth. Figure 2a below shows just such a cycle. Intensity, however, changes as the inverse of the incidence angle, so is represented in the Figure 2b cycle. Morning Noon Evening Figure 2a – Changing Incidence Angle Morning Noon Evening Figure 2b – Changing Light Intensity This cycle of repeating events is called periodic and you might recognize the curves as sine waves.

Here is an equation that describes intensity as a sine wave: I = sin(a) (intensity is proportional to the sine of the incidence angle, a). It is important to remember in this comparison that the angle withrespectto the sun will always be between 90° and 0°. This means that if we determine one quarter of the period (or cycle), then we can know through regression analysis what the rest of the curve should look like. You will complete an investigation that

does exactly this: determine the intensity of a light as the angle of incidence changes from 0° to 90°.