Sample Practicums

Light and Optics
Critical Angle
*Developed by Ted Hale*

Problem

You are to determine the depth of a light bulb under water by observing the circle of light produced on the water surface.

Equipment and Lab Set Up

1. Large bucket
2. Light bulb and base (1.5 V)
3. Voltage source
4. Wire
5. Lycopodium powder
6. Ruler
7. Clamps
8. Dividers
9. Battery
10. Table of indices of refraction

wire leads

Bucket showing the circle of light
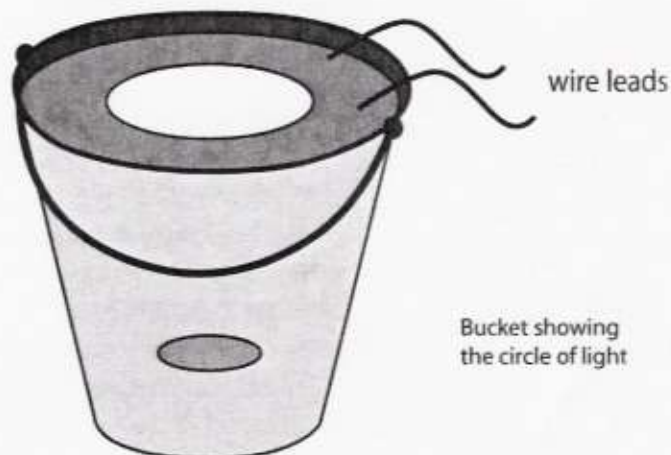
Students must measure the diameter of the circle of light surface. Dividers will allow this measurement to be made accurately without disturbing the water surface.

| Measurements	Sample Data
Diameter of circle	$D = 20.0$ cm
Index of refraction of water	$n_w = 1.33$

Comments

Painting the inside of the bucket flat black and sprinkling the surface of the water with lycopodium powder will increase the visibility of the circle of light. It should be emphasized that measurements are to be made carefully. The socket and the wire leads to the bulb at the bottom of the bucket are dipped in paraffin to prevent the system from shorting out. The wires leading to the bulb should also be attached to the side of the bucket with clamps to prevent any unwanted movement of the light source. When checking the students' prediction of depth, be sure to measure to the filament of the bulb and not just to the top of the bulb. A second bulb that the students can see and handle helps the class understand this measurement. Placing the light bulb on a stand of some sort in the bucket prevents the students from measuring the outside of the bucket.

Sample Calculations
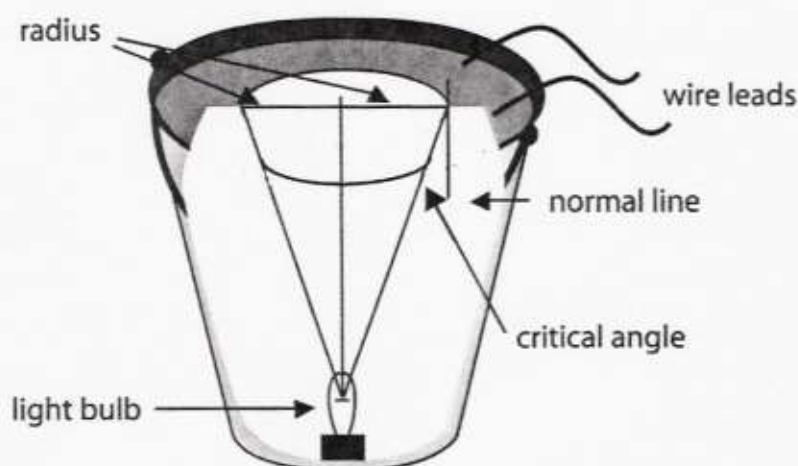
The critical angle for water: $n_w = 1.33$

$$\sin\theta_c = \frac{1}{1.33}$$
$$\sin\theta_c = 0.75$$
$$\theta = 48.6°$$

Use the tangent of the critical angle and the radius of the circle on the water surface to determine the depth of the light source.

$$\tan 48.6° = \frac{10.0 \text{ cm}}{D}$$

$D = 8.81$ cm

Measured value was 8.75 cm.

Comparisons are given for the results calculated by three different classes.

	Class 1	Class 2	Class 3
Calculated depth	6.83 cm	6.17 cm	6.47 cm
Measure depth	6.7 cm	6.3 cm	6.5 cm