UBC Physics Circle

Session 3: Lecture

November 7, 2019

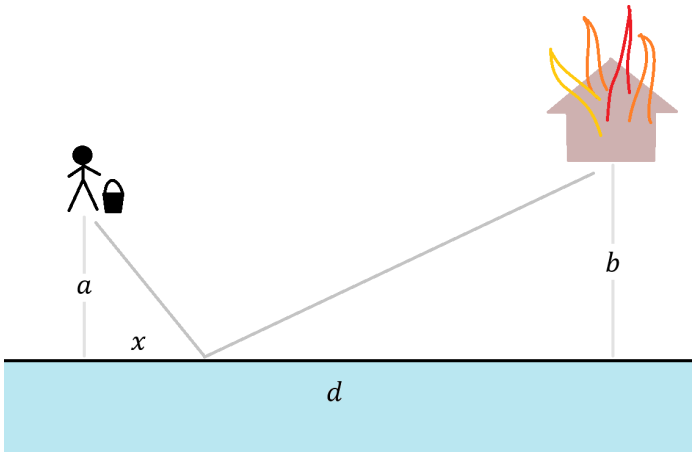
In the first part of the lecture we will cover basics of ray optics, deriving **reflection**, **refraction**, and **dispersion** phenomena. In the second part, we will apply these to understand **rainbows** and their characteristics. You will find plenty opportunity to explore these concepts through fun problems, discussions, and demos.

Ray Optics

Fermat's principle, laws of reflection and refraction, dispersion

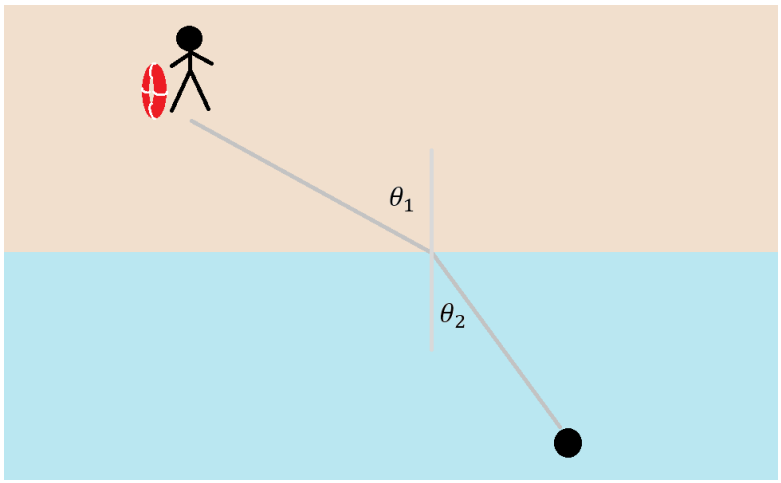
1 House on fire

While serenely walking to work, you notice a house on fire, a (horizontal) distance d away. Luckily, you are carrying an empty bucket and there is a close-by river located a distance a from you and a distance b from the house. Assuming you can instantly fill the bucket, what path should you take to put out the fire as fast as possible?



2 Speedy rescue

At work, you're on shift as a beach lifeguard when you see a swimmer calling for help. You take the fastest route to rescue them so there is minimum harm. What relation holds between the angle you run at θ_1 and the angle you swim at θ_2? You can run with a speed of v_1 and swim with a speed of v_2.

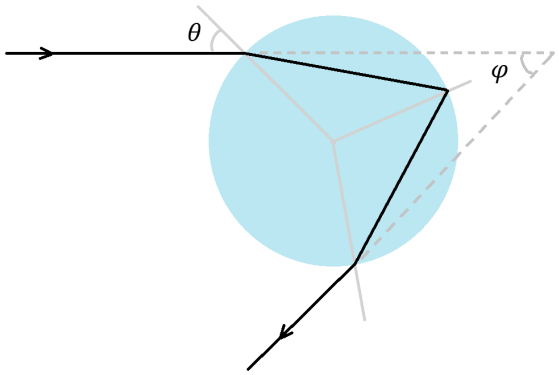


Rainbows

When do we see it? How far away is it? Is there more than one bow?

3 The primary bow

The diagram below shows one of many ways a ray of light can interact with a rain drop; but the one that is responsible for the primary bow. The ray, incident on drop with angle θ is refracted upon entering, is then internally reflected once and refracted again upon exit.



Find the perceived angle between the incident ray and exiting ray, φ in terms of θ. Take index of refraction of water for this wavelength to be n.

Rainbow topics for further exploration

- Secondary and higher-order bows
- Supernumerary bows
- Polarization of bows