

**MATH 111: PRACTICE PROBLEMS: RELATED RATES AND
EXTREMA**

Problem 1. On a starkly cold February afternoon, Henry David Thoreau crosses a meadow on a surveying job. Pausing to observe the vocalizations of a northern bobwhite, the sun strikes his 67-inch tall frame and casts a blueish shadow across a short patch of meadow. An astute observer of all natural phenomena, Thoreau notes that the sun is 12° above the horizon and moves a tenth of a degree towards the horizon over the course of ten minutes. Use this information to estimate the rate at which Thoreau's shadow is lengthening.

Problem 2. At a meeting in 1839, the Transcendental Club of Cambridge, Massachusetts resolves to start publishing *The Dial*, a biannual journal. If the Club wishes to print pages featuring 24 in^2 of text and margins of 1 in on the sides and 1.5 in on the top and bottom, what dimensions should their rectangular paper be in order to minimize the amount of paper used?

Problem 3. Herman Melville cloisters himself to write in his cabin aboard the *Acushnet* during a calm spell in the south Pacific. A candle on his desk decreases in height at a constant rate of 3 cm/hr. A book which is 20 cm tall stands between the candle and the wall. The book is ℓ_1 cm from the wall and ℓ_2 cm from the candle. Melville looks up and observes the shadow when the candle is 4 cm tall. At this moment, at what rate is the length of the book's shadow increasing?

Problem 4. While leafing through books in the Harvard library, Ralph Waldo Emerson notes a curious shape: a circle with an isosceles triangle inscribed in it. After considering the image for a while, Emerson concludes that the triangle is the largest isosceles triangle which can be inscribed in the circle. Specify the shape of the triangle and its area in terms of the radius r of the circle.