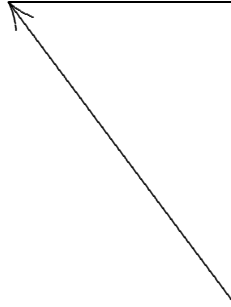


63. We construct a right triangle starting from the clearing on the south

bank, drawing a line (200 m long) due north (*upward* in our sketch) across the river, and then a line due west (upstream, leftward in our sketch) along the north bank for a distance  $(82 \text{ m}) + (1.1 \text{ m/s})t$ , where the  $t$ -dependent contribution is the distance that the river will carry the boat downstream during time  $t$ .



The hypotenuse of this right triangle (the arrow in our sketch) also depends on  $t$  and on the boat's speed (relative to the water), and we set it equal to the Pythagorean “sum” of the triangle's sides:

$$(4.0)t = \sqrt{200^2 + (82 + 1.1t)^2}$$

which leads to a quadratic equation for  $t$

$$46724 + 180.4t - 14.8t^2 = 0 .$$

We solve this and find a positive value:  $t = 62.6 \text{ s}$ . The angle between the northward (200 m) leg of the triangle and the hypotenuse (which is measured “west of north”) is then given by

$$\theta = \tan^{-1} \left( \frac{82 + 1.1t}{200} \right) = \tan^{-1} \left( \frac{151}{200} \right) = 37^\circ .$$