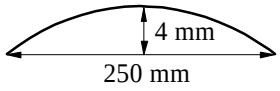
Due to problems in the manufacture of tinplate coils, the edge of the strip can be slightly longer than the centre. This causes a 'wave' on the wall of the coil but can be rectified by differentially stretching the strip to make the edges flat.

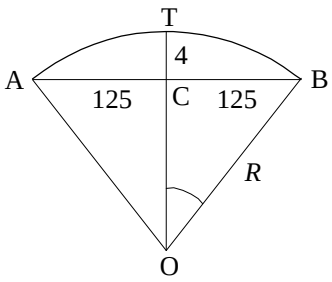
As an example, suppose that the wave when laid flat on a table is found to have a height of 4 mm and a length of 250 mm, as shown.



The percentage *elongation* needs to be determined in order to eliminate this wave condition. To achieve this calculation, it is assumed that the wave is an arc of a circle, so that

percentage elongation =% difference between the chord and arc length

as illustrated below.



If the radius of the circle is assured to be R mm, then

Problem 1

Determine the length of

Solution

Applying Pythagoras' theorem to triangle OBC gives

$$\begin{aligned} & OB^2 = BC^2 + CO^2 \\ \Rightarrow \quad & R^2 = 125^2 + (R-4)^2 \\ & = 125^2 + R^2 - 8R + 16 \\ \Rightarrow \quad & 8R = 125^2 + 16 \\ \Rightarrow \quad & R = \frac{15641}{8} \approx 1955 \text{ mm} \end{aligned}$$

Activity 1

Find the value of the angle q and hence determine the arc length AB, and the percentage difference between this length and the chord AB.

Exercises

1. Find the percentage elongation for a wave of height 5 mm and length 500 mm.

2. Generalize the results to find the percentage elongation for a wave of height h mm and length l mm.

Answers to Exercises

1. 0.0027%

2. $\left(\frac{2R}{l}\sin^{-1}\left(\frac{l}{2R}\right)-1\right)\times 100\%$ where $R=\frac{h}{2}+\frac{l^2}{8h}$