

Programming Lab #4d

Automobile Tire Sizes

Topics: Integer arithmetic.

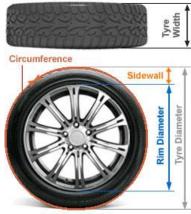
Prerequisite Reading: Chapters 1-5

Revised: November 30, 2020

Background: Automobile tire sizes use a combination of metric and English units and a percentage. For example, a typical tire might be specified as 225/45R17. The first number (225) is the tire's width in *millimeters*. The second number (45) is the tire's aspect ratio; this *percentage* represents the ratio of the sidewall's height to the tire's width. The last number (17) is the diameter of the metal rim in *inches*. The overall diameter of a tire is thus the rim diameter plus twice the sidewall height. I.e., the diameter of a 225/45R17 tire is given by:

$$17 + 2 \times (\frac{45}{100} \times \frac{225}{25.4})$$
 inches.

Assignment: Create ARM assembly functions for the diameter and circumference in inches:



TyreSizeCalculator.com

where W is the tire width in millimeters, A is the aspect ratio (an integer less than 100), and R is the rim diameter in inches. Since you will be using integer arithmetic, you won't be able to return values that have a fractional part. Instead, each function computes two 32bit values and returns them as a single 64-bit number:

$$Diameter = R + 2 \times \frac{A}{100} \times \frac{W}{25.4} = R + \frac{2 \times A \times W}{2540} = R + \frac{A \times W}{1270}$$

$$D_{63-32} = R + Quotient \ of \ \frac{A \times W}{1270}$$

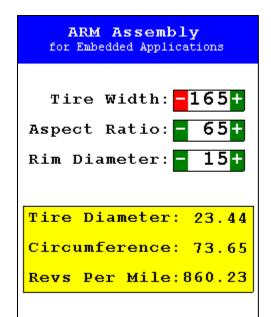
The most-significant half of the return value is the integer part of the result; the least-significant half determines the fractional part.

 $D_{31-00} = Remainder \ of \ \frac{A \times W}{1270}$

$$\begin{split} \textit{Circumference} &= \pi \times \textit{diameter} = \pi \times \left(D_{63-32} + \frac{D_{31-00}}{1270}\right) \\ &= 3.1416 \times \left(\frac{1270 \times D_{63-32} + D_{31-00}}{1270}\right) \\ &= \frac{4987290 \times D_{63-32} + 3927 \times D_{31-00}}{1587500} \end{split}$$

$$\begin{aligned} \textit{C}_{63-32} &= \textit{Quotient of} &\quad \frac{4987290 \times \textit{D}_{63-32} + 3927 \times \textit{D}_{31-00}}{1587500} \\ \\ \textit{C}_{31-00} &= \textit{Remainder of} &\quad \frac{4987290 \times \textit{D}_{63-32} + 3927 \times \textit{D}_{31-00}}{1587500} \end{aligned}$$

The main program (download from here) converts these results into real numbers and displays the diameter, circumference and revolutions per mile with two fractional digits.



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