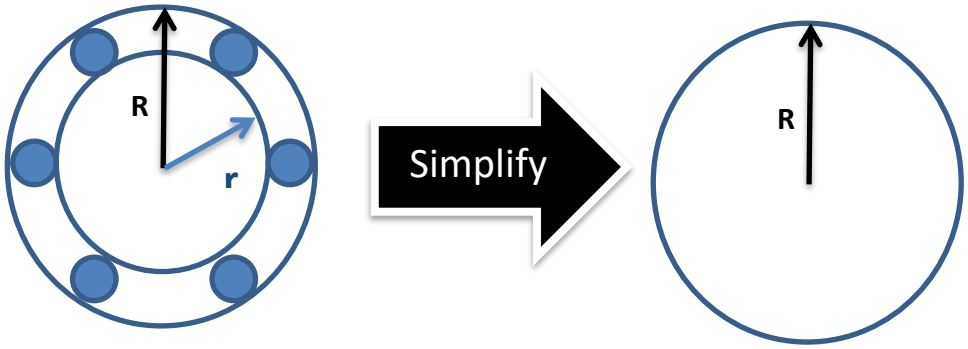
Answer on Question #66909 – Math – Trigonometry

Question

Find the value of common radius which is 4 of the ball bearings.

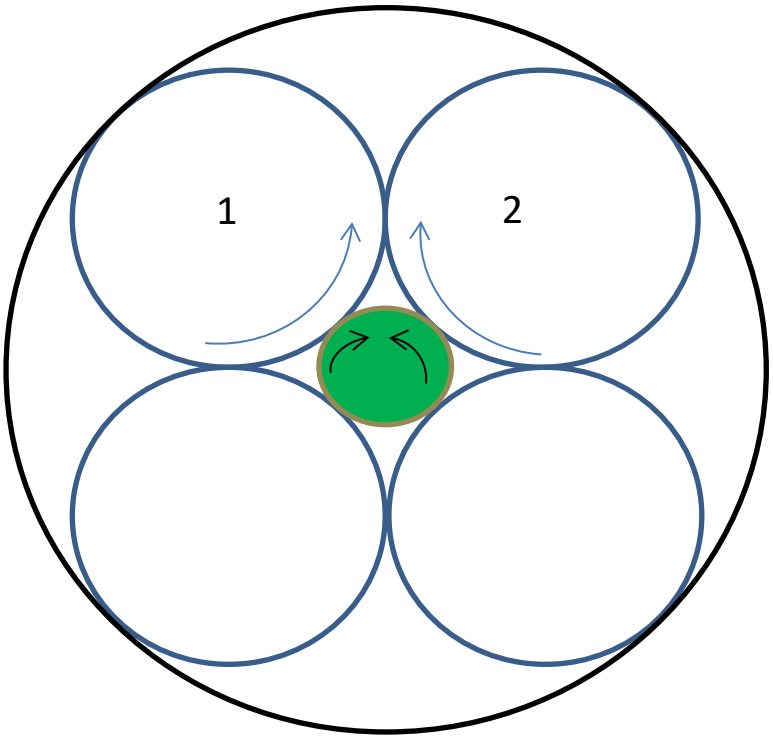
Solution

Ball bearing is pictured below. The blue circles are balls. The balls are rolling between two bearing races. Let's suppose that R is the radius of external race and r is the radius of internal race. The next step is simplifying the sketch, where we do not need to draw all parts of ball bearing:



Combine 4 of the ball bearings (see below).

Here we have four balls; small internal race (green circle) and big external race. **But we have a small problem.** This big ball bearing (combined of 4 ball bearings) will never work. Suppose that 1 ball bearing rotate in a counterclockwise (CCW) direction. Therefore the 2 ball bearing will rotate in a clockwise (CW) direction. According to 1 ball rotating the small internal race (green circle) rotates in a CW direction. In the same way, the small internal race (green circle) will rotate in a CCW direction, if we take into account the 2 ball rotating. So we should leave a free space between two ball bearings.



Combine 4 of the ball bearings with equal spaces between balls (see below).

Let's free space between two ball bearings is a.

NO' length is $\mathrm{NO'} = 0.5a + \mathrm{R}$

Triangle $\Delta ONO'$ is isosceles and right. So OO' length is $\mathrm{OO'} = \sqrt{2}(0.5a + \mathrm{R})$

Answer:

The common radius of external race is $R_e = OO' + R = R(1 + \sqrt{2}) + {}^{a}/_{\sqrt{2}}$

The radius of internal race is $R_{in} = R_e - 2R = R(\sqrt{2} - 1) + {}^{a}/_{\sqrt{2}}$