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Problems 2017-1

We show ten problems taken form a sangaku in Saitama prefecture dated 1874, in each of which the text body is missing. Thereby only the figures can be seen, and are scanned from [3] with permission from the publisher. We denote them below as Figures 1, 2, $\cdots$, 10. The readers are invited to make a complete problem from those figures. Give a solution, say something new if possible, and send the manuscript to the editor. There is no specific deadline of submission.

Problem 1. See Figure 1, where the three small circles seems to be congruent.

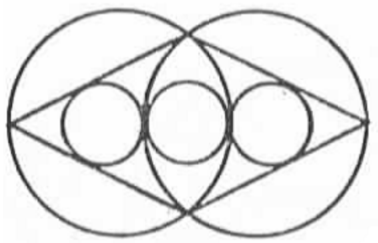

Figure 1.

Problem 2. See Figure 2. It seems to consist of five spheres, each of which touches the other four.

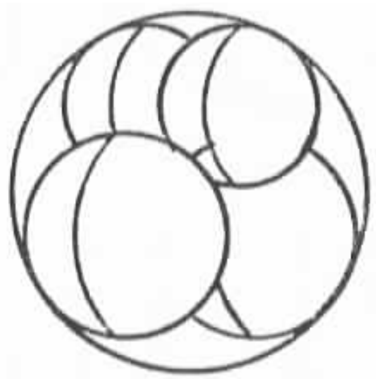

Figure 2.

Problem 3. See Figure 3.

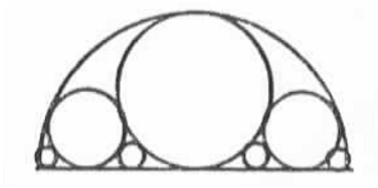

Figure 3.

Remark: A sangaku problem dated 1854 with the same figure can be found in [2, p. 47]. It says that seven circles, consisting of three pairs of congruent circles and one largest circle, touch a semicircle internally and also touch its diameter. If r is the radius of the largest circle, the radius of the smallest circles is $r/9$, and the radius of the second smallest circles equals $r/(1+\sqrt{2})^2 = (3-2\sqrt{2})r$.

Problem 4. See Figure 4.

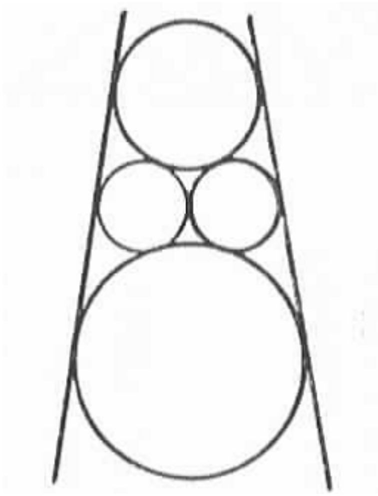

Figure 4.

Problem 5. See Figure 5, the three small congruent rectangles may be squares.

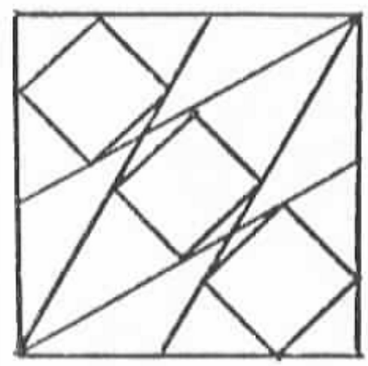

Figure 5.

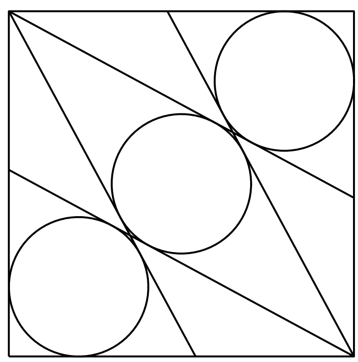

Figure 5'.

Remark: An undated sangaku problem with Figure 5' can be found in [1, p. 82], where the three circles are congruent. It says if s is the side of the square and r is the radius of the circles, $(s^2+6r^2)s = 2(3s^2+2r^2)r$ holds.

Problem 6. See Figure 6.

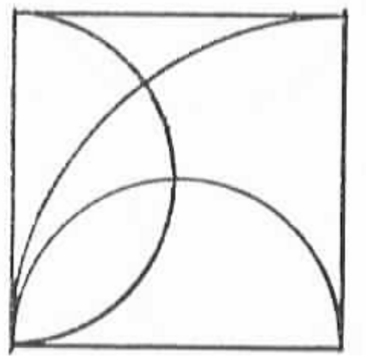

Figure 6.

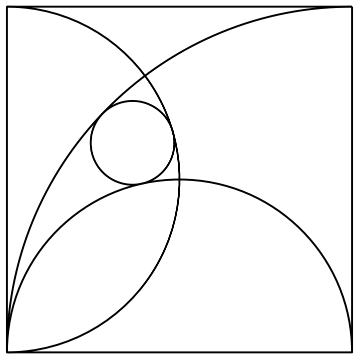

Figure 6'.

Remark: A problem with Figure 6' dated 1898 can be found in [3, p. 180]. It says that the radius of the small circle equals $4s/33$, where s is the side of the square.

Problem 7. See Figure 7, which seems to show four spheres and two lines(?).

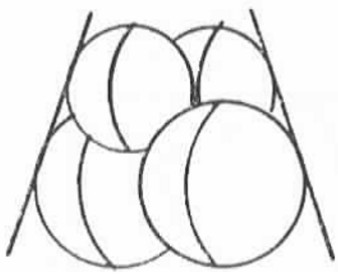

Figure 7.

Problem 8. See Figure 8.

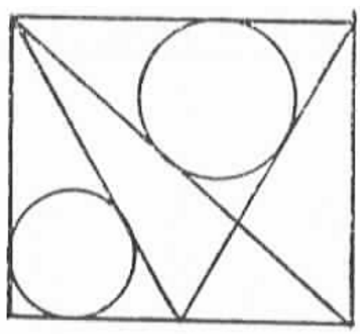

Figure 8.

Problem 9. See Figure 9. Some figures may be missing, because the two small circles touching the largest circle at the top and the bottom are not determined uniquely.

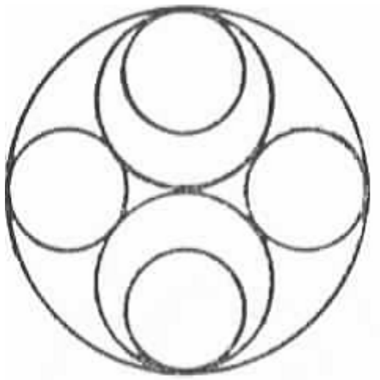

Figure 9.

Problem 10. See Figure 10. It seems to consist of an equilateral triangle and three pairs of congruent circles.

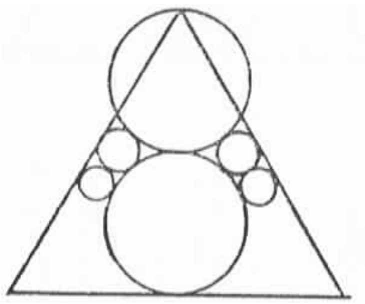

Figure 10.

References

[1] T. Matsuzaki, *The sangaku in Tochigi*, Tsukuba Shorin Tosho, 2000.
[2] T. Matsuzaki, *The sangaku in Ibaragi*, Ibaragi Tosho, 1997.
[3] Saitama prefectural library, *The sangaku in Saitama*, Saitama prefectural library, 1969.