

## Problems 2019-1

We propose five problems taken from the sangaku in Yamagata hung in 1913 [1], each of which considers a figure consisting of five congruent small circles in a large circle and several chords of the large circle touching some of the small circles (see Figures 1, 2, 3, 4, 5). Each of the problems states that the relation

$$s = (2 + \sqrt{5})r$$

holds, where  $s$  and  $r$  are the radii of the large circle and the small circles, respectively. Please send a solution with something extra.

### Problem 1.

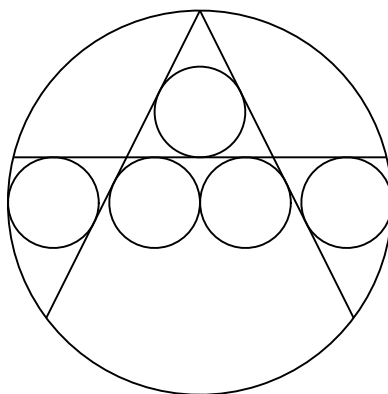


Figure 1.

### Problem 2.

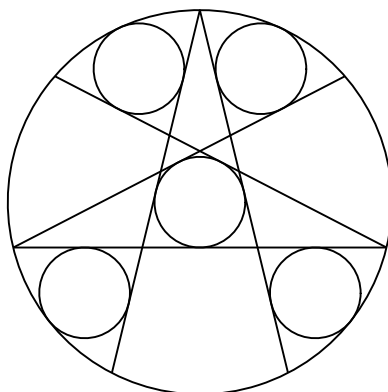


Figure 2.

---

<sup>1</sup>This article is distributed under the terms of the Creative Commons Attribution License which permits any use, distribution, and reproduction in any medium, provided the original author(s) and the source are credited.

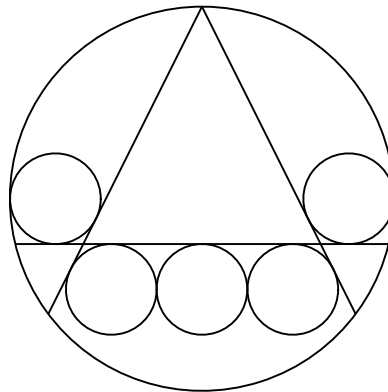
**Problem 3.**

Figure 3.

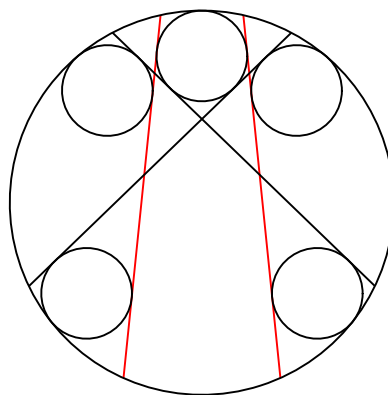
**Problem 4.**

Figure 4: The two red chords are not drawn in the figure in [1].

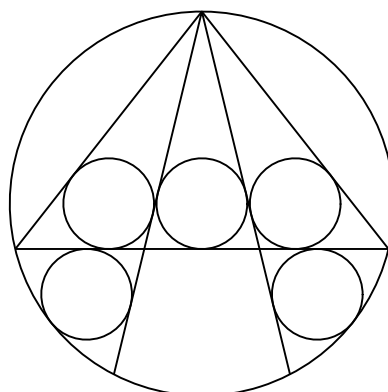
**Problem 5.**

Figure 5.

## REFERENCES

- [1] A. Hirayama, M. Matsuoka ed., The sangaku in Yamagata, 1966.