1. Justify the claim made in Archimedes’ proof of the quadrature of the parabola that starting from a triangle of area $a$ inscribed into the parabola and centered on its axis, one obtains after the $k$-th dyadic subdivision of the segment perpendicular to the axis of symmetry a subregion of the parabolic region of total area

$$a + \frac{1}{4}a + \ldots + \left(\frac{1}{4}\right)^k a$$

2. There is a story about Archimedes that he used a “burning mirror” in the shape of a paraboloid to set fire to enemy ships in the harbor. What would be the equation of the parabola that one would rotate to form the appropriate paraboloid if it were designed to set fire to a ship located at 100 feet from the mirror? How large would the burning mirror need to be? What is the likelihood that the story is true?

3. Solve Problem 20 of Chapter 9 of the *Nine Chapters*: A square walled city of unknown dimensions has four gates, one at the center of each side. A tree stands at 20 pu from the north gate. One must walk 14 pu southward from the south gate and then turn west and walk 1775 pu before one can see the tree. What are the dimensions of the city?

4. Solve Problem I, 4 from the *Shushu jiuzhang*, which is equivalent to the congruences

$$N \equiv 0 \mod 11, N \equiv 0 \mod 5, N \equiv 4 \mod 9, N \equiv 6 \mod 8, N \equiv 0 \mod 7.$$

5. Use trigonometry to prove Brahmagupta’s formula

$$A = \sqrt{(s-a)(s-b)(s-c)(s-d)}, \quad s = \frac{1}{2}(a + b + c + d),$$

for a quadrilateral of sides $a, b, c, d$ inscribed in a circle.