

Mathematician of the week

Liu Hui

Born around 220 AD in Wei, China

Died around 280 AD in China



After the collapse of the Han Empire around 220 AD, 3 kingdoms were set up. Liu Hui lived in the Kingdom of Wei (what is now the Shansi province in north-central China). The three kingdoms lasted for about sixty years, from 220 to 280, which was the period of Liu Hui's life. This period was one of almost constant warfare and political intrigue. However it is now thought of as the most romantic in all of Chinese history.

Liu Hui is famous for two works he wrote. One was a commentary on the Jiuzhang Suanshu or the Nine Chapters on the Mathematical Art and the other a work called Haidao suanjing or Sea Island Mathematical Manual.

The Nine Chapters on the Mathematical Art was thought to be originally written around 1000 BC and was a text book of the time giving examples of maths in everyday life. For example: engineering, surveying, trade, and taxation. Liu Hui is famous for writing proofs to the original answers in the book. He is particularly famous for finding an extremely close approximation to pi (3.14159) using a 96 sided polygon and an application of Pythagoras' theorem which in China is known as the Gougu theorem. He also finds that the area of a circle is found by multiplying half the diameter and half the circumference.

Liu Hui's other famous work the Haidao suanjing or Sea Island Mathematical Manual shows how to use the Gougu theorem (Pythagoras theorem) to calculate heights of objects and distances to objects which cannot be measured directly. The first problem, concerns the height and distance to an island in the sea. It gives its name to the book.

Some questions typical of the questions looked at by
Liu Hui in the Jiuzhang Suanshu,
The Nine Chapters on the Mathematical Art

Chapter 6: Fair Distribution of Goods.

1. A good runner can go 100 paces while a poor runner covers 60 paces. The poor runner has covered a distance of 100 paces before the good runner sets off in pursuit. How many paces does it take the good runner before he catches up the poor runner.
2. A cistern is filled through four canals. Open the first canal by itself and the cistern fills in 2 days; with the second by itself, it fills in 3 days; with the third by itself, in $\frac{1}{3}$ of a day; with the fourth, in 6 days. If all the canals are opened at the same time, how long will it take to fill the cistern?

Chapter 7: Excess and Deficit.

3. Certain items are purchased jointly. If each person pays 8 coins, the surplus is 3 coins, and if each person gives 7 coins, the deficiency is 4 coins. Find the number of people and the total cost of the items.
4. There are two piles, one containing 9 gold coins and the other 11 silver coins. The two piles of coins weigh the same. One coin is taken from each pile and put into the other. It is now found that the pile of mainly gold coins weighs 13 units less than the pile of mainly silver coins. Find the weight of a silver coin and of a gold coin.

Chapter 9: Right angled triangles.

5. There is a square town of unknown dimensions. There is a gate in the middle of each side. Twenty paces outside the North Gate is a tree. If one leaves the town by the South Gate, walks 14 paces due south, then walks due west for 213 paces, the tree will just come into view. If the town is 250 paces long, how far is he now away from the tree?

Answers to Liu Hui questions from the Nine Chapters on Mathematical Art:

1. 250 paces
2. $\frac{1}{4}$ of a day
3. There are 7 people and the total cost of the items is 53 coins.
4. Gold is 35.75 units and Silver 29.25 units
5. $\sqrt{(213)^2 + (20 + 14 + 250)^2} = 355$ steps away