

Problem A: Horse race

The solution is to compute the time (in seconds) used by the horse to finish the race and to convert this time in the $HH : MM : SS$ format. In the following formulae, \div stands for integer division.

$$time = length\ of\ the\ circuit \div average\ speed$$

$$hours = time \div 3600\ (there\ are\ 3600\ seconds\ in\ one\ hour)$$

$$minutes = remaining\ time\ (from\ above) \div 60\ (there\ are\ 60\ seconds\ in\ one\ minute)$$

$$seconds = remaining\ time$$

Problem B: Seconds



Problem C: Sub Triangles

The number of triangles of length 1 that can be seen is just the square of the length of the triangle side.

Demonstration

Let l be the length of a side of an equilateral triangle.

$$Area\ of\ triangle = base \times height \div 2 = l \times height \div 2$$

$$Height\ of\ triangle = l \times \sqrt{3} \div 2\ (from\ Pythagore\ theorem)$$

Thus the area of an equilateral triangle is

$$Area = l^2 \times \sqrt{3} \div 4$$

We can deduce that the height of an equilateral triangle with side $l = 1$ is

$$H(1) = \sqrt{3} \div 4$$

Thus the area of an equilateral triangle with side $l = 1$ is

$$A(1) = \sqrt{3} \div 4$$

So the number of triangles of side $l = 1$ within another triangle of side $l = n$ is:

$$N = A(n) \div A(1)$$

$$N = (n^2 \times \sqrt{3} \div 4) \div (\sqrt{3} \div 4)$$

$$N = (n^2 \times (\sqrt{3} \div 4)) \div (\sqrt{3} \div 4)$$

$$N = n^2$$

Problem D: Sums

Remember these formulae?

$$\begin{aligned}\sum_{i=1}^n i &= \frac{n \times (n+1)}{2} \\ \sum_{i=1}^n i^2 &= \frac{n \times (n+1) \times (n+2)}{6} \\ \sum_{i=1}^n i^3 &= \left(\frac{n \times (n+1)}{2} \right)^2\end{aligned}$$

Use them to simplify the compute $W(n)$ and you will end with this:

$$W(n) = \frac{n \times (n+1)}{2} \times \frac{(n \times (n+1) \div 2) + (2 \times n + 1) + 2}{2}$$

This can be improved since the official solution says that:

$$W(n) = \frac{n \times (n+1) \times (n+2) \times (n+3)}{8}$$

Problem E: Cylinders

Sorry, no solution for this at the moment.

Problem F: Base Conversion

Classic problem about converting a number from a base A to another base B . First convert the number from base A to base 10, then the number from base 10 to base B .