Tangential Velocity

Recall from physics that tangential velocity is the velocity of an object moving on the ground. Da Vinci measured velocity in chains per second. We want to get to kilometers per hour. We start with the fact that there are 20.1168 meters in a chain and multiply that by the number of chains to obtain meters per second:

$$\frac{x\ \cancel{\text{chains}}}{\text{s}} \cdot \frac{20.1168\ \text{m}}{\cancel{\text{chain}}} \quad \text{meters per second}$$

$$\frac{x\ \cancel{\text{chains}}}{\text{s}} \cdot \frac{20.1168\ \cancel{m}}{\cancel{\text{chain}}} \cdot \frac{1\ \text{km}}{1000\ \cancel{m}} \quad \text{kilometers per second}$$

$$\frac{x\ \cancel{\text{chains}}}{\cancel{\text{s}}} \cdot \frac{20.1168\ \cancel{m}}{\cancel{\text{chain}}} \cdot \frac{1\ \text{km}}{1000\ \cancel{m}} \cdot \frac{3600\ \cancel{\text{s}}}{1\ \text{hr}} \quad \text{kilometers per hour}$$

Multiplying this out, we get $\frac{20.1168 \cdot 3600}{1000} \cdot x = 72.42048x$ for x chains. Programatically, you didn't need to multiply the constants as I did in the last step. Indeed, the code is easier to read by not multiplying it out. But either is mathematically correct and would work for this assignment.

Time/Space Velocity

Recall the second law of thermodynamics from physics: energy can not be created or destroyed. This is the motivation for this next part. The idea is that da Vinci would be smart enough to know if you used all your energy for the tangential velocity of the time machine, it wouldn't have energy left to travel through time. The converse is also true: using all your energy for time travel results in you having no energy for tangential velocity. So, from the point of view, of tangential velocity, we can get the time/space velocity by taking the proportion of the energy remaining and multiply by the maximum time/space velocity ($100\ \frac{\text{yr}}{\text{s}}$):

$$v_{ts} = \underbrace{1 - \frac{v_{\tan}}{2.5}}_{\varepsilon \text{ Remaining}} \cdot 100 = \frac{2.5 - v_{\tan}}{2.5} \cdot 100$$

where $v_{\tan}$ is the tangential velocity, and $0 \leq v_{\tan} \leq 2.5$. This could have been implemented by using either form of the equation above. I hope everyone had fun doing Part III.