We are making a scale model of the solar system. We want 40 AU (the distance from the Sun to Pluto) to equal 100 yards. This means the Sun will be on the 0-yard line, and Pluto will be on the 100-yard line.

Conversion Factors
some number of old units = some number of new units
40 AU = 100 yards
(This is a scale conversion.)

Using Conversion Factors
\[ \text{'thing' in old units} \times \text{CF} = \text{'thing' in new units} \]
\[ \text{CF} = \frac{\text{some number of new units}}{\text{some number of old units}} \]

Example: Earth is 1 AU from the Sun. At what yard line will it be in our scale model?

\[ 1 \text{ AU} \times \frac{100 \text{ yards}}{40 \text{ AU}} = 2.5 \text{ yards} \]

We also want to convert the sizes of the planets using the same scale. To do this, we are going to use the same CF, \( \frac{100 \text{ yards}}{40 \text{ AU}} \), which simplifies to \( \frac{2.5 \text{ yards}}{1 \text{ AU}} \) (divide the top and bottom numbers by 40). But planet diameters are measured in km, not AU. Plus, their scaled sizes will be much smaller than a yard, so inches would be a better unit for our scaled diameters. So we're going to re-write our CF. First, the numerator:

\[ 2.5 \text{ yards} \times \frac{36 \text{ inches}}{1 \text{ yard}} = 90 \text{ inches} \]

(This is a real conversion - there are always 90 inches in 2.5 yards.)

For the denominator, we know that there are 150 million km in 1 AU. Now we can re-write our CF:

Old form of CF: \( \frac{2.5 \text{ yards}}{1 \text{ AU}} \) ⇒ New form of CF: \( \frac{90 \text{ inches}}{150 \text{ million km}} \)

Example: Earth has a diameter of 12,756 km. How big will it be in our scale model?

\[ 12,756 \text{ km} \times \frac{90 \text{ inches}}{150 \text{ million km}} = 0.0075 \text{ inches} \]

Putting this all together, Earth would be a grain of sugar on the 2.5 yard line in our scale model of the solar system.