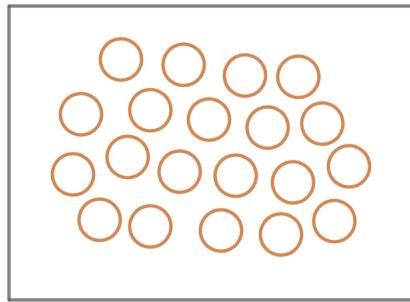


2021 F=ma Exam: Problem 8

Kevin S. Huang



For weighing n coins, we can estimate the total weight as

$$w_{tot} \equiv 100000\bar{w}$$

where

$$\bar{w} \equiv \frac{w_1 + \dots + w_n}{n}$$

is an estimate of the average weight of a coin w_{ave} . Since $w_{tot} = 100000\bar{w}$, the relative uncertainties of both variables are the same. Thus, we want $\Delta\bar{w} = 0.001w_{ave}$. Since w_i are independent and identically distributed variables,

$$\begin{aligned}\text{Var } \bar{w} &= \frac{\text{Var } w_i}{n} \\ \Delta\bar{w} &= \frac{\Delta w_i}{\sqrt{n}}\end{aligned}$$

We have

$$\begin{aligned}\sqrt{n} &= \frac{\Delta w_i}{\Delta\bar{w}} = \frac{0.01w_{ave}}{0.001w_{ave}} = 10 \\ n &= 100\end{aligned}$$

so the answer is D.