Useful Equations

✔ Momentum: \( \vec{p} = m \vec{v} \); \( \vec{F}_{NET} = \frac{d \vec{p}_{NET}}{dt} \)

✔ Center of Mass: \( \vec{r}_{cm} = \frac{1}{M} \sum m_i \vec{r}_i \); \( \vec{r}_{cm} = \frac{1}{M} \int \vec{r} \, dm \)

Problems:

1. (**) On the grid below, mark (and calculate) the location of the center of mass.

![Grid with masses](image)

2. (**) On the object below, locate the center of mass.

![Object](image)
3. (*** Find the center of mass of a square plate of uniform density and side length \( s \) with a circular hole of radius \( s/4 \) in one corner. I decided to place my coordinates at the center of the square.

4. (*) Two particles are moving towards each other on a horizontal frictionless surface. One particle has a mass \( m \) and speed of \( 2v \), the other has a mass of \( 2m \) and speed \( v \). After the particles collide, what is the speed of the center of mass of the system?