LAST TIME: CONSERVATION OF MOMENTUM

For an object (or system) in an environment with translation symmetry in the $\hat{x}$ direction, there is a quantity p_x associated with the object (or system) that is constant (unchanging) in time

ordinary speeds: $p_x = m v_x$ (similar for y and z)

Consequence: NEWTON'S 1ST LAW

- for an isolated object (i.e. in the absence of interactions) $\vec{v}$ is constant in time

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gives rule for physics in outer space:

given initial position $\vec{r}_0$ at $t=0$
initial velocity $\vec{v}_0$

Mom. cons $\Rightarrow$ $\vec{p} = m\vec{v}$ constant in time

or Newton's 1st Law

so: $\frac{d\vec{r}}{dt}$ constant $= \vec{v}_0$

in time t, change in $\vec{r}$ is $\vec{v}_0 \Delta t$

Position at time t is $\vec{r}_0 + \vec{v}_0 \Delta t$

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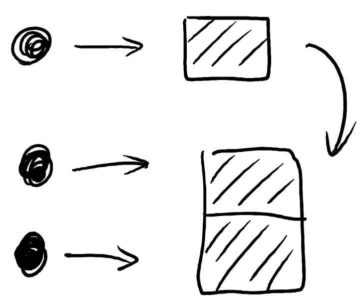
loose end: what is mass?

why not just talk about $\vec{v}$ instead of $\vec{p}$?

Q: How can we determine the masses of objects in outer space?

A: When we interact with an object (e.g. collide, pull, push) the velocity can change. Different objects are affected more/less if their mass is more/less.

One way to define mass: mass is proportional to the number of peas you need to shoot at an object (at some fixed velocity) to get the object to move at a particular speed



twice the mass: need twice as many peas to get same final velocity

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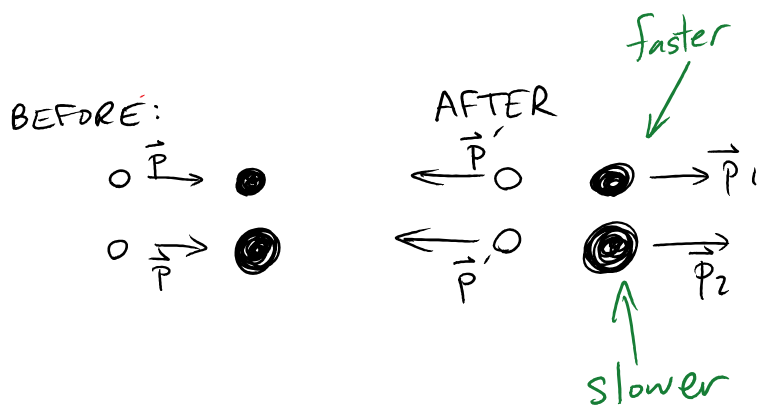
Another result of momentum conservation:

Two objects that experience the same external influence will experience the same change in momentum

NOT true for velocity



Mom. cons.

$$\vec{p} = \vec{p}\,' + \vec{p}_1$$

$$\vec{p} = \vec{p}\,' + \vec{p}_2$$

So: $\vec{p}_1 = \vec{p}_2$