Intro Physics

Day 12

Today

0. Exam reminder
Schedule Review Session
Physics Friday Reminders

I Last time

II What is climate Science?

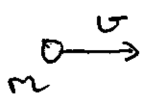
III Momentous Dimensions

I • Principle of inertia:
"Non-interacting objects maintain constant velocity."

• Galilean principle of relativity:
"The rules of motion are the same in all inertial frames"

• Three types of collision:
Elastic, completely inelastic, and

• Defined momentum



$$\boxed{\vec{p} = m\vec{v}}$$

• Developed a theory of interactions:
"In collisional interactions the total momentum is always conserved"

$$\boxed{\vec{P}_{tot\,i} = \vec{P}_{tot\,f}}$$

II I used Nadir Jeevanjee's slides to give you an introduction to what climate scientists are doing. See the Links section of our website.

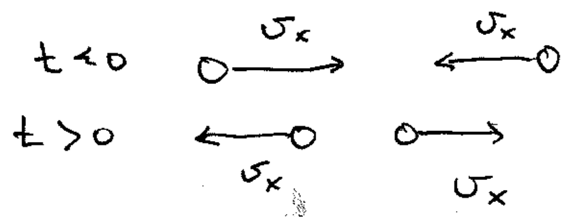
III We've only argued for

$$\vec{P}_{tot\,i} = \vec{P}_{tot\,f}$$

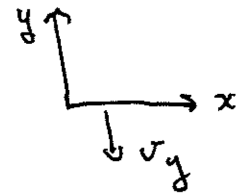
in 1D. Can we do better?

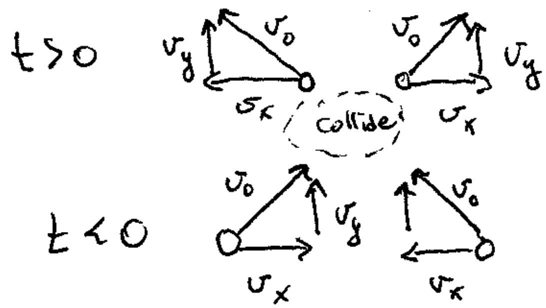
Yes!

Consider an (elastic) interaction in 1D, say the x-direction



View from a frame moving in y-direction





$$\vec{P}_{1f} = -m v_x \hat{i} + m v_y \hat{j}$$

$$\vec{P}_{2f} = m v_x \hat{i} + m v_y \hat{j}$$

* $$\vec{P}_{tot\,f} = 0\,\hat{i} + 2m v_y \hat{j}$$

and we notice again that

$$\boxed{\vec{P}_{tot\,i} = \vec{P}_{tot\,f}}$$

Clearly the nonzero total $\hat{j}$-component comes from the

What are the components of the momenta?

$$\vec{P}_{1i} = m v_x \hat{i} + m v_y \hat{j}$$

$$\vec{P}_{2i} = m(-v_x)\hat{i} + m v_y \hat{j}$$

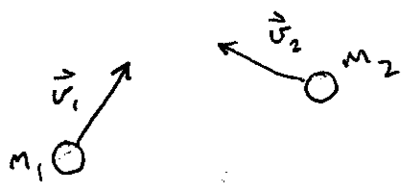
Add to get $\vec{P}_{tot\,i}$:

$$\vec{P}_{tot\,i} = 0\,\hat{i} + 2m v_y \hat{j}$$

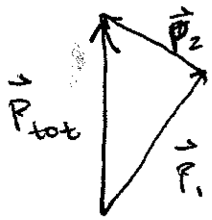
Similarly, we can find the after results

change of frame. This means that we can repeat the argument in any direction.

Can we reverse this logic? That is, start from a complicated collision and find a frame in which it is simple. We can do this and it hides some great results:



$$\vec{P}_{tot} = m_1\vec{v}_1 + m_2\vec{v}_2 = \vec{P}_1 + \vec{P}_2$$



The total system seems to have some overall momentum, hence some

This valuable insight leads into other good ideas too, e.g. the center of mass.

overall motion. What is this motion? Well, it should be

$$\vec{V} = \frac{\vec{P}_{tot}}{M} = \frac{\vec{P}_{tot}}{m_1+m_2} = \frac{m_1}{m_1+m_2}\vec{v}_1 + \frac{m_2}{m_1+m_2}\vec{v}_2$$

If we view the collision from a frame moving at the velocity it's extremely simple again