November 5

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Begin Lab: Jump up!

Collisions

Use Momentum Principle and
Energy Principle

Tangible: Get that Rebound

Using Energy Principle determine speed just before and after impact

Even tables use ball as system

$\Delta E = W + \cancel{Q}$

$\Delta K = mg\Delta y$

$\frac{1}{2}mv_f^2 = mgy$

$v_f = \sqrt{2gy_i}$

$= \sqrt{2\,9.8\,1}\ m/s = 4.4\ m/s$

$v = \sqrt{2 \cdot 9.8 \cdot 0.7}\ m/s = 3.7\ m/s$

Odd table use universe as system

$\Delta E = \cancel{W} + \cancel{Q}$

$\Delta K + \Delta U = 0$

$\frac{1}{2}mv_f^2 - mg\Delta y = 0$

$v_f = \sqrt{2gy}$

Now apply momentum Principle to figure out net force on ball during collision

To do this need to estimate time of collision

$V_{ave} = \left(\frac{4.4+0}{2}\right) m/s = 2.2\, m/s$

$V_{ave} = \frac{\Delta x}{\Delta t}$ ← estimate this

way too much

$\downarrow \uparrow$

$\Delta x \simeq 0.005\, m$

$\Rightarrow \Delta t \approx 2 \times 10^{-3} s$

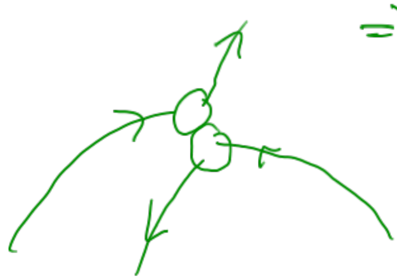
$p_f - p_i = F_{net} \Delta t$

$0.041\, kg\, [4.4 - (-3.7)]\, m/s = F_{net} \Delta t \Rightarrow F_{net} \approx 400 N$

In Collisions: take system to be the two things that are colliding

Momentum principle $\Delta\vec{p} = \vec{F}_{net,ext}\Delta t$

very small



$\Rightarrow \vec{p}_f \approx \vec{p}_i$

elastic: no change in internal energy

inelastic: change in internal energy

Tangible: Crashing the party

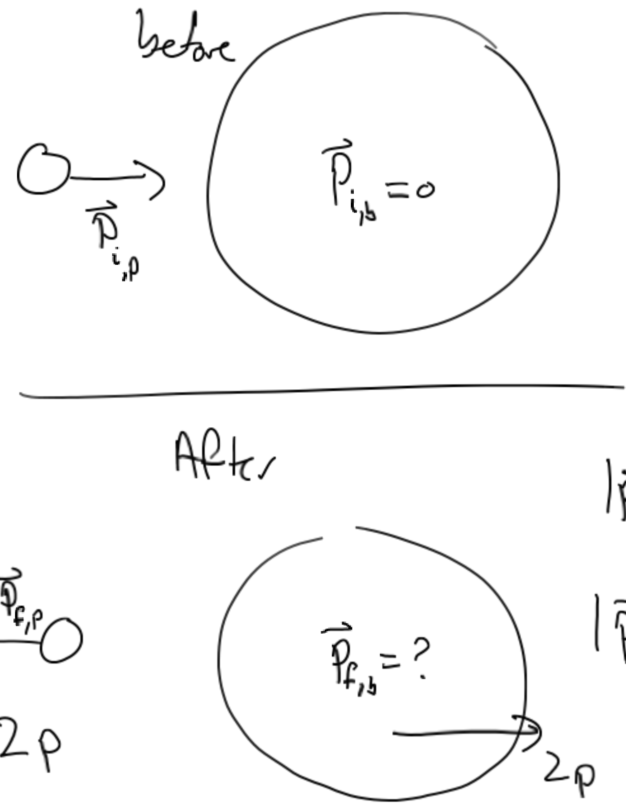
Let's crash

$\vec{p}_f = \vec{p}_i$

$\vec{p}_{i,p} = \vec{p}_{f,p} + \vec{p}_{f,b}$

$\vec{p}_{f,b} = \vec{p}_{i,p} - \vec{p}_{f,p}$

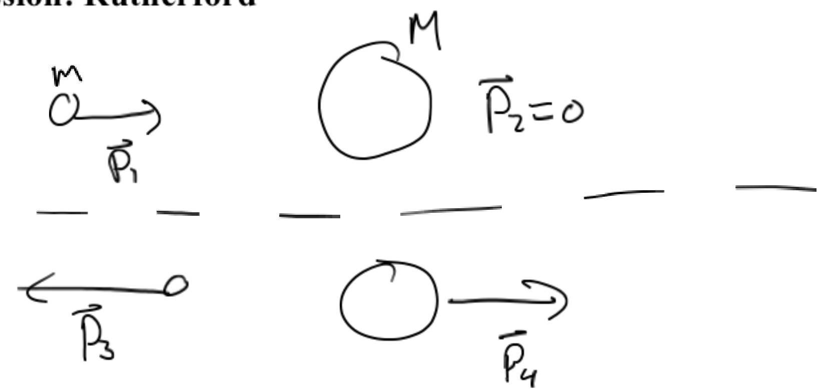
$|\vec{p}_{f,b}| = 2p$



$|\vec{p}_{i,p}| = p$

$|\vec{p}_{f,p}| = p$

Discussion: Rutherford



$$p_{1x} + 0 = p_{3x} + p_{4x}$$

$$K_1 + 0 = K_3 + K_4$$

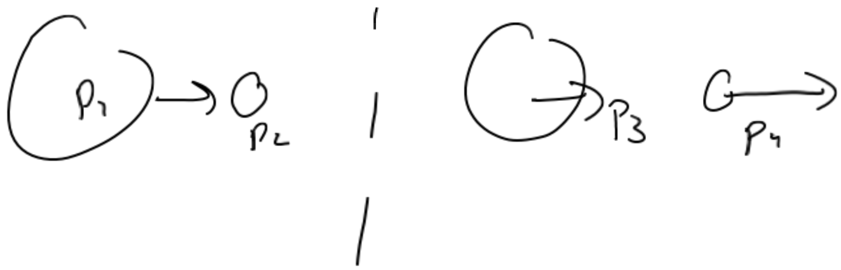
$$\frac{p_1^2}{2m} = \frac{p_3^2}{2m} + \frac{p_4^2}{2M}$$

$$p_{3x} = \left[\frac{m \pm M}{m+M}\right] p_{1x} \approx -p_{1x} \quad \text{for } m \ll M$$

$$p_{4x} = \left[\frac{2M}{m+M}\right] p_{1x} \approx 2p_{1x} \quad m \ll M$$

light projectile off heavy target

Heavy projectile off light target

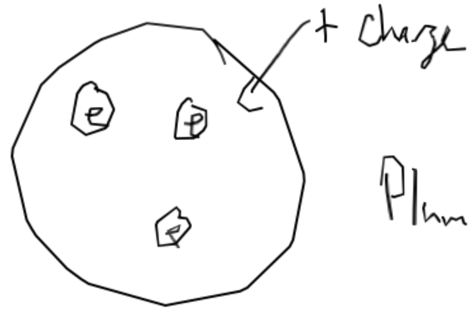


$$p_3 = \left(\frac{M \pm M}{m + M}\right) p_1 \approx p_1$$

$$p_4 = \left(\frac{2m}{M + m}\right) p_1 \approx \frac{2m}{M} p_1 \qquad m v_4 = \frac{2m}{\cancel{M}} \cancel{M} v_1$$

$$\Leftrightarrow \; v_4 \approx 2 v_1$$

Rutherford



Plum pudding model