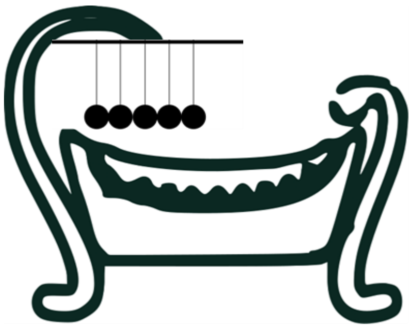
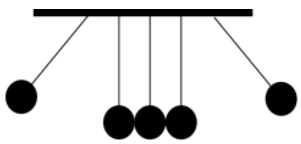
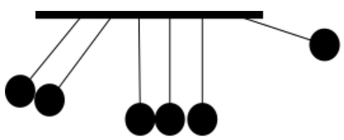


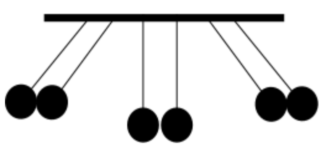
Newton's Cradle



Dropping one ball on the left side creates an impulse that brings the ball to a stop. The impulse is transferred through the other balls to the last ball in the sequence on the right – causing it to rise. If students are asked to explain this phenomenon, they will likely cite "conservation of momentum".



Yet, conservation of momentum (COM) could also explain a phenomenon that we never see – dropping two balls on the left side that causes the last ball in the sequence on the right to move twice as fast – (2m)v = m(2v). Why doesn't this ever happen?



The answer lies in conservation of energy (COE) for an ideal system (perfect alignment, equal density balls, etc.).

COM: $n_R m v_R = n_L m v_L$ … (1) $\Rightarrow \left(\frac{n_L}{n_R}\right) = \left(\frac{v_R}{v_L}\right)$ … (2)

COE: $\frac{1}{2} n_R m v_R^2 = \frac{1}{2} n_L m v_L^2$ … (3) $\Rightarrow \left(\frac{n_L}{n_R}\right) = \left(\frac{v_R}{v_L}\right)^2$ … (4)

Therefore: (2) → (4) $\Rightarrow \left(\frac{v_R}{v_L}\right) = \left(\frac{v_R}{v_L}\right)^2$ $\Rightarrow v_R = v_L$ … (5)

(5) → (3) $\Rightarrow n_R = n_L$

Therefore, the number of balls that rebound on the right equals the number of balls dropped on the left.

- Joe Morin