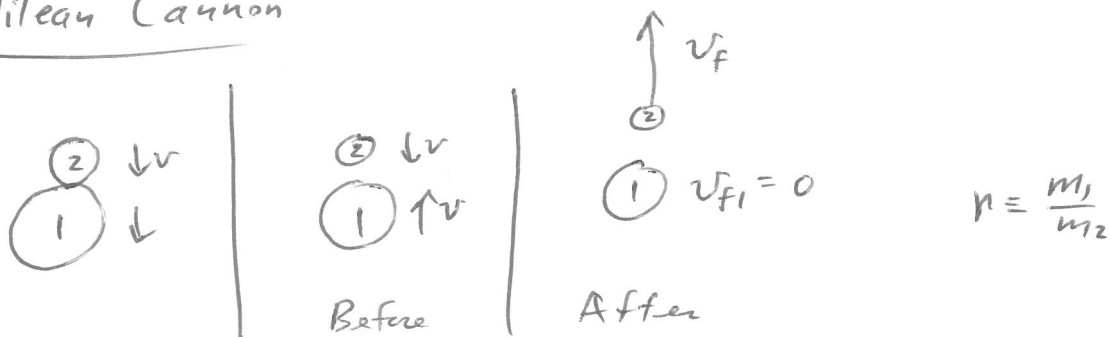


Galilean Cannon



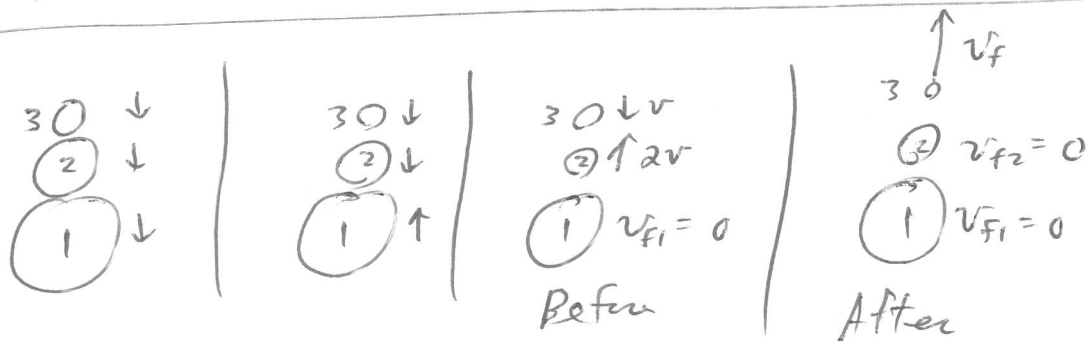
Linear Momentum: $m_1 v - m_2 v = m_2 v_f \Rightarrow v(r-1) = v_f$

Kinetic Energy: $\frac{1}{2} m_1 v^2 + \frac{1}{2} m_2 v^2 = \frac{1}{2} m_2 v_f^2 \Rightarrow v^2(r+1) = v_f^2$

$$(r-1)^2 = r+1 \Rightarrow r^2 - 2r + 1 = r+1 \Rightarrow r^2 - 3r = 0 \Rightarrow \boxed{r=3}$$

$$\frac{v_f}{v} = r-1 = 2$$

$$m_1 = 3m_2 \text{ and } v_f = 2v$$



Lin Mom: $m_2(2v) - m_3 v = m_3 v_f \Rightarrow (2r-1)v = v_f$

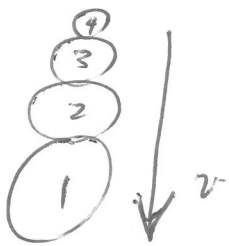
Kin Eqs: $\frac{1}{2} m_2 (2v)^2 + \frac{1}{2} m_3 v^2 = \frac{1}{2} m_3 v_f^2 \Rightarrow (4r+1)v^2 = v_f^2$

$$(2r-1)^2 = (4r+1) \Rightarrow 4r^2 - 4r + 1 = 4r + 1 \Rightarrow r^2 - 2r = 0 \Rightarrow \boxed{r=2}$$

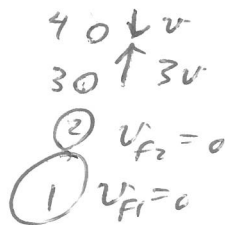
$$\frac{v_f}{v} = 2r-1 = 3$$

$$m_2 = 2m_3$$

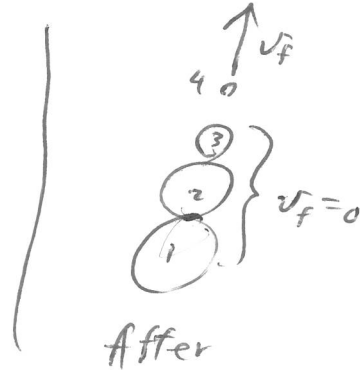
$$v_f = 3v$$



...



Before



After

Lin Mom: $m_3(3v) - m_4 v = m_4 v_f \Rightarrow v(3r-1) = v_f$

kin Eng: $\frac{1}{2} m_3 (3v)^2 + \frac{1}{2} m_4 v^2 = \frac{1}{2} m_4 v_f^2 \Rightarrow v^2(9r+1) = v_f^2$

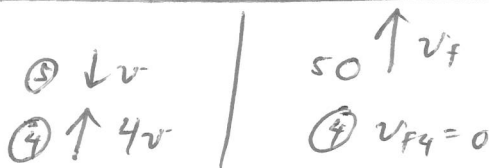
$$(3r-1)^2 = 9r+1 \Rightarrow 9r^2 - 6r + 1 = 9r+1$$

$$\Rightarrow 9r^2 - 15r = 0 \Rightarrow 3r^2 - 5r = 0 \Rightarrow \boxed{r = \frac{5}{3}} \approx 1.67$$

$$\frac{v_f}{v} = 3r-1 = 4$$

$$m_3 = \frac{5}{3} m_4$$

$$v_f = 4v$$



$$v(4r-1) = v_f$$

$$v^2(16r+1) = v_f^2$$

$$(4r-1)^2 = 16r+1 = 16r^2 - 8r + 1 \Rightarrow 2r^2 - r = 2r$$

$$2r^2 - 3r = 0 \quad 2r(r - \frac{3}{2}) = 0 \quad \boxed{r = \frac{3}{2}} \approx 1.5 = \frac{6}{4}$$

$$\frac{v_f}{v} = 4r-1 = 5$$

$$m_4 = \frac{3}{2} m_3$$

$$v_f = 5v$$

$$(5r-1)^2 = 25r+1 = 25r^2 - 10r + 1 \Rightarrow 25r^2 - 35r = 0$$

$$\Rightarrow 5r^2 - 7r = 0 \Rightarrow 5r(r - \frac{7}{5}) = 0 \Rightarrow \boxed{r = \frac{7}{5}} = 1.4$$

$$3 = \frac{3}{1}, \frac{4}{2} = 2, \frac{5}{3}, \frac{6}{4} = \frac{3}{2}, \frac{7}{5}, \frac{8}{6} = \frac{4}{3} \approx 1.3, \frac{9}{7}, \frac{10}{8} = \frac{5}{4} = 1.25, \frac{11}{9}$$

"1.28..