Homework 12

N1.

$$F = G\frac{m^2}{R^2} \rightarrow$$

$$F = 6.67 \cdot 10^{-11}\, N \cdot \frac{\cancel{m^2}}{\cancel{kg^2}} \cdot \frac{70^2\, \cancel{kg^2}}{100\, \cancel{m^2}} \Rightarrow$$

$$\frac{7^2 \cdot 10^2}{100} = 7^2 = 49 \qquad F = 6.67 \cdot 49 \cdot 10^{-11} N$$

$$\boxed{F = 3.3 \cdot 10^{-9}\, N}$$

N2.

$$F = m \cdot g_M = G \cdot \frac{m \cdot M_M}{R_M^2}$$

$$\rightarrow \boxed{g_M = G \cdot \frac{M_M}{R_M^2}}$$

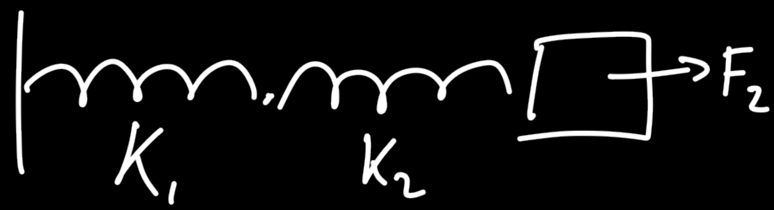
$$g_M = 6.67 \cdot 10^{-11} \frac{N \cdot m^2}{\cancel{kg^2}} \cdot \frac{6.4 \cdot 10^{23}\, \cancel{kg}}{(3400\, km)^2}$$

3400 km $\rightarrow 10^3$ m

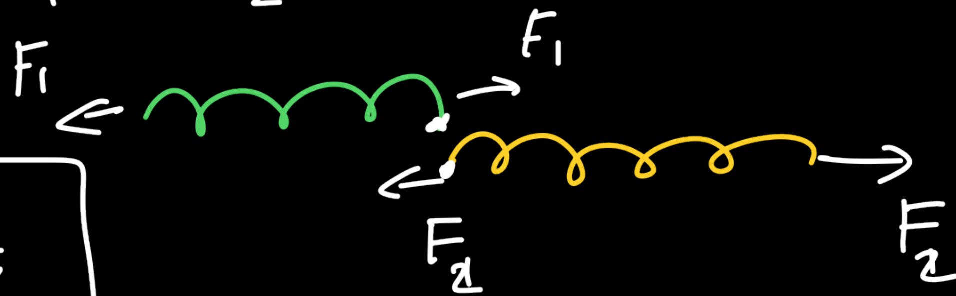
$$g_M = 6.67 \cdot 10^{-11} \frac{6.4 \cdot 10^{23}}{(3.4)^2 (10^3 \cdot 10^3)^2\, \cancel{m^2}} \cdot \frac{N \cdot \cancel{m^2}}{kg}$$

$$g_M = 3.7 \cdot \cancel{10^{23-11-12}} \frac{m}{s^2}; \quad \boxed{g_M = 3.7 \frac{m}{s^2}}$$

Problem 4.*



$$\Delta l = \Delta l_1 + \Delta l_2$$



$$\boxed{\frac{1}{K_{eff}} = \frac{1}{K_1} + \frac{1}{K_2}}$$

$$F_1 = F_2$$

$$\begin{cases} K_1 \Delta l_1 = K_2 \Delta l_2 \\ K_{eff} \cdot \Delta l = F_2 = K_2 \cdot \Delta l_2 \end{cases}$$

$$\begin{cases} K_{eff.} (\Delta l_1 + \Delta l_2) = K_2 \cdot \Delta l_2. \\ \Delta l_1 = \frac{K_2}{K_1} \Delta l_2 \end{cases}$$

$$K_{eff} \left(\frac{K_2}{K_1} + 1 \right) = K_2$$

$$K_{eff} = \frac{K_2 \cdot K_1}{K_1 + K_2}$$

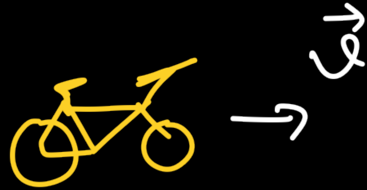
$$\Updownarrow$$

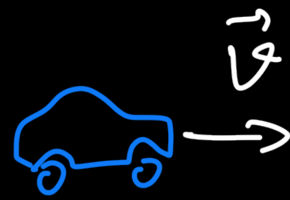
$$\boxed{\frac{1}{K_{eff.}} = \frac{1}{K_1} + \frac{1}{K_{2.}}}$$

Classwork

Momentum.

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





2nd Newton's law:

$$\vec{F} = m \cdot \vec{a} = m \cdot \frac{\Delta \vec{v}}{\Delta t}$$

$$\begin{cases} \Delta \vec{v} = \vec{v}_2 - \vec{v}_1 \\ \Delta t = t_2 - t_1 \end{cases}$$

Mass doesn't change:

$$m \cdot \Delta \vec{v} = m(\vec{v}_2 - \vec{v}_1) = m\vec{v}_2 - m\vec{v}_1$$

$$= \vec{p}_2 - \vec{p}_1$$

$$\vec{F} = \frac{\Delta \vec{p}}{\Delta t}$$

$\Delta p \uparrow \rightarrow F \uparrow$

Momentum Conservation

$$\vec{F}_{Net} = \frac{\Delta \vec{p}}{\Delta t}$$

if $\vec{F}_{Net} = 0 \Rightarrow \Delta \vec{p} = 0$

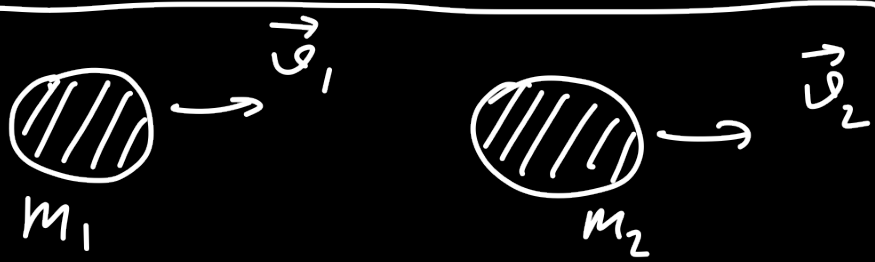
$$\vec{p}_1 = \vec{p}_2$$

for a single object:

$$m \vec{v}_1 = m \vec{v}_2$$

if $m = const.$: $\vec{v}_1 = \vec{v}_2$

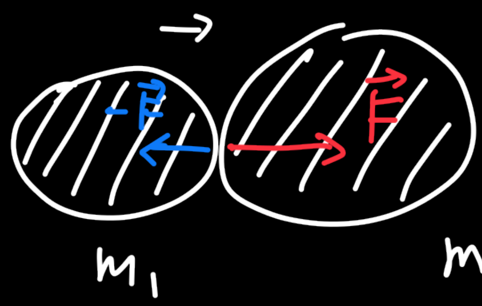
System od two bodies



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

if there are no external forces:

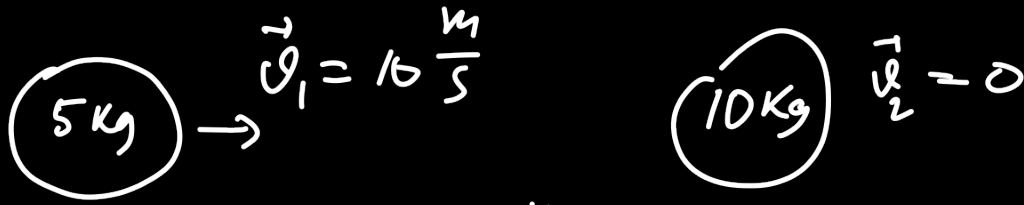
$$\boxed{\vec{p}_{tot} = \text{const.}}$$



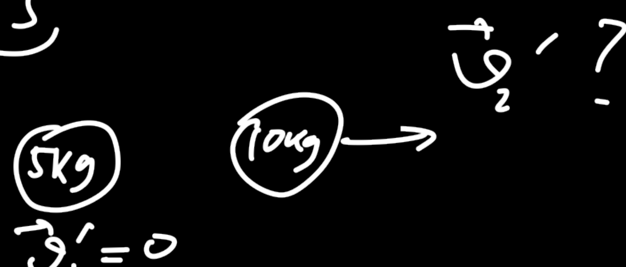
Internal forces:

will always cancel each other out!

$$\vec{F}_{\text{net, internal}} = 0$$



$$p_{tot} = 5 \cdot 10 \; kg \cdot \frac{m}{s}$$



after collision:

$$p_{tot} = 0 + 10 \cdot v_2' \cdot kg.$$

$$\Rightarrow \quad 50 \; kg \cdot \frac{m}{s} = 10 \cdot v_2' \cdot kg$$

$$\boxed{v_2 = 5 \; m/s}$$