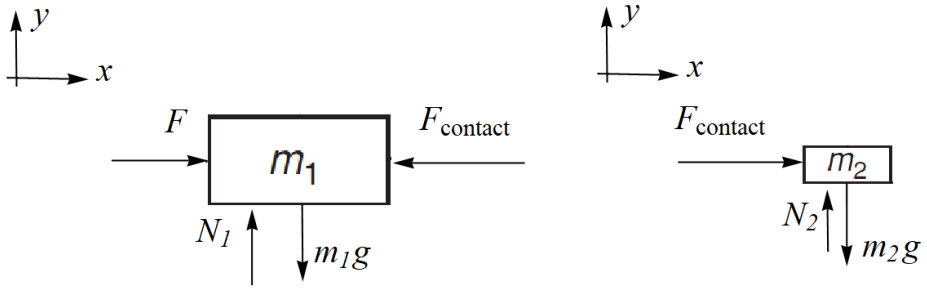
Problem 2.3

Two blocks on table
Two blocks m_1 and m_2 are in contact on a horizontal table. A horizontal force is applied to one of the blocks, as shown in the drawing. If $m_1 = 2$ kg, $m_2 = 1$ kg, and $F = 3$ N, find the force of contact between the two blocks.

Solution

Start by drawing the free-body diagram of each block. Friction is assumed to be negligible.



Newton's second law states that the sum of the forces is equal to mass times acceleration.

$$\sum \mathbf{F} = m\mathbf{a}.$$

This vector equation represents the following two scalar equations in the chosen coordinate system.

$$\sum F_x = ma_x$$
$$\sum F_y = ma_y$$

Since the blocks are in contact, they move as one with the same acceleration a in the x-direction. Apply Newton's second law to each block.

Block m_1	Block m_2
$\sum F_x = F - F_{\text{contact}} = m_1 a$	$\sum F_x = F_{\text{contact}} = m_2 a$
$\sum F_y = N_1 - m_1 g = m_1(0)$	$\sum F_y = N_2 - m_2 g = m_2(0)$

Solve the system of equations for F_{contact}, the variable of interest, by eliminating a.

$$F - F_{\text{contact}} = m_1 \frac{F_{\text{contact}}}{m_2}$$

$$F = \left(1 + \frac{m_1}{m_2}\right) F_{\text{contact}}$$

Therefore,

$$F_{\text{contact}} = \frac{F}{1 + \frac{m_1}{m_2}} = \frac{3\text{ N}}{1+2} = 1\text{ N}.$$