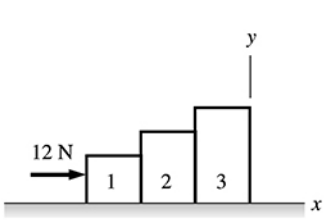
7.10. Model: The blocks are to be modeled as particles and denoted as 1, 2, and 3. The surface is frictionless and along with the earth it is a part of the environment. The three blocks are our three systems of interest.
Visualize:

Pictorial representation

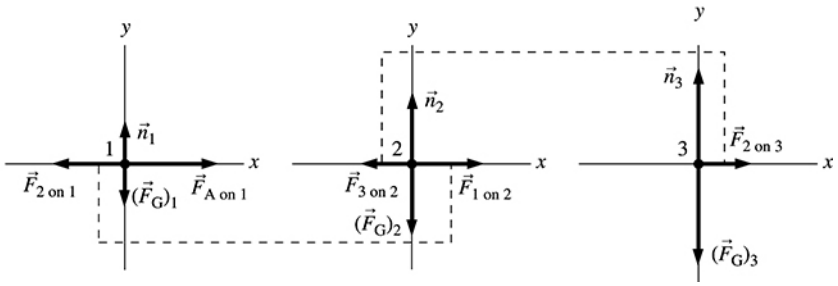


Known

$m_1 = 1$ kg
$m_2 = 2$ kg
$m_3 = 3$ kg
$F_{\text{A on 1}} = 12$ N

Find

$F_{2 \text{ on } 3}$
$F_{2 \text{ on } 1}$



The force applied on block 1 is $F_{\text{A on 1}} = 12$ N. The acceleration for all the blocks is the same and is denoted by a.
Solve: **(a)** Newton's second law for the three blocks along the x-direction is

$$\sum\left(F_{\text{on 1}}\right)_x = F_{\text{A on 1}} - F_{2 \text{ on 1}} = m_1 a \quad \sum\left(F_{\text{on 2}}\right)_x = F_{1 \text{ on 2}} - F_{3 \text{ on 2}} = m_2 a \quad \sum\left(F_{\text{on 3}}\right)_x = F_{2 \text{ on 3}} = m_3 a$$

Adding these three equations and using Newton's third law ($F_{2 \text{ on 1}} = F_{1 \text{ on 2}}$ and $F_{3 \text{ on 2}} = F_{2 \text{ on 3}}$), we get

$$F_{\text{A on 1}} = (m_1 + m_2 + m_3)a \Rightarrow (12 \text{ N}) = (1 \text{ kg} + 2 \text{ kg} + 3 \text{ kg})a \Rightarrow a = 2 \text{ m/s}^2$$

Using this value of a, the force equation on block 3 gives

$$F_{2 \text{ on 3}} = m_3 a = (3 \text{ kg})(2 \text{ m/s}^2) = 6 \text{ N}$$

(b) Substituting into the force equation on block 1,

$$12 \text{ N} - F_{2 \text{ on 1}} = (1 \text{ kg})(2 \text{ m/s}^2) \Rightarrow F_{2 \text{ on 1}} = 10 \text{ N}$$

Assess: Because all three blocks are pushed forward by a force of 12 N, the value of 10 N for the force that the 2 kg block exerts on the 1 kg block is reasonable.