A 21.3 kg box rests on a table. A 16.8 kg box is placed on top of the first box, as shown. Determine the total force in N that the table exerts on the first box.

Solution:

$m_1 = 21.3\ \text{kg}$ – mass of the first box;
$m_2 = 16.8\ \text{kg}$ – mass of the second box;
N_1 – reaction force that acts on the first box;
N_2 – reaction force that acts on the second box;
$P_{2,1}$ – force that the second box exerts on the first box;
F – total force that the table exerts on the first box;
$P_{1,t}$ – force that the first box exerts on the table;

Newton's third law: When one body exerts a force on a second body, the second body simultaneously exerts a force equal in magnitude and opposite in direction to that of the first body:

$$1 \text{ box and } 2 \text{ box: } \vec{N}_2 = -\vec{P}_{2,1};\ |\vec{N}_2| = |\vec{P}_{2,1}| = m_2 g$$
$$1 \text{ box and table: } \vec{P}_{1,t} = -\vec{F};\ |\vec{P}_{1,t}| = |\vec{F}|$$

Newton's second law for the first box:

$$\vec{F} + \vec{P}_{2,1} + \overrightarrow{m_1 g} = \vec{0}$$
$$y: F - P_{2,1} - m_1 g = 0$$
$$F - m_2 g - m_1 g = 0$$
$$F = g(m_1 + m_2) = 9.8 \frac{\text{N}}{\text{kg}} \cdot (21.3\ \text{kg} + 16.8\ \text{kg}) = 373\text{N}$$

Answer: total force that the table exerts on the first box is 373N