Newton's Laws II-1

Stack of blocks (1).

Acceleration:

$$F = (\text{Total mass})\, a\,.$$

Net force on the first block:

$$F_1 = m_1\, a\,.$$

Force of block 2 on block 1 (and similarly of block 3 on block 2):

$$F21 = (m_2 + m_3)\, a\,.$$

Tension in a rope (2). Hint: the mass density of the rope is m/L.

Spider (3): Use

$$m\, g = 2\, T_y \quad \text{and} \quad \frac{T_y}{T} = \sin(\theta)\,.$$

Newton's Laws II-2

Hanging mobile (4).

Key to the problem is that the forces at each vertex have to add to zero (Statics! Otherwise the would move). Due to symmetry is is sufficient to deal with one side, and we have immediately four equations. In Cartesian coordinates they read:

$$T_x^2 + T_x^1 = 0\,, \quad T_x^3 - T_x^2 = 0$$

$$T_y^2 + T_y^1 - m\,g = 0\,, \quad T_y^3 - T_y^2 - m\,g = 0$$

Where the convention is positive for the initially encountered components, the x axis points from left to right and the y axis up. Noting $T_y^1 = 0$, $T_y^3 = T^3 \sin(\theta)$, and so on the solutions are obtained.

Newton's Laws II-3

Spring constant (5):

$$F = (w_2 - w_1) = \kappa \triangle L\,.$$

Two Springs (6).

Newton's 3rd law (magnitudes taken):

$$F_1 = \kappa_1 \triangle x_1 = F_2 = \kappa_2 \triangle x_2\,, \quad \triangle x_1 + \triangle x_2 = \triangle x = d\,.$$

Solve for $y = \triangle x_1$.

Two Spring Accelerometer (7):

$$F = m\,a_y = k \triangle y = k\,y\,.$$

Solve for a_y. Most important perhaps: This is a k, not a κ. The system will give you "false" if you type kappa instead of k.