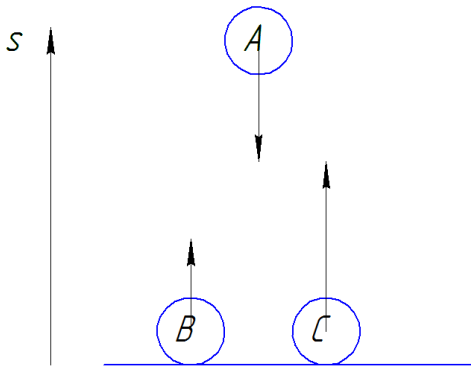**Task:**

Three balls A, B and C have 10 g, 20 g and 30g mass respectively. The ball A is released from rest and ball B and C are thrown straight upward with initial speed of 5 m /s and 10 m/s upward respectively. What are the motions of all masses?

Solution:

$$A: s_A = s_{A_0} + v_{A_0} \cdot t + \frac{a \cdot t^2}{2} = s_0 - \frac{g \cdot t^2}{2}$$

$$B: s_B = s_{B_0} + v_{B_0} \cdot t + \frac{a \cdot t^2}{2} = 5\frac{m}{s} \cdot t - \frac{g \cdot t^2}{2}$$

$$C: s_C = s_{C_0} + v_{C_0} \cdot t + \frac{a \cdot t^2}{2} = 10\frac{m}{s} \cdot t - \frac{g \cdot t^2}{2}$$

Motion of the center of mass:

$$s_{ABC} = \frac{\sum_{i=1}^{n} m_i s_i}{\sum_{i=1}^{n} m_i} = \frac{m_A s_A + m_B s_B + m_C s_C}{m_A + m_B + m_C} =$$

$$= \frac{0.01 \, kg \cdot \left(s_{A_0} - \frac{g \cdot t^2}{2}\right) + 0.02 \, kg \cdot \left(5\frac{m}{s} \cdot t - \frac{g \cdot t^2}{2}\right) + 0.03 \, kg \cdot \left(10\frac{m}{s} \cdot t - \frac{g \cdot t^2}{2}\right)}{0.06 \, kg} =$$

$$= \frac{s_{A_0}}{6} - \frac{g \cdot t^2}{12} + \frac{10}{6}\frac{m}{s} \cdot t - \frac{2 \cdot g \cdot t^2}{12} + \frac{30}{6}\frac{m}{s} \cdot t - \frac{3 \cdot g \cdot t^2}{12} = \frac{s_0}{6} + \frac{40}{6}\frac{m}{s} \cdot t - \frac{6 \cdot g \cdot t^2}{12} =$$

$$= \frac{s_{A_0}}{6} + 6\frac{2}{3}\left(\frac{m}{s}\right) \cdot t - \frac{g \cdot t^2}{2}$$

Answer:

$$s_{ABC} = \frac{s_{A_0}}{6} + 6\frac{2}{3}\left(\frac{m}{s}\right) \cdot t - \frac{g \cdot t^2}{2}$$