Center of mass
Center of mass  (a) -3  (b) 0  (c) 6

Center of mass  (a) 0  (b) 3  (c) 1
Formula for center of mass position

Two bodies

\[ x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} \]

Three bodies

\[ x_{cm} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3} \]

General

\[ x_{cm} = \frac{m_1 x_1 + m_2 x_2 + \cdots + m_k x_k}{m_1 + m_2 + \cdots + m_k} \]
Center of mass is at 0. What is the blue mass?

Ans: 3 Kg
Find the Center of Mass
What is the velocity of the center of mass?

\[ x_1 = -3 + 2t \]
\[ x_2 = 3 \]
At time $t$

\[ x_1 = -3 + 2t \]

\[ x_2 = 3 \]

\[ x_{cm} = \frac{4(-3 + 2t) + 8(3)}{4 + 8} \]

\[ = \frac{12 + 8t}{12} \]

\[ = 1 + \frac{2}{3}t \]

\[ \Rightarrow v_{cm} = \frac{2}{3} \text{m/s} \]
Is $v_{cm}$ the average velocity of the two blocks?

Weighted average velocity $= \frac{4(2)+8(0)}{4+8} = \frac{8}{12} = \frac{2}{3} \text{ m/s}$

So velocity of the center of mass is the weighted average of the velocities of the blocks.
What can the velocity of center of mass tell us about momentum?

Total momentum  \( P_T = 4(2) + 8(0) = 8 \) kg m/s

Total mass  \( M_T = 4 + 8 = 12 \) kg

So we observe that

\[ P_T = M_T v_{cm} \]
Momentum in 2-d
Find magnitude and direction of final velocity
\[
\cos \theta = \frac{4}{5}
\]

velocity = \( \frac{5}{3} \) m/s

momentum vector

A 1 Kg

B 2 Kg

2 m/s

3 m/s
Find magnitude and direction of the final velocity.
What is the angle at which the red ball scatters?
Higgs Boson simulation