Center of Mass

1. Find the center of mass (relative to (0,0)) for the spheres with the following masses and locations: \( m_1 = 5 \text{ kg}, (1,1) \quad m_2 = 10 \text{ kg}, (3,1) \quad m_3 = 15 \text{ kg}, (1,6) \).

\[
\begin{align*}
(1,1) & \quad 3.5
\end{align*}
\]

2. Find the center of mass of the following particles (drawn large so they can be seen):

\[
\begin{align*}
\sum \overrightarrow{X_{Com}} &= 3.17 \text{ m} \\
\sum \overrightarrow{Y_{Com}} &= 0.86 \text{ m} \\
& \text{(from 2 kg)}
\end{align*}
\]

3. An old go-kart with a mass of 300 kg is traveling in a straight line at 80 m/s. It is followed by a 4-wheeler with mass of 200 kg moving at 60 m/s. How fast is the center of mass moving?

\[
\sqrt{v_{Com}^2} = \sqrt{12} \text{ m/s}
\]

4. A 1500 kg VW is heading 40 m/s in a straight line. A 4000 kg Cadillac is heading directly for it at 60 m/s. Find the velocity (magnitude and direction) of the center of mass.

\[
\sqrt{v_{Com}^2} = \sqrt{32} \text{ m/s}
\]

5. A 1500 kg car is at rest. At the instant it starts to move (with an acceleration of 3.5 m/s\(^2\)), a truck (m= 3000kg) traveling at a constant speed of 12 m/s passes it. At \( t = 3 \) seconds:

a. How far is the center of mass of the vehicles, relative to the starting point of the car?

\[
2.92 < \text{m}
\]

b. What is the speed of the center of mass of the vehicles?

\[
11.5 \text{ m/s}
\]

6. A rock, of mass \( M \), is dropped at \( t = 0 \) seconds. Two seconds later a stone, of mass 2M, is dropped. At \( t = 3 \) seconds (assume neither hits the ground):

a. What is the center of mass of the rock and stone relative to the drop point?

\[
17.97 \text{ m}
\]

b. How fast is the center of mass going at this time?

\[
16.3 \text{ m/s}
\]

7. Calculate the \( V_{cm} \) before the collision and then calculate the \( V_{cm} \) after the collision. (Show all work for this problem)

\[
\begin{align*}
\text{Before collision:} & \quad V_0 = 5 \text{ m/s} \quad V_0 = 0 \\
\text{After collision:} & \quad Vf = 1 \text{ m/s} \quad Vf = ? \\
\text{Before} & \quad V_{cm} = 1.43 \text{ m/s} \quad V_{cm} \\
\text{After} & \quad \text{remains unchanged}
\end{align*}
\]