Motion of C.M. (Numerical Prob)

Monday, October 18, 2021 7:55 PM

$$\vec{r}_{cm} = \frac{1}{M}(m_1\vec{r}_1 + m_2\vec{r}_2 + \cdots + m_n\vec{r}_n) \quad -(1)$$

$$\vec{v}_{cm} = \frac{1}{M}(m_1\vec{v}_1 + m_2\vec{v}_2 + \cdots + m_n\vec{v}_n) \quad -(2)$$

$$\vec{a}_{cm} = \frac{1}{M}(m_1\vec{a}_1 + m_2\vec{a}_2 + \cdots + m_n\vec{a}_n) \quad -(3)$$

$$v_{cmx} = \frac{1}{M}(m_1v_{1x} + m_2v_{2x} + \cdots + m_nv_{nx}) \quad -(4)$$

$$v_{cmy} = \frac{1}{M}(m_1v_{1y} + m_2v_{2y} + \cdots + m_nv_{ny}) \quad -(5)$$

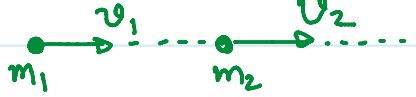
Ex: Two point masses of 2kg and 3kg are moving along the same straight line with speed 3m/s and 5m/s respectively. Find the speed of the centre of mass of the system, if both the masses are moving in:

(a) The same direction (b) in opposite direction

$m_1 = 2kg$, $m_2 = 3kg$

$v_{cm} = ?$

(a)



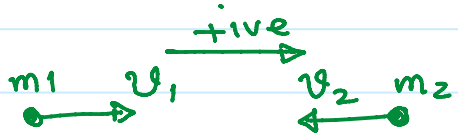
$v_1 = 3m/s$, $v_2 = 5m/s$

$$v_{cm} = \frac{m_1v_1 + m_2v_2}{m_1 + m_2}$$

$$= \frac{2\times3 + 3\times5}{2+3} = \frac{6+15}{5}$$

$$= \frac{21}{5} \Rightarrow v_{cm} = 4.2\,m/s$$

(b)



$v_1 = 3m/s$, $v_2 = -5m/s$

$$v'_{cm} = \frac{2\times3 + 3\times(-5)}{2+3} = \frac{6-15}{5} = -\frac{9}{5} \Rightarrow v'_{cm} = -1.8\,m/s.$$