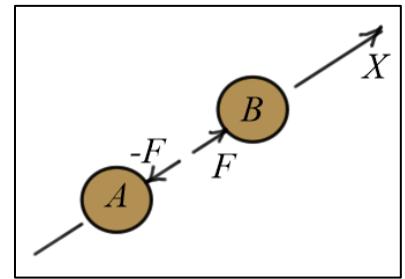


Elementary Dynamics

Conservation of Linear Momentum for Particles

Under certain circumstances, the *net impulse* on a particle (or system of particles) is *zero*, so the *linear momentum* of the particle (or system of particles) is *conserved*. For example, consider the case of two particles in contact. The diagram shows the two particles separated with the contact force F acting along the X -axis.



Assuming no other forces act in this direction, we can write

$$m_A(v_{Ax})_1 + \int_{t_1}^{t_2} -F dt = m_A(v_{Ax})_2 \quad \text{and} \quad m_B(v_{Bx})_1 + \int_{t_1}^{t_2} F dt = m_B(v_{Bx})_2$$

Summing these two equations gives

$$m_A(v_{Ax})_1 + m_B(v_{Bx})_1 = m_A(v_{Ax})_2 + m_B(v_{Bx})_2$$

The linear momentum of the system is *conserved* in the X -direction. Note that if other forces act in the X -direction, but their impulses are *small* in comparison to $\int_{t_1}^{t_2} F dt$, they may be neglected.

This is often true when F is due to the *impact* of the two particles.

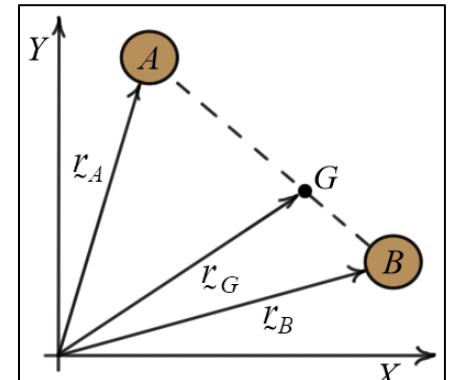
Motion of a System's Mass Center

Consider a system with two particles as shown. From the definition of mass center,

$$(m_A + m_B) \mathbf{r}_G = m_A \mathbf{r}_A + m_B \mathbf{r}_B .$$

If linear momentum is conserved for the system, then by differentiating this equation with respect to time, we see that

$$(m_A + m_B) \mathbf{v}_G = m_A \mathbf{v}_A + m_B \mathbf{v}_B = \text{constant} .$$



So, the system's *mass center* moves at a *constant velocity*.