Definition of momentum: $\mathbf{p} = m\mathbf{v}$. MOMENTUM IS A VECTOR

The net force on a system must change its momentum vector:

$$\sum \mathbf{F} = \frac{\Delta \mathbf{p}}{\Delta t}. \quad \text{(Assumes } \Delta t \to 0\text{)}$$

IMPULSE: $\mathbf{I} = \Delta \mathbf{p} = \sum \mathbf{F}_{avg} \Delta t$.

If no external force acts on a system, then no matter how complex the processes that occur within the system, the total momentum $\mathbf{P} = \sum_i \mathbf{p}_i$ DOES NOT CHANGE!!

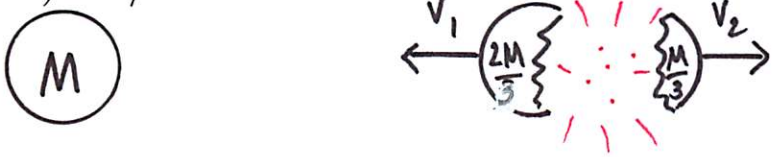
TYPES OF COLLISIONS:

(1) ELASTIC— $\Delta K = 0$.

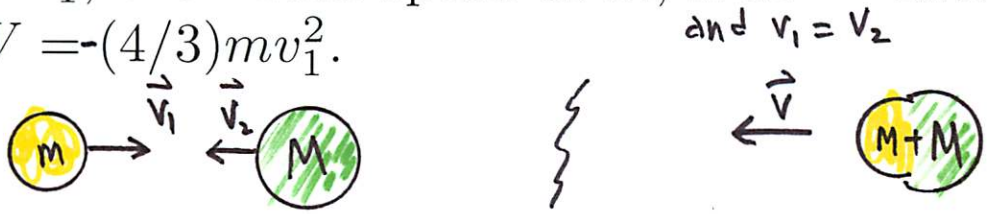
(2) INELASTIC— $\Delta K \neq 0$.

(3) COMPLETELY INELASTIC— the bodies merge into one after collision.

An object of mass M explodes into two pieces, one of mass $2M/3$ and the other of mass $M/3$. If the final momenta are along the x axis, and the speed of the piece of larger mass is 20 m/s along $-x$, what is the velocity of the piece of lesser mass? Answer: $\mathbf{v}_2 = +\hat{\mathbf{i}}(40)$ m/s.



An object of mass m collides head-on with an object of mass M. The objects stick together after collision. What is the final speed of the combined mass? Answer: $v = (Mv_2 - mv_1)/(M + m)$. How much work was done during the collision, in terms of v_1, the initial speed of m, if $M = 2m$? Answer: $W = -(4/3)mv_1^2$.



Two objects of masses m_1 and m_2, with m_2 intially at rest, collide head-on. Show that $v_0 + v_1 = v_2$, and that $v_1 = (m_1 - m_2)v_0/(m_1 + m_2)$ and that $v_2 = (2m_1v_0)/(m_1 + m_2)$, if the collision is ELASTIC.

Important special cases:

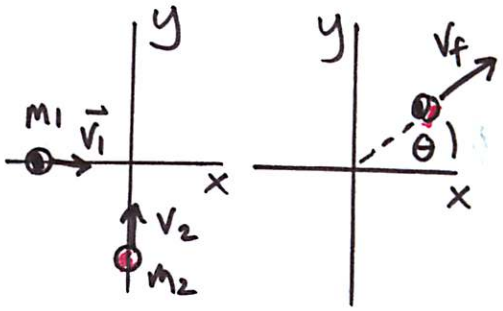
(1) $m_2 = m_1$, so $v_1 = 0$ and $v_2 = v_0$.

(2) $m_1 >> m_2$, so $v_1 \simeq v_0$ and $v_2 \simeq 2v_0$.

(3) $m_2 >> m_1$, so $v_1 \simeq -v_0$ and $v_2 \simeq 0$.

} ELASTIC!

- For the collision shown, demonstrate that $\theta = \tan^{-1}[(m_2 v_2)/(m_1 v_1)]$. The collision is completely inelastic. Also, what is the speed of the combined masses after the collision if both masses are 1 kg, v_1 is 1 m/s and v_2 is 2 m/s?



- For the head-on collision illustrated, is the collision elastic?

- For the head-on collision illustrated, if $v_1 = 2v_0$, what is v_2?

• A 0.1 kg ball is dropped from a height of 1.0 m, from rest, and rebounds from the floor to a maximum height of 0.5 m. What average force did the floor exert on the ball, if the ball was in contact with the floor for 0.01 seconds?

Answer: Using $\Delta \mathbf{p} = \mathbf{F}_{avg} \Delta t$, it is easy to see that the upward force exerted by the floor is about 76.3 N.