Answer on Question #48576 – Physics - Mechanics | Kinematics | Dynamics

if a 200 m/s running car pushes me , then will i be thrown with the same 200 m/s speed or more or less. when will my speed be highest and lowest?? and will the speed decrease in respect of time ??

Solution:

$M - mass\ of\ the\ car;$
$m - mass\ of\ the\ person;$

$v_1 = 200\frac{m}{s} - initial\ velocity\ of\ the\ car;$
$u_1 = 0 - person's\ initial\ velocity;$

$v_2 - final\ velocity\ of\ the\ car;$
$u_2 - person's\ final\ velocity;$

The law of conservation of momentum states that the total momentum of a closed system does not change. This means that when two objects collide the total momentum of the objects before the collision is the same as the total momentum of the objects after the collision.

$$M_{before} = M_{after} \quad (1)$$

$$M_{before} = M_{car_1} + M_{person_1} = Mv_1 + mu_1 \quad (2)$$
$$M_{after} = M_{car_2} + M_{person_2} = Mv_2 + mu_2 \quad (3)$$
$$(3) and\ (2) in (1):$$
$$Mv_1 + mu_1 = Mv_2 + mu_2$$

Because after pushing the person, we can assume that the person and the car will move as one system, thus they will move with the same velocity u_2:

$$v_2 = u_2$$
$$Mv_1 + mu_1 = Mu_2 + mu_2$$
$$Mv_1 + mu_1 = u_2(M + m)$$
$$u_2 = \frac{Mv_1 + mu_1}{M + m} = \frac{M \cdot 200\frac{m}{s} + m \cdot 0}{M + m} = 200\frac{m}{s}\left(\frac{M}{M + m}\right) = 200\frac{m}{s}\left(\frac{M}{M + m}\right)$$

Because of $\frac{M}{M+m}$ always is less that 1, final velocity of the person will be less then $200\frac{m}{s}$.

$$u_2 < 200\frac{m}{s}$$

The velocity of the person will be highest after end of the pushing (when it will be momentum M_{after}), the lowest velocity will be before pushing ($u_1 = 0$ when there is a momentum M_{before})

The speed of the object will change in respect of time only if the momentum of the system will change (momentum will decrease – the speed will desrease; momentum will increase – the speed will increase)

Answer: final velocity of the person: $u_2 = 200\frac{m}{s}\left(\frac{M}{M+m}\right)$.