Momentum and Impulse

$$\vec{F} = ma = m\frac{\Delta \vec{v}}{\Delta t},$$

$$\boxed{\Delta \vec{p} = \vec{F}\Delta t}$$

$\vec{p} = m\vec{v}$ called Momentum

$\vec{F}\Delta t$ called Impulse

Conservation of Momentum

2nd Newton's Law
for ***n*** objects:

$$\Delta\vec{p}_1 = \vec{F}_1\Delta t$$

$$\Delta\vec{p}_2 = \vec{F}_2\Delta t$$

$$\cdots\cdots$$

$$\Delta\vec{p}_n = \vec{F}_n\Delta t$$

3rd Newton's Law,
<u>no external forces!</u>

$$\vec{F}_1 + \vec{F}_2 + ... + \vec{F}_n = 0$$

$$\Delta\left(\vec{p}_1 + \vec{p}_2 + ... + \vec{p}_n\right) = 0$$

$$\vec{p}_1 + \vec{p}_2 + ... + \vec{p}_n = const$$

<u>**Total Momentum of Isolated System is Conserved**</u>

Homework 16

As You probably know, Elon Mask's company, SapceX has launched its most powerful rocket this week, called Falcon Heavy. The payload was Tesla Roadster car that will now orbit Sun.
One of the coolest part of the launch was a return of the boosters back to Earth (please check the videos which are easy to google!)

Now, Let us understand how this last part worked. The two boosters where coming to earth at rather high speed, at least the speed of sound v=300m/s . They dramatically slowed down by using their engines.
Estimate how much fuel was used for this maneuver, if the dry mass of a booster is M= 22000 kg, and the burned fuel gets out of the engine at speed u=3000m/s