Impulse and Momentum

$$\vec{L} = m\vec{v}$$

$$\vec{F} = \frac{d}{dt} m\vec{v}$$

$$\int_{t_1}^{t_2} \vec{F}\, dt = m\vec{v}_2 - m\vec{v}_1 = \vec{L}_2 - \vec{L}_1$$

$$\int_{t_1}^{t_2} \vec{F}\, dt = \overrightarrow{Imp}_{1\to 2} = \vec{F}_{avg}\,\Delta t$$

$$\overrightarrow{Imp}_{1\to 2} = \vec{L}_2 - \vec{L}_1$$

$$\vec{L}_1 + \overrightarrow{I_{mp_{1\to 2}}} = \vec{L}_2$$

$$\vec{L}_1 + \Sigma \overrightarrow{I_{mp_{1\to 2}}} = \vec{L}_2$$

$$\Sigma \vec{L}_1 + \overrightarrow{I_{mp_{1\to 2}}} = \Sigma \vec{L}_2$$

Conservation of energy

$$\Sigma \vec{L}_1 = \Sigma \vec{L}_2$$

A 2500-lb automobile is moving at a speed of 60 mi/h when the brakes are fully applied, causing all four wheels to skid. Determine the time required to stop the automobile (a) on dry pavement ($\mu_k = 0.75$), (b) on an icy road ($\mu_k = 0.10$).

$\vec{L}_1 = m\vec{v}$

$= 77.6 \frac{lb\,s^2}{ft} \; 88 \; ft/s$

$= 6832 \; lb\,s$

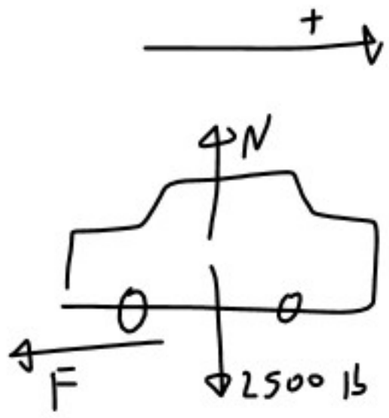
$\vec{L}_2 = 0$

$\frac{2500 \; lb}{32.2 \; ft/s^2} = m = 77.6 \frac{lb\,s^2}{ft}$

$\vec{L}_2 - \vec{L}_1 = \vec{I}_{mp_{1\to 2}}$

$-6832 \; lb\,s = \vec{F}_{avg} \Delta t$

$60 \frac{mi}{h} \; \frac{5280 \; ft}{1 \; mi} \; \frac{1 \; h}{3600 \; s} = 88 \; ft/s$



$N = 2500\,lb$

$F = -\mu_k N = -0.75(2500) = -1875\,lb$

$F = -0.1(2500) = -250\,lb$

$-6832\,lb\,s = \vec{F}_{avg}\,\Delta t$

$-6832\,lb\,s = -1875\,lb\,\Delta t$

$\frac{-6832\,lb\,s}{-1875\,lb} = 3.64\,s = \Delta t$

$\frac{-6832\,lb\,s}{-250\,lb} = \Delta t = 27.3\,s$

A sailboat weighing 980 lb with its occupants is running downwind at 8 mi/h when its spinnaker is raised to increase its speed. Determine the net force provided by the spinnaker over the 10-s interval that it takes for the boat to reach a speed of 12 mi/h.

$W = mg$

$\frac{W}{g} = \frac{980\ lb}{32.2\ ft/s^2} = 30.4\ \frac{lb\,s^2}{ft}$

$\vec{L}_2 - \vec{L}_1 = \vec{I}_{mp_{1\to2}} = \vec{F}_{avg}\,\Delta t$

$179 = F_{avg}\,10$

$\frac{179\ lbs}{10\ s} = 17.9\ lb$

$8\ \frac{mi}{h}\ \frac{5280\ ft}{1\ mi}\ \frac{1\ h}{3600\ s} = 11.7\ ft/s$

$12\ \frac{mi}{h} = 17.6\ ft/s$

$\vec{L}_1 = m\vec{v}_1 = 30.4 \cdot 11.7 = 356\ lbs$

$\vec{L}_2 = m\vec{v}_2 = 30.4 \cdot 17.6 = 535\ lbs$

$\vec{L}_2 - \vec{L}_1 = 535 - 356 = 179\ lbs$