101. (a) The initial momentum of the car is

$$\vec{p}_i = m\vec{v}_i = (1400\,\text{kg})(5.3\,\text{m/s})\hat{\text{j}} = (7400\,\text{kg}\cdot\text{m/s})\hat{\text{j}}$$

and the final momentum is $\vec{p}_f = (7400\,\text{kg}\cdot\text{m/s})\hat{\text{i}}$. The impulse on it equals the change in its momentum: $\vec{J} = \vec{p}_f - \vec{p}_i = (7400\,\text{N}\cdot\text{s})(\hat{\text{i}} - \hat{\text{j}})$.

(b) The initial momentum of the car is $\vec{p}_i = (7400\,\text{kg}\cdot\text{m/s})\hat{\text{i}}$ and the final momentum is $\vec{p}_f = 0$. The impulse acting on it is $\vec{J} = \vec{p}_f - \vec{p}_i = (-7.4\times10^3\,\text{N}\cdot\text{s})\hat{\text{i}}$.

(c) The average force on the car is

$$\vec{F}_{\text{avg}} = \frac{\Delta\vec{p}}{\Delta t} = \frac{\vec{J}}{\Delta t} = \frac{(7400\,\text{kg}\cdot\text{m/s})(\hat{\text{i}} - \hat{\text{j}})}{4.6\,\text{s}} = (1600\,\text{N})(\hat{\text{i}} - \hat{\text{j}})$$

and its magnitude is $F_{\text{avg}} = (1600\,\text{N})\sqrt{2} = 2.3\times10^3\,\text{N}$.

(d) The average force is

$$\vec{F}_{\text{avg}} = \frac{\vec{J}}{\Delta t} = \frac{(-7400\,\text{kg}\cdot\text{m/s})\hat{\text{i}}}{350\times10^{-3}\,\text{s}} = (-2.1\times10^4\,\text{N})\hat{\text{i}}$$

and its magnitude is $F_{\text{avg}} = 2.1 \times 10^4$ N.

(e) The average force is given above in unit vector notation. Its *x* and *y* components have equal magnitudes. The *x* component is positive and the *y* component is negative, so the force is 45° below the positive *x* axis.