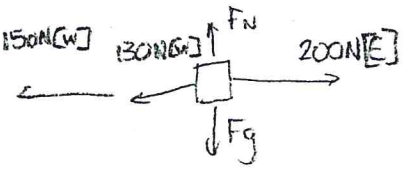
Newton's Second Law in One Dimension

Answer the following questions in the space provided. Be sure to provide a free-body diagram with your solution.

1. A 1000-kg car experiences the forces shown below. Determine the net force acting on the car and the car's vector acceleration.

$\bar{F}_1 = 130$ N [W], $\bar{F}_2 = 150$ N [W], $\bar{F}_3 = 200$ N [E]



$\vec{F}_{NET} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$
$= 130\text{ N[W]} + 150\text{N[W]} - 200\text{ N[W]}$
$= 80\text{ N[W]}$

$\vec{F}_{NET} = m\vec{a}$
$\vec{a} = \frac{\vec{F}_{net}}{m}$
$= \frac{80\text{N[W]}}{1000\text{kg}}$
$= 0.080\text{ m/s}^2\text{[W]}$

2. A skateboarder is riding his skateboard across a horizontal surface. If the skateboarder and skateboard have a combined mass of 75 kg and the horizontal surface has a coefficient of kinetic friction of 0.20,
a) what is the frictional force acting on the skateboard?
b) how far will the skateboarder travel if his initial speed is 0.80 m/s?

$m = 75\text{kg}$
$\mu_K = 0.20$
a) $F_f = ?$
$F_f = \mu_K F_N$
$= \mu_K mg$
$= (0.20)(75\text{kg})(9.8\text{N/kg})$
$= 147\text{ N}$
∴ the frictional force is 147 N backwards or -147N

b) $d = ?$
$V_1 = 0.80\text{m/s}$
$V_2 = 0\text{m/s}$
$F_{NET} = F_f = ma$
$a = \frac{F_f}{m}$

$V_2^2 = V_1^2 + 2ad$
$d = \frac{V_2^2 - V_1^2}{2a}$
$d = \frac{V_2^2 - V_1^2}{2\left(\frac{F_f}{m}\right)}$
$d = 0.16\text{m}$

3. A motorcycle rider accelerates his motorcycle from rest to 100 km/h in 8.0 s. If the combined mass of the rider and his motorcycle is 300 kg and the coefficient of kinetic friction in the road is 0.15, what constant force must be provided by the motorcycle's engine?

$V_1 = 0\text{ m/s}$
$V_2 = 100\text{km/h} = 27.8\text{ m/s}$
$\Delta t = 8.0\text{s}$
$m = 300\text{kg}$
$\mu_K = 0.15$
$F_{app} = ?$

$F_{app} = F_{NET} + F_f$
$= ma + \mu_K mg$
$= \frac{m(V_2 - V_1)}{\Delta t} + \mu_K mg$
$= \frac{(300\text{kg})(27.8\text{m/s} - 0\text{m/s})}{8.0\text{s}} + (0.15)(300\text{kg})(9.8\text{N/kg})$

$F_{app} = 1483.5\text{ N} = 1500\text{N}$
∴ the motorcycle's engine must provide a constant force of 1500 N.

