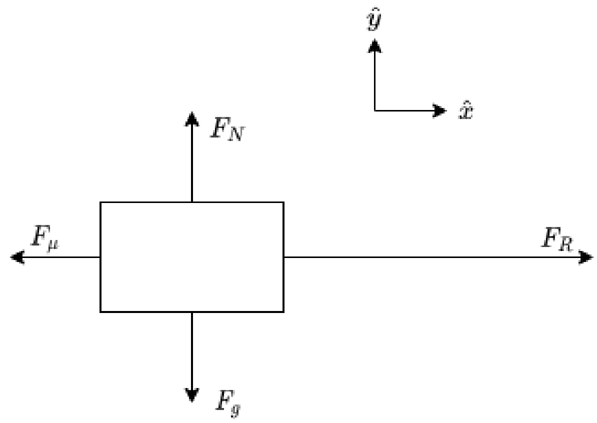
A rocket-powered sled has a mass of 240 kg. The rocket motor has a thrust of 6000 N. The coefficient of kinetic friction with the snow is 0.150. What is the net acceleration of the sled?

Assuming the sled is on level ground, we can draw a free-body diagram for the sled that looks like this:



- F_R Rocket thrust
- F_μ Friction (resists rocket)
- F_g Force of gravity
- F_N Normal force (exerted by ground)

Start by considering the forces on the y axis because they're easy. On level ground we expect that the sled won't be moving up or down at all, so acceleration on the y axis must be 0. Think about Newton's second law, applied to the y axis:

$$
\begin{aligned}
\sum F_y &= ma_y \\
F_N + F_g &= m * a_y && \text{Add all the forces along the y axis.} \\
F_N + F_g &= m * 0 && \text{Let y acceleration be 0.} \\
F_N + F_g &= 0 \\
F_g &= -F_N && \text{Subtract one force to the other side.}
\end{aligned}
$$

This shows that F_g and F_N are *equal and opposite*. We can calculate the force of gravity easily enough, and now we know how to get the normal force from that.

$$
\begin{aligned}
F_g &= mg \\
&= -1 * (240\,\mathrm{kg}) * (9.8\,\mathrm{m/s^2}) \quad \text{Use -1 to indicate that } F_g \text{ is pointed down}
\end{aligned}
$$

$$
\begin{aligned}
F_N &= -F_g && \text{Equal and opposite, from above} \\
&= -1 * -1 * (240\,\mathrm{kg}) * (9.8\,\mathrm{m/s^2}) && \text{Plug in } F_g \\
&= (240\,\mathrm{kg}) * (9.8\,\mathrm{m/s^2})
\end{aligned}
$$

Now that we have all the forces along the y axis figured out, we look to the x axis. The rocket thrust is given to us:

$$F_R = 6000\,\mathrm{N}$$

Given the coefficient of friction μ, and using the normal force F_N that we calculated above, we can find the force of friction like so:

$$
\begin{aligned}
F_\mu &= \mu F_N \\
&= -0.150 * F_N && \text{Use -1 to indicate that } F_\mu \text{ points in the negative x direction} \\
&= -0.150 * (240\,\mathrm{kg} * 9.8\,\mathrm{m/s^2}) && \text{Plug in } F_N
\end{aligned}
$$

Now we have all of the forces on the sled calculated, and we can move on to finding the acceleration. *Net acceleration* describes the acceleration in all directions. In vector notation, that looks like:

$$\vec{a} = a_x \hat{x} + a_y \hat{y}$$

However, since we assume the sled is on level ground, we have already found that there is no acceleration on the y axis! That means net acceleration, in this case, is only along the x axis. Consider Newton's second law for the x axis:

$$
\begin{aligned}
\sum F_x &= m a_x \\
F_R + F_\mu &= m a_x && \text{Add all the x axis forces together} \\
\frac{F_R + F_\mu}{m} &= a_x && \text{Divide by } m \text{ on both sides to isolate } a_x
\end{aligned}
$$

So, finally:

$$
\begin{aligned}
a_{net} &= a_x \\
&= \frac{F_R + F_\mu}{m}
\end{aligned}
$$