Problem Solving Worksheet

You are pulling your 37.0kg sister along on a 7.00kg sled across a frictionless icy surface. You pull the sled by exerting a 12.0N force on a rope attached to the front of the sled. The rope makes an angle of 30° with respect to the horizontal. a) What is the acceleration of the sled? b) What normal force does the icy surface exert on the sled?

A. Natural description
A.1. Sketch: Make a sketch of the situation,

B. Physics description
B.1. Draw a force diagram that shows the weight, normal force and force of the rope on the sled.

\[ F = m_i g \]
B.2 Express all forces in rectangular components.

\[
\begin{align*}
(F_N)_x &= 0 & (F_g)_x &= 0 & F_x &= (12 \text{N}) \cos(30^\circ) \\
(F_N)_y &= F_N & (F_g)_y &= -m_{\text{tot}}g & F_y &= (12 \text{N}) \sin(30^\circ)
\end{align*}
\]

B.3. Find the net force in the horizontal direction and use Newton’s 2nd Law to find the acceleration.

\[
(F_{\text{Net}})_x = m_{\text{tot}}a_x
\]

\[
(12 \text{N}) \cos(30^\circ) = (37 \text{kg} + 7 \text{kg})a_x
\]

\[
a_x = 0.236 \text{ m/s}^2
\]

B.4. Find the net force in the vertical direction and use Newton’s 2nd Law to find the normal force the icy surface exerts on the sled.

\[
(F_{\text{Net}})_y = m_{\text{tot}}a_y
\]

\[
F_N - m_{\text{tot}}g + (12 \text{N}) \sin(30^\circ) = 0
\]

\[
F_N = m_{\text{tot}}g - (12 \text{N}) \sin(30^\circ)
\]

\[
F_N = (37 \text{kg} + 7 \text{kg})(9.8 \text{ m/s}^2) - (12 \text{N}) \sin(30^\circ)
\]

\[
F_N = 437 \text{ N}
\]