1. (a) If the cart \((M)\) rolls up the incline, then the net force acting on the system is

\[
F_{\text{net}} = (m + M)a_{\text{net}} = mg - T + T - Mg \sin \theta - \mu_k Mg \cos \theta
\]

so \(a_{\text{net}} = \frac{mg - Mg \sin \theta - \mu_k Mg \cos \theta}{m + M}\).

(b) Since the cart rolls at a constant velocity, we know that \(a_{\text{net}} = 0\), so we can solve for the hanging mass \(m\):

\[
a_{\text{net}} = 0 = \frac{mg - Mg \sin \theta - \mu_k Mg \cos \theta}{m + M}
\]

\[
mg = Mg \sin \theta - \mu_k Mg \cos \theta
\]

\[
m = M(\sin \theta - \mu_k \cos \theta) = (500)(\sin(15) - (0.10) \cos(15)) = 178 \text{ g}.
\]

2. The car will start to slide with the force down the incline \((F_\parallel)\) overcomes the static friction \(f_s = \mu_s mg \cos \theta\):

\[
F_{\text{net}} = 0 = F_\parallel - f_s
\]
\[ mg \sin \theta = \mu_s \cos \theta \]
\[ \tan \theta = \mu_s \implies \theta = \tan^{-1}(\mu_s) = \tan^{-1}(0.8) = 39^\circ \]

(b) Once the car starts moving, the static friction is replaced by the kinetic friction, and the net acceleration is determined from Newton’s second law:

\[ F_{\text{net}} = ma_{\text{net}} = F_\parallel - f_k = mg \sin \theta - \mu_k mg \cos \theta \]
\[ a_{\text{net}} = g(\sin \theta - \mu_k \cos \theta) = (9.8)(\sin(39) - (0.3) \cos(39)) = 3.8 \text{ m/s}^2 \]

3. Since the sign is suspended (not moving), the gravitational force is completely balanced by the two ropes. So, the net force must be

\[ F_{\text{net}} = 0 = F_g - T - T \implies T = \frac{mg}{2} = \frac{(100)(9.8)}{2} = 490 \text{ N} \]

The cables are thus almost maxed out!! Each of them can only take an additional 10 N of force before snapping, which means only 20 N extra can be added to the sign. Each seagull weighs \( W_{\text{seagull}} = m_{\text{seagull}}g = (5)(9.8) = 49 \text{ N} \), so it will take only one seagull to break it.

4. (a) The jet-ski is propelled by a force \( F_{\text{jet}} = 200 \text{ N} \), which is counteracted by the frictional force \( f_k = \mu_k n = \mu_k mg \), so the net force is \( F_{\text{net}} = F_{\text{jet}} - \mu_k mg \) The net acceleration is thus \( a_{\text{net}} = \frac{F_{\text{jet}} - \mu_k mg}{m} = \frac{200 - (0.1)(9.8)}{75} = 1.7 \text{ m/s}^2 \). Assuming he starts from rest, his maximum velocity is calculated from kinematics: \( v_f = a_{\text{net}}t = (1.7)(10) = 17 \text{ m/s} \).

(b) When the jet stops, the only force acting on the ski is friction, thus \( F_{\text{net}} = -f_k \), which serves to slow the sled down to a stop. The acceleration is \( a_{\text{net}} = \frac{-f_k}{m} = -\frac{\mu_k mg}{m} = -\mu_k g \). The distance he will travel is determined until stopping \( (v_i = 17 \text{ m/s}, v_f = 0) \) by kinematics again: \( \Delta x = \frac{v_i^2 - v_f^2}{2a_{\text{net}}} = \frac{0 - 17^2}{-2(0.1)(9.8)} = 147 \text{ metres} \).