Name: _____Section/Instr.: _____

Partners: _____

Cooperative Problems 4: Friction and Drag Forces

1. The magnitude of the force on an object due to turbulent drag as it moves through a fluid is $D = \frac{1}{2} C\rho A v^2$.

While hiking, you come to a swiftly moving stream that appears to be roughly 1.0 m deep (i.e., about the length of your legs). You estimate the coefficient of static friction between your hiking boots and the rocks in the bottom of the stream to be $\mu_s = 0.5$.

(a) Draw a carefully labeled FBD showing all the forces that would act on you if you were to step into the stream.

(b) Express the magnitude of the drag force D that would be exerted on you by the flowing water as a function of its speed v. Assume that the water density is $\rho_w = 1000\,\text{kg/m}^3$, and that your legs can be modeled as cylinders which have a drag coefficient $C \approx 1.2$. (Hint: What is the effective area A of your legs? You may need to make some estimates here.)

(c) What force would be exerted on you if the water flowed at 10 m/s (about 22 mi/h)?

(d) What is the maximum value of the magnitude of the frictional force, $f_{s,\max}$, between your boots and the rocks? (Use your own mass.)

(e) What is the maximum drag force magnitude $D_{\max}$ that you can experience and not lose your grip on the rocks on the bottom of the stream? To what water speed v does this correspond?