A log is floating downstream. How would you calculate the drag force acting on it?

Answer: There are two basic types of the log movement in the water.

1) if $\frac{\upsilon \cdot L \cdot \rho}{\mu} < 10$, where υ is the velocity of log in the water, m/s; L is the length or width of the log, m; ρ is the water density, kg/m^3; μ is the viscosity of water, Pa·s.

In such conditions the drag force can be calculated as $F = k \cdot \mu \cdot L \cdot \upsilon$, where k is a dimensionless coefficient, which depends from the shape and streamlining of the log.

For example, if the log is a sphere with diameter D, then k = 3π ≈ 9.42, and $F = 9.42 \cdot \mu \cdot D \cdot \upsilon$.

As you see, in this case the drag force is directly proportional to the speed of the log, $F \propto \upsilon$.

2) if the log moves in such conditions, that $\frac{\upsilon \cdot L \cdot \rho}{\mu} > 100$, then the drag force can be calculated as $F = C \cdot A \cdot \frac{\rho \cdot \upsilon^2}{2}$, where A is the maximal value of cross-sectional area of the log, m^2; C is a dimensionless coefficient, which depends from the shape and streamlining of the log.

For example, if the log is a sphere with diameter D, then k = 0.44, and $F = 0.44 \cdot A \cdot \frac{\rho \cdot \upsilon^2}{2} =$

$$= 0.44 \cdot \frac{\pi \cdot D^2}{4} \cdot \frac{\rho \cdot \upsilon^2}{2} = 0.173 \cdot \rho \cdot D^2 \cdot \upsilon^2.$$

As you see, in this case the drag force is directly proportional to the square of speed of the log, $F \propto \upsilon^2$.