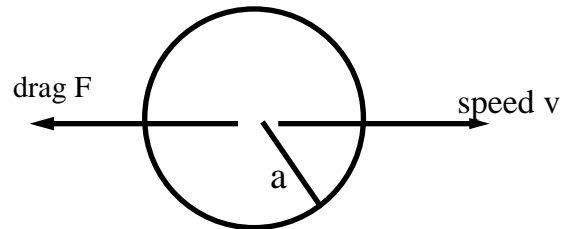


## Worksheet #1: Dimensional Analysis

Say we suspect that drag force  $F$  depends only on a sphere's radius  $a$ , its speed  $v$ , and the surrounding fluid density  $\rho$ .



- What are the dimensions of  $a$ ,  $v$ ,  $\rho$  and  $F$ ?
- Create the dimensions matrix for this problem.
- Find a dimensionless combination of the quantities,  $\pi$ .
- Find  $\boldsymbol{\alpha} = [\alpha_1, \alpha_2, \alpha_3, \alpha_4]$  so that  $\pi = a^{\alpha_1} v^{\alpha_2} \rho^{\alpha_3} F^{\alpha_4}$ . Is this choice unique? Find the subspace of all such vectors and find a basis.
- What is the number of independent dimensionless parameters?
- What does the Pi Theorem tell us for this problem? How must  $F$  depend on  $a, v, \rho$ ?
- If  $F$  also depended on viscosity  $\eta$  (units  $ML^{-1}T^{-1}$ ) Repeat part e).