## *Aerodynamic drag force*

To see how a resistive force arises from air consider the motion of an object falling vertically. In a time ?*t*, the object sweeps out a cylindrical volume in space equal to p$R^2v$? *t* where $R$ is its cross-sectional radius, and $v$ is its average speed.. The amount of air that is affected is equal to this volume multiplied by the density of air, ρ. The air is imparted a velocity from the object of order $v$, so the force exerted on it by the ball is given by

$$F\Delta t = m\Delta v = \left(p\, R^2 v \Delta t\right) r\, v$$

$$F = m\frac{dv}{dt} \approx rp\, R^2 v^2$$

By Newton's 3rd an equivalent force acts on the ball. This aerodynamic drag force acts exactly opposite in direction to the object's velocity and its magnitude is usually written as

$$\left|\vec{F}_{drag}\right| = \frac{1}{2} C\, r\, A v^2 \, ,$$

where $C$ is the drag coefficient and $A$ is the frontal cross-sectional area. This is a good approximation for objects around which the air flows in a turbulent manner, e.g., baseballs. The drag coefficient actually depends on the shape and texture of the object's surface. The program assumes a smooth sphere and calculates the drag coefficient based on its cross-sectional area.