Sheet of Dimensional Analysis

The drag force on a cylinder is studied in a wind tunnel. If wall effects are negligible, relate the drag force to the wind's speed, density and kinematic viscosity, and the cylinder's diameter and length.

The distance of the flight of a golf ball is assumed to depend on the initial velocity of the ball, the angle of the ball from the club, the viscosity and density of the air, the number of dimples on the ball and its diameter, and gravity. Write an expression for the flight distance. How would the temperature of the air influence the flight distance?

The flow rate Q of water in an open channel is assumed to depend on the height h of the water and width w and slope S of the channel, the wall roughness height e, and gravity g. Relate the flow rate to the other variables.

The lift F_L on an airfoil is related to its velocity V, its length L, its chord length c, its angle of attack α, and the density ρ of the air. Viscous effects are assumed negligible. Relate the lift to the other variables.

The drag F_D on an airfoil is related to its velocity V, its length L, its chord length c, its angle of attack α, and the density ρ and viscosity μ of the air. Relate the drag to the other variables.

Find an expression for the torque required to rotate a disk of diameter d, a distance t from a flat plate at a rotational speed Ω, a liquid fills the space between the disk and the plate.

The power $\dot{W}_P$ required for a pump depends on the impeller rotational speed Ω, the impeller diameter d, the number N of impeller blades, the fluid viscosity and density, and the pressure difference Δp. What expression relates the power to the other variables?

Write an expression for the torque required to rotate the cylinder surrounded by a fluid
(a) Neglect the effects of h. (b) Include the effects of h.

An object falls freely in a viscous fluid. Relate the terminal velocity V to its width w, its length l, gravity g, and the fluid density ρ and viscosity μ. Relate the terminal velocity to the other variables. Select (a) w, g, and ρ as the repeating variables and (b) l, g, and ρ as the repeating variables. Show that the relationship for (a) is equivalent to that of (b).

It is proposed that the velocity V issuing from a hole in the side of an open tank depends on the density ρ of the fluid, the distance H from the surface, and gravity g. What expression relates the variables?

Include the viscosity μ in the list of variables   Find the expression that relates the variables.

Include the diameter d of the hole and the viscosity μ in the list of variables   . Find an expression that relates the variables.

The pressure drop Δp over a horizontal section of pipe of diameter d depends on the average velocity, the viscosity, the fluid density, the average height of the surface roughness elements, and the length of the pipe section. Write an expression that relates the pressure drop to the other variables.

Assume a vertical pipe and include gravity in the list of variables   and find an expression for the pressure drop.

The drag force on a sphere depends on the sphere's diameter and velocity, the fluid's viscosity and density, and gravity. Find an expression for the drag force.