

A Successful Application

Dimensional analysis is fun, but does it work? Yes; if all important variables are included in the proposed function, the dimensionless function found by dimensional analysis will collapse all the data onto a single curve or set of curves.

An example of the success of dimensional analysis is given in Fig. 5.3 for the measured drag on smooth cylinders and spheres. The flow is normal to the axis of the cylinder, which is extremely long, $L/d \rightarrow \infty$. The data are from many sources, for both liquids and gases, and include bodies from several meters in diameter down to fine wires and balls less than 1 mm in size. Both curves in Fig. 5.3a are entirely experimental; the analysis of immersed body drag is one of the weakest areas of modern fluid-mechanics theory. Except for some isolated digital-computer calculations, there is no theory for cylinder and sphere drag except *creeping flow*, $Re < 1$.

The Reynolds number of both bodies is based upon diameter, hence the notation Re_d . But the drag coefficients are defined differently:

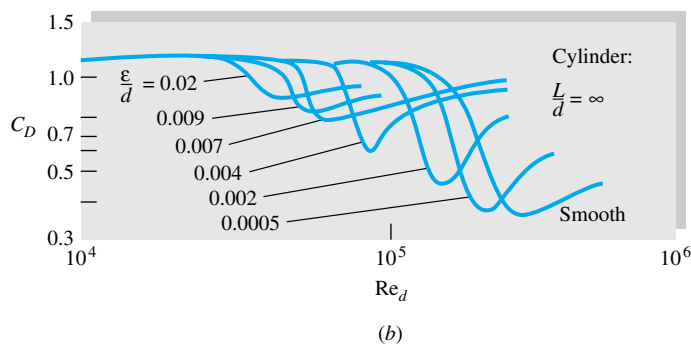
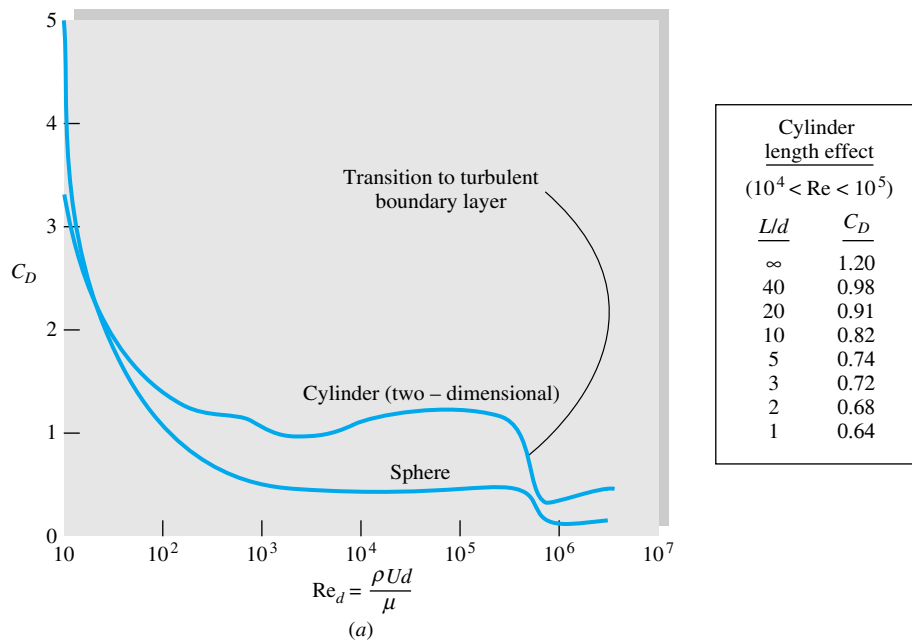


Fig. 5.3 The proof of practical dimensional analysis: drag coefficients of a cylinder and sphere: (a) drag coefficient of a smooth cylinder and sphere (data from many sources); (b) increased roughness causes earlier transition to a turbulent boundary layer.