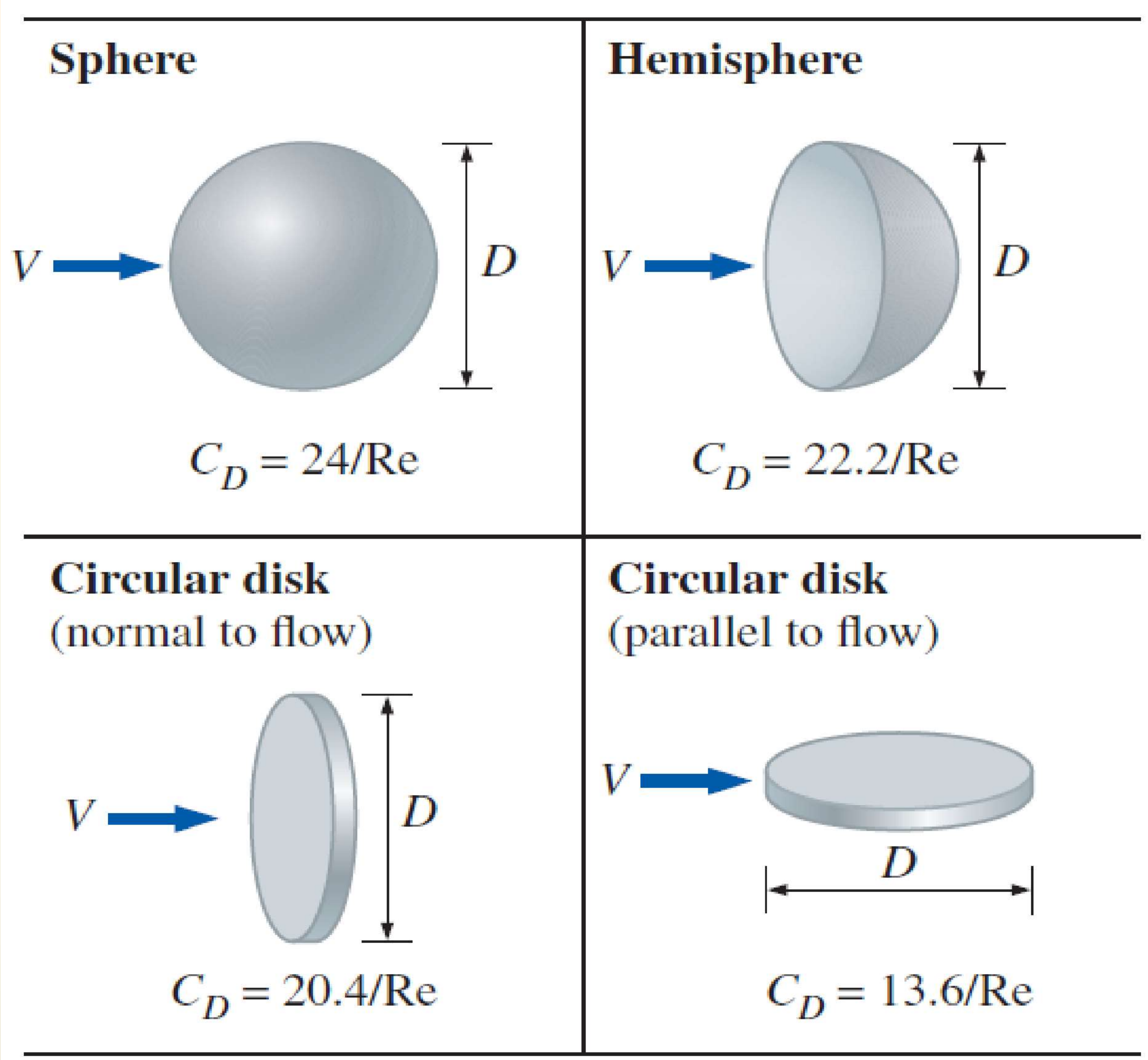
15-4 DRAG COEFFICIENTS OF COMMON GEOMETRIES-1

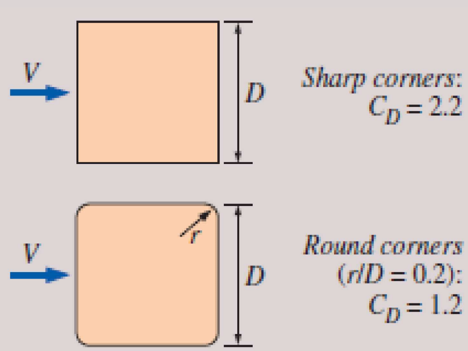


Drag coefficients C_D for creeping flow at low Reynolds number ($\mathrm{Re} \leq 1$ where $\mathrm{Re} = VD/\nu$ and $A = \pi D^2/4$).

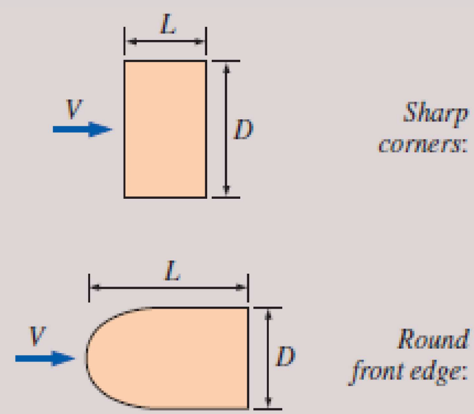
15-4 DRAG COEFFICIENTS OF COMMON GEOMETRIES-2

Drag coefficients C_D of various two-dimensional bodies for $\mathrm{Re} > 10^4$ based on the frontal area $A = bD$, where b is the length in direction normal to the page (for use in the drag force relation $F_D = C_D A_\rho V^2/2$ where V is the upstream velocity)

Square rod



Rectangular rod

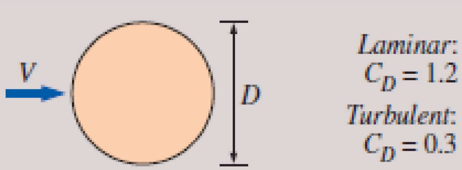


L/D	C_D
0.0*	1.9
0.1	1.9
0.5	2.5
1.0	2.2
2.0	1.7
3.0	1.3

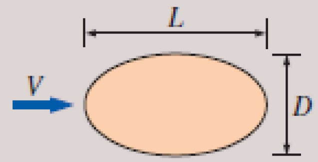
*Corresponds to thin plate

L/D	C_D
0.5	1.2
1.0	0.9
2.0	0.7
4.0	0.7

Circular rod (cylinder)

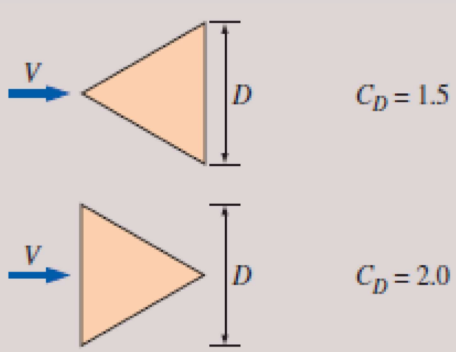


Elliptical rod

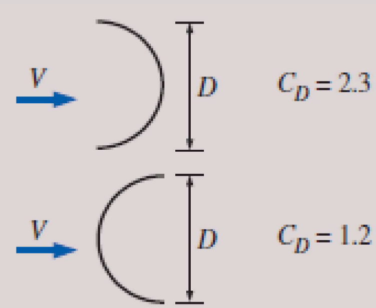


L/D	C_D Laminar	C_D Turbulent
2	0.60	0.20
4	0.35	0.15
8	0.25	0.10

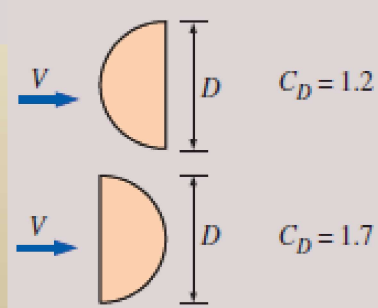
Equilateral triangular rod



Semicircular shell



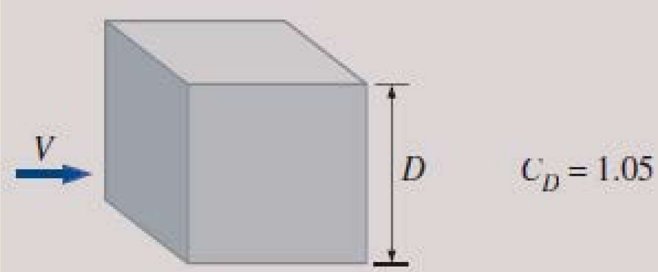
Semicircular rod



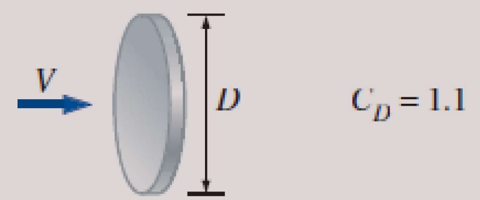
15-4 DRAG COEFFICIENTS OF COMMON GEOMETRIES-3

Representative drag coefficients C_D for various three-dimensional bodies based on the frontal area for $\mathrm{Re} > 10^4$ unless stated otherwise (for use in the drag force relation $F_D = C_D A_\rho V^2/2$ where V is the upstream velocity)

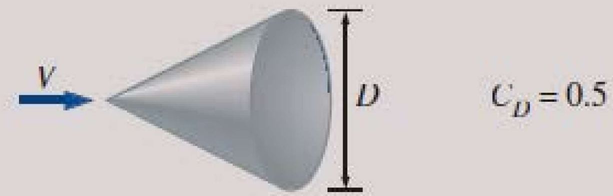
Cube, $A = D^2$



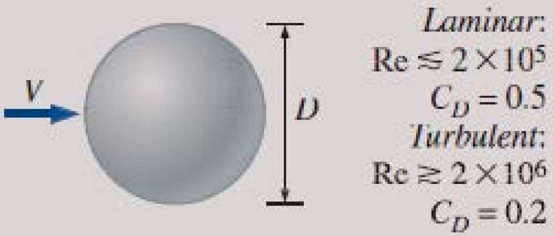
Thin circular disk, $A = \pi D^2/4$



Cone (for $\theta = 30°$), $A = \pi D^2/4$

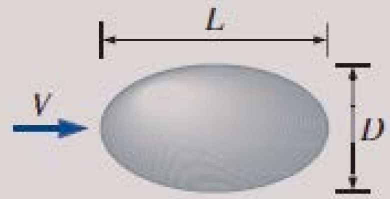


Sphere, $A = \pi D^2/4$



See Fig. 11-36 for C_D vs. Re for smooth and rough spheres.

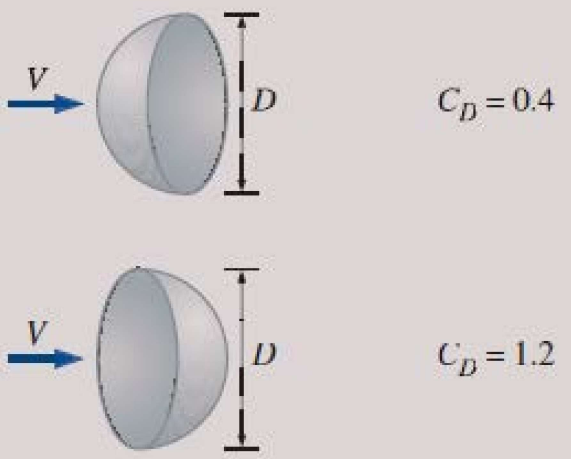
Ellipsoid, $A = \pi D^2/4$



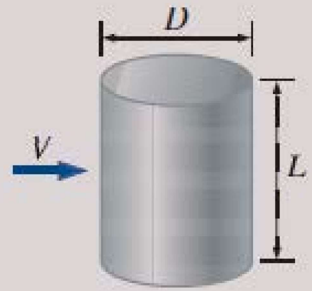
L/D	C_D Laminar $Re \lesssim 2\times10^5$	C_D Turbulent $Re \gtrsim 2\times10^6$
0.75	0.5	0.2
1	0.5	0.2
2	0.3	0.1
4	0.3	0.1
8	0.2	0.1

15-4 DRAG COEFFICIENTS OF COMMON GEOMETRIES-4

Hemisphere, $A = \pi D^2/4$



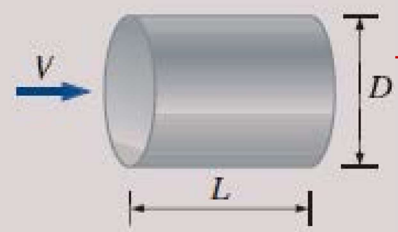
Finite cylinder, vertical, $A = LD$



L/D	C_D
1	0.6
2	0.7
5	0.8
10	0.9
40	1.0
∞	1.2

Values are for laminar flow ($Re \lesssim 2 \times 10^5$)

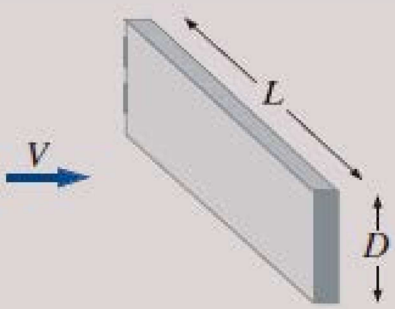
Finite cylinder, horizontal, $A = \pi D^2/4$



L/D	C_D
0.5	1.1
1	0.9
2	0.9
4	0.9
8	1.0

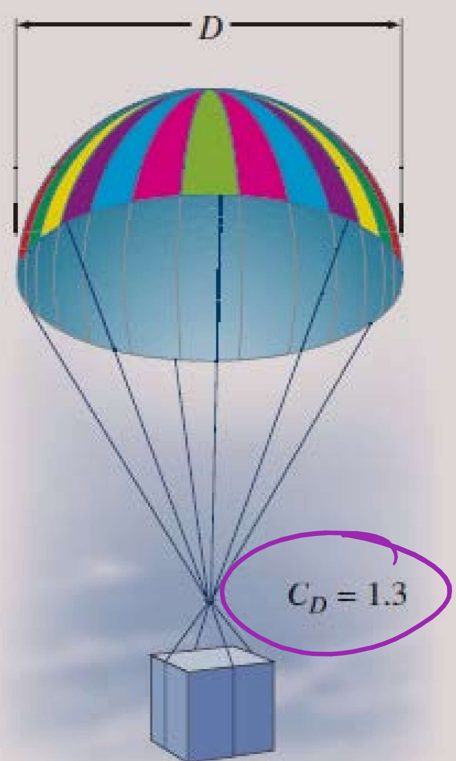
Streamlined body, $A = \pi D^2/4$

Rectangular plate, A=LD

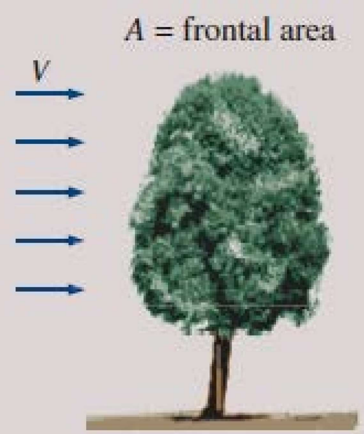


$C_D = 1.10 + 0.02\,(L/D + D/L)$ for $1/30 < (L/D) < 30$

Parachute, $A = \pi D^2/4$



Tree, A=frontal area



V, m/s	C_D
10	0.4-1.2
20	0.3-1.0
30	0.2-0.7

15-4 DRAG COEFFICIENTS OF COMMON GEOMETRIES-5