List of Symbols

Typical units given in square brackets. If no units are given, variable is dimensionless.

A_e	Exit area [m^2]
A_i	Intake area [m^2]
A_f	Frontal area [m^2]
A_{plan}	Planview or planform area [m^2]
A_{ref}	Reference area [m^2]
A_{wet}	Wetted area [m^2]
AR	Aspect ratio
α	Angle-of-attack (pronounced *alpha*) [degrees]
α	Shear angle (or a fluid element) [degrees, radians]
b	width of a wing (i.e. span), or the vehicle body [m]
c	Chord [m]
C_d	Drag coefficient
$C_{d,fr}$	Drag coefficient based on frontal area
$C_{d,i}$	Induced drag coefficient
$C_{d,plan}$	Drag coefficient based on planview area
$C_{d,wet}$	Drag coefficient based on wetted area
C_f	Skin-friction coefficient based on wetted area
$C_{f,flat}$	Skin-friction coefficient of a flat plate based on wetted area
$C_{f,lam}$	Laminar skin-friction coefficient based on wetted area
$C_{f,turb}$	Turbulent skin-friction coefficient based on wetted area
C_L	Lift coefficient
$C_{L,f}$	Lift coefficient at front axle
$C_{L,r}$	Lift coefficient at rear axle
C_{rr}	Rolling-resistance coefficient
C_{rr1}	Zero-speed rolling-resistance coefficient
C_{rr2}	Rolling-resistance speed factor [1/ mph, 1/ kph]
C_τ	Shear-stress coefficient (local skin-friction coefficient)
$C_{\tau,lam}$	Laminar shear-stress coefficient (local skin-friction coefficient of laminar flow)
$C_{\tau,turb}$	Turbulent shear-stress coefficient (local skin-friction coefficient of turbulent flow)
$C_d A$	Drag area [m^2]
$C_f A_{wet}$	Skin-friction drag area [m^2]
$C_L A$	Lift area [m^2]
CG	Center of gravity
Cp	Coefficient of pressure
CP	Center of pressure
D	Drag [N, lbs]
D	Diameter [m]
d'	Ground clearance ratio, eg. h_{min} / b
D_i	Induced drag [N, lbs]
D_j	Junction drag [N, lbs]
D_{pres}	Pressure drag [N, lbs]
D_{skin}	Skin-friction drag [N, lbs]
δ_{lam}	Laminar boundary-layer thickness (pronounced *delta*) [m]
δ_{turb}	Turbulent boundary-layer thickness [m]
δ^*_{lam}	Laminar displacement thickness [m]
δ^*_{turb}	Turbulent displacement thickness [m]
Γ	Circulation (pronounced *gamma*) [m^2/ s]
h	Height [m]
h^+	Riblet number [nondimensional]
h_{min}	Minimum ground clearance [m]
H	Shape factor
H_r	Riblet height [m]
k_a	Gas constant of dry air [J/kg-K, Nm/kg-K]
k_w	Gas constant of water vapor [J/kg-K, Nm/kg-K]
l	Length [m]
L	Length [m]
L	Lift [N, lbs]
m	Mass [kg]
M_{bl}	Momentum flow in boundary layer [kg m/s^2]
M_f	Momentum flow in freestream [kg m/s^2]
μ	Dynamic viscosity (pronounced *mu*) [Ns/m^2]
ν	Kinematic viscosity (pronounced *nu*) [m^2/s]
P_a	Partial pressure of air [Pa, N/m^2, psi]
P_∞	Freestream or ambient pressure [Pa, N / m^2, psi]
P_{loc}	Local pressure [Pa, N / m^2, psi]
P_{stag}	Stagnation pressure [Pa, N/m^2, psi]
P_w	Partial pressure of water [Pa, N/m^2, psi]
q	Dynamic pressure [Pa, N/m^2, psi]
R_j	Junction radius [m]
Re_L	Reynolds number based on total body length
Re_x	Reynolds number at some location x based on length from leading edge, local Reynolds number
ρ	Fluid density (pronounced *rho*) [kg/m^3]
t	Thickness (of an airfoil) [m]
t	Time [sec]
T	Temperature [°C, K , °F]
τ	Shear stress (pronounced *tau*) [Pa, N / m^2, psi]
θ_f	Leading-edge junction angle of a strut in side view (pronounced *theta*) [°]
θ_{lam}	Laminar momentum thickness [m]
θ_{turb}	Turbulent momentum thickness [m]
U	Velocity [m/s]
$u(y)$	Local velocity at some location y [m/s]
V_{car}	Velocity of car [m/s, kph, mph]
V_∞	Freestream flow velocity [m/s]
V_{loc}	Local flow velocity [m/s]
V_{wind}	Velocity of wind [m/s, kph, mph]
W	Weight [N, lbs]
x	Distance, usually from leading edge [m]
x_t	Location of transition from leading edge [m]

USEFUL RELATIONSHIPS

Angle	Degrees [°] Radians [rad]
Distance	Kilometer [km] Mile [mi]
Drag	Equivalent to a force.
Energy	Joule [J] Watt-hour [Wh or Whr] Work, Newton-meter [Nm]
Force	Newton [N] Pound [lb]
Length	Meter [m] Foot [ft]
Mass	Kilogram [kg] Pound mass [lbm] Slug [sl]
Power	Watt [W] Horsepower [hp]
Pressure	Pascal [Pa], equivalent to N/m^2 Pounds per square-inch [psi] Atmosphere [atm] Millimeters of mercury [mm Hg]
Rotational speed	Revolutions per minute [rpm]
Temperature	Degrees Celsius [°C] Kelvin [K] Degrees Fahrenheit [°F]
Velocity	Kilometers per hour [kph] Miles per hour [mph]
Weight	Equivalent to a force

Angle	1 rad = 180 / π° = 57.3°
Area	$1\ m^2 = 10.76\ ft^2$ $1\ m^2 = 1550.0\ in^2$
Energy	1 J = 1 Nm 1 Whr = 3600 J
Force	4.448 N = 1 lb
Length	1 m = 39.37 in 1 inch = 0.0254 m = 2.54 cm 1 mile = 1609 m = 1.609 km 1 mile = 5280 ft
Mass	1 kg = 2.205 lbm 14.594 kg = 1 slug 32.174 lbm = 1 slug
Power	745.7 W = 1 hp Motor power (given motor torque and rpm) W = (0.105) (Nm) (rpm) hp = (ft-lbs) (rpm) / (5252) Road power (given drag force and velocity) W =(N) (m/s) = (0.278) (N) (kph) = (1.988) (lbs) (mph)
Pressure	6895 Pa = 1 psi 1 atm = 760 torr = 760 mm Hg = 14.696 psi = 101.3 kPa
Temperature	°C = (5/9) × (°F - 32) K = °C + 273
Torque	1.356 Nm = 1 ft-lb
Velocity	1.609 kph = 1 mph 0.447 m/s = 1 mph