

Automotive Aerodynamics Cheat Sheet

Drag, lift, downforce, body shape and ventilation

ENGINEERING
CHEAT SHEET

Key equations

Quantity	Equation	Notes
Air speed seen by the car	$v = v_{veh} - v_{wind}$	Wind is negative in a headwind, so v is larger
Drag force	$F_D = \frac{1}{2} \rho C_D A_f v^2$	Textbook form; post names ρ , C_D , A_f , v
Lift, side force, moments	$F, M = \frac{1}{2} \rho v^2 A (C \text{ or } C_M l)$	Same pattern for lift, side force and moments
Drag power	$P = F_D v$	Textbook; varies as v^3
Post's sedan example	C_D 0.30, A_f 2.2 m ² , 27.8 m/s	$F_D \approx 312$ N, about 8.7 kW (checked)
Diffuser angle	9.8° to 16°	Removes positive pressure disturbances at underbody edge
Cooling air share of drag	10 to 15%	Engine cooling and air intake system
Drag split, ICE car	65 / 20 / 10 / 5 %	Body / wheel housings / mirrors, windows / engine ventilation

Key takeaways

- Drag types: form (pressure) drag is the largest, then skin friction in the boundary layer, excrescence (wheels, mirrors, handles) and internal (cooling, cabin air).
- Reduce drag: streamline and taper the rear, cut frontal area, air dam and side skirts, underbody panels, air curtains, camera mirrors, shark-fin antenna.
- Production C_D per post: EQS 0.20, Model S 0.208, Prius 0.24, Camry 0.28, Mustang 0.35, Wrangler 0.45.
- Cutting C_D about 10% improves highway ICE economy roughly 2 to 3%; EVs lose most energy to drag above about 50 mph.
- Spoiler redirects air to cut lift; a wing is an inverted airfoil making downforce. Downforce adds grip without adding mass.
- Downforce depends on ride height and center of pressure, so springs, damping and aero are designed together (Newey, 2017).
- Correction to the post: it says power quadruples if speed doubles. Drag force quadruples; power rises about 8 times (mine).

Ventilation airflow placement (windshield and backlight angles: SAE J1100)

Intake or exit	Location	Why
Cabin air intake	High-pressure zone ahead of windshield	Fresh air, less road debris
Cabin air exit	Low-pressure zone, rear of vehicle	Pulls stale air out
EV vs ICE grille	EV grille can be much smaller	Battery needs less cooling air