3 APR 24 DD

$$ma = F_D = -\frac{1}{2} \rho V^2 S \, C_D \quad (1)$$

MINUS SIGN = RETARDING ACCEL.

EFFECTIVE SURFACE AREA

DIMENSIONLESS DRAG COEFICIENT

$$a = -\frac{1}{2} \rho V^2 \frac{S}{m} C_D \quad (2)$$

$$BC = \text{BALLISTIC COEFFIENT} \equiv \frac{m}{S} \quad (3)$$

$$a = -\frac{1}{2} \rho V^2 \frac{1}{BC} C_D \quad (4)$$

C_D MEASURED EXPERIMENTALLY.
NO "SIMPLE FORMULA DERIVATION."

IN USEFUL REGION, $1.2 < \text{MACH} < 2.5$,

$$C_D = \frac{K_3}{\sqrt{\text{MACH}}} = K_3 \frac{\sqrt{a}}{\sqrt{V}} \qquad a = V_{SOS} \quad (5)$$

$$a = -\frac{1}{2} \rho \frac{1}{BC} K_3 \frac{\sqrt{a}}{\sqrt{V}} V^2 \quad (6)$$

$$a = -\underbrace{\left[\frac{1}{2}\,\rho\,\frac{1}{Bc}\,K_3\,\sqrt{a}\right]}_{\text{DEFINE } \underline{J} \equiv} V^{3/2} \qquad (7)$$

$$\frac{dV}{dt} = -J V^{3/2} \qquad (8)$$

SEPARATE VARIABLES, INTEGRATE

$$\frac{dV}{V^{3/2}} = -J\,dt \qquad (9)$$

$$\int V^{-3/2}\,dV = \int -J\,dt \qquad (10)$$

$$\frac{-2}{\sqrt{V}} = -Jt + c_1 \qquad (11)$$

SEE P2A

BOUNDARY CONDITION @ $t = 0$, $V = V_m$

$$\frac{-2}{\sqrt{V_m}} = 0 + c_1 \qquad (12)$$

$$c_1 = \frac{-2}{\sqrt{V_m}} \qquad (13)$$

D2A

— SIGN

$$\int v^{-\frac{3}{2}} \, d v$$

NATURAL LANGUAGE

MATH

Indefinite integral

$$\int v^{-3/2} \, dv = -\frac{2}{\sqrt{v}} + \text{constant}$$

REWRITE, REARRANGE (11)

$$\frac{2}{\sqrt{V}} = Jt - c_1 \qquad (14)$$

$$\frac{\sqrt{V}}{2} = \frac{1}{Jt - c_1} \qquad (15)$$

$$\sqrt{V} = \frac{2}{Jt - c_1} \qquad (16)$$

$$V = \frac{dx}{dt} = \frac{4}{(Jt - c_1)^2} \qquad (17)$$

$$\int dx = \int \frac{4\, dt}{(Jt - c_1)^2} \qquad (18)$$

$$X + c_2 = \frac{4}{J(c_1 - Jt)} \qquad (19)$$

SEE PAGE D3A