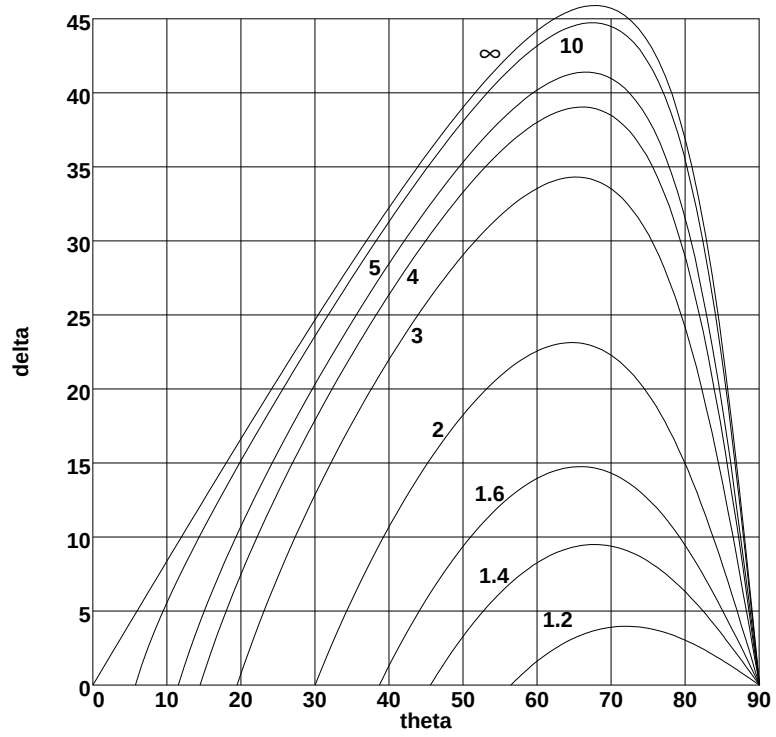
What is the Maximum Deflection of a Supersonic Stream with an Attached Shock Wave ?

The deflection angle, delta, for a given wave angle, theta, and a given Mach number M is governed by

$$\cot\delta = \tan\theta\left[\frac{(\gamma+1)M^2}{2(M^2\sin^2\theta-1)}-1\right]$$

This is equation 138 of NACA report 1135 and is illustrated in the following chart.



For a given upstream Mach number, there is a maximum value of deflection angle and you can read the value on the y-axis. If you are writing a computer code and you need a function that returns the maximum deflection angle for a given Mach number, what equation do you use? If you want a fast routine that gives you this result, simply use BrentMin on equation 138. BrentMin is one of the members of the library of Computer Methods for Mathematical Computation downloadable from this site. You are looking for a maximum of deflection angle, delta, and BrentMin finds a minimum. But, you are in luck, because equation 138 returns cot(delta) and a minimum of cot(delta) is a maximum of delta. Cool. If you want to go thru the details, see the numerics page at
http://www.pdas.com/maxramp2.xml.

The results are summarized below.

Mach	delta, deg
1.05	0.56
1.10	1.52
1.20	3.94
1.30	6.66
1.40	9.43
1.60	14.65
1.80	19.18
2.00	22.97
2.50	29.80
3.00	34.07
4.00	38.77
5.00	41.12
6.00	42.44
8.00	43.79
10.00	44.43

¡td¿ ¡img src="maxramp.png" alt="curve of max Ramp vs. Mach" /¿ ¡/td¿

The source file is maxramp1.tex
Last updated: 20 March 2003 by Ralph Carmichael (ralph@pdas.com)
Public Domain Aeronautical Software
P.O. Box 1438, Santa Cruz CA 95061 USA