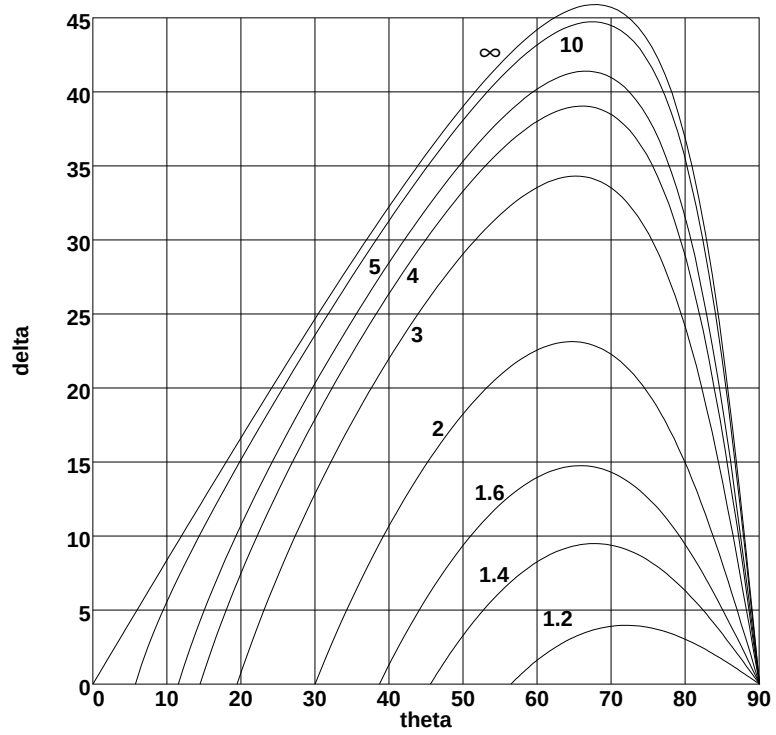
# What is the Wave Angle for a Given Deflection Angle and Mach Number with an Attached Shock Wave ?

The relationship between deflection angle, wave angle, theta, and Mach number M in an attached oblique shock is governed by

$$\cot\delta = \tan\theta\left[\frac{(\gamma+1)M_1^2}{2(M_1^2\sin^2\theta-1)}-1\right]$$

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




It is quite straightforward to compute the deflection angle associated with a given wave angle. The most typical problems encountered by engineers usually involve finding the wave angle for a given deflection angle. There is no simple solution to this problem. One procedure that is shown in many textbooks and NACA 1135 is a clever substitution of variables that leads to a cubic polynomial equation. After finding the three roots to this equation, we are told that the solution for the weak shock corresponds to the middle root. Taking this middle root, one then applies the inverse of the original transformation and gets the desired wave angle.

There is nothing really wrong with this approach. I would like to suggest that the solution for wave angle can be found using Newton's method and that learning how to apply Newton's method can prove useful in many scientific and engineering applications.

If you want to go thru the details, see the numerics page
XHTML: http://www.pdas.com/oshock2.xml.
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The source file is oshock1.tex
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