The Concorde aircraft flies at Ma≈2.3 at 11 km standard altitude. Estimate the temperature in °C at the front stagnation point. At what Mach number would it have a front stagnation point temperature of 450 °C?

SOLUTION:

The temperature at the stagnation point is determined using:

$$\frac{T}{T_0} = \left(1 + \frac{\gamma - 1}{2} \text{Ma}_\infty^2\right)^{-1}$$

(1)

where

γ = 1.4
Ma_∞ = 2.3
T_∞ = 217 K (from standard atmosphere tables at an altitude of 11 km)
$\Rightarrow$ $\boxed{T_0 = 447 \text{ K} = 174 \text{ °C}}$

For the next part of the problem, re-arrange Eqn. (1):

$$\text{Ma}_\infty = \sqrt{\frac{2}{\gamma - 1}\left(\frac{T_0}{T} - 1\right)}$$

(2)

Using the given data:

γ = 1.4
T_∞ = 217 K
T_0 = 450 °C = 723 K
$\Rightarrow$ $\boxed{\text{Ma}_\infty = 3.4}$