ME 356: Hypersonic Aerothermodynamics, Spring 2020
Stanford University
Homework 2: Hypersonic Inviscid Flows (II)
Due Tuesday, May 12.

Guidelines: Please turn in a neat and clean homework that gives all the formulae that you have used as well as details that are required for the grader to understand your solution. Attach these sheets to your solutions. In the calculations, assume a calorically perfect gas with $\gamma = 1.4$ unless stated otherwise.

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Questions (100 pts)

1. Explain what an entropy layer is and how is it formed downstream of the nose shock around blunt bodies.

   SEE PAGES 53-55 OF THE CLASS NOTES

2. In the figure below, the surface pressure coefficient at point Q on the fuselage of projectile #1 is $C_p = 0.2$. Assuming $c/\lambda_1 = 1/7$ and $\lambda_2 = \lambda_1/2$, at what Mach number would van Dyke’s hypersonic similarity rule studied in class could be used to obtain a value of $C_p$ at point Q on the fuselage of projectile #2? Provide the resulting value of $C_p$.

   \[
   \begin{align*}
   Ma_{\infty} &= 12 \\
   \lambda_1 &= \\
   C_p &= 0.2 \\
   M_{\infty} &= 12 \\
   \end{align*}
   \]

3. Is a Mach-8 flow over a two-dimensional wedge of semiangle $\delta = 7^\circ$ hypersonic? Justify your answer.

   NO, BECAUSE IF IT WERE, $\dot{E}$ WOULD BE POSITIVE, BUT $M_{\infty} = 8 \gg 1$, SO IT CAN'T BE HYPERSONIC.

4. Explain the reasons why the straight Newtonian theory is more accurate in three-dimensional flows (i.e., flows over cones) than in two-dimensional flows (i.e., flows over wedges).

   BECAUSE THE SHOCK IS ALWAYS CLOSER TO THE BODY IN 3D FOR THE SAME $S$ AND $Ma$. 