AS 203 Gas Dynamics
Practice Problems -2

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1. Air from a reservoir at 10MPa and 1000K is expanded to 1atm pressure. Then is made to change the flow direction by 10^o by an oblique shock. Find the shock angle and the conditions after shock. [*23.44^o, M=3.059, 2.36 atm, 348K*]

2. Air is flowing at 1000 m/s at 1atm and 300K conditions. Flow is turned by a compression corner to an angle of 15^o. Find the final mach number if the corner was (a) smooth and (b) sharp. Also find the pressure, temperature and velocity for the two cases. [*(a) 2.167, 2.73 atm, 411K, 883.7m/s; (b) 2.225, 2.755atm, 400.7 K, 896 m/s*]

3. Air is flowing at 1000 m/s at 1atm and 300K conditions. Flow is turned by a expansion corner to an angle of 15 degrees. Find the final mach number if the corner was (a) smooth and (b) sharp. Also find the pressure, temperature and velocity for the two cases. [*3.754, 0.282atm, 209K, 1091m/s*]

4. A shock is moving at 3000 m/s in a duct with still air at 500K and 2 atm pressure. Find P, T, u and M of the air that follows the shock. Also give its temperature and pressure. Find the stagnation conditions also. Explain the change in stagnation conditions. [*(a) 103.5atm, 4796K, 2443.8m/s, 1.754; (b) before shock: 6101atm, 4949K after shock: 554.7 atm, 7748K; (c) The shock is moving so there is energy kinetic energy associated with it, which is transferred to the gas as total temperature change. This is called the shock heating of the gas. It can also be thought of as the kinetic energy associated with the reference frame is now transferred to the gas partially.*]

5. A special gas (γ=1.3 and MW = 18) is to replace air in a special experiment in which the oblique shock angle is fixed to be 40 degrees. If the incoming Mach number is 3.2, find the final deflection angle for the new gas. [*24.3^o*]

6. Air flows over a flat wall parallel to ground at M=2 at P=1atm, T=300K. The wall smoothly moves away from the flow to an angle of 15^o, and after some more straight length, it is further deflected to around 15^o away from flow. Find the flow conditions at the two flat portions (M, P, T). Also find the maximum deflection the flow can have further after the second deflection. [*(a) 2.5984, 0.393atm, 229.7K; (b) 3.3683, 0.124 atm, 165.2K; (c)74.05^o*]

7. A double wedge airfoil as in **assignment1** is flying at 5km altitude at zero angle of attack in M = 2 flow. Find the drag force on the airfoil. (This drag over a body in inviscid flow is called **wave drag**, which is characteristic of supersonic flows only) [*10.8 kN*]

8. A supersonic aircraft is having a pitot probe in the front of the nose cone such that at zero angle of attack flight, the probe point straight 10^o below the incoming flow vector. If the aircraft is flying at 5 km altitude with 10^o angle of attack, at Mach 2 speed with respect to the ground, find the pressure measured by the pitot probe. [*0.39 bar*]

9. An oblique shock at M=3(P=1atm, T=300K) is deflecting the flow by 20 degrees. Find the resultant flow conditions when this shock reflects at a wall parallel to the free stream flow direction. [*M=1.204, P3=10.72 atm, T3=651.2 K, beta2=53.63*]

10. A duct with cross section area $0.01m^2$ is having a 10 m/s flow through it at 1atm and 300K. The duct area is monotonically decreased to 5cm2. Find the flow conditions at the exit. [M=0.853, 0.622 atm, 262K]