COMPRESSIBLE FLOW

SEMINAR 8 EXAMPLES

1. A certain aircraft flies at the same Mach number regardless of its altitude. Compared to its speed at 12000 m (ISA conditions), it flies 127 km/h faster at sea level. Determine its Mach number.

Ans: 0.78

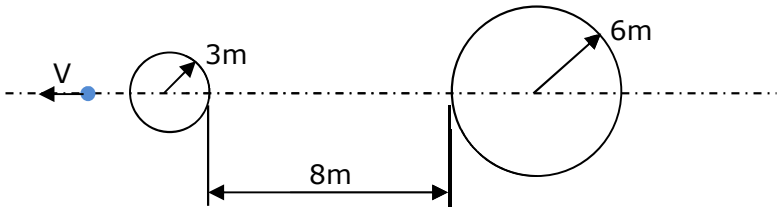
2. An ideal gas flows adiabatically through a duct. At section 1 p_1 = 140 kPa , T_1 = 260°C and V_1 = 75 m/s. Downstream at section 2 p_2 = 30 kPa , T_2 = 207°C. Calculate V_2 and the change in entropy $s_2 - s_1$ if the gas is a) air with γ=1.4and b) Argon with γ=1.67.

Ans: a) 335 m/s, 337 J/KgK; b) 246 m/s, 266 J/KgK

3. An aeroplane flies at Mach 0.8 in air at 15°C and 100 kPa . Calculate the stagnation temperature and pressure.

Ans: 325 K, 152.4 kPa

4. A particle is moving supersonically in air at 1.01325 bar and 288.15K. From the two disturbance spheres shown compute: a) Mach angle, b) particle Mach number, and c) particle velocity.



Ans: 10.2°, 5.7, 1940 m/s

5. (extension question) An air tank of volume 1.5 m^3 is at 800 kPa and 20°C when it begins exhausting through a converging nozzle to sea-level conditions. The throat area is 0.75 cm^2. Estimate a) the initial mass flow; b) the time to blow down to 500 kPa (hint: recall that $\dot{m} = \frac{dm}{dt}$) and c) the time when the nozzle ceases being choked.

Ans: 0.142 kg/s, 47.3s, 143.6s