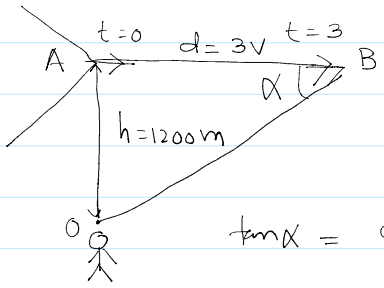
Calculate the velocity and mach number of a supersonic aircraft flying at an altitude of 1200m where the temperature of is 0 º C. the sound of air craft is heard 3 second after passage of air craft over the head of an observer. Assume R=287 J/kg K and γ=1.4



Given Data

$h = 1200m$

$T = 0^{\circ}C = 273K$

$t = 3$ sec

$R = 287$ J/kgK

$\gamma = 1.4$

$V = ?$

$M = ?$

$C = \sqrt{\gamma RT}$

$= \sqrt{1.4 \times 287 \times 273}$

$C = 331.197$ m/sec

$\tan\alpha = \frac{OA}{AB}$

$\sin\alpha = \frac{1}{M}$ $\qquad \tan\alpha = \frac{1200}{3V}$

$M = \frac{1}{\sin\alpha} = \frac{1}{\sin 34.1}$

$\sin\alpha = \frac{331.19}{V}$

$M = 1.7833$

$\tan\alpha = \frac{\sin\alpha}{\cos\alpha} \Rightarrow \frac{1200}{3V} = \frac{\frac{331.19}{V}}{\cos\alpha}$

$V = \frac{331.19}{\sin\alpha} = \frac{331.19}{\sin 34.1}$

$\cos\alpha = 0.82799$

$\alpha = 34.1^{\circ}$

$V = 590.68$ m/s

$= \frac{590.68 \times 3600}{1000} = 2126.46$ km/hr

A super sonic aero plane is flying at 1500 km/hr at an altitude of 10 km above sea level in standard atmosphere. The pressure and density are as 2.5 N/cm2 absolute and 0.4 kg/m3. Calculate the pressure and temperature and density at the stagnation point on the nose of the plane. Assume R=287 J/kg K and γ=1.4

given Data

$V_1 = 1500$ km/hr

$= \frac{1500 \times 1000}{3600} = 416.66$ m/s

$h = 10$ km

$P_1 = 2.5$ N/cm^2 $= 2.5 \times 10^4$ N/m^2

$\rho_1 = 0.4$ kg/m^3

$R = 287$ J/kg K

$\gamma = 1.4$

P_0, ρ_0, T_0

$C_1 = \sqrt{\gamma R T_1}$ $\quad \frac{P_1}{\rho_1} = RT_1$ $\quad \frac{2.5 \times 10^4}{0.4} = 287 \times T_1$

$= \sqrt{1.4 \times 287 \times 217.77}$ $\quad T_1 = 217.77$

$C_1 = 295.80$ m/s

Mach Number $M_1 = \frac{V_1}{C_1} = \frac{416.66}{295.80} = 1.4085$

$P_0 = P_1 \times \left[1 + \frac{\gamma - 1}{2} M_1^2\right]^{\gamma/\gamma-1}$

$= 2.5 \times 10^4 \left[1 + \frac{1.4-1}{2} \times (1.408)^2\right]^{1.4/1.4-1}$

$= 2.5 \times 10^4 \times 3.2206 = \boxed{80515.96 \text{ N/m}^2}$

$T_0 = T_1 \times \left[1 + \frac{\gamma - 1}{2} M_1^2\right]$

$= 217.77 \times \left[1 + \frac{1.4-1}{2} \times (1.408)^2\right]$

$\boxed{= 304.17 \text{ K}}$

$\rho_0 = \rho_1 \left[1 + \frac{\gamma - 1}{2} M_1^2\right]^{1/\gamma-1}$

$= 0.4 \left[1 + \frac{1.4-1}{2} \times (1.408)^2\right]^{1/1.4-1}$

$\boxed{= 0.9223 \text{ kg/m}^3}$