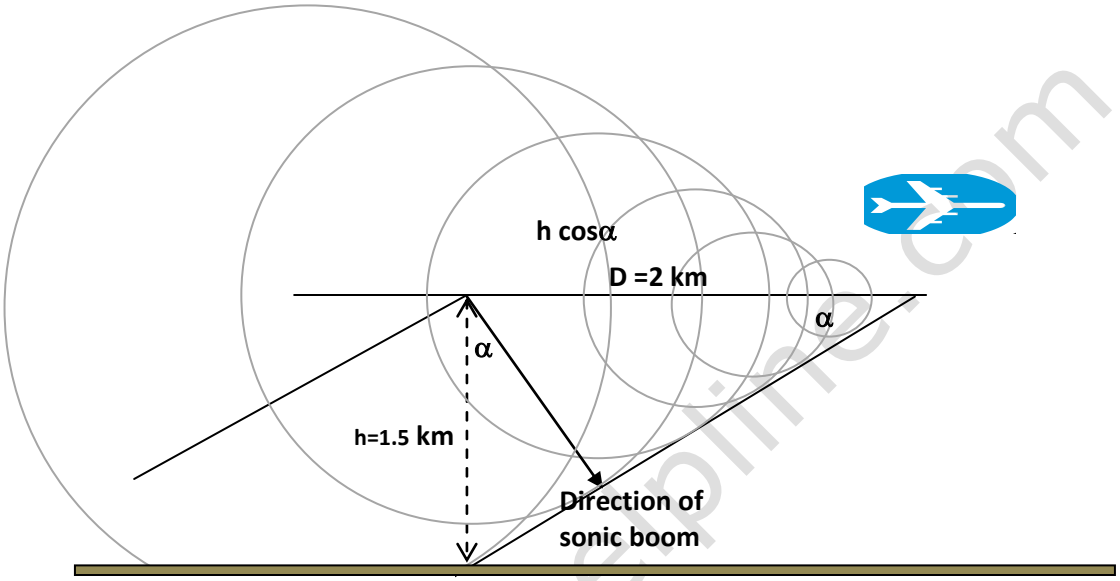
Q- A person looks directly overhead and sees a plane exactly 1.5 km above the ground flying faster than the speed of sound. By the time he hear the sonic boom, the plane has traveled a horizontal distance of 2.0 km. Find the angle of the shock cone.
(a) Find the angle of the shock cone.
(b) Find the speed of the plane (the Mach number). Assume the speed of sound is 330 m/s.



(a) As the plane advances the sound is produced at all points of the path momentarily and creating spherical wave fronts. These waves will travel with speed of sound and the resulting wave front will be a cone. This wave is called sonic boom of shock waves and the cone is called shock cone. From the diagram it is clear that the half angle of this shock cone is given by

$$\tan\alpha = \frac{h}{D} = \frac{1.5}{2} = 0.75$$

Gives $\alpha = \tan^{-1} 0.75 = 37^0$

(b) The sound produced overhead will reach the listener at ground in time

$$t = \frac{1500}{v_{sound}} = \frac{1500}{330} = \frac{50}{11}\ s$$

During this time the plane moves a distance D = 2.0 km thus the speed of the plane will be

$$v_{plane} = \frac{2000}{50/11} = 440\ m/s$$

Thus the Mach number for the plane will be $\frac{v_{plane}}{v_{sound}} = \frac{440}{330} = 1.33$