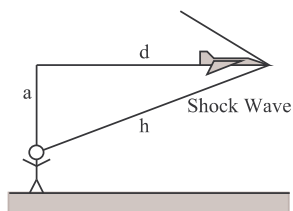


Chapter 14 Problem 75 †



Given

$$v = 340 \text{ m/s}$$

$$u = 2.2v$$

$$\Delta t = 19 \text{ s}$$

Solution

Find the altitude of the plane.

Since the plane is travelling at super-sonic speeds the angle of the shock wave is given by

$$\theta = \sin^{-1} \left(\frac{v}{u} \right)$$

Substituting in the value for u gives

$$\theta = \sin^{-1} \left(\frac{v}{2.2v} \right) = \sin^{-1} \left(\frac{1}{2.2} \right) = 27.0^\circ$$

From the diagram the altitude can be calculated from the angle of the shock wave and the distance the plane travels before the shock wave hits you.

$$\tan \theta = \frac{a}{d} \tag{1}$$

The distance the plane travels is velocity times time

$$d = u \cdot t$$

Substituting this into equation 1 and solving for altitude gives

$$a = d \tan \theta = u \cdot t \tan \theta$$

Substituting in the appropriate values gives

$$a = 2.2v \cdot t \tan \theta = 2.2(340 \text{ m/s})(19 \text{ s}) \tan 27.0^\circ$$

$$a = 7240 \text{ m} = 7.24 \text{ km}$$

†Problem from Essential University Physics, Wolfson