

70. (a) The blood is moving towards the right (towards the detector), because the Doppler shift in frequency is an *increase*: $\Delta f > 0$.
- (b) The reception of the ultrasound by the blood and the subsequent remitting of the signal by the blood back toward the detector is a two step process which may be compactly written as

$$f + \Delta f = f \left(\frac{v + v_x}{v - v_x} \right) \quad \text{where} \quad v_x = v_{\text{blood}} \cos \theta .$$

If we write the ratio of frequencies as $R = (f + \Delta f)/f$, then the solution of the above equation for the speed of the blood is

$$v_{\text{blood}} = \frac{(R - 1)v}{(R + 1) \cos \theta} = 0.90 \text{ m/s}$$

where $v = 1540 \text{ m/s}$, $\theta = 20^\circ$, and $R = 1 + 5495/5 \times 10^6$.

- (c) We interpret the question as asking how Δf (still taken to be positive, since the detector is in the “forward” direction) changes as the detection angle θ changes. Since larger θ means smaller horizontal component of velocity v_x then we expect Δf to decrease towards zero as θ is increased towards 90° .