19) A 15.0-kg child is sitting on a playground teeter-totter, 1.50 m from the pivot. What is the minimum distance, on the other side of the pivot, such that a 220-N force will make the child lift off the ground? Assume the teeter-totter is horizontal.

A) 1.50 m  
B) 9.78 m  
C) 2.35 m  
D) 1.00 m  
E) 0.102 m

\[ \sum \tau = 0 \quad (\text{teeter-totter is balanced at its center of mass \rightarrow no torque}) \]

\[ \tau_c + \tau_F = 0 \quad \Rightarrow \quad L = \frac{2mg}{F} \]

\[ -Lmg + LF = 0 \quad \Rightarrow \quad F = \frac{1.5 \times 15 \times 9.81}{220} \approx 1.00 \text{ m} \]

20) A factory siren indicating the end of a shift has a frequency of 80 Hz. What frequency is perceived by the occupant of a car traveling away from the factory at 30 m/s? The speed of sound in air is 343 m/s.

A) 77 Hz  
B) 75 Hz  
C) 81 Hz  
D) 79 Hz  
E) 73 Hz

\[ f_s = 80 \text{ Hz}, \quad v_0 = 30 \text{ m/s} \]

\[ f_0 = f_s \left(1 - \frac{v_0}{v}ight) = 80 \left(1 - \frac{30}{343}\right) = 73 \text{ Hz} \]

Prob. 17 (cont’d)

\[ \frac{1}{2} g \tau_1^2 + V \tau_1 - V \tau_2 = 0 \]

\[ \tau_1^2 + \frac{2V}{g} \tau_1 - \frac{2V}{g} \tau_2 = 0 \]

\[ \tau_1 = -\frac{b}{2a} \pm \sqrt{\frac{b^2 - 4ac}{2a}} \]

\[ = -\frac{V}{g} \pm \sqrt{\frac{V^2}{g^2} + \frac{2V}{g} \tau_2} \]

\[ = -\frac{343}{9.81} \pm \sqrt{\left(\frac{343}{9.81}\right)^2 + 2 \left(\frac{343}{9.81}\right) 1.63} \]

\[ \tau_1 = -34.9643 \pm 36.5580 = (1.5945, -71.5) \text{ s} \]