13.42. An 85.0-kg mountain climber plans to swing down, starting from rest, from a ledge using a light rope 6.50 m long. He holds one end of the rope, and the other end is tied higher up on a rock face. Since the ledge is not very far from the rock face, the rope makes a small angle with the vertical. At the lowest point of his swing, he plans to let go and drop a short distance to the ground. (a) How long after he begins his swing will the climber first reach his lowest point? (b) If he missed the first chance to drop off, how long after first beginning his swing will the climber reach his lowest point for the second time?

**Identify:** Since the rope is long compared to the height of a person, the system can be modeled as a simple pendulum. Since the amplitude is small, the period of the motion is

\[ T = 2\pi \sqrt{\frac{L}{g}} \]

**Set Up:** From his initial position to his lowest point is one-fourth of a cycle. He returns to this lowest point in time \( T/2 \) from when he was previously there.

**Execute:**

(a) \[ T = 2\pi \sqrt{\frac{6.50 \text{ m}}{9.80 \text{ m/s}^2}} = 5.12 \text{ s} \]

\[ t = T/4 = 1.28 \text{ s} \]

(b) \[ t = 3T/4 = 3.84 \text{ s} \]

**Evaluate:** The period is independent of his mass.