56. For simple harmonic motion, Eq. 16-24 must reduce to

$$\tau = -L\,(F_g \sin\theta) \;\longrightarrow\; -L\,(F_g\theta)$$

where θ is in radians. We take the percent difference (in absolute value)

$$\left|\frac{(-LF_g \sin\theta) - (-LF_g\theta)}{-LF_g \sin\theta}\right| = \left|1 - \frac{\theta}{\sin\theta}\right|$$

and set this equal to 0.010 (corresponding to 1.0%). In order to solve for θ (since this is not possible "in closed form"), several approaches are available. Some calculators have built-in numerical routines to facilitate this, and most math software packages have this capability. Alternatively, we could expand $\sin\theta \approx \theta - \theta^3/6$ (valid for small θ) and thereby find an approximate solution (which, in turn, might provide a seed value for a numerical search). Here we show the latter approach:

$$\left|1 - \frac{\theta}{\theta - \theta^3/6}\right| \approx 0.010 \quad\Longrightarrow\quad \frac{1}{1-\theta^2/6} \approx 1.010$$

which leads to $\theta \approx \sqrt{6(0.01/1.01)} = 0.24\,\text{rad} = 14^\circ$. A more accurate value (found numerically) for the θ value which results in a 1.0% deviation is 13.986°.