14.25. Model: Assume the pendulum to have small-angle oscillations. In this case, the pendulum undergoes simple harmonic motion.

Solve: Using the formula $g = GM/R^2$, the periods of the pendulums on the moon and on the earth are

$$T_{\text{earth}} = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{L_{\text{earth}}R_{\text{earth}}^2}{GM_{\text{earth}}}} \text{ and } T_{\text{moon}} = 2\pi\sqrt{\frac{L_{\text{moon}}R_{\text{moon}}^2}{GM_{\text{moon}}}}$$

Because $T_{\text{earth}} = T_{\text{moon}}$,

$$2\pi\sqrt{\frac{L_{\text{earth}}R_{\text{earth}}^2}{GM_{\text{earth}}}} = 2\pi\sqrt{\frac{L_{\text{moon}}R_{\text{moon}}^2}{GM_{\text{moon}}}} \Rightarrow L_{\text{moon}} = \left(\frac{M_{\text{moon}}}{M_{\text{earth}}}\right)\left(\frac{R_{\text{earth}}}{R_{\text{moon}}}\right)^2 L_{\text{earth}}$$

$$= \left(\frac{7.36\times10^{22}\text{ kg}}{5.98\times10^{24}\text{ kg}}\right)\left(\frac{6.37\times10^{6}\text{ m}}{1.74\times10^{6}\text{ m}}\right)^2 (2.0\text{ m}) = 33\text{ cm}$$