54. Since the centripetal acceleration is horizontal and Earth's gravitational $\vec{g}$ is downward, we can define the magnitude of an "effective" gravitational acceleration using the Pythagorean theorem:

$$g_{\text{eff}} = \sqrt{g^2 + \left(\frac{v^2}{R}\right)^2} \ .$$

Then, since frequency is the reciprocal of the period, Eq. 16-28 leads to

$$f = \frac{1}{2\pi}\sqrt{\frac{g_{\text{eff}}}{L}} = \frac{1}{2\pi}\sqrt{\frac{\sqrt{g^2 + v^4/R^2}}{L}} \ .$$