

Special and General Relativity (PHZ 4601/5606) Fall 2018 Solutions

Set 2

4. Small oscillations and m_I/m_G .

The tangential force of the bob is

$$F = m_G g \sin \theta \approx m_G g \theta,$$

where the approximation defines small oscillations. By Newton's second law the acceleration is given by

$$F = -m_I l \ddot{\theta} \Rightarrow \ddot{\theta} = -\frac{m_G g}{m_I l} \theta,$$

and with suitable initial conditions the solutions is

$$\theta = \text{const} \cos \sqrt{\frac{m_G g}{m_I l}} t$$

with period

$$T = 2\pi \sqrt{\frac{m_I}{m_G}} \sqrt{\frac{l}{g}}.$$

If the period depends only on l and g , then m_I/m_G must be the same for all bobs independently of the material used.