Special and General Relativity (PHZ 4601/5606) Fall 2017 Solutions

Set 2

3. 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

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

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.