$$m_i \frac{d^2(l\theta)}{dt^2} = -m_g g\theta$$

$$\Rightarrow \frac{d^2\theta}{dt^2} + \frac{m_g}{m_i}\frac{g}{l}\theta = 0$$

The period of oscillation is $T = 2\pi\sqrt{\frac{m_i l}{m_g g}}$

But Newton on measurement of T found that it agreed with the formula

$$T = 2\pi\sqrt{l/g}$$

This means that $m_i = m_g$.

However, Newton failed to make out why it was so. Newton was followed by Bessel (1827) ~~and~~ southerns (1910), Dicke (1964) and Brogius (1971) who also arrived at the same result.

Using $m_i = m_g$ and writing $g = \frac{GM_g}{R^2}$ in equation (2); we obtain

$$\underset{\text{(inertial acceleration)}}{\bar{a}} = \underset{\text{(gravitational field)}}{g} \longrightarrow (4)$$

Therefore it is the principle of equivalence that is responsible for the equality of inertial mass and gravitational mass.

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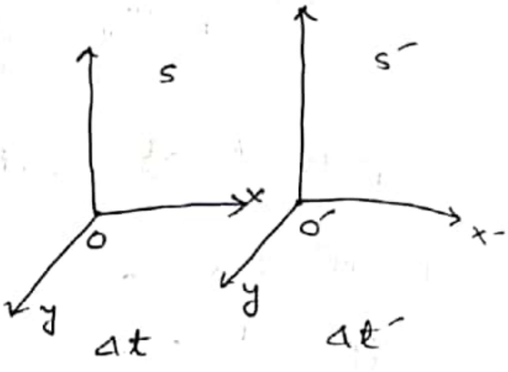
clock paradox (premilinary knowladge):-

1) Time-dilation:-

$$\Delta t' = t_2' - t_1'$$

$$= \frac{(t_2 - t_1) - \frac{v}{c^2}(x_2 - x_1)}{\sqrt{1 - \frac{v^2}{c^2}}}$$



$$= \frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{if } x_1 = x_2.$$

$$\Rightarrow \Delta t = \Delta t' \sqrt{1 - \frac{v^2}{c^2}}$$

$$\Rightarrow \Delta t' > \Delta t \qquad \because \sqrt{1 - \frac{v^2}{c^2}} < 1$$

2) Light consists of streams of particles called photons, each having energy $h\nu$, where h is called Plank's canstant and ν is the frequency of light (considered as wave).

3) $E = mc^2$

Accordingly, $h\nu = mc^2$

$$\therefore m \text{ (mass of photon)} = \frac{h\nu}{c^2}$$

4) If a photon of energy $h\nu$ goes up against gravitational field g through a distance d, its energy becomes

$$h\nu' = h\nu - mgd$$

$$= h\nu - \left(\frac{h\nu}{c^2}\right) gd$$

$$= h\nu \left(1 - \frac{gd}{c^2}\right)$$

$$\therefore \quad \nu' = \nu\left(1 - \frac{gd}{c^2}\right)$$

$$\Rightarrow \frac{1}{\nu'} = \frac{1}{\nu}\left(1 - \frac{gd}{c^2}\right)^{-1}$$

$$\Rightarrow T' = T\left(1 + \frac{gd}{c^2}\right).$$