Formulation of the principle of Equivalence:

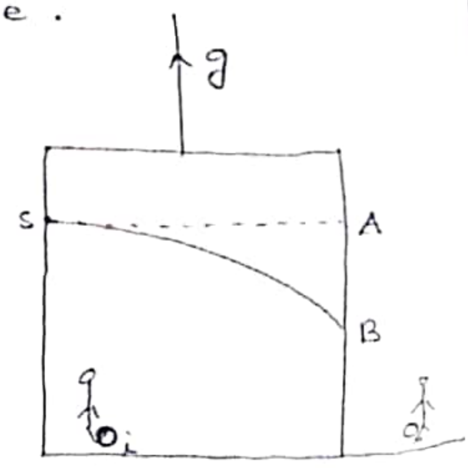
The principle of equivalence gives specific expression to the correspondence between the results which would be obtained by an observer who makes measurements in a gravitational field using a frame of reference which is held stationary and the results obtained by a second observer who makes measurements in the absence of a gravitational field but using an accelararated frame of reference.

So, it is immediately evident that some measure of correspondence between the two sets of measurements should exist since both observers would find an acceleration with respect to their frames of reference for all free particles left to their own motion.

curved Space-time:

A lift is moving with an acceleration g in a gravitation free space.

A treal light emitted from a source at s. If the lift were not accelerated, the ray would have hit the point A.



But due to the accelerated motion of the lift, the ray follows a curved path according to the inside observer O_i, (because the ray follows a straight path) and reach at B.

However O_i concludes from the curvature of the path of light that the space has been curved due to the presence of the gravitational field.

Hence since the special relativity has led to the concept four-dimensional space-time we have to say that the curvature of four dimensional space-time is a manifestation of a gravitational field. Hence general Relativity which is the Relativistic theory of gravitation deals with curved space-time.

⊛ Some applications of the Principle of equivalence:-

1) Equality of inertial mass and gravitational mass:-

Einstein appears to have found the clue for ~~for~~ the principle of equivalence from the equality of inertial mass (m_i) and the gravitational mass (m_g).

If a force F acts on a body of inertial mass m_i and produces an acceleration a (fig 1), then

From Newton's law of motion,

$F = m_i a$ ⟶ (1)

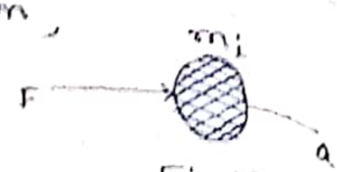


Fig (1)

Now, if this body is dropped from the hand and it falls with an acceleration a then according to Newton's law of gravitation

$$F = G\frac{M_g m_g}{R^2} \longrightarrow (2)$$

where M_g, m_g are the gravitational mass of the earth and the body respectively and R is the radius of the earth.

Newton initially took the inertial mass and the gravitational mass to be different because there ~~mass~~ was apparently no physical reason why they should be taken to ~~be~~ be the same.

However in 1680, Newton performed an experiment with a pendulum to decide the question.

Consider the inertial mass m_i and the gravitational mass m_g of the bob.

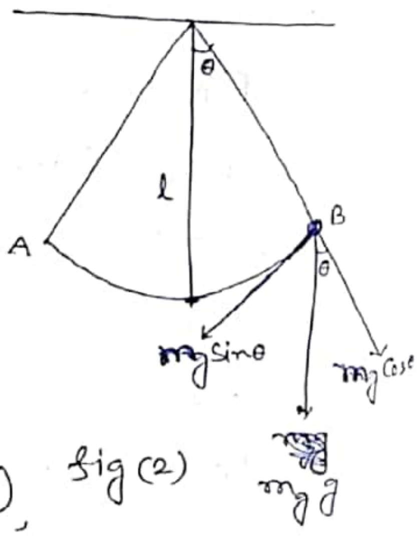


fig (2)

The equation of motion for a displacement, ~~lsinθ~~

$l\sin\theta = l\theta$ (for all small θ)

from the mean position is