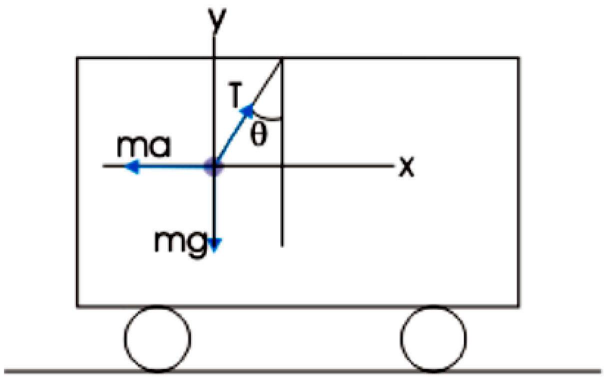
Answer on Question #39666, Physics, Other

a) Consider a simple pendulum of mass m mounted inside a railroad car that is accelerating to the right with constant acceleration a. Analyse this problem in the non inertial frame of reference to find the angle alfa(F) with the vertical direction at which the pendulum will remain at rest relative to the moving car.

Solution:

The non-inertial frame is the frame of reference which is not inertial or is moving.

Free body diagram of pendulum



The pendulum is at rest. The forces on the pendulum are: weight of the pendulum, mg, tension T in the string and pseudo force ma.

$$\sum F_x = T\sin\theta - ma = 0$$
$$\sum F_y = T\cos\theta - mg = 0$$

$$T\sin\theta = ma$$
$$T\cos\theta = mg$$

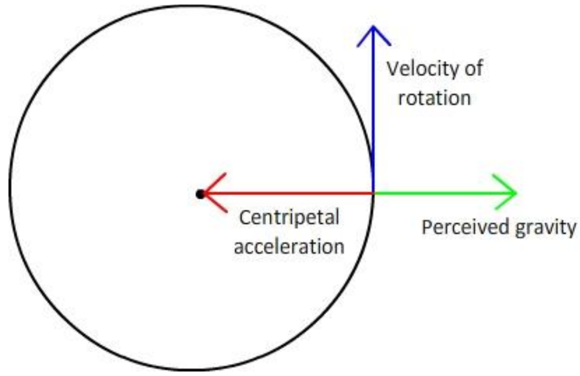
Combining two equations, we have :

$$\tan\theta = \frac{a}{g}$$
$$\theta = \tan^{-1}\left(\frac{a}{g}\right)$$

b) On Jupiter a day lasts for 9.9 earth hours and the circumference at the equator is 448600 km. If the measured value of gravitational acceleration at the equator is 24.6ms^-2, what is the true gravitational acceleration and the centrifugal acceleration.

Solution:

Along the Jupiter equator, the outward centrifugal force is vertical and upward. Thus, it directly subtracts from the gravitational force, and the measured gravitational acceleration results from the difference:



$$g_{measured} = g_{true} - g_{centrifugal} = 24.6 \text{ m/s}^2$$

The angular velocity

$$\omega = \frac{2\pi}{T} = \frac{2 \cdot 3.14}{9.9 \text{ hours}} = \frac{2 \cdot 3.14}{9.9 \cdot 3600 \text{ s}} = 0.0001762 = 17.62 \cdot 10^{-5} \text{ s}^{-1}$$

The radius of Jupiter

$$R = \frac{L_{equator}}{2\pi} = \frac{448600 \text{ km}}{2 \cdot 3.14} = 71433.121 \text{ km}$$

The centrifugal acceleration (perceived gravity):

$$g_{centrifugal} = \omega^2 R = (17.62 \cdot 10^{-5})^2 \cdot 71433.1 \cdot 10^3 = 2.2177 = 2.22 \text{ m/s}^2$$

The true gravitational acceleration:

$$g_{true} = g_{measured} + g_{centrifugal} = 24.6 + 2.22 = 26.82 \text{ m/s}^2$$

Answer. a) $\theta = \tan^{-1}\left(\frac{a}{g}\right)$

b) $g_{centrifugal} = 2.22 \text{ m/s}^2$, $g_{true} = 26.82 \text{ m/s}^2$.