Answer on Question #78188, Physics / Mechanics | Relativity | for completion

The earth is suddenly condensed so that its radius becomes 1/√6 of its original value but its mass remains unchanged. How will its period of daily rotation change? State the underlying principle

Solution:

In this case we can state the conservation of kinetic momentum principle. According to it: $I_1\omega_1 = I_2\omega_2$, where I is moment of inertia and ω is angular speed.

To find how the period of the daily rotation will change it is enough to find the ratio of ω_2 and ω_1:

$$\frac{\omega_2}{\omega_1} = \frac{I_1}{I_2}.$$

$I_1 = \frac{2}{5}mr^2$, where m and r are mass and radius of the Earth.

$$I_2 = \frac{2}{5}m{r_1}^2 = \frac{2}{5}m\left(\frac{r}{\sqrt{6}}\right)^2 = \frac{mr^2}{15},$$

$$\frac{\omega_2}{\omega_1} = \frac{I_1}{I_2} = \frac{\frac{2}{5}mr^2}{\frac{mr^2}{15}} = 6.$$

As ω=2π/T, where T is a daily rotation period, we can assume that T will become 6 times less and become equal nearly 4 hours.