Answer on Question#47941 - Physics - Other

It was thought that the material that was to become the moon began as part of the earth. This fission theory was proposed that back in the time when the earth was composed of magma the earth's rotation was fast enough to eject some of the magma into space, where it cooled to be the moon. If this theory was true what would the rotation period of the earth need to be? Assume the material is on the equated and rotation is sufficient enough that the weight at the equator would be 0 if placed on a scale. That is, the object's weight is just sufficient to keep it traveling in a circle with a radius equal to the earths. Give answer in hours.

<u>Solution:</u>

Since the mass and the volume of the moon are much smaller than the earth mass and volume, we can neglect the fact that the earlier the earth mass and radius were larger. For the weight of the material at the equator to be equal 0 the centrifugal force should compensate the gravitational force

$$m\omega^2 R = \frac{GmM}{R^2}$$

where R is the radius of the earth, M is the mass of the earth, ω is the circular frequency of the earth, and m is the mass of some material at the equator.

Since $\frac{GM}{R^2}$ is equal to the g, for the circular frequency we obtain

$$\omega = \sqrt{\frac{g}{R}}$$

Since the circular frequency equals $\frac{2\pi}{T}$ (where T is the rotation period if the earth), we obtain

$$\frac{2\pi}{T} = \sqrt{\frac{g}{R}}$$

or equivalently

$$T = 2\pi\sqrt{\frac{R}{g}}$$

Substituting $g = 10\frac{\mathrm{m}}{\mathrm{s}^2}$ and $R = 6400000\mathrm{m}$ we obtain

$$T = 2\pi\sqrt{\frac{6400000\mathrm{m}}{10\frac{\mathrm{m}}{\mathrm{s}^2}}} = 1.4\mathrm{h}$$

<u>Answer:</u> $T = 2\pi\sqrt{\frac{R}{g}} = 1.4\mathrm{h}.$