Answer on Question # 70328 - Physics - Mechanics | Relativity

Question

A centrifuge has radius of 50 Cm and is operated at 500 r/min. Determine the ratio of radial acceleration to gravitational acceleration

Solution

The magnitude of the radial (centripetal) acceleration a_c in uniform circular motion is

$$a_c = r\omega^2 \qquad (1)$$

which is the acceleration of an object in a circle of radius r revolved at an angular velocity ω.

A centrifuge is operated at 500 r/min. The term r/min stands for revolutions per minute. By converting this to radians per second, we obtain the angular velocity ω

$$\omega = 500\,\frac{r}{\text{min}} \times \frac{2\pi \text{ rad}}{1 \text{ rev}} \times \frac{1 \text{ min}}{60.0 \text{ s}} = 52.36 \text{ rad/s}$$

Converting $r = 50\ cm$ to meters and substituting known values into (1) gives

$$a_c = (0.5\ m) \cdot (52.36\ \text{rad/s})^2 = 1370.8\ \text{m/s}^2$$

Note that the unitless radians are discarded in order to get the correct units for radial acceleration. Taking the ratio of a_c to $g = 9.8\ \text{m/s}^2$ which is the gravitational acceleration, yields

$$\frac{a_c}{g} = \frac{1370.8}{9.8} = 140$$

Answer: the ratio of radial acceleration to gravitational acceleration is 140.