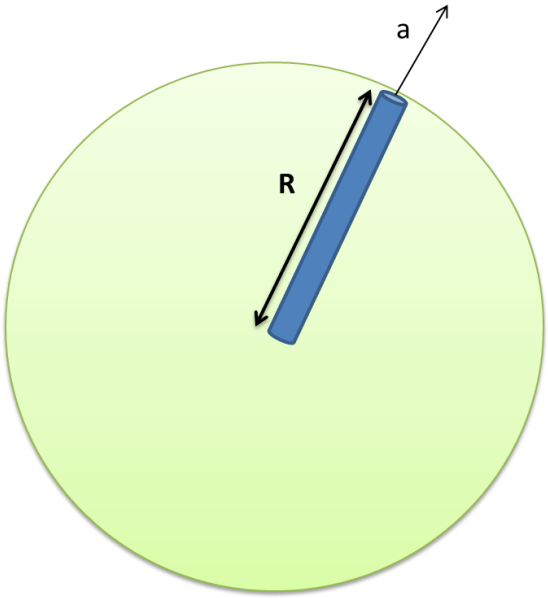
Answer on Question #45360, Physics, Mechanics | Kinematics | Dynamics

A typical laboratory centrifuge rotates at 4000 rpm. Test tubes have to be placed into a centrifuge very carefully because of the very large accelerations.

(a) What is the acceleration at the end of a test tube that is 10 cm from the axis of rotation?
(b) For comparison, what is the magnitude of the acceleration a test tube would experience if dropped from a height of 1.0 m and stopped in a 1.0-ms-long encounter with a hard floor?

Solution.



a)

The relation for the centripetal acceleration is:

$$a_C = \omega^2 R = 4\pi^2 f^2 R$$

Where f is a frequency of rotation, R – distance from axis of rotation to the end of the tube.

Numerically:

$$a_C = 4 \cdot 3.14^2 \cdot \left(4000 \frac{1}{60s}\right)^2 \cdot 0.1m \approx 17.5 \cdot 10^3 \frac{m}{s^2}$$

b)

Just before hitting the floor tube has the speed:

$$V = gt$$

Where t is the time of falling. It can be obtained from relation:

$$\frac{gt^2}{2} \rightarrow t \quad \sqrt{\frac{2h}{g}}$$

$$V \quad g\sqrt{\frac{2h}{g}} \quad \sqrt{2gh}$$

After hitting the floor speed of the tube is equal to 0, so acceleration is:

$$a \quad V/\Delta t$$

Where Δt is the time of interaction of tube with the floor. So:

$$a \quad \frac{\sqrt{2gh}}{\Delta t}$$

Numerically:

$$a \quad \frac{\sqrt{2 \cdot 9.8\frac{m}{s^2} \cdot 1m}}{0.001s} \approx 4.4 \cdot 10^3 \frac{m}{s^2}$$

Answer:

a) $a \approx 17.5 \cdot 10^3 \frac{m}{s^2}$

b) $a \approx 4.4 \cdot 10^3 \frac{m}{s^2}$