Chapter 4 Problem 63 [†]

Given
$r = 8.00\ m$

Solution
How many revolutions per minute are needed in order for the centripetal acceleration to equal that of earth's gravity.

The value of centripetal acceleration is given by

$$a_c = \frac{v^2}{r}$$

Solving for velocity gives

$$v^2 = a_c r$$

$$v = \sqrt{a_c r} = \sqrt{(9.80\ m/s^2)(8.00\ m)} = 8.85\ m/s$$

Average velocity is defined as

$$v_{avg} = \frac{\Delta x}{\Delta t}$$

Solving for time gives

$$\Delta t = \frac{\Delta x}{v_{avg}}$$

In one revolution $\Delta x = 2\pi r$, so the time for one revolution is

$$\Delta t = \frac{2\pi r}{v_{avg}} = \frac{2\pi(8.00\ m)}{8.85\ m/s}$$

$$\Delta t = 5.68\ s$$

Convert this time into minutes

$$\Delta t = 5.68\ s \left(\frac{1\ min}{60\ s}\right) = 0.0947\ min$$

If $1\ rev = 0.0947\ min$, then dividing both sides by $0.0947\ min$ will give the number of revolutions per minute

$$rotation = \frac{1\ rev}{0.0947\ min} = 10.6\ rev/min$$

[†]Problem from University Physics by Ling, Sanny and Moebs (OpenStax)