CIRCULAR MOTION PROBLEMS
Problems document

These problems build on the skills covered in my video series “Newton’s Second Law problems, explained step by step”.

Answers to these problems are available in the Answers document.

Brief solutions to the problems are available in the Brief Solutions document.

Step-by-step solutions to the problems are available in the Step-by-Step Solutions document, and in the YouTube videos.

You can find links to these resources at my website:
www.freelance-teacher.com

Links to the documents are also in the video description boxes for the YouTube videos.

You can support these resources with a monthly pledge at my Patreon page:
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If you find that the video explanations move too slowly, you can simply try the problems in this Problems document, study the solutions in the Solutions document, and skip to any particular parts of the videos that cover parts of the solutions that you find confusing. Each video has a table of contents, to make it easier to skip to particular topics.

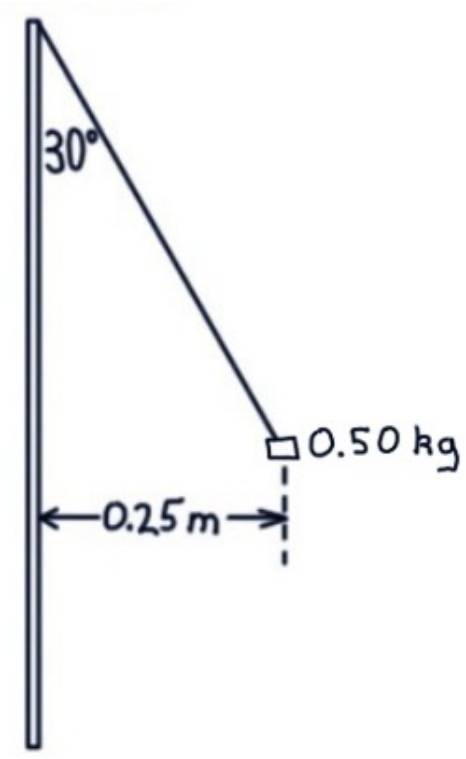
If you find a particular problem to be difficult, then, after studying the solution, *before* you try the next problem, you should take a blank piece of paper and retry that problem from scratch. Don’t move on to the next problem in the series until you are comfortable with the solution for the current problem.

TABLE OF CONTENTS FOR THE VIDEO SERIES

Problems begin on next page.

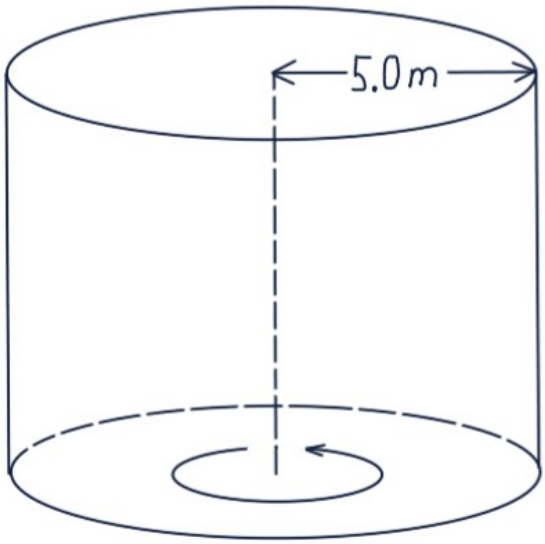
Video (1)

A mass of 0.50 kg is attached by a string to a vertical pole. The mass travels around the pole in a horizontal circle with radius 0.25 m. The string makes an angle of 30° with the vertical. What is the speed of the mass?



Video (2)

An amusement park ride consists of a large hollow cylinder that rotates about its central axis quickly enough that any person inside is held up against the wall when the floor drops away. The cylinder has a radius of 5.0 m. The coefficient of static friction between the person’s clothing and the wall is 0.70.
(a) What is the minimum linear velocity required to prevent the person from slipping downward?
(b) What is the minimum angular velocity, in radians per second, required to prevent the person from slipping downward?
(c) What is the minimum angular velocity, in rpm, required to prevent the person from slipping downward?



Video (3)

A pilot flies a plane in a vertical circle of radius R. The plane’s speed at the bottom of the circle is v_b. At the top of the circle, the pilot is upside down. What is the speed v_t of the plane at the top of the circle, such that the force from the seat cushion that the pilot feels at the top of the circle will be the same as at the bottom of the circle?

Video (4)

In this video we discuss the *meaning* of the concepts and formulas we have been using in the previous videos.

If you are not interested in, or don't have the time for, a discussion of these topics, you can simply proceed to the next video in this series, which contains another circular problem.

The material covered in the video is also discussed in the "Step-by-step Solutions" document.

Topics discussed in the video

Axes for motion in vertical and horizontal circles

The velocity vector for circular motion

The acceleration vector for circular motion
The *meaning* of the radial acceleration and the tangential acceleration

The *meaning* of the net radial force

The *meaning* of the formula $a_{\text{radial}} = +\frac{v^2}{r}$

How does the amusement park ride in Video (2) prevent the riders from slipping?

Do our results from Video (3) make sense?

The effect of *mass* on circular motion

Video (5)

Mass m_1 on a horizontal table is attached by a cord through a hole in the table to a hanging mass m_2. The table is frictionless. Mass m_1 rotates with uniform circular motion of radius R, while mass m_2 hangs motionless.
(a) What is the speed of mass m_1?
(b) What is the time period for the uniform circular motion of mass m_1?