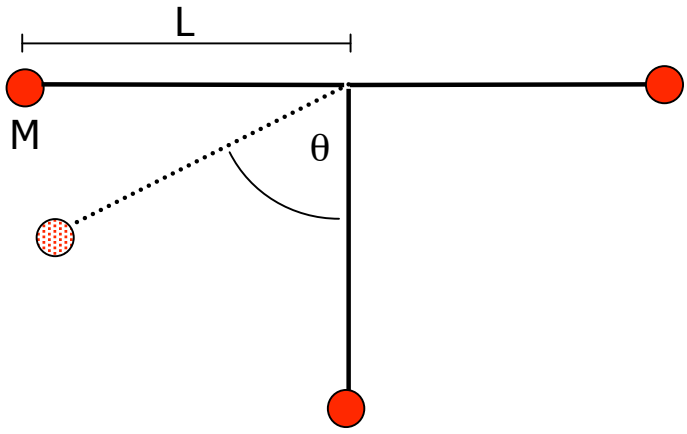
A simple pendulum consisting a 4 kg mass and a 2 m long "massless" string is held at a 90° angle relative to vertical as pictured at right. The mass is released from rest.



1. Calculate and plot the tension in the string as a function of the angle (theta) as the mass swings from 90° to -90°.

2. Calculate and plot the centripetal acceleration (a-"perpendicular"), the tangential acceleration (a-"parallel") and the magnitude of the acceleration as a function of the angle (theta) as the mass swings from 90° to -90°.

Procedure — Mathematical Methods and Physical Models

In an embedded Word document (or series of embedded Word documents) *on a separate worksheet*, you are expected to include a thorough, step-by-step discussion/description of the physics, including a clear statement of how (and why) you derived/calculated all values. Clear, well-labeled diagrams should be included as part of that discussion. This is your opportunity to demonstrate your depth of insight and understanding and to discuss what you learned by completing this exercise. You should use the drawing tools in Microsoft Word or Excel to produce annotated diagrams.

Analysis of Results + Questions, Answers and Annotations

As a part of your analysis, be sure to discuss/explain:

1. The shape (*and values*) of a-parallel over this range of angles. (HINT: What does a-parallel affect? Consider looking at a-parallel as a function of something other than theta.) In addition, note, discuss and explain the relationship between the parallel acceleration and perpendicular acceleration. Where is each a maximum? Minimum? Why does this make sense physically?
2. The plot the tension, T, as a function of the centripetal acceleration. Include an appropriate trendline and algebraically derive a relationship for T as a function of acceleration (in terms of M, L, and other *constants*) that is consistent with this trendline. A hint will be provided at a later date. Discuss and explain your results.

For the questions below, consider how to visualize and present answers to these questions graphically.

1. If the string has a breaking tension of 80 N, at what angle would the string break?
2. At what angle are the two component accelerations equal?
3. What is the tension when the two component accelerations equal? (HINT: What plot would allow you to make this determination?)

In addition to the questions above, be sure to address other general questions (as appropriate) found in the document *Description of XL Lab Content—Format+Grading* found on the website. As with the procedure, this analysis should be on a separate worksheet ***as an embedded Word document.***

REMEMBER: All XL labs have "required elements" of content and style. Be sure to refer to the ***Grading Rubric for Advanced Physics XL Labs***, ***Description of XL Lab Content—Format+Grading*** and the ***Reference and Style Guide for Microsoft Excel*** in order to acquaint yourself fully with these requirements.