

Lab – Mind That Turn**Objective:**

To determine the maximum speed you could navigate a turn on the highway with using satellite data.

Materials:

Computer with internet access
ruler
compass

Procedure:

- Using an internet browser find a website that provides satellite images of the earth. You may use the *Google Earth* application, Google Maps, or Mapquest (just be sure to print out a scale on your map!)
- Search for a location containing a highway or a large road with a curve in it. This is pretty much “catch as catch can.” One location that is good is the interchange between I-94 and US-23. You can “zoom in” and “zoom out” using the buttons on the screen.
- Once you have a useable picture of your curve, take a “screen shot” using the following steps (be sure you get a SCALE with your picture):

Macintosh:

- Press the <shift> <apple> 4 keys at the same time.
- Your cursor will turn into a plus sign. Draw a box around the picture on the screen (be sure to include the scale!).
- When you let go of the mouse you’ll see a little camera appear and you’ll hear a “click”.
- To access your photo go back to the desktop and click on the file entitled “Picture 1”. You can print this or insert it into your lab document.

PC:

- Press the <Prnt Scrn> key. This takes a screen shot of your screen (you will not see or hear anything)
- Open a program (like MSPaint or Word) and select “Edit” “Paste”. Once your screen shot appears you can copy whatever part of it you want and paste it into your lab document.

Analysis:

Use a ruler and compass to draw—as accurately as possible a circle that goes through the center of your turn. Measure the radius of the turn and use the scale to determine the radius in meters. Show all work.

Draw a **Free Body Diagram** of the car in each situation below. Label and resolving ALL forces. For the banked turn you can assume a 5° bank. When friction is present, assume the coefficient of static friction is 0.750 for rubber on concrete.

Determine the maximum speed *in miles per hour* for the following cases (show ALL work and ALL derivations):

- (i) car on your turn with no bank, no friction
- (ii) car on your turn with no bank, friction
- (iii) car on your turn with a 5° bank, no friction
- (iv) car on your turn with a 5° bank, friction

Questions:

- 1.) What angle would be needed for a banked turn of 200m radius to be maneuvered by a car at 60.0 miles per hour with no friction?
- 2.) Does the maximum speed calculated in part (i) make sense? Explain in terms of Newton's Laws.
- 3.) How does the maximum speed compare for the four situations? Rank them *from slowest to fastest*. Does the order make sense? Explain.
- 4.) How would your answers for the four speeds differ if your road was on the moon?

Error Analysis

What factors outside of your control may have caused your calculations to be not fully correct?

Conclusions

What did you do?

What did you find?

What generalizations can you make?

XC.) Derive a formula for the banking angle needed to make a turn with friction in terms of v , r , and g .