Physics 151 Class Exercise: Centripetal Acceleration

For each of the following situations, draw a free body diagram showing all of the forces acting on the object. Then write an equation expressing the sum of forces in the radial direction – along the line from the object to the center of the circle and write an algebraic expression for the centripetal acceleration $a_c$ in terms of the given variables.

**Situation #1** – A boy ties a ball to the end of a string (length $L$) and swings the ball in a vertical circle. Consider the ball when it is at the lowest point in its swing, the tension in the string is $T$ at that moment.

**Situation #2** – The boy then attempts to swings the ball (mass $m$) in a horizontal circle (radius $R$) about his head. (Hint: How does gravity affect the direction of the tension in the string?)

**Situation #3** – A bug sits on the edge of a 45 record being played on a turntable, the coefficient of the static friction between the bug and a record is $\mu$. 
**Situation #4** -- A car moves on a circular exit ramp banked at angle $\alpha$ to the horizontal. Neglect friction. (Hint: Draw the car so that you are looking at the back or the front.)

**Situation #5** – A “corkscrew” roller coaster does a loopy-loop. Consider the situation of a man of mass $m$ riding in the roller coaster when he is upside-down, the normal force acting on the man is $N$.

**Situation #6** - A daredevil stunt involves riding a motorcycle around the vertical inside wall of a cylindrical structure. The coefficient of friction between motorcycle and a wall is $\mu$ (Hint: How big does the normal force have to be?)