

**9/27 In Class–Circular Motion**

1. A child of mass 25kg rides on a merry-go-round. The child is 0.5 meters from the center of the merry-go-round, and it goes at a constant angular speed of 5rpm. What is the centripetal acceleration?
2. A 1.5 kg mass on the end of a string 20cm long spins in a vertical circle.
  - (a) Draw a free body diagram for the mass at the bottom of the circle.
  - (b) Draw a free body diagram for the mass when the string is horizontal.
  - (c) Draw a free body diagram for the mass at the top of the circle.
  - (d) What speed is necessary at the top so that the string just barely goes slack for an instant?
  - (e) This is the minimum speed it can have and make it around the circle. What would happen if the speed were less?
  - (f) If it continues at constant speed (the speed from part (d)), what will be the tension at the bottom of the circle?
3. A tetherball of mass 0.4kg is attached to a rope of length 1.5m. The ball is hit so that it moves at constant speed in a circle around the pole. The rope makes an angle of  $20^\circ$  with respect to the pole.
  - (a) Draw a free body diagram for the tetherball.
  - (b) What is the tension in the rope?
  - (c) What is the speed of the tetherball?
4. A car of mass 2500kg, traveling at a speed of 35mph, enters a level, circular turn with a radius of 20m.
  - (a) Draw two sketches of the car: a top down view and a looking at the front or back of the car as it turns.
  - (b) Draw a free body diagram for the car at a point on the circular turn. (Pick a view).
  - (c) What force (or component of a force) acts in the centripetal direction?
  - (d) What is the magnitude of the friction force on the car?
5. A car of mass 2500kg, traveling at a speed of  $v$ , enters a banked, circular turn with a radius of 20m. The bank makes an angle of  $10^\circ$  with respect to the horizontal. If you ignore friction:
  - (a) Draw two sketches of the car: a top down view and a looking at the front or back of the car as it turns.

- (b) Draw a free body diagram for the car at a point on the banked, circular turn.
  - (c) What force (or component of a force) acts in the centripetal direction?
  - (d) What is the normal force on the car?
  - (e) How fast can the car go and maintain a horizontal circle on the road?
6. Repeat the last problem but now with friction! A car of mass 2500kg, traveling at a speed of  $v$ , enters a banked, circular turn with a radius of 20m. The bank makes an angle of  $10^\circ$  with respect to the horizontal. The coefficient of friction between the tires and the road is 0.9.
- (a) Draw two diagrams of the car: a top down view and a side view.
  - (b) Draw a free body diagram for the car at a point on the banked, circular turn.
  - (c) What force(s) (or components of forces) act in the centripetal direction?
  - (d) What is the normal force on the car?
  - (e) How fast can the car go and maintain a horizontal circle on the road?