1. (2 pts) In order for an object to move in a circular path, which of the following is (are) necessary? You may choose more than one answer if applicable.

a) A force in the direction of the object’s velocity.

b) A force perpendicular to the velocity, directed inward toward the center of the circular path.

c) A force perpendicular to the velocity, directed outward away from the center of the circular path.

d) A pathway tilted toward the center, in the case of a moving car, for example.

e) Friction, in the case of a moving car, for example.

2. (2 pts) A marble falls from rest through a jar of honey. Its velocity is given by

\[ v(t) = v_T \left( 1 - e^{-\frac{t}{3s}} \right) \frac{m}{s} \], where \( t \) is measured in seconds and \( v_T \) is the terminal velocity. About how many seconds does it take for the marble to reach a significant fraction (between \( \frac{1}{2} \) and \( \frac{3}{4} \), for instance) of the terminal velocity?

a) About 3 seconds.

b) About 30 seconds.

c) It depends on the value of \( v_T \).

d) Sorry, but the velocity doesn’t change, no matter how long you wait.

3. (3 pts) A 40 kg child plays on a tire-swing held by a single rope to the branch of a tree. If the tire has a mass of 8 kg and the rope is 5 m long, what is the maximum swing velocity the child can enjoy when she reaches the lowest point of the motion if the rope can only withstand a tension of 600 N?

a) 3.67 m/s

b) 4.72 m/s

c) 5.19 m/s

d) 6.08 m/s

The FBD of the tire/girl system shows the tension force upward and both weight forces downward. The radial (upward) acceleration is \( \frac{v^2}{r} \) where \( r \) is the length of the rope. Newton’s 2\(^{nd}\) Law becomes \( T - (m_{tire} + m_{girl})g = m\frac{v^2}{r} \). If we set \( T = 600 \) N and solve for \( v \), we’ll find the fastest speed the girl can have at the bottom of the swing before the tension exceeds this maximum and the rope breaks.

4. (3 pts) As a skydiver falls, he feels a resistive force \( R = \frac{1}{2} D \rho Av^2 \), where \( D \) is the drag coefficient, \( \rho \) is the density of air, \( A \) is the skydiver’s area in a plane perpendicular to his motion, and \( v \) is his velocity. If the skydiver has a mass \( m \), derive the expression for his terminal velocity \( v_T \) in terms of the variables given.

Just set the drag force and the weight force equal (true at terminal velocity) and solve for \( v, v_T = \sqrt{\frac{2mg}{D\rho A}} \)