Kinematics – Motion along a Curved Path

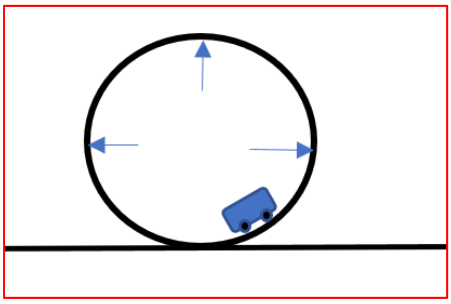
1. Find the magnitude (that means a positive number!) *and direction* (***in degrees***) of the car's acceleration.
   - ✓ You could express direction relative to cardinal direction (e.g. 30 degrees north of east).
   - ✓ Also, in each case give the direction of the net Force on the car.

   a. A car is moving north. It's speed is increasing by 4 ft/sec every second.
   b. A car is moving north. Its speed is decreasing by 8 ft/sec every 4 second.
   c. A car is moving northwest. It's northerly acceleration is 16 ft/s^2 while it's speed in the western direction is increasing by 16 ft/sec every second.
   d. A car is moving northwest. Its northerly acceleration is 16 ft/s^2 while it's speed in the western direction is decreasing by 12 ft/sec every second.
   e. A rocket has a horizontal propulsive force acting on it and so accelerates horizontally at 3 m/sec per sec. Determine its total acceleration (magnitude and direction relative to the horizontal). Assume air resistance is negligible.

2. See section 2/5 as necessary.
   a) What is meant by normal acceleration? What direction is normal acceleration?
   b) What is meant by tangential acceleration? What direction is tangential acceleration.
   c) What is $\hat{e}_n$?
   d) What is $\hat{e}_t$?

3. *(You may want to look at equation 2/10 before trying these problems).*A car moving on a horizontal surface negotiates a turn.
   a) Find the acceleration (magnitude in ft/s^2 and direction) if the car moves at constant speed 30 mph and the turn has radius of curvature 60 feet.
   b) The car speeds up as it negotiates the turn which has diameter 80 feet. Its speed is increasing by 5 mph every second. Find the acceleration (magnitude in ft/s^2) at the instant the car's speed is 40 mph.
   c) It is determined from tire tread information that the car's maximum acceleration is 30 ft/s^2. Determine the maximum constant speed (in mph) with which the car can negotiate a turn of diameter 100 feet.
   d) It is determined from tire tread information that the car's maximum acceleration is 30 ft/s^2. The car enters a left-hand ¼ turn of radius 60 feet with speed 12 mph. Determine the car's maximum possible tangential acceleration (in mph/second).

4.



A car speeds up while navigating a vertical loop of diameter 40 feet. Find the car's acceleration (magnitude in ft/s^2 and direction) when the car is at

a) the right point (motion = vertical up). The car is going 7.5 mph and is increasing its speed at a rate of 8 ft/sec per second.

b) the top point (motion = horizontal). The car is going 15 mph and is increasing its speed at a rate of 6 ft/sec per second.

c) the left point (motion = vertical down). The car is going 40 mph and is increasing its speed at a rate of 4 ft/sec per second.

5.  (Consider the equation $\theta = s/r$).

The 2-foot-long rod shown is above rotating CCW about a pivot at its left end. The right end of the rod travels 2.5 ft. Determine the rod's angular displacement during this travel (i.e., determine the angle the rod turns through in a) radians b) degrees.

6.  (Consider the equation $d\theta/dt = v/r$).

The 2-foot-long rod shown above is rotating CCW about a pivot at its left end. The right end of the rod is travelling at 8 ft/sec. Determine the rod's angular velocity during this travel (i.e., determine the angle the rod turns through in a) radians/sec b) degrees/sec.

Also, determine the acceleration of the rod's right end in ft/sec^2 when the rod is vertical (i.e., its rotated 90 degrees from the depicted position).

7. 

The 2-foot-long rod is shown above rotates CW about a pivot at its right end. The rod starts at rest but its angular rotation rate increases by 1 rad/second every second. Determine the following:

a) The rod's rotation rate after 3 seconds.
b) The time it takes the rod to reach the vertical orientation.
c) The speed of the left end of the rod when it reaches the vertical orientation.
d) The acceleration of the rod when it reaches the vertical orientation.