Week 10-Problems

10-1 The Kinematics of a particle in uniform circular motion is specified by four vectors: position ($\underset{\rightarrow}{r}$), tangential velocity ($\underset{\rightarrow}{v}$), centripetal acceleration ($\underset{\rightarrow}{a_c}$) and angular velocity ($\underset{\rightarrow}{w}$). Which of these vectors rotates with time and what is the rate of rotation?

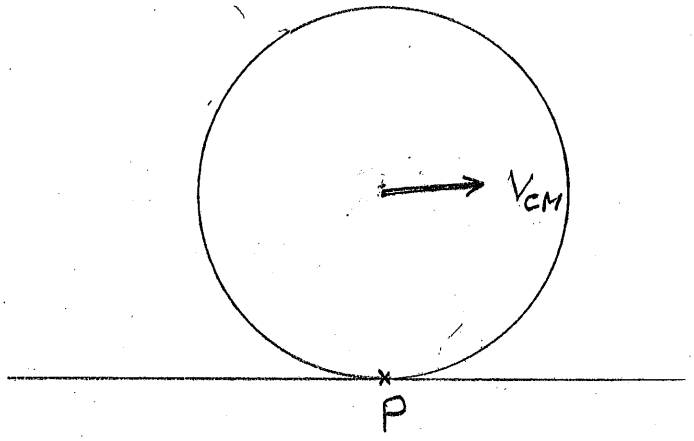
10-2 A 30cm diameter turntable starts from rest and takes 2 seconds to reach its ultimate rotation rate of $33\frac{1}{3}$ revs per minute. Determine a) the angular acceleration, b) the number of revolutions completed in 5 secs, c) the time needed to complete 2 revs, d) the radial and tangential acceleration of a point on the rim at 1 sec.

10-3 A particle moves in a circle of radius r with angular velocity w and angular acceleration α. Show that the total linear acceleration is $a = r\left[w^4 + \alpha^2\right]^{\frac{1}{2}}$

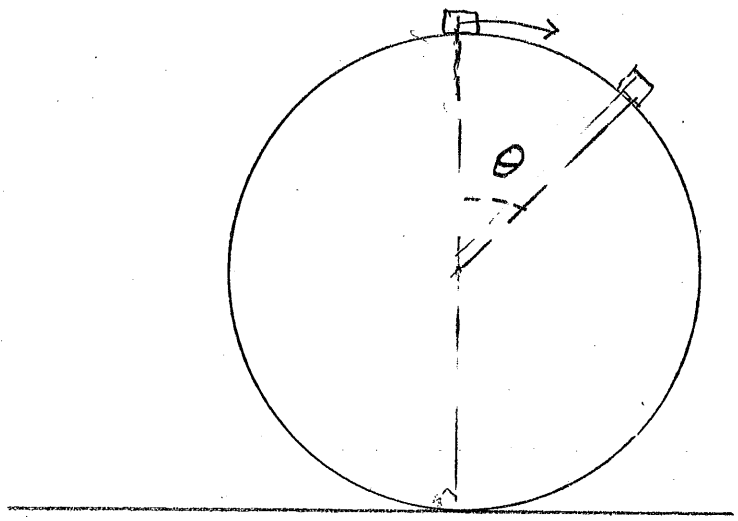
10-4 Vectors $\underset{\rightarrow}{A}$ and $\underset{\rightarrow}{B}$ have magnitudes A and B meters respectively. Show that $\underset{\rightarrow}{C} = \left[\underset{\rightarrow}{A} \times \underset{\rightarrow}{B}\right]$ represents the area (vector) of the parallelogram formed by $\underset{\rightarrow}{A}$ and $\underset{\rightarrow}{B}$. What is the direction of $\underset{\rightarrow}{C}$?

10-5 What is the difference between Force ($\underset{\rightarrow}{F}$) and Torque ($\underset{\rightarrow}{\tau} = \underset{\rightarrow}{r} \times \underset{\rightarrow}{F}$)?

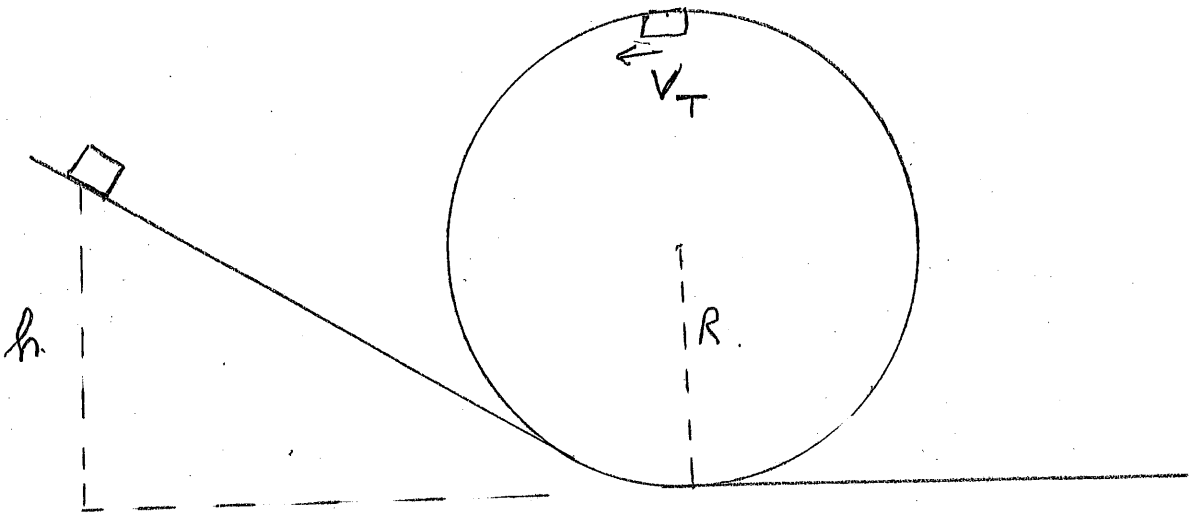
10-6 A disk of radius 0.5m is rolling, without slipping, on a horizontal surface. The center of mass velocity is $2\text{m/s}\,\hat{x}$. i) What is the velocity at the point of contact at all times? ii) What is the angular velocity of the disk?



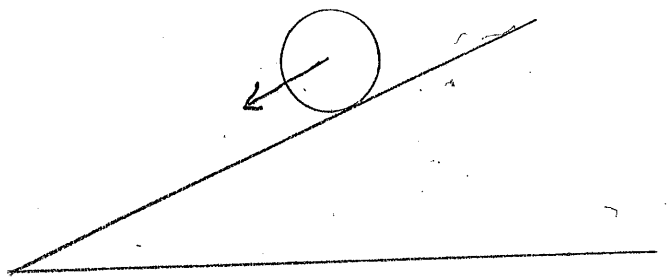
10-7 A smooth cylinder of diameter 2m is fixed on a horizontal surface. An object located at the top begins to slide on its surface. At what angle θ will the object leave the cylinder? What will be the velocity of the object at that point? ($g = 9.8\text{m/s}^2$)



10-8 In the loop-the-loop situation, why does the velocity $\underrightarrow{V}_T$ at the top have to be larger than $\sqrt{Rg}$ so the object will go around the loop without falling down?



10-9 As shown, a sphere is rolling without slipping down an inclined plane. Do you need friction for this to happen? If so. How much work is done by friction as the sphere moves 1m? Why?



10-10 In problem 10-8, what is the smallest value of h so that the object will go completely around the loop? Why?

10-11 You are stopped at a red light on a horizontal road where the coefficient of friction is 0.3. When the light turns green, what is the maximum acceleration with which you can take off? Why?