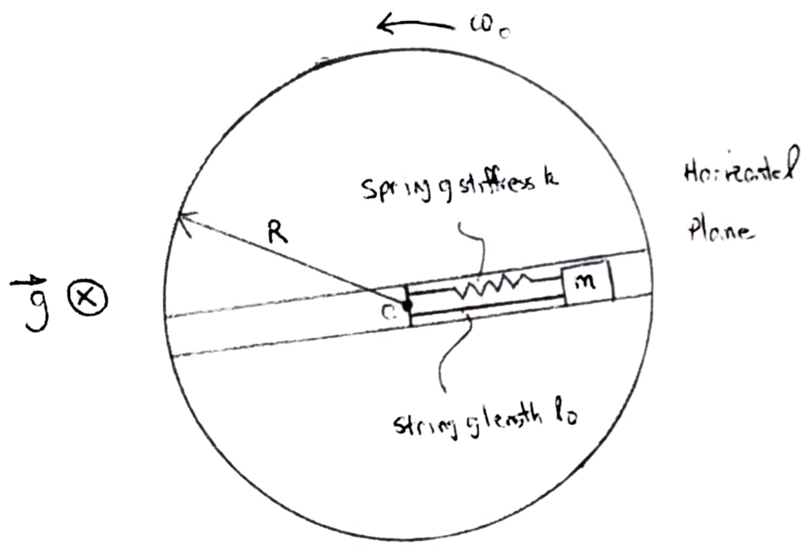
[1] (50%) A particle of m is initially held in place by a string of length l_o and within a groove machined in a spinning disk. The disk, which has radius R, spins at the constant angular rate ω_o about its center C, and the groove has frictionless bottom and sidewalls. A spring having stiffness k and free (unstretched) length R also acts on the particle. Gravity acts perpendicular to the plane of the disk (points into the plane of the disk as shown).



(a) When the string is present, determine the velocity of the particle.

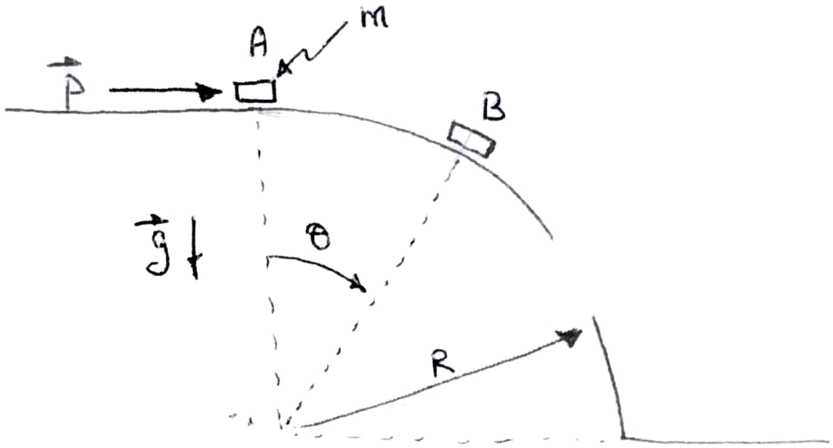
(b) When the string is present, determine the tension in the string.

(c) Determine the acceleration of the particle at the instant the string is cut (i.e., the instant the string is no longer acting on the particle).

(d) Derive the scalar equations of motion that describe the motion of the particle after the string is cut.

(e) Determine the speed of the particle within the groove during the ensuing motion as a function of the radial distance $r(t)$ within the groove. That is, find $\dot{r}=\dot{r}(r)$ and note that $l_o \leq r \leq R$.

[2] (50%) A particle of mass m slides without friction along a circular ramp of radius R while subject to the force $\vec{P}$ that has constant magnitude P and constant (horizontal) direction. The particle begins at rest at A (at the top of the ramp) and accelerates along the ramp through position B described by the angle θ.



(a) Compute the work done by the force $\vec{P}$ from position A to B.

(b) Describe whether the force $\vec{P}$ is conservative or non-conservative and present your reason(s) in a sentence.

(c) Compute the velocity of the particle at position B.

(d) Draw a free body diagram of the particle at position B and clearly label all forces.

(e) Determine the minimum value of P (the magnitude of $\vec{P}$) that would induce loss of contact when the particle reaches position B.