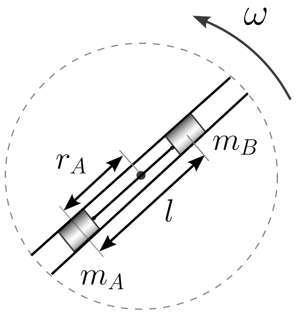
Tutorial 3 **Dynamics in Polar coordinates** 16 August 2024

Problem 1. (KK Q2.30) Two masses m_A and m_B can slide frictionlessly in a pipe as shown. This pipe is rotating about its center wth constant angular speed ω. The masses are connected by a massless string of length l, held by a catch, with m_A at a distance r_A from the center. The catch is removed at $t = 0$. Now the masses are free to slide.



The task is to find $\ddot{r}_i$ at the instant the catch is released. Before the catch is released,

(a) Write down the acceleration of each mass in polar coordinates

(b) Identify the forces on each mass in polar coordinates.

At the instant the catch is released,

(c) Write down the radial force equation for each mass

(c) Implement the constraint of $r_A + r_B = l$ and calculate $\ddot{r}_A$ and $\ddot{r}_B$.

Problem 2. (KK 2.29) A car is driving at constant speed v_0 along a straight line radially outward from the center of a platform rotating with constant angular speed ω. The mass of the car is M and μ is the coefficient of friction between the wheels and the platform.

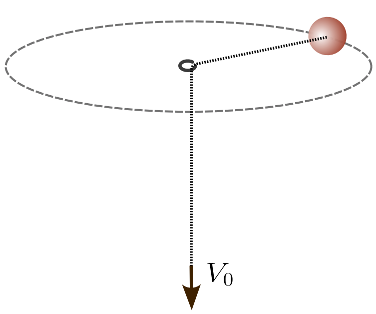
(a) Find the acceleration of the car as a function of time, in polar coordinates.

(b) Draw a vector diagram showing the components of the acceleration at time $t > 0$.

(c) Find the time at which the car just starts to skid.

(d) Find the direction of the frictional force at this instant.

Practise: (K.K 2.34)



A mass m is tied to a (massless) string that passes through a tiny ring as shown, and whirled around (anticlockwise). Initially the mass is at a distance r_0 from the center, and revolving with angular speed ω_0.
At $t = 0$, the string is pulled down with constant speed V_0.

(a) Draw a force diagram, obtain a differential equation for $\omega(t)$.

(b) Solve this equation for $\omega(t)$.

(c) Find the force neeced to pull the string.