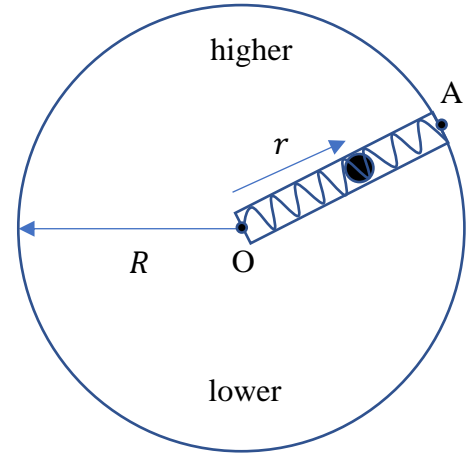9. An ideal massless spring with spring constant $k = 10 \text{ Nm}^{-1}$ and unstretched length $L = 0.5 \text{ m}$ is attached to point O on axis of a disc. It has a point mass $m = 1 \ kg$ attached at $L_1 = 0.2 \text{ m}$ of the unstretched spring. The spring is stretched and the other end is attached to point A on the edge of the disc at $R_0 = 1 \text{ m}$. The point mass is constrained to **move radially only**.

The disc can rotate around the axis at a constant an angular frequency ω. Take $t = 0$ s when OA is horizontal and A is to the right and the disc is rotating anti-clockwise. Although some air resistance will help the system achieve a **steady state**, you may assume that air resistance is negligible in your working

a) If the disc is **horizontal** and $\omega = 0,$ derive an expression for the **effective spring constant** k_t in terms of the given parameters.
    [5 marks]

b) If the disc is **horizontal** and rotating and constant angular velocity ω, derive an expression for r_0, the **equilibrium** position of the mass.
    [5 marks]

c) If the disc is at **an angle $\varphi = 0.4 \text{ rad}$** from the horizontal, what is the lowest angular frequency ω where the point mass can just about reach the edge of the disc at a **steady state**?
    [5 marks]