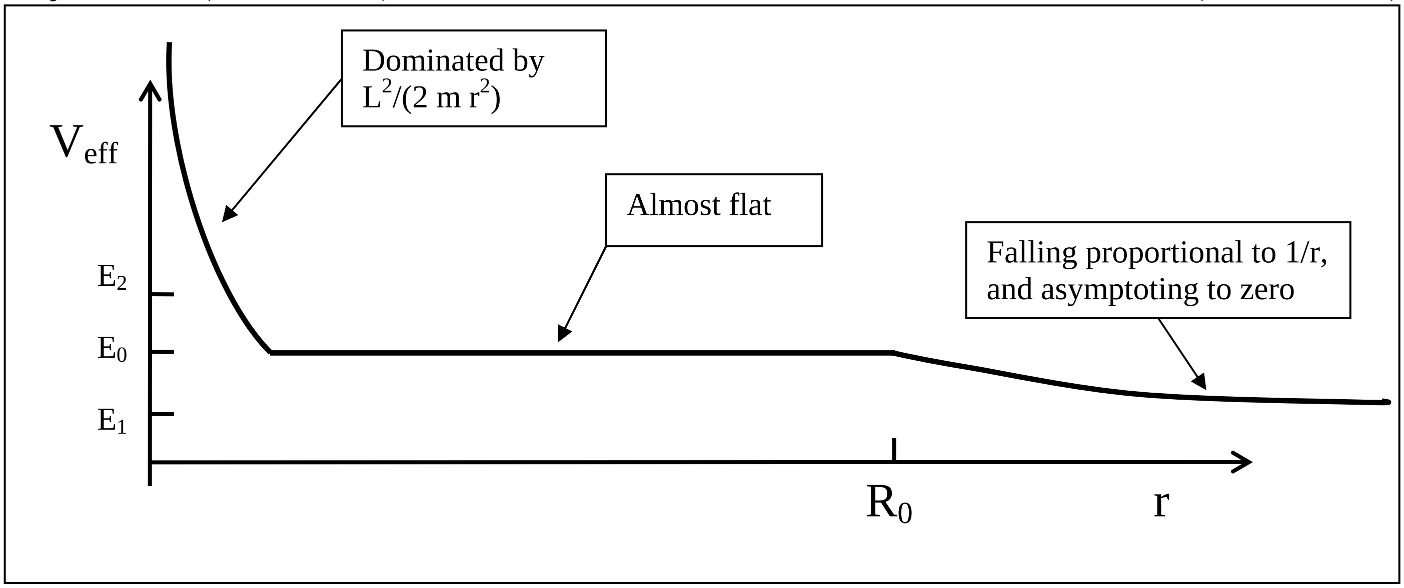
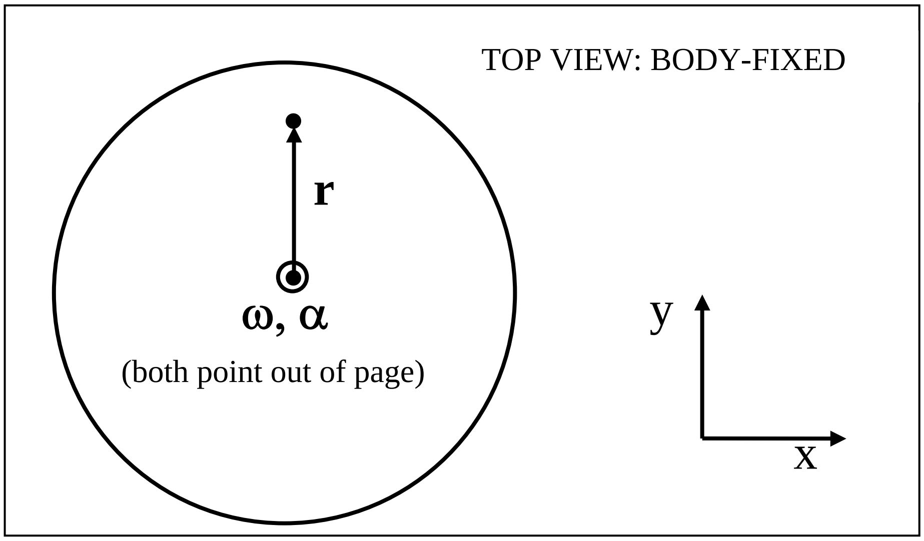


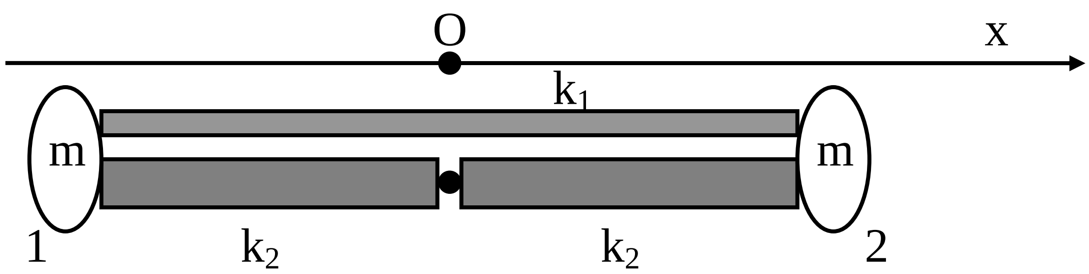
Qu. 1 [13 pts] Consider the scattering of a particle of mass *m* from a fixed potential. The corresponding effective potential is sketched above. Here L is the angular momentum about the origin, while E_0 and R_0 are fixed parameters of the potential. In the space below or on the back, sketch the two trajectories that are taken if the particle has the two energies E_1 and E_2 shown above, assuming that L is the same for both, and that they begin parallel at infinite r. Explain all the features that you can deduce from the given information, making sure to explain any differences between the two trajectories.

Qu. 2. [12 pts] A small object of mass m is fixed on a flat turntable at a radius r from the center as seen in the sketch (which uses body-fixed coordinates). The turntable is ``spinning up'', i.e. it has both angular velocity ω *and* angular acceleration α in the direction shown (out of the page). This question only concerns forces and motion in the plane of the turntable.



A. What force $\mathbf{F}_{\mathbf{attach}}$ must be exerted on the object in order to keep it fixed in place? Give both x and y components using the body-fixed axes shown on the sketch.

B. Now assume that the body is moving. For what instantaneous velocity **v** (as seen in the body-fixed frame) does the object move without instantaneous acceleration (also in the body-fixed frame)?



Qu. 3 [25 pts] Two objects of equal mass m are attached to each other by a spring with spring-constant k_1, and are also each attached to the fixed origin by springs with spring-constants k_2. All three springs have the *same* unstretched length *b*. (Recall that the potential energy of a spring is $V = (k/2)\,(L\text{-}b)^2$, where L is its length.) The set-up is shown in the sketch. The objects are constrained to move in the x direction, with object 1 to the left of the origin and object 2 to the right.

A. Write down the Lagrangian for the system.
B. Determine the stationary positions of the two masses.
C. Consider small oscillations about the stationary positions. Determine the frequencies of the normal modes, the corresponding normal mode vectors *and* normal coordinates. Both normal mode vectors and coordinates should be properly normalized.

Be sure to explain your work in parts **B** and **C**.