1 Hockey

(Synthesis Problem: Brings together several different concepts from this unit.) *Use effective potential diagrams for other than* $1/r^2$ *forces.*

Consider the frictionless motion of a hockey puck of mass m on a perfectly circular bowl-shaped ice rink with radius a. The central region of the bowl ($r < 0.8a$) is perfectly flat and the sides of the ice bowl smoothly rise to a height h at $r = a$.

(a) Sketch the potential energy for this system (just the potential energy, not the effective potential). Set the zero of potential energy at the top of the sides of the bowl.

(b) Situation 1: the puck is initially moving radially outward from the exact center of the rink. What minimum velocity does the puck need to escape the rink?

(c) Situation 2: a stationary puck, at a distance $\frac{a}{2}$ from the center of the rink, is hit in such a way that it's initial velocity $\vec{v}_0$ is perpendicular to its position vector as measured from the center of the rink. What is the total energy of the puck immediately after it is struck?

(d) In situation 2, what is the angular momentum of the puck immediately after it is struck?

(e) Draw a sketch of the effective potential for situation 2.

(f) In situation 2, for what minimum value of $\vec{v}_0$ does the puck just escape the rink?