

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 its 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?