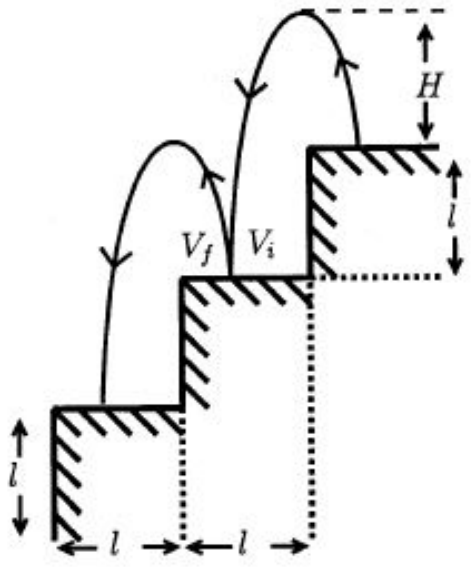
QP44



A marble bounces down a long flight of stairs in a regular manner, hitting each step vertically at the same speed and distance from the edge and bouncing up to the same height above each step, as shown in the figure below. Each stair has the same height and depth l, as shown. The hortizontal component of velocity V_h is unaffected, but the stairs have the property that $-V_f/V_i = e$, where V_i and V_f are the vertical velocity components just before and after the bounce respectively, and e is a constant $(0 < e < 1)$.
Ignore the size of the marble and air resistance is answering the following questions. Assume the trajectory of the marble lies in the plane of the paper.

a) (2 points) Find an expression for V_i in terms of e, l and the acceleration of gravity g.

b) (2 points) Find the time between bounces in terms of e, l and g.

c) (1 point) Find an expression for the bouncing height, H, in terms of l and e.