Classical Mechanics

Directions: Solve all 3 problems.

1. (35 pts) Two identical harmonic oscillators are placed so that the two masses slide against one another as shown below. A frictional force (coefficient $\mu$) exists between the masses and is proportional to the instantaneous relative velocity. (You may assume the contact area between the masses does not vary.)

(a) Calculate the frequencies of the normal modes of this system.
(b) For the case $\mu^2 = 2km$, obtain expressions for the time dependence of the normal mode coordinates in terms of the given parameters (plus any arbitrary constants which depend on initial conditions).

2. (25 pts) A homogeneous cube (mass $M$), each edge of which has a length $L$, is initially in a position of unstable equilibrium with one edge in contact with a horizontal plane. The cube is then given a small displacement and allowed to fall. Assuming the edge cannot slide on the plane, calculate the angular velocity of the cube at the instant when one face strikes the plane. Express your answer in terms of $L$, $M$, $g$, and $I$, the moment of inertia for rotation of the cube about an edge.