Physics Problems:– December-2010

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Q1. A certain mass of Helium gas in a vertical cylindrical container is in thermodynamic equilibrium with the surroundings. The gas is confined by a movable heavy piston. The piston is slowly elevated a distance H from its equilibrium position and then held in the elevated position long enough for the thermodynamic equilibrium to be reestablished. Now, the container is insulated and then the piston is released. After the piston comes to rest, what is the new *equilibrium* position of the piston?

Q2. Two oppositely charged particles (m_1, q_1) and (m_2, q_2) are held at rest at some separation in a gravity less region of constant electric field E_o. When they are released simultaneously it is observed that their separation remains constant. Find this separation (in meters), given that $|q_1| = 2\mu C$, $|q_2| = 3\mu C$, $m_1 = 3kg$, $m_2 = 2kg$ and $E_o = 2500$ N/C.

Q3. A flat board of length l and mass m_o is moving with a velocity v_o from left to right on a smooth horizontal surface. The right edge of the board now comes under a stationary sand-dropper which drops sand on the board at a mass rate (dm/dt) of μ. What is the velocity of the board when the left edge clears off from below the sand-dropper? Assume that there is enough friction between the sand particles & the flat board.

Q4. Consider a planet of mass M and radius R and a very long, uniform stick of length $2R$, which extends from just above the surface of the earth as shown in the figure. If initial conditions have been set up so that this stick moves in a circular orbit while always pointing straight towards the centre of the planet, what is the period of this orbit?