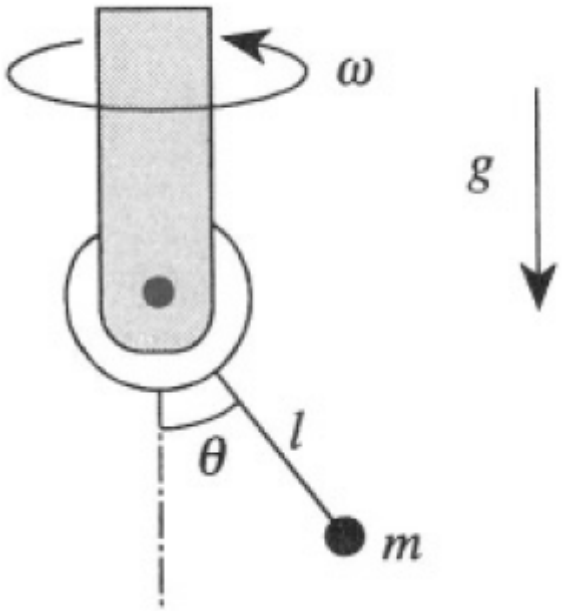
Dr. Sasha

Please, solve this problem and also show the steps to solve it.

5.06.2015 – N15

1) The bearing of a rigid pendulum of mass m is forced to rotate uniformly with angular velocity ω (see figure below). The angle between the rotation



axis and the pendulum is called θ. Neglect the inertia of the bearing and of the rod connecting it to the mass. Neglect friction. Include the effects of the uniform force of gravity.

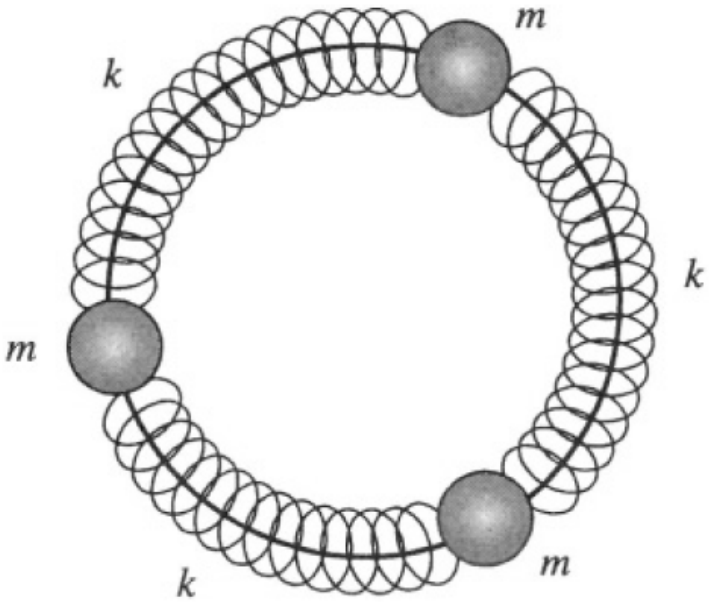
a) Find the differential equation for $\theta(t)$.

b) At what rotation rate ω_c does the stationary point at $\theta = 0$ become unstable?

c) For $\omega > \omega_c$ what is the stable equilibrium value of θ?

d) What is the frequency Ω of small oscillations about this point?

2) Three masses, each of mass m, are interconnected by identical massless springs of spring constant k and are placed on a smooth circular hoop as shown in figure below. The hoop is fixed in space. Neglect gravity and friction. Determine the natural frequencies of the system, and the shape of the associated modes of vibration.

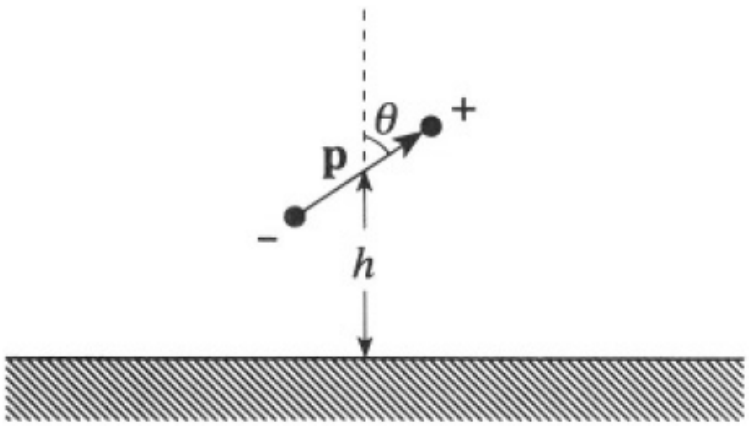


3) Consider a photon of energy ε_γ incident on a stationary proton. For sufficiently large ε_γ, a π meson can be produced in a reaction

$$\gamma + p \rightarrow p + \pi^0$$

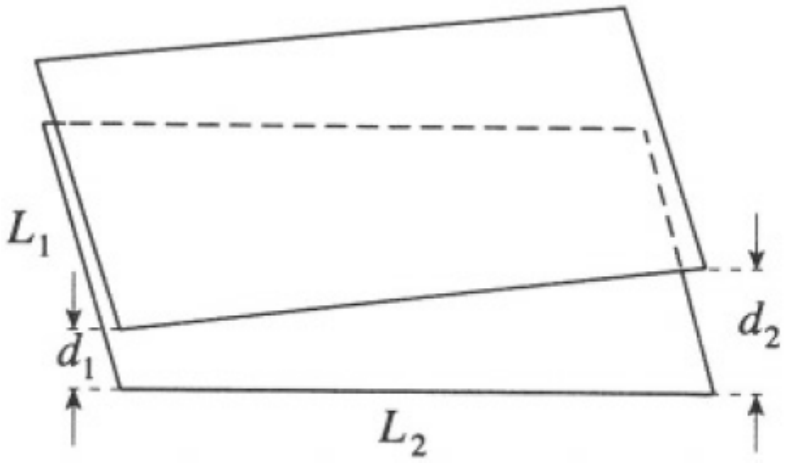
What is ε_{min}, the threshold photon energy for this reaction to occur? The rest mass of π^0 is 135 MeV/c^2.

4) An electric dipole of moment p is placed at a height h above a perfectly conducting plane and makes an angle θ of with respect to the normal to this plane (see figure below).



a) Calculate the work required to remove the dipole to infinity.

5) A capacitor is formed by two rectangular conducting plates having edges L_1 and L_2 . The plates are not parallel. One pair of edges of length L_1 is separated by a distance d_1 everywhere, and the other pair of edges of length L_2 is separated by d_2 everywhere: $d_2 > d_1$.



Neglecting edge effects, when a voltage difference V is placed across the two conductors, find the capacitance.