Exam zeroth: General Physics I: Advanced course Feb. 14th, 2017

1. Two blocks 1 and 2 with mass m_1 and m_2, respectively, are connected by a massless string on a wedge with a frictionless pulley of negligible mass as shown in Fig.1. The two blocks contact with the wedge with friction coefficient μ for each and can slide on the wedge. The wedge has mass M and the incline of which is placed at angle θ from the horizontal floor. The wedge can move on the floor without any friction. A gravitational force acts on each component of the system downward with the gravitational constant g. A force F acts on the wedge rightward. We suppose that the mass 2 is heavier sufficiently than the mass 1 and the string is so long. When they are released at the height h of the block 2, the block 2 can fall down to the floor before the block 1 collides with the pulley. (a) Describe all possible motions that can arise when the block 2 is released from the height h in terms of m_1, m_2, M, μ and F. (b) Obtain the accelerations of the wedge and the mass 2. (c) Obtain the tension of the spring T. (d) Obtain the normal force N between the wedge and the block 2.

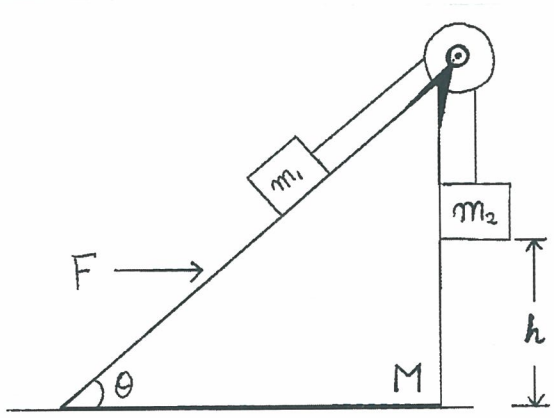

Fig 1

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2. A fish rests on the bottom of a bucket of water while the bucket is being weighted. When the fish begins to swim around, describe how the weight changes for any type of motion of the fish ?

3. Each pendulum ($i = 1$ and 2) of the mass m is connected to the rigid common frame of the mass M by the massless rigid rod of length $\ell = \ell_1 = \ell_2$. The frame at the horizontal positin X is attached to a spring with the spring constant K. The sliding motion of the frame and the pivot motion of the pendulum are frictionless. Gravitational field g is applied downward vertically. The three movable objects (the frame and the two pendulums) are described by the coordinates X, θ_1 and θ_2, respectively. (a) Derive the equations of motion for each object. (b) Describe the motion of each pendulum when the frame with mass M is fixed. (c) We suppose that the frame can move. Describe the motion of each pendulum for the two initial conditions (i) $\theta_1 = \theta_2$ and (ii) $\theta_1 = -\theta_2$ at $t = 0$.

4. What are (a) the standing wave and (b) normal modes produced in a string fixed at both walls separated by L in one dimension ? Answer to the questions in English. The separation between the two walls are reduced by external force to $L/2$ through the adiabatic process during which the normal mode with the lowest frequency are maintained. (c) Calculate the work done by the external force.

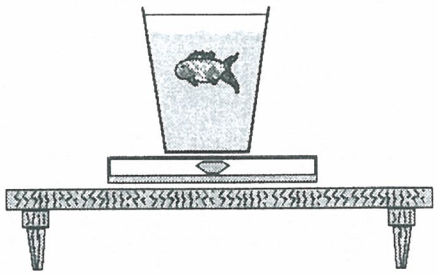

Fig.2

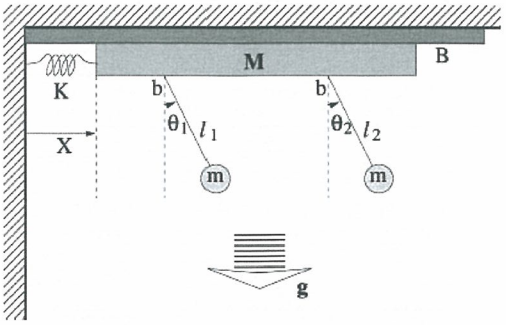

Fig.3