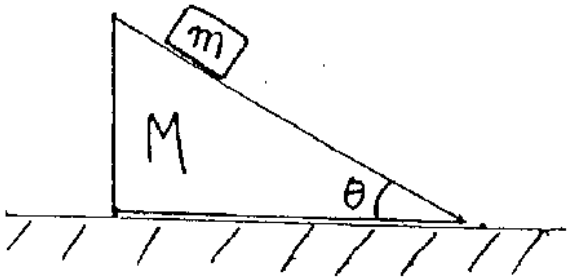
1. A block of mass m is released on a wedge of mass M at a height h above the floor as shown in the figure. All surfaces are frictionless. Find the speed of the wedge relative to the floor when it hits the floor, express your answer in terms of m, M, θ and g (acceleration due to gravity). (15%)



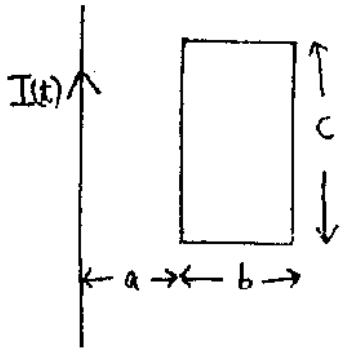
2. A baseball bat rests on a horizontal frictionaless surface. The bat has a length L and a mass M, and its center of mass is located at a distance D from the handle end. The momentum of inertia of the bat about its center of mass is I. The bat is struck by a base ball traveling perpendicular to the bat at a distance x from the handle end of the bat. What must x be so that the handle end remains at rest as the bat begin to move? (15%)

3.(a) Find the molar specific heat at constant volume, C_v, for an ideal monatomic gas. (b) Find the change in entropy for n moles of an ideal monatomic gas when the pressure changes from P_1 to P_2 at constant volume. (17%) Express all your answers in terms of the gas constant R.

4. Consider a rectangular box of gas, which is put on a horizontal surface. Now assume that all the particles can only move in the horizontal plane, i. e. they behave like a 2-dimensional gas system. (1) Find an expression for the pressure on the wall, relating to properly averaged speed. (2) Derive its equation of state.

You can make any appropriate assumption. If you cannot finish the derivation, please just state your ideas and method to obtain the required results.

5. A flat rectangular loop and a long straight wire lie in the same plane. The size of the loop is $b \times c$ and is at a distance a from the wire as shown. The current in the wire varies in time as $I(t) = I_o \sin(\omega t)$ where $I_o > 0$. Find the induced emf in the loop. What is the direction of the induced emf in the period $0 < t < \pi/(2\omega)$?



6. Consider an electric dipole p in a uniform electric field E (The dipole consists of two identical spheres and each has the same mass m, and they are separated by a distance d which can be taken as constant when the electric field is too strong.) Initially the direction of the dipole is the same as the field. Now assume a small perturbation which makes the dipole tilted a small angle θ from the direction of E. (1) Derive an equation of motion for the dipole after the perturbation is removed. (2) Solve (1) when $\theta << 1$. What kind of movement will the dipole take? Express it mathematically.