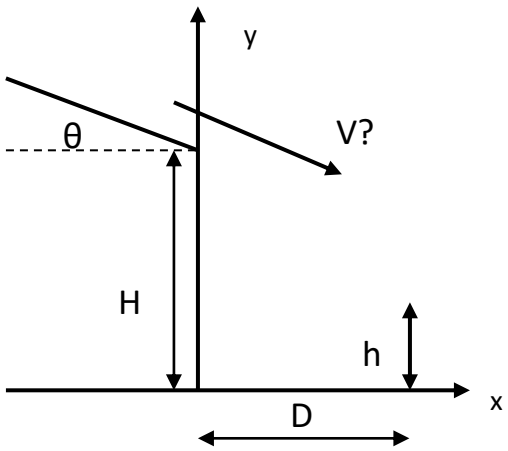
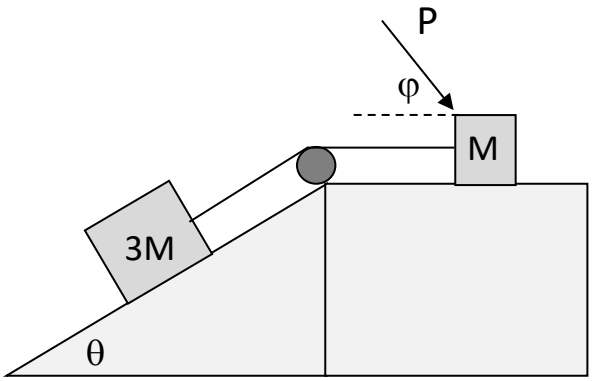
Physics 1135 Test 1 Preparation Homework

1. Students roll a snowball from a roof that makes an angle θ with respect to the horizontal. The snowball leaves the roof with speed *V*, at height *H* above the ground. A physics professor is standing a horizontal distance *D* away from the building; the professor's head is at height *h* above the ground.



a) Complete the diagram with all information necessary for the task below.
b) Derive an expression for the initial speed *V* the snowball must have in order to hit the professor's head.
c) Derive an expression for the speed with which the snowball hits the professor's head. You may use V as a system parameter for this part.

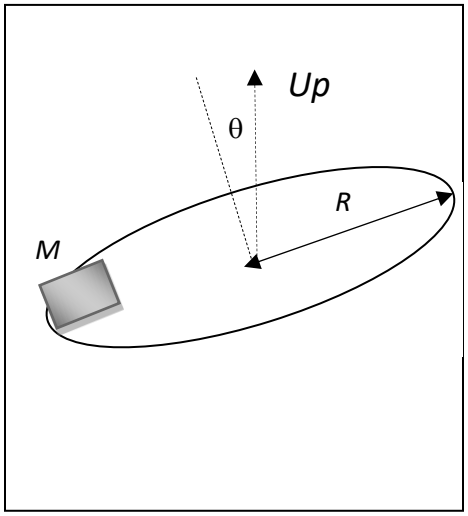
2. A block of mass 3*M* is sliding down a **frictionless incline** that makes an angle θ with the horizontal. It is connected to a second block of mass *M* that is on a **rough horizontal** surface by a massless rope that passes over a frictionless massless pulley. An external force *P* retards the motion by pushing the block at an angle φ with horizontal as shown.



a) On the figure, superimpose fully labeled free-body diagrams for each block, including all information that you need to solve the task below.

b) Derive an expression for the coefficient of friction μ between the horizontal surface and the block of mass *M* that is required for the blocks to move at a constant speed.

3. A motorized cart of mass *M* moves with constant speed along the edge of a rough circular disk of radius *R* that is tilted by an angle □ from the vertical, as shown in the figure. The coefficient of friction between the cart's wheels and the disk is μ.



a) Complete the diagram to the right with a free body diagram for the cart with an appropriate *x*-*y* coordinate system.

b) Derive an expression for the minimum speed *V* that the cart must have at the position shown in the diagram so that it does not slide off the disk.