AP Physics C: Mechanics

Unit 2: Forces Test

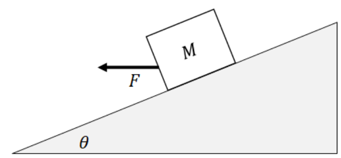
Directions: **You must show all steps** required to arrive at the correct answer for the problem below.

1. (12 points) A spooky ghost of mass $M = 40\ kg$ is rest at the origin at time t = 0 when it is subjected to a spooky force that results in its position being given by the function $x(t) = 4t^2 + 4\sqrt{t}$

a) Calculate the instantons force on the ghost at time t = 4 s.

b) At time t = 4 s, the spooky force is removed and the ghost is now subject to a resistive force given by $F_{DRAG} = -8v^2$. Taking this as the new time t = 0 s, write a function for the velocity of the ghost as a function of time. You can leave your final answer as a function of $\frac{1}{v(t)}$.

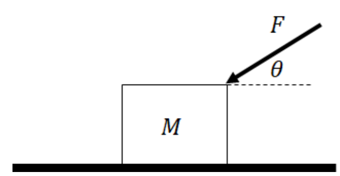
2. (8 points) A block of mass M is placed on an incline that makes an angle of θ with the horizontal because this is a physics test and of course it was going to have a block placed on an incline. The interface between the block and the incline has a coefficient of static friction, μ_s, and a coefficient of kinetic friction, μ_k.The block is now pulled down the incline with a force of magnitude F that acts parallel to the ground as shown.



a) Draw a free-body diagram of the forces on the block.

b) Determine tan expression for the acceleration of the block down the incline.

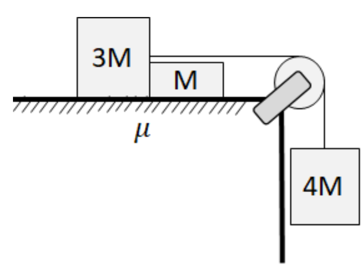
3. (10 points) A block of mass M rests on a rough horizontal surface with a cofficienct of static friction, μ_s, acting between the surface and block. A force of F acts downward on the block at angle of θ with the horizontal as shown.



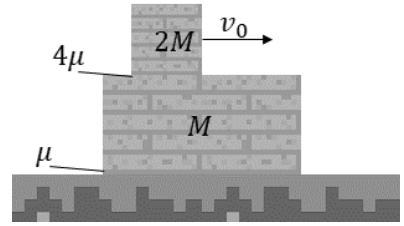
a) Show that the minumum value of F that will move the block is given by $F = \frac{\mu_s Mg}{cos\theta - \mu_s \sin\theta}$.

b) Explain why the block will not move if the value of θ is too large regardless of how strong the pushing force is.

4. (6 points) Consider the pulley system shown. Two blocks of masses $3M$ and M rest on a horizontal table with a coefficient of kinetic friction, μ. A string is connected to the block of mass $3M$ which passes over a frictionless pulley and connects to a hanging block of mass $4M$. The system is set into motion, with the hanging block pulling the $3M$ block which then pushes the block of mass M. Determine an expression for the magnitude of the force that the block of mass M exerts on the block with mass $3M$.

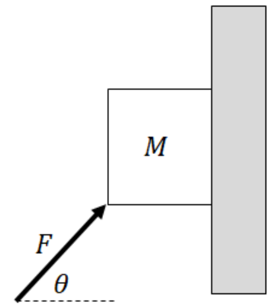


5. (8 points) A mass M rests on a rough horizontal surface. The coefficient of sliding friction between the block and the surface is μ. A block of $2M$ is on top of the block of mass M and is given an initial velocity of v_0 at time t = 0 s. The coefficient of friction between the two blocks is 4μ. The bottom block starts at rest and the following are known: $v_0 = 10\frac{m}{s}, \mu = 0.2, M = 1.0\ kg$.



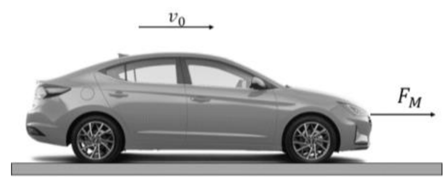
a) Write a velocity vs. time function for the top block.
b) Write a velocity vs. time function for the bottom block.

6. (8 points) A block of mass 10 kg initially at rest is pushed against a wall by a force of magntiude F as shown. The force acts at an angle of 60° with the horizontal. The coefficient of kinetic fricton is .3 while the coefficient of static friction is .5.



a) Draw a free-body diagram of all the forces on the block if the block slides up the wall.
b) Determine the value of F for the block to slide up the wall at constant speed.

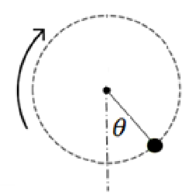
7. (12 points) A Hyundai Elantra of mass M = 1000 kg initially and rest and is propelled by a constant forward force provided by its motor, F_M=400 N. The car moves in the direction indicated along a horizontal road. While moving, the car encounters a resistance force equal to -2v, where v is the velocity of the car



a) Write and solve a differential equation to obtain an expression for the velocity of the car as a function of time.
b) Use your answer to b) to derive an expression for the acceleration of the car as a function of time.

8. (14 points) Patrick hones his yo-yoing skills while waiting for milk to heat up. Assume that the mass of the yo-yo string is negligible, and the plastic part of the yo-yo has a mass of $M = 0.5\ kg$.

a) First, Patrick tries spinning; that's a good trick. He spins the yo-yo in a vertical circle as shown with a $R = 0.6\ m$. At a certain point, the yo-yo string makes an angle of $\theta = 30°$ with vertical as shown, and it in the lower right part of its motion. At this point, the tension in the rope is found to be 320 N. Calculate the components of the yo-yo's total acceleration (tangential and radial) at this point.



b) In another feat of yo-yoing, Patrick whirls the yo-yo in a horizontal motion by swinging the yo-yo above his head as shown, forming a conical pendulum. The yo-yo string makes an angle of $\theta = 45°$ with horizontal and the yo-yo travels in a horizontal circle with radius R = 0.6 m. Calculate the speed of yo-yo.