Physics 121

Assignment #2

Forces and Atwood Machines

Due Friday, March 2nd, 2018

Multiple Choice

1. A modified Atwood machine (like the one below) consists of two masses. The hanging mass is 10kg, the mass on the table is 100kg the coefficient of static friction is 0.3 and the coefficient of kinetic friction is 0.15. Upon releasing the hanging mass the tension in the rope when there is:

   a) 98N   b) 980N   c) 294N   d) 147N

2. If the mass on the table in question 2 is changed to 50kg, the tension in the rope would be:

   a) 98N   b) 490N   c) 147N   d) 73.5N

3. Which of the following situations would have a normal force less than the weight of the object?

   a) A box sits on a horizontal surface   b) A box is being pulled with an upward force

   c) A box is being pushed with a downward force   d) None of the previous

4. The smaller mass on an Atwood machine is 40kg.   If the tension in the rope is 500N, the second mass is:

   a) 27. 72kg   b) 70.42kg   c) depends on direction of motion   d) none of the previous

5. A cart with a mass M is pushed at a downward angle of **B**. The coefficient of friction is stated as **μ**. Which of the following equations could be used to determine the applied force?

   a) $M(a+\mu g)/(\cos B - \mu \sin B)$ b) $M(a+\mu g)/(\cos B + \mu \sin B)$

   c) $M(a+\mu g)/(\sin B - \mu \cos B)$ d) $M(a+\mu g)/\cos B$

6. A box with a mass of **m** sits on a ramp that makes and angle **A** with the horizontal. The coefficient of friction is **μ**. Which of the following equations would represent the acceleration of the box?

   a) $g(\sin A - \mu \cos A)$ b) $g(\sin A + \mu \cos A)$ c) $g(\cos A - \mu \sin A)$ d) $mg(\cos A + \mu \sin A)$

Open Response

7. You are preparing to enter a dog sled race in Nunavut. Your sled, loaded with you and supplies, has a mass of 200kg. After doing research you find that the dogs need 10 meters to reach their constant velocity of 5m/s. Two ropes are attached to the sled, one on each side of the dogs. The ropes pull upward at an angle of $10°$. a) What are the tensions in the ropes in the beginning stage of the race? b) What are tensions in the ropes after they reach constant velocity? Assume the tension in the ropes is equal. The coefficient of static friction is 0.10 and the coefficient of kinetic friction is 0.05.

8. You have been challenged to move a solid aluminum box across a mild steel platform. You have the choice of pulling the box with a rope upward at an angle of $30°$ or pushing downward with an angle of $30°$. Determine the required force to get it started with each angle. The dimensions of the box are 50cm in length, 20cm in width and 30cm high.

9. The figure below shows two boxes attached by a light rope of negligible mass that runs over an essentially frictionless peg. The mass of the block on the $60°$ incline is M kg and the mass of the block on the $45°$ incline is N kg. For simplicity assume the surfaces are frictionless.

   a. Determine and equation for the acceleration of the blocks when they are moving.

   b. What is the resultant force exerted on the peg? (don't forget direction)

   c. What is the acceleration of the blocks if the coefficient of kinetic friction is 0.2 and M is 10kg and N has a mass of 15kg.
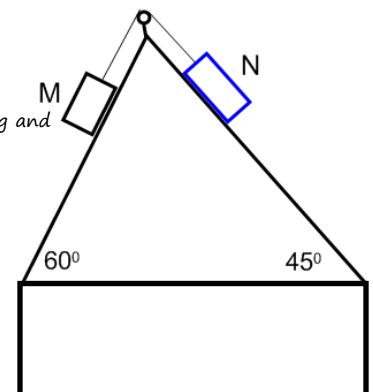
Extra Practice Problems

10. A tractor is being used to pull a large block. Determine the ideal angle, within 1 degree to pull the block with for the following situations: i) Mass is 1000kg and μ = 0.6 ii) Mass is 1000kg and μ = 0.3 iii) Mass is 500kg and μ = 0.6. Solve using Excel,if you prefer. **(30.96°, 16.70°, 30.96°)**

11. A load of lumber is being unloaded from a goose neck trailer. The trailer is designed such that the front of it will lift to allow the load to slide off the deck of the trailer. The hydraulic system is designed such that the rotational velocity is 2.0 rads/min. a) If the μ_s is 0.80 and μ_k is 0.45 and the weight of the load is 400 lbs determine how long it takes (to the closet whole second) to get the front of the trailer to the height required to make the load slide off.

12. A 3 m long inclined plane is used to load bricks into the back of a truck which is 0.9 m high. a) If each pack of bricks has a mass of 45kg, and the coefficient of friction between the surfaces is 0.35, how much force is needed in order to slide the bricks up the ramp at a constant velocity? b). The same ramp is now used to unload the bricks, will they slide down by themselves? If not, how much force is going to be required in order to make them slide? If they will, what is the acceleration? **(279.45N, 14.85N)**

13. A 7.25kg block sits on an inclined plane that makes an angle of 34° with the horizontal. The coefficient of friction is 0.12. The block is attached by a string, over a pulley at the top, to a hanging mass of 6kg. A) What is the acceleration of the objects? B) What is the tension in the string when the objects are moving?

14. A modified Atwood machine is designed like the one below. Determine the acceleration of the masses if mass 1 is 5kg, mass 2 is 40kg and mass 3 is 10kg. The coefficient of friction is 0.100.
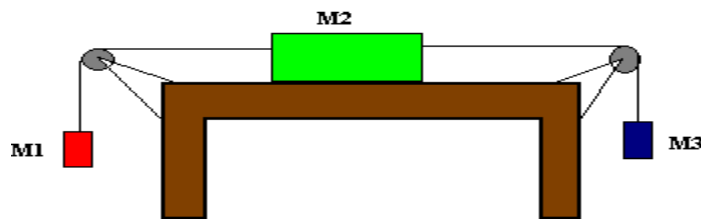
15. Hank is pushing a shopping cart that has a mass of 30kg at a constant velocity.   a) If the force of friction is 80N, determine the force on the handle if the force is applied at an angle of 55° with the horizontal. b) Determine the required force to move the cart at a constant velocity if the mass of the shopping cart is increased to 60kg. **(139.48N, 118.16N)**

16. A modified Atwood machine is set up such that one mass is sitting on a table top with a coefficient of friction of 0.25. It has a mass of 100 kg and is attached to a hanging mass. a) Determine the acceleration of the masses if the hanging mass is 20kg. b) Determine the acceleration of the masses if the hanging mass is 50kg. **(0, 1.63m/s²)**