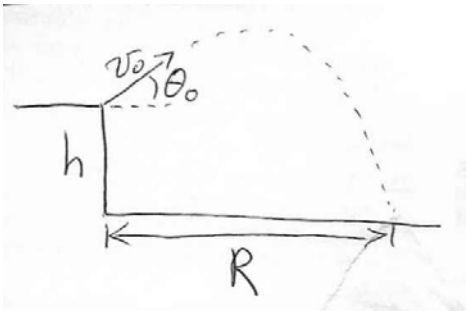
Tutorial Sheet - 3

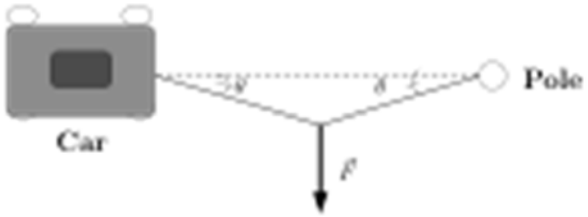
FIRST SEMISTER 2014
PHYSICS-101

Date: 25.08.2014 Tut. Sheet **03**

1. A projectile is shot from the edge of a cliff of height h at an angle of θ_0 above horizontal and with speed v_0. What horizontal distance R will it move before it hits the ground?

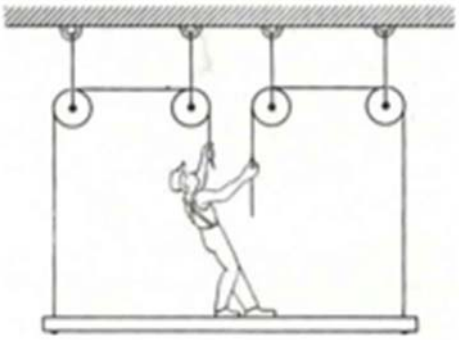


2. Your car is stuck in a mud hole. You are alone but have a long, strong rope. Having studied physics you tie the rope tautly to a telephone pole 50 feet away and pull on it sideways as in the figure below. If the midpoint of the rope is displaced transversely by 3 ft when he pushes with a force of 500 N (≈50 kg), what force does this exert on the car? If this were sufficient to begin to move the car, and the man pushed the rope another 2 ft, how far would the car be shifted, as- suming that the rope does not stretch any further? Does this seem like a practical method of dealing with the situation?

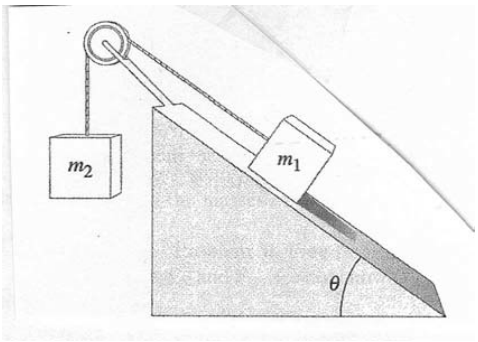


3. What is the maximum speed *v* that *a* car of mass *M* can move around a turn of radius *R* if its tires have a coefficient of static friction μ?

4. A painter of mass M stands on a platform of mass m and pulls himself up by two ropes, which hang over pulleys, as shown. He pulls each rope with force F and accelerates upward with a uniform acceleration a. Find a – neglecting the fact that no one could do this for long.

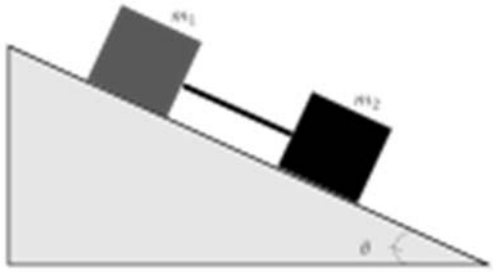


5. a) Derive the condition under which the static friction coefficient μ_s is large enough to keep the blocks below from sliding?
   b) What is the vertical acceleration of m_2 if there is no friction?



6. Consider a roller of radius r being pulled over a step as shown below. The height of the step is h. What is the minimum force F required if the roller is pulled in the direction shown and is about to roll over the step? What are the normal and frictional forces at this instant?

7. Two blocks are connected by a massless, rigid rod and placed on an inclined plane as shown in the figure below. The blocks have masses m1 and m2 and coefficients of kinetic friction (with the plane) of μK1 and μK2.
   A) Find a symbolic formula for the acceleration of the system.
   B) Find a symbolic expression for the force that the connecting rod exerts on either block.
   C) Show that the force from part B) is zero when μK1 = μK2.



8. A popular demonstration of inertia involves pulling the tablecloth out from beneath dishes with which the table is set. Suppose a tablecloth just covers the area s^2 of a square table. A dish is in the exact center of the table. The coefficient of sliding friction between the dish and the cloth is μ_1, and that between the dish and the table is μ_2. A dinner guest withdraws the cloth swiftly, but at a steady rate. Let the distance the dish moves while in contact with the moving cloth be x_1 and the distance it moves while in contact with the table be x_2.
   (a.) Solve for the maximum velocity v of the dish in terms of x_1,μ_1 , and g.
   (b.) Do the same in terms of x_2, μ_2, and g.
   (c.) Show that the dish just remains on the table when $x_1 = (s/2)\dfrac{\mu_2}{\mu_1 + \mu_2}$
   (d.) Find the length of time during which the dish and tablecloth are in contact under conditions (c.).
   (e.) A pitfall for the dinner guest is that the dish may not slide at all, but instead merely move with the cloth. How does she avoid that?