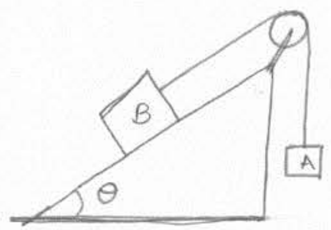
HOMEWORK 2.

INSTRUCTOR: ARIJIT BOSE

DUE: TUESDAY, MAY 31, 2011.

(1) Two blocks A and B are connected by a pulley. The mass of block B is M.



The coefficient of kinetic friction between block B and inclined plane is μ_K. The angle of the inclined plane is θ. Block B slides down the incline at a constant speed.

(i) What is the mass of block A?

(ii) Use $M = 20$ kg, $\mu_K = 0.30$ and $\theta = 30°$ in the above result and find the mass of block A.

(2) Block A (in figure) weighs 1.20 N, block B weighs 3.60 N. The coefficient of kinetic friction between all surfaces is 0.300. Find the magnitude of the horizontal force $\vec{F}$ necessary to drag block B to the left at constant speed

a) if A rests on B and moves with it (fig (i))

b) if A is held at rest. (fig (ii))

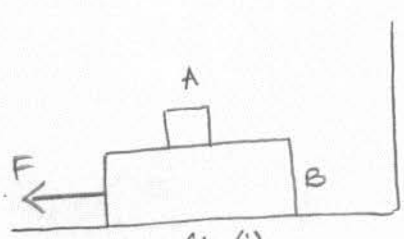


fig (i)

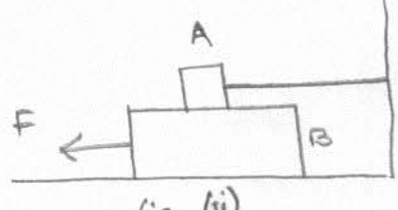
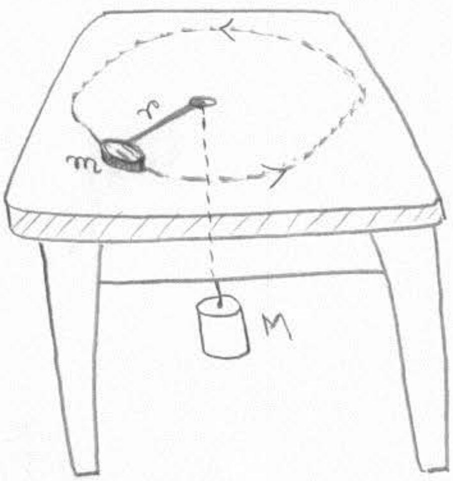


fig (ii)

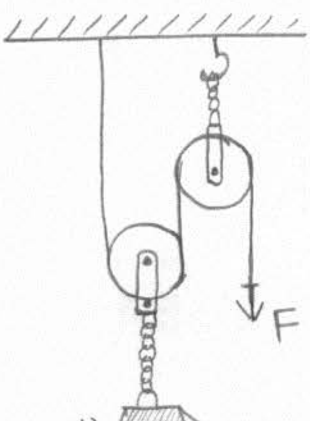
(3) The terminal velocity of a sky diver is 100 km/hr in the spread eagle position and 300 km/hr in the nosedive position. Assuming that the diver's drag coefficient C does not change from one position to the other, find the ratio of the effective cross sectional area A in the slower position to that in the faster position.

(4)



A dice of mass m slides on a frictionless table while attached to a hanging cylinder of mass M by a cord through a hole in the table. What speed keeps the cylinder at rest?

(5)



In this figure, a worker lifts a weight w by pulling down on a rope with a force $\vec{F}$. The upper pulley is attached to the ceiling by a chain, and the lower pulley is attached to the weight by another chain. In terms of w find the tension in each chain and the magnitude of $\vec{F}$ if the weight is lifted at constant speed. Include all free body diagrams in the answer. Assume that the rope, pulleys and chains all have negligible weights.

(6) A flat (unbanked) curve on a highway has a radius of 220 m. A car rounds the curve at a speed of 25.0 m/s. What is the minimum coefficient of friction that will prevent sliding?

(7) One problem for humans living in outer space is that they are apparently weightless. One way around this problem is to design a space station that spins about its central axis at a constant rate. This creates "artificial gravity" at the outside rim of the station.

(a) If the diameter of the space station is 800 m, how many revolutions per minute are needed in order for the "artificial gravity" acceleration to be $9.8\ m/s^2$?

(b) If the space station is a waiting area for travelers going to Mars, it might be desirable to simulate the acceleration due to gravity on the Martian surface ($3.70\ m/s^2$). How many revolutions per minute are needed in that case?

(8) A bowling ball weighing 71.2 N is attached to the ceiling by a 3.80 m rope. The ball is pulled to one side and released; it then swings back and forth as a pendulum. As the rope swings through the vertical, the speed of the bowling ball is 4.20 m/s.

a) What is the acceleration of the bowling ball, in magnitude and direction at this instant?

b) What is the tension in the rope at this instant?

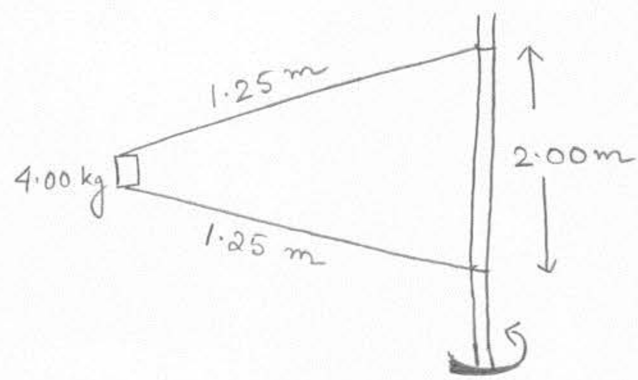
(9) A 4.00 kg block is attached to a vertical rod by means of two strings. When the system rotates about the axis of the rod, the strings are extended as shown in the diagram and the tension in the upper string is 80.0 N

a) What is the tension in the lower cord?

b) How many revolutions per minute does the system make?

c) Find the number of revolutions per minute at which the lower cord just goes slack.

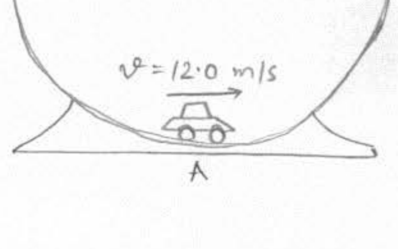
(d) Explain what happens if the number of revolutions per minute is less than in part (c).



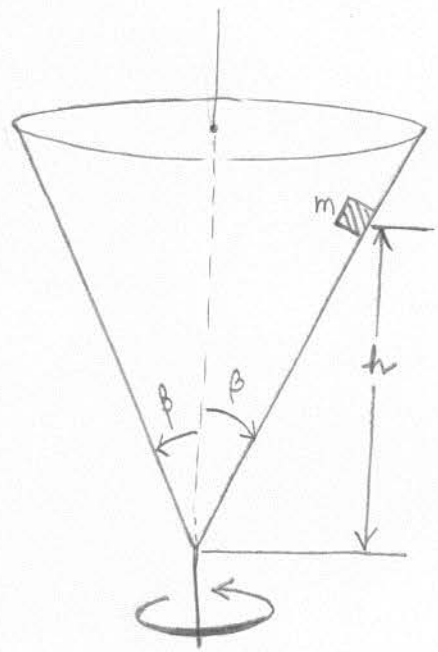
(10) A small remote-control car with a mass of 1.60 kg moves at a constant speed of $v = 12.0$ m/s in a vertical circle inside a hollow metal cylinder that has a radius of 5.00 m (figure) What is the magnitude of the normal reaction force exerted on the car by the walls of the cylinder at

(a) pt A (at the bottom of the vertical circle)

(b) pt B (at the top of the vertical circle).



(11) A small block with mass m is placed inside an inverted cone that is rotating about a vertical axis such that the time for one revolution of the cone is T. The walls of the cone make an angle β with the vertical. The coefficient of static friction between the block and the cone is μ_s. If the block is to remain at a constant height h above the apex of the cone, what are the maximum and minimum values of T?



(12) A 2.00 kg block is pushed against a spring with negligible mass and force constant $k = 400$ N/m, compressing it 0.220 m. When the block is released, it moves along a frictionless, horizontal surface and then up a frictionless incline with slope 37.0°.

a) What is the speed of the block as it slides along the horizontal surface after having left the spring?

b) How far does the block travel up the incline before starting to slide back down?