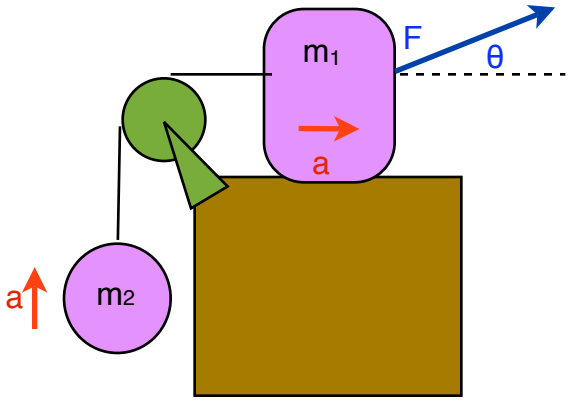
5th Assignment due Wednesday, **November 11th (class**, no later then noon) - distributed October 23rd

Please note your name clearly on your solutions, number the pages and write notes along the way, so that it is easy to follow your thought process.
The points for every single number are stated below. This assignment has 30 point, but I will treat 25 as 100%, since number 8 is hard - most of it will be extra points.
Also note, at the point of handing it out, you will not have heard everything you need in the lecture. This assignment includes topics until November 4th (inclusive) for 8 and 9.

1.) A block of mass m_1 = 1.3 kg on a rough horizontal surface is connected to a ball of mass m_2 = 2.7 kg by a lightweight cord over a lightweight, frictionless pulley as shown in the figure. A force of magnitude F at an angle Θ = 27° with the horizontal is applied to the block as shown and the block slides to the right. The coefficient of kinetic friction between the block and the surface is μ = 0.23. Determine the magnitude of the acceleration of the two objects.
(Start by drawing two free body diagrams - one for the ball and one for the block. Then write down all equilibrium conditions for the ball vertical, the block vertical and the block horizontal.) (4 points)



2.) A water bed has dimensions of 1.83 m x 2.13 m x 0.229 m. The floor of the bedroom will tolerate an additional weight of no more than 6600 N. Find the weight of the water in the bed and determine if it should be purchased. (2 points)

3.) A cylinder (with circular ends) and a hemisphere are solid throughout and made from the same material. They are resting on the ground, the cylinder on one of its ends and the hemisphere on its flat side. The weight of each causes the same pressure to act on the ground. The cylinder is 0.500 m high. What is the radius of the hemisphere?
(3 points)

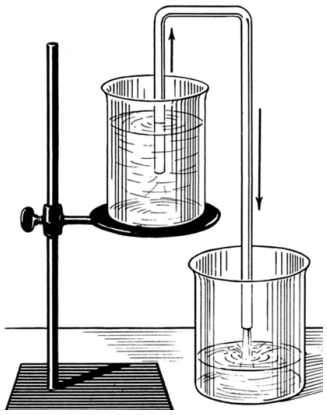
4.) The human lungs can function satisfactorily up to a limit where the pressure difference between the outside and inside of the lungs is one-twentieth of an atmosphere. If a diver uses a snorkel for breathing, how far below the water can he/she swim? Assume the diver is in salt water whose density is 1025 kg/m^3. (3 points)

5.) What is the smallest number of whole logs (ρ = 725 kg/m^3, radius r = 0.0800 m, length l = 3.00 m) that can be used to build a raft that will carry four people, where every person has a mass of 80.0 kg? (3 points)

6.) A room has a volume of 120 m^3. An air-conditioning system is to replace the air in this room every twenty minutes, using ducts that have a square cross section. Assuming that air can be treated as an incompressible fluid, find the length of a side of the square if the air speed within the ducts is (a) 3.0 m/s and (b) 5.0 m/s. (3 points)

7.) An airplane wing is designed so that the speed of the air across the top of the wing is 251 m/s when the speed of the air below the wing is 225 m/s. The density of the air is 1.29 kg/m^3. What is the lifting force on a wing of area 24.0 m^2? (3 points)

8.) A siphon tube is useful for removing liquid from a tank. The siphon tube is first filled with liquid, and then one end is inserted into the tank. Liquid then drains out the other end, as the drawing illustrates.



In this figure the upper container is called tank. The length of the tube under water in the upper container is d, the remaining length to the first bend is h. The length from the top of the water in the upper container to the bottom of the tube in the second container is called y. The highest point of the siphon is between the two bends in the system and we call it A.

a) make your own drawing and put all these parameters in correctly: h, d, y and A.

b) Using reasoning, derive an expression for the speed v of the fluid emerging from the tube into the bottom container. This expression should give v in terms of the vertical height y and the acceleration due to gravity g. Note that it does not depend on the depth d of the tube below the surface of the water.
c) At what value of the vertical distance y will the siphon stop working?
d) Derive an expression for the absolute pressure at the highest point in the siphon (point A) in terms of the atmospheric pressure P_0, the fluid density ρ, g and the heights h and y. Note that the fluid speed at point A is the same as the speed of the fluid emerging from the tube, because the cross-sectional area of the tube is the same everywhere.) (6 points)

9.) A 1.0 x 10^{-3} kg spider is hanging vertically by a thread that has a Young's modulus of 4.5 x 10^9 N/m^2 and a radius of 13 x 10^{-6} m. Suppose that a 95-kg person is hanging vertically on an aluminum wire. What is the radius of the wire that would exhibit the same strain as the spider's thread, when the thread is stressed by the full weight of the spider? (Young's module of aluminum: 6.9 x 10^{10} N/m^2) (3 points)