Homework 8

Due Tuesday, 18 April, by 1 PM

Note: The recitation instructors' mailboxes are located across from room 201. Please turn your homework into their mailboxes. Make sure that you staple your homework together and that you remove jagged edges of the page that come from tearing paper out of a spiral-bound notebook. Otherwise, your homework might get mixed up with someone else's.

1. Suppose that you want to hold a meter stick horizontal to the ground by touching it with only two fingers. One finger is at the 10cm mark, while the other finger is at the 20cm mark. The meter stick has a mass of 100g. What must you do with your fingers, and what normal forces do they exert on the meter stick

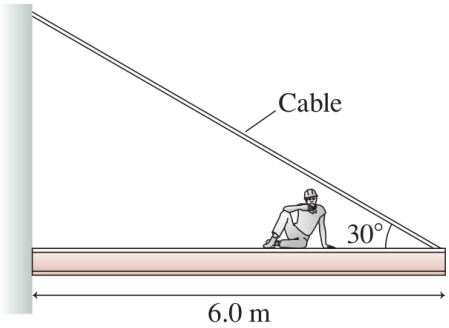
   What if your fingers are at the 10cm and 12cm marks?

2. In the Second World War, the Americans and British built large aircraft driven by four engines turning propellers mounted along the wings. Two inner engines were located closer to the fuselage, and two outer engines were mounted further out along the wings.

   (a) One such aircraft, the Flying Fortress, was known for its ability to still fly despite extensive damage. In particular, they were able to fly with three engines destroyed. Would it be easier to fly such an aircraft with (1) only an outer engine remaining, or (2) only an inner engine remaining? Why?

   (b) There is another report of an aircraft of this sort losing hydraulic control, eliminating its ability to steer using normal means. However, the pilot was able to steer by altering the power supplied to the engines, and landed safely. How was he able to do this? Explain using concepts from our Phys211 class.

3. Consider the following situation. The steel beam has a mass of 1450 kg, and the construction worker shown has a mass of 80 kg. He sits 2 meters from the end of the beam. The cable is rated to transmit a tension of 15 kN. Should the worker be worried that the cable might fail?



4. A spool of thread sits on a table. A cat steps on one end of the thread and nudges the spool off of the table so that it falls. (The spool has moment of inertia $I = \frac{1}{2}mr^2$.) What is its acceleration as it falls? Discuss why this doesnt depend on the radius of the spool.

5. Engineers have considered storing energy in the rotation of rapidly-spinning flywheels. Consider a flywheel consisting of an iron cylinder, 20 cm in radius and 10 cm thick; its mass is 100 kg.

   To see how efficient this device would be at storing energy, calculate the required angular velocity (in revolutions per minute) for it to match the energy density of lithium-ion batteries (around 0.5 MJ/kg). What is the centripetal acceleration of a point on the edge of the flywheel at this speed?

6. The launcher in a pinball machine consists of a spring of spring constant k. A ball of mass m is used to compress the spring a distance d; when the spring is released, the ball is launched up a ramp of total height h.

   In terms of m, d, k, h, and g, how fast is the ball moving at the top of the ramp?

7. A person stands on a platform that is free to rotate around its center. You may model this person as a cylinder with radius 15 cm and mass 80 kg, centered on the platform. Someone throws a baseball to him; he has to reach out to the side 60 cm in order to catch it. The baseball is traveling at 20 m/s and has a mass of 150 grams. Describe his motion after he catches the ball.