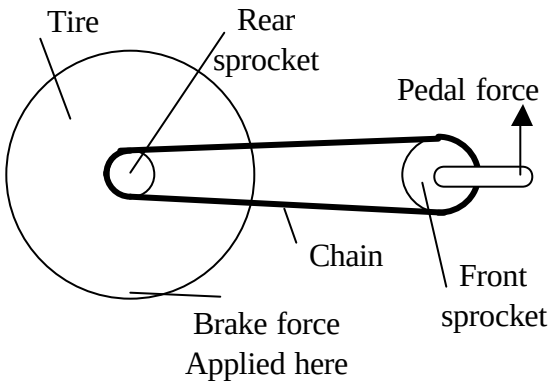
24-261 Statics September 11, 2001
Problem Set #3 Due: September 18, 2001

1. The relation between the force on a bicycle pedal and rotation of the wheel is studied. The bicycle is placed upside down on its seat and handlebars. Using the pedal, the wheel is made to turn <u>at a constant speed</u> with the brake applied lightly. At the instant of interest, an upward force is applied to the pedal in the position shown. The brake is located at the bottom of the tire. [Dimensions: tire diameter = 82 cm; front sprocket diameter = 20 cm, rear sprocket diameter = 12 cm, pedal length = 15 cm, pedal force = 50 N.]

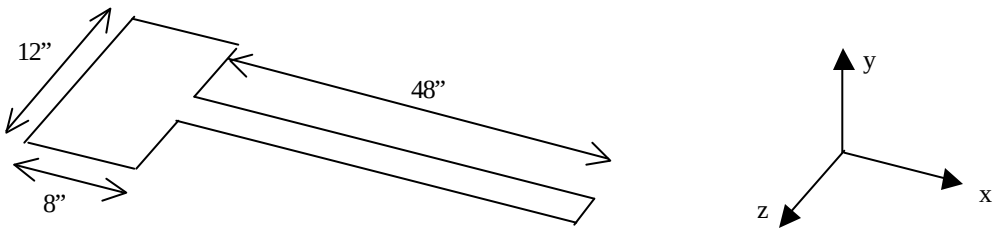


The brake pads squeeze the tire; the friction between the pads and tire leads to the braking force which opposes rotation. **You are to determine the brake force acting on the tire.** To calculate the brake force, you need only consider the rotational equilibrium of the front sprocket and the rear wheel. (The frame provides additional forces that maintain the sprockets and tire in position, but permit them to rotate.)

Solve this problem by breaking it up into the following bodies: (1) the front sprocket plus the part of the chain that wraps around it, (2) the rear wheel, rear sprocket and the part of the chain that wraps around it, (3) the upper part of the chain not contacting the sprockets and (4) the lower part of the chain not contacting the sprockets. Remember that the chain does not have uniform tension along its entire length.

3. This problem is based on the parts of Laboratory #1 dealing with the shovel.

The shovel consists of a uniform stick weighing 3 lb and a uniform pan weighing 2 lb. The book weighs 4 lb and is placed in the center of the pan. Take your left hand to to be at 18” from the right end of the stick and your right hand at the right end. In those configurations in which the book is placed to the side, it acts at a point which is 3 inches laterally from the center of the pan. Use the x-y-z axes shown below.



For each of the configurations 1 to 4:

Redraw the free body diagrams, but now represent the unknown force and moments with variables, such A_x or M_{Bz}. Unknowns should be drawn along the positive x, y, or z-axes, even if you know the direction is opposite (in which case the values will turn out to be negative).

Solve the equations of equilibrium to determine the values of the variables you defined.

Redraw the free body diagrams, and now draw the vectors all in the correct sense, labeled with their correct magnitudes.