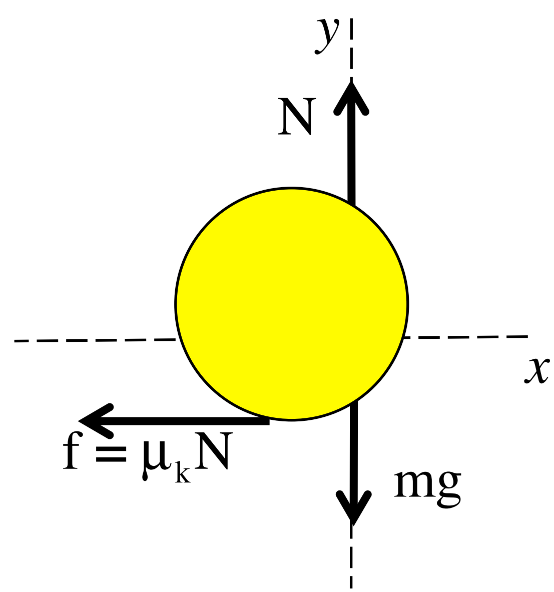
Problem 5.42

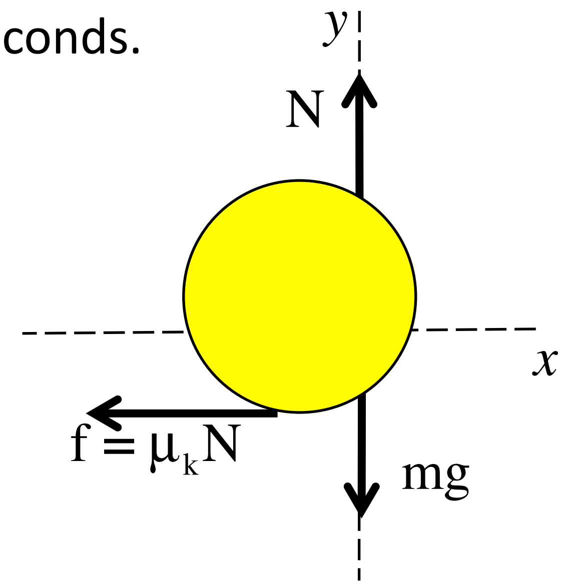
A car accelerates through a quarter mile in 4.43 seconds.

a.) If two tires are in contact with the street during the acceleration, what is the coefficient of friction between the street and wheel?



The first thing to notice about this is that they are being tricky in the presentation. How so? In the model we are using for friction, it shouldn't matter whether its four tires (assuming it's an all-wheel drive vehicle), two tires or just one tire that meets the road. Why? Because the model we are using here maintains that the only thing that matters is the normal force and the coefficient of friction between the tires and the road. That's what the expression $f_k = \mu_k N$ *means*. On a flat road with no other forces acting, the normal force is just "mg." And in that model, it doesn't matter how the weight is distributed between the tires, it only matters what the total weight is (weight distributed over four tires means each tire bites the ground less because there's less weight bearing down on it than would be the case if all the weight was distributed between only two tires). The problem here? This isn't a good model for dragster tires, where "lighting them up" before the run makes them sticky. In that case, the greater the surface area, the more friction and the better the traction. In any case, all we have to work with is the standard model, so that's the direction we will go.

Again, the car accelerates through a quarter mile in 4.43 seconds.



a.) What is the coefficient of friction between the street and wheel?

We need to begin by determining the acceleration using kinematics.

$$x_2 = \cancelto{0}{x_1} + \cancelto{0}{v_1}(\Delta t) + \frac{1}{2}a(\Delta t)^2$$

$$\Rightarrow \quad a = \frac{2x_2}{(\Delta t)^2}$$

$$= \frac{2\left[\frac{\frac{1}{4}(1.61\text{x}10^3 \text{ m})}{(\text{quarter mi})}\right]}{(4.43 \text{ s})^2}$$

$$= 41.0 \text{ m/s}^2$$

With the acceleration, N.S.L. (incorporating the fact that the frictional force equals $\mu_k N$) can be written as:

$$\underline{\sum F_x :}$$

$$\mu_k N = ma$$

$$\Rightarrow \quad \mu_k (mg) = ma$$

$$\Rightarrow \quad \mu_k = \frac{a}{g}$$

$$= \frac{(41.0 \text{ m/s}^2)}{(9.80 \text{ m/s}^2)}$$

$$= 4.18$$

b.) How would increased horsepower affect the run?

The first possibility is that the car might flip over. If that didn't happen, as counterintuitive as this is going to sound, the elapsed time would probably go UP. Why? More power would make the tires *spin* for a longer time before grabbing complete traction with the road. Slipping tires, which is what spinning tires are, will not effect as great an acceleration as the same power being transferred to the road without slipping, so as I said, the time would probably go UP. What this suggests is that there is a fine line between traction ability and optimal horsepower, which I learned to considerable dismay when I bought a Pontiac GTO as a kid and found that when I "got on it," the miserable thing (with a HUGE engine and tons of horse power) would just sit there with its rear wheels spinning like a dervish and smoking to beat all, but going essentially nowhere.