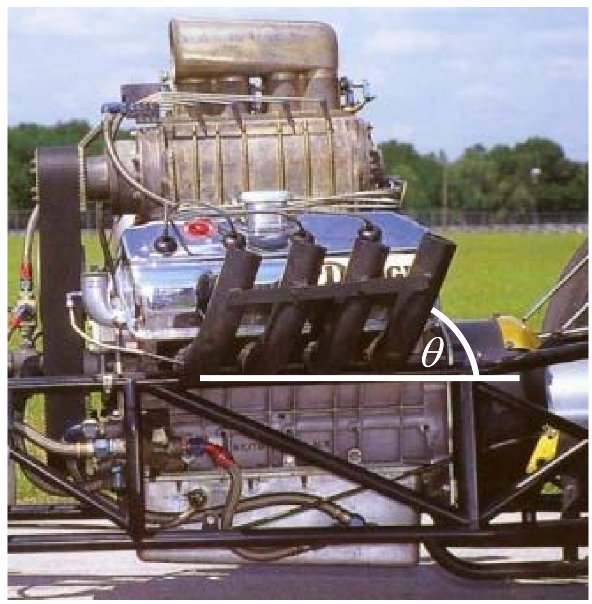
Top-fuel dragsters can accelerate from rest at a rate of about 5*g*. If this does not sound impressive, consider that for most automobiles the friction between the ground and the tires produces the acceleration. Since the coefficient of friction between regular treaded tires and pavement is typically less than or about equal to 1.0, a car relying on friction with normal force equal to its weight should accelerate at no more than about 1*g*.

Dragsters use two methods to increase their acceleration. First, they greatly increase the friction between their tires and the road by *eliminating* tire tread (dragsters do not race in wet or snowy road conditions) and also by performing a "burnout" (top picture) which lays down a patch of heated rubber on the track that the partially-melted tires will adhere to. The result of these measures is a coefficient of friction exceeding 2.0. The second important method for increasing acceleration is the use of engine exhaust to provide force. The high-speed exhaust gases (second picture) exiting the dragster's enormous 8000 hp engine produce a force with a size comparable to the car's weight. (Top photos by Lt. Col. William Thurmond, courtesy U.S. Army. Bottom photo by Glen Menesses.)

a.) Assuming a coefficient of friction equal to 2.5, at what angle θ measured with respect to the horizontal (bottom picture) should the exhaust pipes be oriented in order to achieve maximum acceleration? Assume the engine is capable of using the tires to produce a force equal to the maximum friction force (μN) regardless of how large the normal force becomes!



b.) Supposing the coefficient of friction is 2.5 and the exhaust is configured at the optimal angle found in part (a), how much force (as a fraction of the dragster's weight) would the exhaust have to produce if the dragster accelerates from rest at 4.7*g*?