

Spring 2001 Physics 2048 Test 3 solutions

Problem 3 (Essay 10 points)

You may use diagrams and equations but no calculations in your response for this problem.

Student Response 1:

When the brakes of a car lock up, then the car slides. When the car is sliding, then kinetic friction is involved. When the wheels are turning, then static friction is involved. In the case of rubber on wet concrete, the coefficient of kinetic friction (sliding) is less than that of static friction (rolling). And when trying to stop it is best to have the most friction possible for faster deceleration. Therefore, it would be best to have static friction in this case (in the rain) which means the wheels need to be turning. Anti-lock brakes keep the wheels turning which means there is more friction between the tires and the road.

This is good essay that hits most of the key points. The only points that are missed are that the friction force governs the braking of the car (bring the car to a stop) and why you want maximum deceleration in the rain. The following response addresses these points.

Student Response 2

Static friction is larger than kinetic friction. When stopping, if the wheels lock up kinetic friction is used to slow the car down. However, since static friction is larger, what anti-lock brakes do pump the breaks so that the tires do not experience kinetic friction but static, which in turn slows the car faster and in a shorter distance. Since the coefficient of static and kinetic friction drop dramatically on a wet road, anti-lock brakes are particularly safer.

The small friction force due to skidding in the rain also reduces your control over the car, so the anti-lock brakes reduce your stopping distance and help you maintain control of your car in the rain.

Key points:

- When the wheels are locked and skidding, braking is by kinetic friction
- When the wheels are rotating, braking is by static friction
- The coefficient of static friction is greater than that of kinetic friction
- The larger the coefficient of friction, the greater the frictional force from braking. A larger frictional force means the car stops in less time and less distance.
- Both coefficients of friction for rubber and concrete are reduced when it is raining and the car is wet. This means that in the rain, the driving will be more slippery and it will take longer to stop.
- Since driving in the rain is more slippery, you would like the largest frictional force possible to minimize your braking distance and maximize your ability to keep the car under control.
- Anti-lock brakes prevent the wheels from locking up and skidding so that the braking force is from static friction instead of kinetic friction.