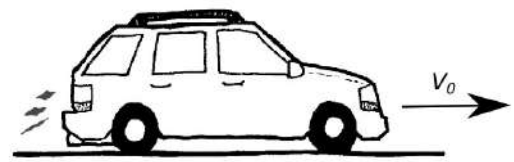
NAME ____________________ DATE ____________

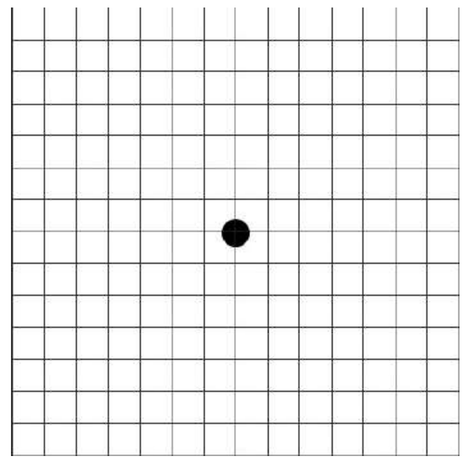
Scenario

Consider a car of mass m moving with initial speed v_0 on a straight, flat road. At time $t = 0$, the driver fully applies the brakes to avoid colliding with debris in the road in front of the car. The car's wheels lock, causing the car to slide on the roadway until the car stops, before running over the debris. The distance that the car slides is D. The coefficient of kinetic friction between the car's tires and the roadway is a constant value μ_k.



Using Representations

PART A: The dot at right represents the car. Draw a free-body diagram showing and labeling the forces (not components) exerted on the car, while the car slides to a stop. Draw the relative lengths of all vectors to reflect the relative magnitudes of all the forces. Each force must be represented by a distinct arrow starting on and pointing away from the dot. Note that the car is moving to the right.



Argumentation

PART B: The stopping distance D depends on the value of v_0 and μ_k.

i. Does the value of D increase or decrease with increasing initial speed v_0? Give a physical explanation why this is the relationship.

________ Increase ________ Decrease ________ Remains the same

ii. Does the value of D increase or decrease with increasing coefficient of friction μ_k? Give a physical explanation why this is the case.

________ Increase ________ Decrease ________ Remains the same

PART C: In the spaces below, derive two equations, one in the "y" direction and one in the "x" direction, expressing Newton's second law using the symbols m, g, a, μ and physical constants as appropriate. For each line of the derivation, explain mathematically what was done (i.e., annotate your derivation). The first line is done for you as an example.

$\Sigma F_y = ma_y$	Newton's second law states that the sum of the forces in the "y" direction will be equal to the mass of the car times the acceleration of the car in the "y" direction, therefore:

Quantitative Analysis

PART D: Use your equations from Part C along with an appropriate kinematic equation to do the following:

i. Write an equation for D in terms of v_0, g, and μ.

ii. Explain how your equation in Part D (i) supports your reasoning about the relationships among D, v_0, and μ outlined in Part B.