Name: _____ Date: _____

Case Study #3: Self-Driving Car Ethics

Consider the choices that autonomous (self-driving) vehicles have to make. In how much time must a decision like this be made? How do different scenarios impact the ethics of the decision that the vehicle makes? **How might physics impact which choice is more ethical in each of the following scenarios?**

Scenario 1: The reaction time of a self-driving car can be significantly faster than that of a human being. Some have argued that this means that speed limits for self-driving cars should be higher since they will be able to respond to changes more quickly.

"*The reaction time of an autonomous vehicle from the moment an obstacle is recognized to the moment the brakes are applied was found to be in the order of 0.5 seconds, [compared to] AASHTO's driver's reaction time of 2.5 seconds*" (Khoury, Amine, & Abi Saad, 2019, "3.1.2," para 1).

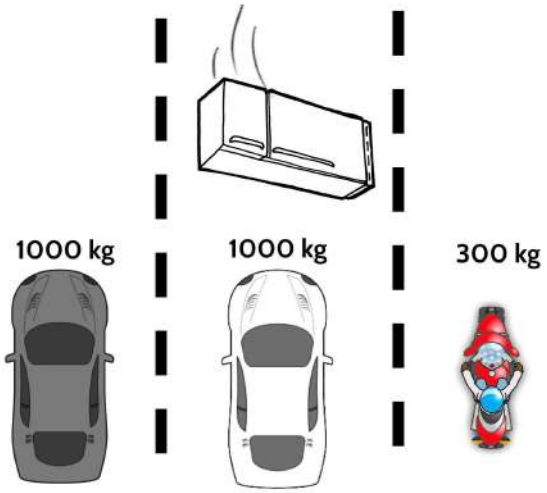
Use physics models and data from the table to decide what speed limit could result in a reaction distance for self-driving cars equal to the reaction distance of a typical human.

	Reaction Δt	City speed limit	Reaction distance		Highway speed limit	Reaction distance
Human driver	2.5 s	35 mph = 15 m/s			65 mph = 30 m/s	
Autonomous	0.5 s					

Focus questions

1. Who is impacted by the self-driving car's speed choices?
2. Whose safety should be prioritized, and why?
3. What recommendation would you offer for speed limits of self-driving cars?

Scenario 2: A self-driving car (white) is in the center lane on the highway, with a similarly sized car in the lane to the left



(black) and a motorcycle to the right. A fridge falls out of a truck directly in front of the self-driving car, and the software must choose between three basic options:

A. Continue straight: great risk to the occupants of the self-driving car (white)
B. Swerve right: safer for the white car but risks the life of the motorcyclist
C. Swerve left: somewhat safer for the white car, more dangerous for the black car

Focus questions

1. Who is impacted by the decision the car makes? Whose safety should be prioritized and why?
2. How can we use physics to model the differences among these choices?

Scenario 3: If the braking force is strong enough, the passengers of the braking car can be made uncomfortable. Self-driving cars need to make decisions about how hard to brake, given the obstacle to be avoided and the braking time to reach that obstacle. When making braking decisions, should the self-driving software prioritize the comfort of the passengers inside or the obstacles it could avoid (people, animals, property)?

Imagine that a self-driving car is moving at 45 mph (20 m/s) through a commercial and residential area when an obstacle appears in front of the car. Assume that this car can brake at a rate that exerts an average force of 700 N on an 80 kg passenger, but this will cause passengers in the vehicle to feel very uncomfortable. Alternatively, the self-driving car can brake with less force, but this could result in the car hitting the obstacle.

Under what conditions should the self-driving car's algorithms risk making its passengers uncomfortable in order to avoid colliding with an obstacle?

Obstacle	Higher braking force	Shorter braking time	Outcome	Lower braking force	Longer braking time	Outcome
A kid runs into the street 30 m ahead. (*At 20 m/s the car goes 30 m in 1.5 s.*)			Passengers are uncomfortable; kid is safe.			Passengers are comfortable; kid is hit.
A raccoon runs into the street 20 m ahead.						

A small box falls out of a delivery truck 30 m ahead.						

Focus questions

1. Who is impacted by the decision the car makes? Whose safety should be prioritized, and why?
2. How can we use physics to model the difference between shorter and longer braking times?
3. How does the distance from the car to the obstacle impact the ethics of the car's decision?

References

Khoury, J., Amine, K., & Abi Saad, R. (2019). An Initial Investigation of the Effects of a Fully Automated Vehicle Fleet on Geometric Design. *Journal of Advanced Transportation*, *vol. 2019*, Article ID 6126408. Retrieved from https://doi.org/10.1155/2019/6126408