Lab 12: Driving Formulas

In this lab, we'll take a look at how a few important formulas apply to driving safety! We'll start with looking at the "two second rule". If you're not familiar with it, it says that when a car in front of you passes some kind of object on the side of the road (like a sign, or a tree), you should start counting to 2 ("one-Mississippi, two-Mississippi"). If you pass that same object before you're done counting to 2, then the rule says you're following too closely!

Why does this rule exist? Well, humans have a hard time estimating distances (especially when we're moving). Here's an example: you know, out on the highway, when you see those dashed lines that indicate when you can and can't pass on multilane roads? How long do you think those lines are?

1. (**1 point**) What's your best guess as to how long they are?

2. (**1 point**) Now do a little Googling and see how long they ***actually*** are!

Chances are, if you're like most people, you *vastly* underestimated that distance. Don't feel bad! That's why things like the 2-second rule help us! Let's learn about it!

Well, first we need to take a look at how far you actually ***go*** in 2 seconds. And, of course, the answer is "it depends on how fast you're driving!" Let's pick a speed: **35 miles per hour**.[1]

3. (**3 points**) (**w**) How far would you travel in 2 seconds if you were going 35 miles per hour? Show me ***everything*** you do!

Since that's the distance you travel in 2 seconds, if you used the 2-seond rule while following someone who's also going 35 MPH, you'd be just over 100 feet behind them. Nice!

But…is it far ***enough***? What if that car in front of you suddenly slows down…will you have enough space to brake safely?

To test this, we'll need to use two important formulas from physics. Here's the first one!

The **time it takes to brake** (we'll call this **T**) is given by

$$T = \frac{S}{F}$$

where

- **T** is the amount of time until the car comes to a stop (in ***seconds***). This depends on:
  - **S**, the speed of the car when the brakes are first applied (in ***feet per second***), and
  - **F**, a force known as "deceleration", which is measured with a unit of $\frac{\text{feet}}{\text{sec}^2}$ (*that unit's a little wonky, but you might remember it from when we measured rock drops with Galileo*!
    - If someone is braking in a ***controlled*** manner, **F** should be about 15 $\frac{\text{feet}}{\text{sec}^2}$.
    - If someone ***slams*** on their brakes to avoid an imminent collision, **F** can be up to 30 $\frac{\text{feet}}{\text{sec}^2}$

[1] The speed limit on Mount Washington Drive in Bend. based on my own anecdotal evidence, I bet that many folks think it's much faster.

4. (**2 points**) (**w**) So, if you're traveling at 35 miles per hour and apply your brakes in a ***controlled*** manner, how many seconds will it take you to stop? Again, show me how you got your answer! Note: as I mentioned up top, the units are a bit weird on that "***F***" variable (it's a deceleration, so the units aren't intuitive). If it helps you to do these next few problems, you can just run the numbers and trust the units. If you're like me, and want to see how the units all work in these, check out this video!

5. (**1 point**) (**w**) What if you're traveling at 35 miles per hour and ***slam*** on your brakes…how many seconds will it take you to stop then?

OK! Once you have the time it takes you to stop, then you need ***this*** formula: The **distance traveled during braking**. It's given by:

$$D = \frac{1}{2} * S * T$$

where

- **D** is the distance (in ***feet***) until the car stops. It depends on
  - **S** , the speed of the car when the brakes are first applied (in feet per second), and
  - **T** , the amount of time until the car comes to a stop, in seconds, that you got from the previous formula!

OK! Let's test out the 2-second rule using these formulas!

6. (**5 points**) (**w**) Suppose you're going 35 miles per hour, and using the 2-second rule to keep yourself safely behind the car in front of you (who's also going 35 miles per hour). Suppose that car in front of you suddenly stops, and you apply your brakes in a controlled manner. Using the above formulas, show me why you're far enough behind that car to stop safely! Be sure to explain using words ***and*** math; not ***just*** math.

OK! Let's get out on the open highway! What if you were traveling at 65 mph, as you might on Highway 97 or Highway 20? How would the 2-second rule hold up then?

And guess what? We'll make a Google Sheet Formula as we go (*note: I'm gonna do a bit of a deep dive into Google Sheet commands here – if you don't like them, feel free to just use the "pencil/paper" math you did in the previous questions*)!

7. **(1 point)** Assume you're traveling at 65 miles per hour, how fast are you going in *feet per second*? This video'll help ya get it into the spreadsheet!

8. **(1 point)** Assuming you're braking in a ***controlled*** manner, how long (in seconds) will it take you to brake completely at 65 MPH? Let's check it out in Sheets with this video!

9. **(1 point)** How far would you travel during that controlled braking? Check out this video for the formula (and the next one you'll need)!

10. **(1 point)** How far (in feet) do you travel in 2 seconds going 65 MPH?

Whoops! Looks like we'd have ourselves an accident at that speed!

11. **(1 point)** What about if you ***slam*** on the brakes (that is, decelerate at 30 feet/sec^2 instead of the 15 we've been using)? Will that be OK?

Whew. 😊

But wait! You shouldn't always "slam on your brakes" to stop…if you do that in the wrong situation, you might skid (which then breaks all the assumptions about "safe braking") or slide (if the ground is, say, wet or icy). So, IMHO, we should follow at a distance that allows us to brake in a controlled manner…and that means that the "2 Second Rule" is only good for certain speeds; we might need more time for faster speeds.

Let's create a new "Second Rule" for when you're traveling ***65*** miles per hour!

12. (**5 points**) (**w**) Look back at your answer to #7. Using that rate and the distance you got in #9, figure out how many seconds (more than 2, for sure!) that you should allow from the moment the car in front of you passes an object. Assume the car in front of you is traveling the same speed as you!

13. (**2 points**) Now, that last answer you got wasn't a nice, whole number, like "2" was. So, you probably want to round it off to a whole number of seconds – but explain why you shouldn't round it ***down***!

And as we close out the lab, keep this in mind, too: when something dangerous happens, it actually takes you about 1.5 seconds to perceive, process, and react (that is, even ***realize*** that you ***have*** to apply the brakes). So that really means that the "2 Second Rule" should be more like the "3.5 or 4 Second Rule", and the "4 Second Rule" more like the "5.5 or 6 Second Rule" (and, in snowy weather, maybe add even more). Be safe out there, y'al!!