CLASS NOTES 6: FORMULAS

"Once you have fractions, decimals, ratios, proportions, dimensional analysis, order of operations and negative numbers in the bag, what's left to do?", you might ask.

Formulas!

Formulas are one of the ***most*** important applications of mathematics. We explored them a little bit with Bear Grylls, but now it's time to buckle down and spend some time with as many types of formulas as possible.

What are formulas? Simply, a formula is a mathematical equation that contains variables. You've seen them before; let's look at one now as an example.

Total Cost of an Item = One Time Fixed Cost + Repeated Cost

This is one you'll likely use in MTH 105 and can use in your life, as well. You use it when you talk about buying (and keeping) a car, a house, or even smaller things like appliances and bicycles. Let's look at one.

1. Suppose you buy a used car for $5000. It has a repeated gas cost of $250 per month. What's the total cost of the car after one month?

   Using our formula:

   Total Cost of the Car for One Month = One Time Fixed Cost + Repeated Cost

   Total Cost of the Car for One Month = $5000 + $250

   Total Cost of the Car for One Month = $5250

In this example, the **independent variables** are the **Fixed** and **Repeating Costs**, as you need to know what ***they*** are to find the Total Cost of the Car. (The Total Cost of the Car is the **dependent variable.)**

2. Same car that you bought for $5000, and it still has the repeated gas cost of $250 per month. What's the total cost of the car after two months?

3. Same car that you bought for $5000, and it still has the repeated gas cost of $250 per month. What's the total cost of the car after a year? Note: Please ignore other costs like oil changes for now – we'll deal with those shortly!

(*let's check-in with a video*!)

When we work with formulas like this one, it's often easier to use shorthand for the variables. Here's one way to use such a shorthand.

Total Cost of the Car = One Time Fixed Cost + Repeated Cost $\rightarrow$ **C = F + R**

(note: if you don't like my variables, you can make up your own!)

4. Find **C** if **F = $5000** and **R = $5000**.

5. Assuming that last problem is describing the same car we've been talking about, how many months have we owned it?

6. Different car this time! Find **F** if **C = $12000** and **R = $4500**.

7. What did you just find in that last problem?

8. OK – let's go back to our first car (the one that cost us $5000 and has a monthly gas cost of $250). Find **C** if you've owned the car for 3 years.

9. Same car again. Find **C** if you've owned the car for 4 years.

10. Same question, but 5 years!

(*let's do another video check-in here*!)

OK – so what you probably did over and over again in those last few problems (not to mention in #2 and 3) was to multiply the $250 monthly cost by the number of months to figure out the repeated cost. So, in that way, the repeated cost is, itself, a formula!

R = (number of months) * $250

11. In the formula **C = F + R**, replace **R** with what it's equal to from the formula above! Leave the other variables the same (for now).

And don't you agree that, if we're talking about the same car over and over (as we've done everywhere except in #6 and 7 here), that "F" is always going to be equal to $5000?

12. Re-rewrite the formula **C = F + R**, replacing **F** with $5000 (and also leaving in your good work from #11).

So now you have a really cool, clean-looking formula:

C = $5000 + (number of months) * $250

Which we can make even simpler by letting "**number of months**" be a variable itself. Say, **n** for "number":

C = $5000 + n*$250

Nice and concise. Let's practice using it, using Sheets! If you get stuck on 13 through 15, just watch the video linked below!

13. How is the total cost changing from month to month? Write a sentence to explain.

The number you just discovered has many names, depending on context. We've talked about it a little already in this class, and we'll come back to it soon.

14. Now, let's create a **scatterplot** of these data, also in Sheets!

15. Would it make sense to connect those dots with a straight line? Why or why not?

(*let's check in again*!)

OK! So maybe thinking that a car would only have two costs (the one-time fixed cost of purchasing, and the monthly cost of gas) was a little simplistic. We also have to ***insure*** it every year, right? And we should probably give it an oil change every year, too.

So, we should probably change our formula **C = $5000 + n*$250** into something more like

C = $5000 + y*(yearly cost in dollars)

where ***y*** is the number of years we own the car, and the "yearly cost in dollars" is just that – costs of gas, insurance, and an oil change each year.

16. Rewrite the formula **C = $5000 + n*$250** as **C = $5000 + y*(yearly cost in dollars)** by figuring out that yearly cost. Assume the same gas cost ($250 per month), and assume about $800 a year for insurance, and $50 per year for an oil change.

Let's once again use Sheets to look at the total cost of the car (using our new formula from 16) from, say, 0 years to 10 years.

17. What's the total cost of the car after 5 years? 10 years?

18. How is ***this*** cost changing from year to year?

19. How is this related to your answer in #13?

20. For practice, definitely create a scatterplot for your new formula!

(*let's do a video check-in*!)

One last formula for these notes!

Something else that many people talk about when it comes to making purchases is how "things get cheaper over time". The drum set pictured at right cost $300 in 1987 when I bought it. What we'll do here is see how much that drum set has cost me, on average, each year I've owned it! Here's a table showing these average costs.

y = # years drumset owned	Average Cost (per year) after *y* years
1	$300.00
2	$150.00
3	$100.00
4	$75.00
	…
32	$9.38
33	$9.09

21. Can you figure out the formula for the average cost of the drum set per year? What is it?

22. In Sheets, create a table that runs from 1 to 33 years, with the corresponding average prices for each of those years.

23. Now create a scatterplot of that data in Sheets!

24. How is your last scatterplot different than the previous two you created?

25. Will the average cost per year ever get to $0?

26. Why or why not?

(*one last check-in for these notes*!)