1. So, the other day, I came to work and, outside my office, this was written on the whiteboard:

![Whiteboard image](image)

Being curious, I started asking everyone, “Hey! What is this?” No one knew – until Bruce Emerson fessed up. He told me it was the “What3Words” address for my office.

Start by reading up on what What3Words (W3W) actually is! [https://what3words.com/](https://what3words.com/) (the “about” tab is pretty helpful)

So, this is cool, yeah? I mean, to address the whole world! Using only three words each! Wow!

Of course, then I started worrying. “Are there enough words?” I asked Bruce. “What do you mean?” he asked. “Well”, I said, “It’s a game of Woot!” After hearing this, of course, he walked away.

But I’m right, right? I mean, if you have a certain number of words that you want to turn into addresses, on way to do so is to put one word each on a playing card, then put all your words together into a word card deck, and shuffle out the top three cards. How many ways can you do this? Well, that depends on the number of “cards” you have!

<table>
<thead>
<tr>
<th>Number of words (“cards”)</th>
<th>Number of “addresses” (different ways to deal them out)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3<em>2</em>1 = 6</td>
</tr>
<tr>
<td>4</td>
<td>4<em>3</em>2 = 24</td>
</tr>
<tr>
<td>5</td>
<td>5<em>4</em>3 = 60</td>
</tr>
</tbody>
</table>

See, it’s kinda of like the work we did with the game of Woot – but a little simpler. You only have to deal out three cards, so you stop after three multiplications.

a. **(4 points)** (w) Suppose you had 10 words. How many address could you form? Remember that “(w)’s” mean to show how you got your answer!

b. **(4 points)** (w) Suppose you had 1000 words. How many address could you form now?

Please note: in all of the previous examples, we’re assuming that, once you use a word, you can’t reuse the word again. This is exactly how What3Words works!

c. **(4 points)** (w) Suppose *(for just this problem)* that you could reuse a word more than one time in a What3Words address. Answer b again, allowing for all the repeated word addresses!

(OK – no more of that repetition silliness. 😊)
d. **(4 points)** (w) Assuming 200,000 words in the English language, and assuming again, that all three words in a W3W address need to be distinct, how many possible addresses are there?

**WHOA!**

OK...that’s great and all, but we still have to figure out the answer to my question...is it **enough**?

e. **(2 points)** Start by Googling the surface area of the Earth. This would be what we have to map! Include the unit, of course!

f. **(2 points)** Convert your answer in e to square meters. You’ll thank me in a second. :)

g. **(2 points)** Remember from the description of W3W that they divide the world up into 3 meter by 3 meter grids (that is, every 3 meter by 3 meter square on earth has a unique address). What would the area of one of those 3m by 3m grids be? Be sure to include the measurement unit here, too!

h. **(3 points)** (w) Using your answers from e and g, how many addresses are there to be addressed on earth? No “e”s, please – tell me what that number **is**!

i. **(1 point)** So, assuming that they start with 200,000 words, do we have enough addresses? Just “Yes” or “No” for this one. :)

But then, I did some more digging and found out the bit at right³.

j. **(4 points)** (w) Assuming only 40,000 words available to use in addresses (that’s the number used in the English language version), how many addresses are able to be created, using 3 unique words?

k. **(1 point)** From this smaller bank of 40,000 words, are we able to create enough 3 word addresses? Again, just “yes” or “no” here.

And then **that** got me thinking...an address (like “**dog.cat.ferret**”) is, technically, “different” than an address with the same words reordered (“**ferret.cat.dog**”, for example). So, in other words, we’re assuming that, if the same three words were used, but in a different order, then we got a **different** address.

l. **(6 points)** Using the 3 root words “**dog**”, “**cat**” and “**ferret**”, list all possible 3-word addresses using those three root words (I already gave ya 2).

(for reference – all of those are included up there in the number you got in j)

³ Notice, also, that it’s clear that W3W maps the water of the world. BadASS.
m. **(2 points)** Look at the number of addresses you created in the last part – would that number of addresses be the same for any 3 root words you start with? Just “yes” or “no” for this one!

Now, let’s say that the what3words team coded their algorithm so that, once 3 unique root words were used in an address, **all 3** of those can’t be used in any **other** address (meaning that, if “dog.cat.ferret” is used, then “ferret.cat.dog” – or any other arrangement of those three root words – can’t be)

n. **(5 points)** So, if we instituted this new “not using the same 3 root words in any address” rule, how many addresses would be possible? Hint: start with the number you got in j, and then edit it with the number of ways that your work in l implied!

o. **(1 point)** Would there be enough of these addresses to cover the earth? Just a “yes” or “no” here!

So, I guess that tells us something about the algorithm.

For more info: [https://theethicalist.com/three-words-making-world-safer-place/](https://theethicalist.com/three-words-making-world-safer-place/)

2. Some of you are enrolled in my streaming MTH 105 class this term – what this means is that, depending on the day, I’m physically teaching in either Bend, Redmond or Prineville and live-streaming the class out to whichever locations I’m not physically in. And, since I ride my bike out to wherever I’m teaching from, I thought it might be cool to check out the rides from my house to each location. Here they are!

![Prineville](image1.png)

![Redmond](image2.png)

![Bend](image3.png)

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b You could use 2 of the 3 with some other third word, though…like “ferret.cat.duck”

c If you take more stat classes later, you might study things called “permutations” and combinations”. You just did some of each here! 😊
So, what you’re looking at (like we did in class) is the elevation chart from each of these rides. On the horizontal axis is the distance I traveled on each one, and on the vertical is my elevation at any given distance. Fun!

**Note:** the Bend and Redmond chart shows me going from my family’s home in Bend to each of those town’s campuses. The Prineville one shows me going from COCC Prineville back home to Bend. You can assume that the graph shows the entire ride I did for each of the three commutes.

Let’s start with some orienting questions!

a. **(2 points)** At what elevation is our family’s home? I’m not looking for a value down to the nearest foot – just a measure to, say, the nearest ten feet.

b. **(6 points….2 for each)** Please find the elevations of the Prineville, Redmond, and Bend COCC campuses where I end my ride (I know that the Bend one jumps up to around 4100 feet and then drops back down again – you can ignore that little bit for now; it’s my “Jedi Training Commute” 😊)

c. Based on the values you just figured out for parts a and b, reckon\(^d\) what my average grade of my commutes to each campus are! Remember that “average grade” just looks at the starting and ending points and ignores everything in between! Feel free to use the Excel Calculator; increase the decimal like we did in class if necessary.

   i. **(3 points)** Home to COCC Prineville.
   ii. **(3 points)** Home to COCC Redmond.
   iii. **(3 points)** Home to COCC Bend.

Now, you know that the average grade can hide very steep grades within the route. If you take a look at the three graphs, there are sections on each of the three trips that appear to be “the steepest parts”. What I’d like you to do is to take a screen shot (PCs can use Snipping Tool) of those three graphs up there, and then use the “pen” feature to draw a circle around the region of each that appears the “steepest”.

d. **(5 points)** Include that screenshot as your answer for part d. Here’s a video link if you need help doing that!

   [https://www.youtube.com/watch?v=IJMFQ3OF3SU&feature=youtu.be](https://www.youtube.com/watch?v=IJMFQ3OF3SU&feature=youtu.be)

e. **(points)** Please give me the grades of those three “steepest” sections!

   i. **(3 points)** Home to COCC Prineville.
   ii. **(3 points)** Home to COCC Redmond.
   iii. **(3 points)** Home to COCC Bend.

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\(^d\) Sorry – all of a sudden, I got the strange desire to use the word “reckon” here. Feel free to replace with “figure out” or some other phrase that didn’t fall out of usage 200 years ago.
Now, when you look at the grades you just got (both the average ones and the “steepest” ones), you might notice that they seem waaaaaaay less than what appears in the graphs. There’s a section from the Prineville graph at right – heck, it looks to be over 100%, yes?

f. **(5 points)** How can you tell that section appears to be over 100%? Explain in a sentence or two!

g. **(5 points)** *Why* are the graphs so skewed? Again, write a sentence or two!

3. In this last question, we’ll do another cost analysis like we’ve been doing in class. A few of my friends have been asking me (over the past couple of years) if I think it’s smart to install one of those under sink hot water heaters. You know the ones – there’s an extra little spigot on your sink that, basically, delivers on-demand boiling water:

![Instant Hot Water Dispenser](image)

People that are in favor of these tell me that they’re great, because you no longer have to wait for boiling water (there’s a small tank under the sink – usually a gallon or two – that’s heated constantly with a little teeny tiny water heater. It’s like our on-demand hot water heater example that we warmed up with in class).

Of course, there are a couple of things that need to be considered here:

- How much do these things cost?
- How much does it cost to run them all day long to keep their water boiling?

Then, thinking about the benefits of not installing one, we have to ask the same questions:

- How much would it cost to not install one (and instead use, say, an electric teakettle)?
- How much does it cost to heat water to boiling with said electric teakettle?

I’ll take care of the second bullet in each of those pairs. You? You do some Googling and take care of the first!

a. **(2 points)** Do a Google Search for “Instant Hot Water Dispenser”, and settle on one that you would buy, if you had to. Include a screenshot of it as your answer to a, so I can see its cost.

b. **(2 points)** Find a decent electric kettle that you would consider purchasing online. Again, include a screenshot so I can see its price!

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* Nyuck, nyuck.
As for the costs associated with actually running these instant hot water dispensers, I did a bit of searching, and discovered that they have two costs associated with them:

- the “standby” energy usage, which is how much energy it takes to actually keep the water in its little tank hot (“on-time” power). This works out to an average of 0.605 Kilowatt-Hours per day of energy usage.
- the “dispensing” energy usage, which is how much energy it takes to actually deliver the water into your cup. This is much less…about 0.021 Kilowatt-Hours per 8 ounce cup of dispensing.

To compare, let’s look at the costs of not using these dispensers. My family uses an electric teakettle, so I’ll use that to compare.

- To heat 8 ounces of water to boiling in our electric teakettle will take 0.04 kilowatt-hours. I addition, every additional 8 ounces adds another 0.04 kilowatt-hours (so the usage “scales up” – it would take 0.08 kilowatt-hours for 16 ounces, 0.12 kilowatt-hours for 24, and so on).

Let’s make an assumption: the family we’re analyzing will make two individual 8 – ounce cups of coffee in the morning, and one 8-ounce cup of tea in the evening. So, all told, we’ll boil 8 ounces of water three times.

c. (5 points) After reading all of the above, tell me why it doesn’t make sense to purchase an instant hot water dispenser to save money if your family is only going to use it to make three 8-ounce cups of coffee a day. Make sure to reference the above energy values in your answer!

d. (5 points) How many 8-ounce cups of boiling water would you need to make each day until you’d spend the same amount of energy using the electric teakettle as the instant hot water dispenser? . Hint: you can use the Excel Calculator’s “Linear Modeling” tab here; your “costs” won’t be measured in dollars, but rather in kilowatt hours.

So, really, there’s no cost savings reason to use these to boil water to just make coffee (well, unless you’re going to make one helluva lot of coffee). There are other reasons, however, you might consider one (for example, using it to help with making pasta – instead of having to wait for a big pot of water to boil on a stove).

Like so many things in life, the answer to this one (“Should I get an instant hot water dispenser?”) is, “it depends.” 😊

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1 I’m assuming that the instant hot water dispenser you screenshot in a is less than the kettle in b.