Estimation – Are more doors or wheels in the world?

## Description



This internet debate perfectly describes the current state of social media. Grab everyones attention, keep them engaged long enough to feel they have an opinion worth commenting, and then offer no resolution unless they subscribe or watch for part 2.

But if you are like me, you have a problem-solving itch that needs to be scratched! I have really enjoyed the conversations it has sparked, but the articles about the answer don't really offer an answer. Many of which are basing their conclusion on public polls. But as a nerd, I can't accept the answer to a math problem based on public opinion.




So I am going to answer this thought experiment so it doesn't end up like the dress color debate.

## How to solve estimation problems

Answering this type of question should also be of interest for anyone like myself wanting to work at Google, Meta, or Amazon, who all famously uses estimations as part of their interview process.

In fact, practicing this type of question has taught me that a great framework already exists for trying to solve estimations of this scale, the Drake Equation. (If you are unfamiliar, google the Fermi Paradox for your next internet rabbit hole).

So let's start with the obvious, this is a math problem. (If you don't like math, jump to the TL;DR) Which means we'll need an equation like the one Frank Drake famously proposed to help us break down the problem into MECE (mutually exclusive, collectively exhaustive) pieces.

Before writing an equation though, let's review how we can structure our approach to estimation problems:

- Clarify – What are we really asking?
- Method – How can we approach this problem?
- Equation – How can we solve for X?
- Calculate – Make key assumptions as we solve.
- Sanity – Check our math using logical comparisons.
- Implications – What did we discover?

## Clarify – What are we really asking?

> Language allows information to accumulate more and more rapidly as time passes. Due to language I can receive signals from Confucius, Heraclitus, Plato, et cetera, et cetera… — Robert Anton Wilson



We use language everyday, but it only works when we agree on the meaning. So what do we mean when we say wheel and door, or even world? Should we assume right now? Wheels and doors have existed for millennia and not many of them have not been taken off the planet (The space station has doors, and Elon Musk's car in space has both doors and wheels!)

So it's clear we need to define wheel, door, and world. Which is probably why the debate is interesting to us, since in English these words can mean a lot of things. For example, is a wheel of cheese really a wheel?

Let's start with a fairly universal principle, the world. The context suggests that we are talking about:

- The current state of the world, specifically a snapshot of the current state of matter on Earth
- So nothing in the past that was one of these things, nor things that will become one
- That tells us that we should be able to access it if we could magically count them all, so not buried, burned or being built

**What is a door?** Let's break on through to the other side of the doors. A door on a house or a car is easy to imagine, but what about an oven door? We have sliding doors, but how are those different from windows with nearly identical features? Do we have to include doors on doll houses and cabinet doors too?

- Let's suppose a door needs to makes sense within the context of a person (known to be in the world right now) asking the question
- This seems to indicate that doors (and wheels) should be functional, not ornamental. Otherwise pictures and paintings of these items would further complicate our definitions
- Which tells us we are talking about portals with physical boundaries
- This would imply a lid or a hatch could be a door. But then why do we have separate terms? This could be a significant factor later, but keeping with common terminology means we should exclude portals with boundaries that have their own classification as a non-door item

So then we could say **a door is a physical boundary to distinct spaces which is not considered a non-door item**

(so not lids, hatches, covers, canopies, etc)

**What is a wheel?** Wheels seems like an equally ambiguous term. But our human context applied here should help us out:

- A wheel is also functional and not symbolic
- It's round. There are likely other shapes, but this exercise is not about reinventing the wheel
- It spins, and more specifically it can and will spin around an axle as it's primary function
- This tells us it can perform work when force is applied to affect the position of itself or other objects

Okay so then a **wheel is a round object capable of spinning around an axle to apply force but is also not considered a non-wheel item** (not gears, records, discs, etc.).

## Method – How to approach this problem



> We cannot solve problems with the same thinking we used when we created them. — **Albert Einstein**

Trying to think on the scale of the entire world provides us with many known ways to segment doors and wheels. The entirety of the world is large, but it is also a singular economy that does a great job of classifying objects. We can even use fairly simple equations for estimating supply and demand.

There is some public data available about revenues generated by these items, which we might be able to use to determine demand.  But even simpler, we all have experience with seeing the scale of supply of these items in our daily lives.

Which is why I think taking a **bottom-up approach** to solving this problem would be easier to understand the significant groupings that can be added together to estimate the total.

## Equation – How can we solve for X?

> Math — The only place you can buy 64 watermelons and no one asks why

The math here couldn't be any simpler. If we had a magic artificial intelligence machine that could take these definitions and give us the totals, then we simply compare the 2 numbers.

But we don't have one of those, at least not yet. So how can we use our economic supply instincts to get a sum for each of these items?

I think the way to solve this problem is to break it down into 3 parts:

1. How many objects have both doors and wheels
2. Sum the types of doors without wheels
3. Sum the types of wheels without doors

First step is estimating the **ratio of doors to wheels** on items that contain both. This ratio will provide us with a relative index we can use to compare with the scale of each respective summed total. If the summed totals for doors and wheels are similar, this index score could essentially be the tie breaking multiplier.

# Assumptions and Calculations

> It's not what we don't know that gets us in trouble. It's what we know for sure that just ain't so — Mark Twain

Assumptions about items with both Doors and Wheels

Vehicles in general seem to universally have both, and we could segment further by common types:

- Automobiles – Typically 4 doors, 4 wheels. They all have at least 1 steering wheel (technically it might be slightly more than 1 on average because of driver's education cars). Most automobiles also have a spare wheel. Remembering our definition, a hood and trunk are not doors but I would consider the glove box opening as a door. The engines contain many wheel components, but there are also compartment doors throughout the vehicle. So it seems the most significant factor might be with automobiles like trucks and coupes that only have 2 doors and 4 wheels (plus steering wheel and spare wheel).
- Commercial – 18 wheelers tells a clear story about wheels, as do most buses. Delivery and service vehicles generally fit the patterns found in automobiles. Fire trucks have many compartment doors, but are not the most common vehicle. There are also tractors and farm equipment that many times don't even have doors. Trains definitely have more doors than other commercial vehicles, but generally don't have stagecoach doors anymore, yet have 8 or 16 wheels per car.
- Airplanes – Typically include many wheels as well as the snack carts and yet only a few doors to board, enter the cockpit or the bathroom. However, isn't an overhead bin is essentially a cabinet door? Which reiterates the importance of clarification of our terms. However, most luggage have multiple wheels on them. And I don't think we could reasonably assume opening a suitcase is a door by common usage of language.
- Toy vehicles – Yes, they are after all a scaled down model of a vehicle. And while there are toy versions of all the vehicles mentioned, we all have experience seeing a clear difference in the number which have functional doors vs functional wheels. I don't think I've ever experienced a toy airplane with overhead bins that can open and close.
- Mobile homes and RVs – This might be the only category of vehicles where the doors might have a significant advantage. But as a category, it seems to pale in comparison to the combined volume of other vehicles listed here. At best it seems like an edge case, but we will consider it in our estimate.

Appliances / Furniture / Industrial equipment

- Appliances – Modern refrigerators have both doors and wheels. Less than 3 doors on average, but usually 4 wheels. Drawers don't seem like doors since they are the space themselves, but they still have wheels on them. Washers/Dryers have 1 door, maybe 2 but not many have wheels. Ovens might have a few doors, but tend to have 4 or more wheels unless in a commercial kitchen.

- Furniture – When both wheels and doors are present we have items like rolling cabinets, which might have an equal amount on a large enough scale. Sliding doors are very interesting as they are 1 door but will have multiple wheels
- Office equipment – Printers, shredders, portable storage cabinets, and other type of large office equipment typically have doors to compartments but will have at least 4 wheels
- Industrial equipment – Such as tool boxes or all of the various storage apparatus that will have cabinet doors and wheels to move around. The drawer exclusion as a door makes me believe this will lean towards wheels when both are present

Great, so we now we should be able to estimate the ratio for each of these cohorts and weigh them as a percentage of all items with both doors and wheels.

First breakdown is vehicles vs equipment. The importance of oil and supply chains of our economy says a lot about the significance of transportation and therefore vehicles in the world. We also know that millions of vehicles are produced annually and need to have their wheels replaced far more often than doors.

I also am going to use my intuition about normal and Pareto distributions occurring in complex systems like a global economy and say the Vehicles account for 80% and Equipment 20%

Vehicles – Percentages of this segment and estimated ratio of avg D:W

- Automobiles (50%) 2D:3W
- Commercial (40%) 1D:3W
- Airplanes (1%) 6D:1W
- Toy vehicles (7%) 1D:4W
- Mobile homes (2%) 10D:1W

Equipment

- Appliances (60%) 1D:2W
- Furniture (20%) 2D:3W
- Office (10%) 1D:3W
- Industrial (10%) 2D:3W

And making it math:

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Vehicles = 1/2 x 2/3 + 2/5 x 1/3 + 1/100 x 6 + 3/50 x 1/4 + 1/50 x 10

        = 1/3 + 2/15 + 3/200 + 1/5

        = 200/600 + 80/600 + 9/600 + 120/600

        = ~400/600 == 2/3

Equipmnt = 3/5 x 1/2 + 1/5 x 2/3 + 1/10 x 1/3 + 1/10 x 2/3

        = 3/10 + 2/15 + 1/30 + 2/30

        = 9/30 + 4/30 + 3/30
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        = ~15/30 == 1/2

Total index = 4/5 x 2/3 + 1/5 x 1/2

           = 16/30 + 3/30 = 19/30 = ~2/3

           = about 2D:3W on average when both are present
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This number definitely favors wheels (50% more), but now we need to look at both independently to know if this index is of any significance when compared to the totals for each.

## How many doors are there in the world?

This follows the same thought process of segmentation. Again, we should think about outliers to see if they would be significant. But when talking about the scale of the whole world, we should try to avoid focusing on too many edge cases that get rounded out when calculating large numbers.



Assumptions about doors when no wheels are present:

Structures – This includes houses, buildings, and all other structures that are not mobilized with wheels.

- Houses – Or we should say residential households which include all the different types of housing
    - There are about 100M households and a ratio of 3:1 people to households in the US
    - There are 8B people in the world, and using the same ratio about 80/3 or 25 times so let's suppose 2.5B households in the world
    - To simplify, let's suppose the average household has 2bd / 2ba
    - There are closet and exterior doors such as front, back, garage (which have wheels??), and doors for pets
    - We established cabinets and furniture doors should count and they typically have no wheels
    - So we can estimate 2 bd + 2 ba + 2 exterior + 14 cabinet/closet = 20 doors per household on avg
- Buildings – Commercial real estate in NYC and Hong Kong will be much different than rural cities
    - I believe there are fewer than 10M commercial real estate buildings in the US, or using our same ratio, about 250M in the world
    - Office buildings have transitioned to open floor plans, but will still need doors for bathrooms, cabinets, conference rooms, and some private offices
    - So let's suppose a single floor of a commercial building has about 20 doors
        - Another thought, would you count a revolving door as 1 door or 4?
    - Skyscrapers exist in high density areas, but there are likely fewer than 100 cities in the world with significant density of skyscrapers. We will take a simplified approach with powers of 10 and break into cohorts by density
        - 50 cities with 100 tall buildings, average of 30 stories per building
        - 20 cities with 50 tall buildings, average 20 stories
        - 30 cities with 33 1/3 tall buildings, average 10 stories
        - 1,000 cities with 10 buildings, average 2 stories
        - For all skyscrapers, we will also add 10 doors to account for elevators and maintenance rooms
    - Hospitals and Hotels have lots of doors, but are essentially a collection of 1 bedroom

    residences without a kitchen (typically), so we could calculate similar to residential buildings.
        - Let's suppose there are 10M hospitals/hotels in the world each with 100 1bd rooms, 4 doors per room
    - Restaurants and grocery stores will have storage equipment such as walk-ins or freezers with doors and even lockers, but most of the space is usually a large open floor plan with no doors. Which makes me think on average we could calculate them as non-residential commercial buildings as well
        - Let's suppose there are 1M restaurants  and grocery stores in the US. Then we could assume the same ratio as residential and say there are 25M restaurant/gocery in the world
    - Schools have many types of doors such as lockers
        - Although the most common type of lock on a school locker is very much a type of wheel that spins to apply force
        - So we will consider the doors at a school to be about 500 doors per school
        - Not everyone goes to school, so if we assume 10% of the worlds population uses schools and that each school can support 500 people on average we would estimate  800M/500 = 1.6M schools x 500 doors = 800M doors
- Stand alone structures – Places with doors such as storage units and post office boxes
    - There are a lot of boxes in a post office, but not a tremendous amount of post offices considering that only 10 cities in the US have over 1M residents. Let's suppose we have 500 PO boxes per post office or similar place of business. And using the US comparison for the world estimate 1 similar building for every 100K people, or about 80K x 500 doors = 40M doors
    - Similarly, storage units have lots of doors. But most of them use roll-up garage doors. Instead of trying to count both, I would consider this statistically insignificant since these doors likely have 6 or more wheels per door
    - There are also backyard sheds, furniture, farm and other structures used outside of these common building types. So let's add in another 100M doors globally for misc structures



Non-structures with doors and no wheels

- Furniture / Appliances – We touched on this in the ratio section, and could think of things like microwave doors. But we already considered locker doors and similar po boxes. Let's use a simple power of 10 to assume 10 furniture doors in every resident and 100 furniture doors per commercial building
- Doors for sale – If you walk into a building supply store, you can buy a door. It is not acting as a portal, but it is in the current state of being an actual door in name. Same goes for all replacement parts available on the internet using the name door (panel doors, etc)
    - Let's assume the available supply of various doors (cabinets too) in stores is 500
    - These stores are few and far between, but not insignificant. Let's estimate 10K stores in the world carrying 500 doors, or about 5M doors for sale
    - We would then assume much fewer on the resale market. However, there will be varieties such as panels for computers, machines, etc. Let's just then assume another 5M for various door sizes for sale
- Toys – Doll houses and even the He-Man Grayskull castle has doors on it. But just like furniture, these last a long time and are far less abundant than toy cars. Let's estimate these as 2 doors per toy and 1 in every 5 households (accounting for households with multiple toys,

consumerism!).
  - Which is (2.5B / 5) x 2 = 1B doors

Did I miss any significant place where we use doors? Are there a lot of trap doors or something like in Monster's Inc we should consider?

We are ignoring lids, covers, and hatches, and we already have an estimate for the ratio on vehicles and other door/wheel items to account for the significance of one over the other.

So if not, let's calculate our estimate for doors in the world

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Houses       = 2.5B x 20 Doors = 50B

Commercial   = Offices + Skyscrapers + Hospitals/Hotels + Restaurant/Grocery +

Skyscrapers = 5k buildings x 30 x (20+10 doors) +

              2k x 20 x 30 doors +

              1k x 10 x 30 doors +

              10k x 2 x 20 doors (no elevators)

           = 4.5M + 1.2M + 300K + 400K = ~6.5M doors = Round up to 10M doors

Offices      = (250M - Skyscrapers) x 20 Doors

           = (250M - (5k+2k+1k+10k)) x 20 doors = ~5B doors

Hosp/Hotel   = 10M x 100 x 4 doors = 4B doors

Rest/Grocry = 25M x 20 doors = 500M doors

Schools      = 800M doors

StandAlone   = 140M doors

Furniture    = 2.5B x 10 doors + 250M x 100 doors = 25B + 25B = 50B doors

For Sale     = 10M doors

Toys         = 1B doors

? Doors      = 50B+10M+5B+4B+500M+800M+140M+50B+10M+1B = about 111B doors
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So as a power of 10, we can say the scale is **around 100B doors in the world**

## How many wheels are there in the world?

We can re-purpose some of our estimates from doors for wheels found in those environments. But we will also need to think about wheeled items that exist on their own. And again, when thinking on the scale of the world, we will try to only consider statistically significant segments.

Assumptions about wheels

- Mobility
    - Bicycles
        - 2 wheels each, tricycles and others are likely statistically insignificant
        - Not every household has a bicycle, but some have multiple bikes
        - Bikes are also shared or owned by companies
        - Let's suppose for the world that 1 in 3 households have 1 bike, but round up to account for the additional ownership
        - 2.5B households / 3 = about 1B bikes = 2B wheels
    - Motorcycles
        - Vastly fewer than automobiles and even bicycles. But in most of the world, these are much more common
        - If we use our power of 10, let's suppose there is 1 motorcycle, motor scooter, or similar for every 10 bicycles
        - 100M x 2 wheeled motorized vehicles = 200M wheels
    - Skates / scooters
        - Roller skates/blades, skate boards, scooters, and all of the other non-bicycle
        - Each of which on their own are fewer than bicycles in the world
        - However, they tend to have 2-4+ wheels
        - Let's suppose 10% of bike ownership again, but 4 wheels each
        - 100M x 4 wheels  = 400M wheels
    - Wheelchairs
        - All have at least 4 wheels, modern ones have more but we can avg at 4
        - Most people do not need a wheelchair, and it is a shared asset in hospitals
        - Let's suppose 1/2% of all people need a wheelchair
        - 40M x 4 = 160M wheels
    - Luggage
        - The most common type now is 4 wheels, but there are still many with 2. So let's assume 3
        - Air travel, despite covid, has become a very common mode and most people have luggage
        - Not everyone household has a suitcase with wheels, but some have multiple. Let's assume 1/2 of households have 2 suitcases at 3 wheel avg. Or 2.5B x (1/2 x 2) x 3 = 7.5B wheels
    - Shopping carts / Trolleys
        - Airports, hotels, and grocery stores have these carts all with 4 wheels
        - If we use our restaurant and grocery store estimate of 25M globally and assume 20% of those are grocery stores with shopping carts, then that would be 5M wheels
        - Costco and airports have hundreds of carts while other stores have less. Let's take a mean that is a power of 10 it and say 100 carts per store with 4 wheels each
        - Which would be about 2B trolley/cart wheels
    - Roller coasters
        - An interesting edge case, but surely there are not that many rollercoasters in the world
        - Even if there are 10K roller coasters (theme parks, carnivals, gondolas, ski lifts, etc) in the world with 100 wheels each is only 1M wheels

        - However, theme parks will have lots of push carts, trams, maintenance carts, etc that have no doors
        - So the whole category of amusement parks would at best be 10M wheels. Seemingly insignificant
- Furniture
    - Chairs
        - Chairs in office buildings usually have 4-6 wheels each
        - All of the commercial buildings we identified have many chairs
        - Standing desks are gaining popularity, but very far from common
        - A conference room might have 20 chairs, and open office plans have hundreds
        - Let's suppose 50 chairs per floor at 6 wheels each, or 300 wheels per floor
        - Using our skyscraper estimate, it is about 300M wheels in skyscrapers (simple comparison of 30 doors vs 300 wheels per floor)
        - Even if only 100M of commercial office buildings have 300 wheels that is 30B wheels
        - But the remaining 150M likely have at least 10 chairs on avg. So let's suppose 150M x 10 x 6 = ~10B
    - File cabinets
        - Far less likely to exist than rolling office chairs and even file cabinets without wheels
        - I feel comfortable considering this a rounding error at best. So 0
    - Clothing racks
        - Another interesting edge case, but highly unlikely to be a considerable factor in the total sum
    - Dressers / Drawers
        - There are usually 4 wheels used for sliding drawers (dressers, kitchens, desks, etc)
        - Sliding drawers exist in cabinets or dressers, maybe even 3 or 4 drawers on avg
        - Most households have more than 1 place with drawers. Although not all drawers necessarily have wheels (plastic, wood, etc)
        - Let's suppose 25% of households have only 10 sliding drawers with wheels (40 wheels / household)
        - But also, that 50% of offices have at least 10 sliding drawers with wheels (40 wheels / office)
        - housing = 2.5B x 1/4 x 40 wheels = 25B wheels
        - offices = 250M x 1/2 x 40 wheels = 5B wheels
- Industrial
    - Hospital / Hotels
        - Hospital beds have 4 wheels, portable equipment (IVs, etc) have 3-4 wheels, push carts for laundry, maintenance, etc have 4 wheels
        - If we assumed 100 rooms in these places on avg, then each room could have an avg of 1 bed, 1 portable machine, and 10 types of carts to maintain every 100 rooms
        - (100rooms x (4+4 wheels)) + (10 carts x 4 wheels) = (800+40) wheels
        - A hotel has less, let's say 10% or 100 wheels
        - If we assume 80/20 split of hotels/hospitals (10M), then: 8M x 100 + 2M x 1K = ~3B wheels
    - Fork lifts / hand trucks / dollies / push carts
        - Every warehouse and storage facility within any building will have at least 1 of these, some times dozens
        - Schools and offices will have maintenance, custodians, and other needs for carts

        - Large equipment and furniture moving uses 4 wheels
        - Many small business and households have their own small cart with 2 or 4 wheels
        - Let's suppose 50% of commercial buildings have 2 of these typer of equipment on avg with 4 wheels, and 10% of households have 1 with 2 wheels
        - 250M x 1/2 x 2 x 5 + 2.5B x 1/10 x 2 = 1.25B + 0.5B = ~2B wheels
    - Motorized and industrial equipment
        - Lawn mowers, motorized carts, golf carts, ATVs, construction machines, etc have 4 wheels
        - There are applications for households, construction, roadways, airports, warehouses, etc
        - Let's suppose 25% of households have 2 of these items with 4 wheels
        - And 50% of commercial/industrial buildings have 4 of these with 4 wheels
        - 2.5B x 1/4 x 2 x 4 + 250M x 1/2 x 4 x 4 = 5B + 2B = 7B wheels
        - To account for all of the other industrial applications, we could round this total to 10B wheels
    - Conveyor belts / rollers
        - Not thinking about the gear and belt ones, there are still lots of conveyor systems using wheels as rollers. Of which, also have wheels on the bottom of them in many applications
        - However, these are not used in most buildings
        - Let's suppose each of these conveyor systems have 100 wheels each, any place using these will have on avg 10 conveyors, but only about 1% of commercial places have these systems
        - 250M x 1/10 x 10 x 100 = 25B



- Toys – We could name things like merry-go-rounds which are fun to think about but are a single wheel. Since toy cars are accounted for in our first step and bicycles in the above, we can consider the rest of this category to be likely less than a few hundred million wheels, which is insignificant on this scale.
- Pulleys – I have a hard time not considering wheels found in pulleys. A gear isn't a wheel because of its definition as a non-wheel term (similar to lid and hatch not being doors). But the wheels found in pulley machines have no other term and fit the "spin around an axle to perform work" definition perfectly
    - Elevators
        - Every modern elevator has at least 2 pulley wheels, if not 4 or more used. Let's suppose 3 avg
        - As we reviewed, not all buildings have elevators
        - Let's suppose 100M buildings have 2 elevators with 3 wheels = 600M wheels
    - Engines
        - Trying to keep with mutually exclusive segmentation, we will not include automobiles here
        - Even excluding automobile engines, nearly all engines use pulleys to deliver power
        - Let's suppose 10% of commercial buildings are for companies that offer solutions that use engines, and that each company has on average at least 2 machines, each with 5 wheels to perform work
        - 250M x 1/10 x 2 x 5 wheels = 250M wheels
    - Curtains / blinds
        - This is an interesting category. Most types of blinds rely on pulleys to raise and lower.

        And many modern window curtains actually use wheels in the track. Each of which will have at least 10 wheels each. And when found, such a household will have them on many windows
        - However, I don’t believe it is the most common type of system for curtains around the world
        - Let’s break these down and suppose only 1% of households have 1 curtain with 10 wheels
        - But 50% of households have 4 blinds with 2 pulley wheels
        - 2.5B x 1/100 x 10 + 2.5B x 1/2 x 4 x 2 = 250M + 10B = ~10B
- Spare parts
    - Unlike doors, replacement wheels are easily more ubiquitous based on the average lifespan of a wheel compared to a door. Especially considering that car wheels are constantly being worn down by usage and weather
    - The plastic wheels found on most products also are more easily broken and cheaper to replace than doors
    - Let’s assume for all of our wheels, that there is a supply of replacement products for at least 1% of the existing wheels. This is an underestimate IMO given that cars have tires, wheels, and brake calipers that are available in mass quantities. But should account for the other areas that have less replacement supply. ? Ws x 1%



## Math time

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Mobility   = 2B+200M+400M+160M+7.5B+2B = ~12B

Furniture  = 300M+30B+10B+25B+5B = 70B

Industrial = 3B+2B+10B+25B = 40B

Pulleys    = 600M+250M+10B = ~11B

Spare part = (12B+70B+40B+11B)x1/100 = about 1B

? Wheels  = about 130B
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Similar to doors, we can look at this as on the scale of **about 100B wheels in the world**.

## Sanity Check

> Education is the process of becoming more aware of and engaged with the universe, and your place in it. — John Green

Let’s review our results

- Door + Wheel items have a ratio of 2D:3W
- Doors are on the scale of 100B
- Wheels are on the scale of 100B

The reason I am considering the scale and power of 10 the most significant factor is because we made a lot of assumptions and generalized to get averages. However, if we changed some of those numbers, how likely would it be for us to be off by a factor of 10?

Let's see if we can use some basic logic staying within the context of our original scope. We started by saying that a person on earth right now would want to know the result.

When it comes to doors, this result implies that there are about **100B doors / 8B = 12 doors for every human** on earth . Which is not unreasonable considering we share most of the spaces (housing, offices) with other people.

Wheels per person seems less intuitive, but we also used households and buildings to define our scope. So this result implies that there about **100B wheels / (2.5B + 0.5B other buildings) = 33 wheels in every building** on earth. Which is also reasonable after looking at where wheels exist in these places.

## Are there more doors or wheels in the world?



*TL;DR*

I am really glad I started with the ratio of items that contain both. The slight variance in my final result between the 2 different sums wouldn't be very convincing to me about which is more abundant. But knowing that all things being equal, the ratio of wheels to doors is a significant factor.

After going through these estimations, what really stood out to me is that language seems to really drive the result in this debate. We have specific names that do not include door nor wheel for items that have the essence and functionality for either one. For example, should a lid, hood, hatch, or cover be considered a door? If so, then is a disk, gear, or record a wheel?

And so it seems, the correct answer as usual is the math we made along the way.

But the math makes it clear to me: **I believe there are more wheels than doors in the world**.

**Category**

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**Date Created**
February 2022
**Author**
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