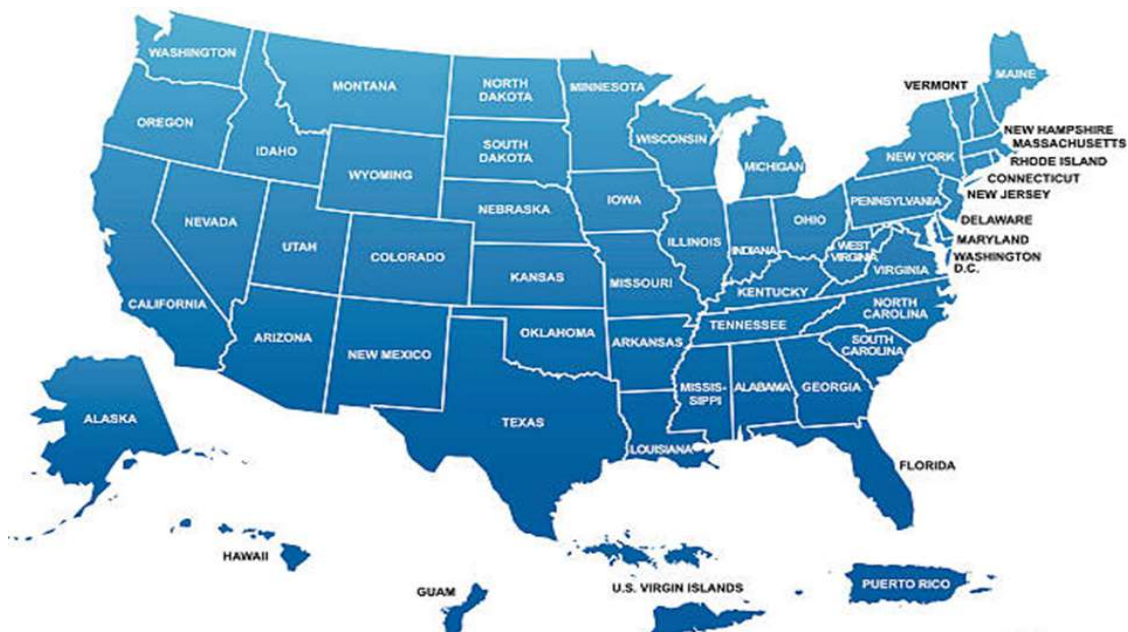


2024 Frankenmuth Eagle Invitational. Fermi Questions.

* Hi, I'm Tomás Díaz, your favorite Fermi questions maker. Haha. For this exam I decided to make a US States and Territories themed Fermi Questions. Not all the states will be represented here, though. Some states are lame for Fermi, I guess. Or I just ran out of ideas for that state.

Q	State	Fermi Question	F.A.
1	Alabama	Claudette Colvin was arrested in Montgomery, Alabama for refusing to give her "whites only" seat on the bus. Rosa Parks copied her 9 months later. The mass of how many Claudette's is equal to the mass of that bus?	
2	Alaska	Alaska is home to many grizzly bears and home of Denali. How many grizzly bears on top of each other standing on two legs are needed to equal the height of Denali?	
3	Arkansas	Home of Hot Springs National Park. What is the thermal energy in Joules that a standard can of soda filled with water from one of those hot springs will give if put inside a freezer?	
4	California	In eastern California, a Great Basin bristlecone pine (Pinus longaeva) known as Methuselah has long been considered Earth's oldest living thing. According to tree-ring data, Methuselah is how many fortnights old?	
5	Colorado	Colorado is home to a lot of peaks that exceed 14,000 feet in elevation, also known as 14ers. How many 14ers does the Colorado Geological Survey says are there in Colorado?	
6	Delaware	Delaware was the first of the thirteen original colonies to ratify the U.S. Constitution on December 7, 1787. If you had put a single dollar in a bank back then at 6% interest per year, how many dollars would it be today?	
7	Florida	My friend Hunter Leininger set a record last month by running the entire state of Florida from the Everglades to Pensacola. The clock for the official record time didn't stop when he was sleeping. How many seconds it took him?	
8	Georgia	Home of Coca Cola headquarters. How many molecules of caffeine in a standard can of Coca Cola?	
9	Hawaii	Hawaii is known for volcanoes. The area of how many US quarters is needed to be equal to how much land did the lava flow from the Kīlauea volcano added in Hawaii for the 30-year eruption?	
10	Idaho	Idaho produces about $\frac{1}{3}$ of the annual US production of potatoes. If I have a magic potato cannon that uses ALL of the energy from all of last year's Idaho potato yield and convert all of that energy to kinetic energy without losses to shoot a large potato from this cannon, what speed in m/s will a potato exit this cannon?	
11	Illinois	On 2 December 1942, the world's first artificial nuclear reactor was initiated in Chicago during an experiment led by Enrico Fermi, the scientist for which this event is named after. How many nuclear reactors in the US after that one?	
12	Indiana	Home of the Indy 500. What is the kinetic energy in joules of an Indy 500 race car at the max speed ever recorded there during the Indy 500?	
13	Iowa	Born in Iowa, Norman Borlaug was an agronomist who led initiatives that contributed to the increases in agricultural production through genetic engineering. How many people worldwide is he credited with saving from starvation?	
14	Kansas	Kansas is known for its tornados. What is the Kinetic Energy of the largest EF5 tornado in Joules ?	
15	Kentucky	Home of Kentucky Fried Chicken (KFC). How many chickens are slaughtered in the US every year for human consumption?	
16	Louisiana	What is the length of Louisiana's Lake Pontchartrain Causeway in Astronomical Units ?	
17	Maine	Steven King, a long time resident of Maine, has written a lot of books. Counting each novel once, how many words are printed in all of his novels?	
18	Massachusetts	Home of the Boston Tea Party protest on December 16, 1773. How many pounds of tea were destroyed in that protest?	
19	Michigan	Michigan, the Great Lakes State. The state that I call home where you are taking this weird test. The mass of how many Michigan apples do you need to equal the mass of the water of all of the Great Lakes?	
20	Minnesota	How many lakes are there in Minnesota? (It's literally printed on their license plates)	
21	Mississippi	Assuming he never gets tired, never stops, and can swim at his fastest record speed from the Olympics, how many seconds will it take Michael Phelps to swim the entire length of the Mississippi River?	
22	Missouri	Dorothy Jean Johnson Vaughan, born in Missouri, was an American mathematician who worked for NASA and was one of the main characters depicted in the movie Hidden Figures. In her honor, what is..... $\sum_{k=0}^{2024} k^3$?	
23	Nebraska	Nebraska is where investor Warren Buffet lives. If he liquidated all of his assets and spread it out evenly amongst every human being in the world, how many US dollars will you receive from him?	
24	Nevada	Home of Las Vegas. In the game of craps, a pair of dice is rolled several times. If you make a Pass Line bet, the more consecutive 7's you roll, the more money you make. What is the probability of rolling 100 consecutive 7's?	
25	New Jersey	New Jersey, where John Nash earned a Ph.D. in Math from Princeton with a key concept in game theory that earned him a Nobel Prize. In his honor, what is..... $\int_0^2 x^{2024} dx$?	
26	New York	New York was home to the Twin Towers which were taken down by terrorist before you were born. How many mg of steel was sold as scrap from the Twin Towers?	

27	North Carolina	In this state the Wright brothers made history by flying for the first time. Last year, including passenger, cargo, and military aircraft, how many flights happened?	
28	Ohio	How may airplanes in the USAF museum in Dayton, Ohio?	
29	Pennsylvania	Home of the Liberty bell. The weight of how many of those ring bells that you press for service at hotels is needed to equal the weight of the liberty bell?	
30	Rhode Island	If I throw a dart on a US map of the 48 contiguous states and the dart will always land inside the area of those 48 states, what is the probability that the dart lands on Rhode Island?	
31	South Dakota	Home of Mount Rushmore. How many grams of rock were blasted to create the presidents' head?	
32	Tennessee	Home of Jack Daniel's distillery. All of the water for their whiskey comes from the same spring in Lynchburg, TN. How many barrels of whiskey do they produce each year?	
33	Texas	"Houston, we have a Fermi problem?" Ok, I changed the quote a little bit. When returning to Earth, spacecraft and their payloads re-enter the atmosphere at what speed in mph ?	
34	Utah	Home of the Bonneville Salt Flats where people attempt land speed records. What's the current land speed record there in lightyears per second ?	
35	Vermont	Vermont's early industries included paper mills. Find Vermont on the map below. How many molecules of cellulose of paper are there in the section of this page that's covered by Vermont?	
36	Virginia	The John F. Kennedy Eternal Flame is a presidential memorial in Arlington National Cemetery in Virginia. How many nanoseconds has this flame been on assuming it was never off for maintenance?	
37	Washington	Headquartered in Washington, what is Amazon market cap in US dollars ?	
38	West Virginia	West Virginia is famous for coal mining. How many pounds of coal do we need to burn to charge the battery of a Tesla Model 3 every day for a whole year from 0% to 100%? (Yes, EV's need coal burning in certain regions)	
39	Wisconsin	Wisconsin is famous for cheese. They produce about 1/5 of all of the US cheese production. How many pounds of cheese per year does Wisconsin produce?	
40	Wyoming	Home of Yellowstone National Park, how many gallons of water have erupted from Old Faithful Geysir last year?	
41	Territories: D.C.	Washington D.C. is where our politicians do their corruption and stealing, oops, I mean our governing. Assuming no vacancies, in how many ways can we arrange all of the US Senators in Congress on a single line?	
42	Territories: Puerto Rico	This is where I was born. Last year I set a record in Puerto Rico as the fastest run/hike from the Luquillo Beach to the top of El Toro, the highest peak on the El Yunque rainforest. How many seconds was my record climb?	
43	Other territories	If you were to do a roundtrip flight in a Cessna airplane from US Virgin Islands to Guam to Northern Mariana Islands to American Samoa and back to the US Virgin islands, how many centuries will it take excluding stops?	



* Map of the territories, Alaska, and Hawaii are not to scale with respect to the 48 states. Puerto Rico is about 1/5 in length of what is shown *

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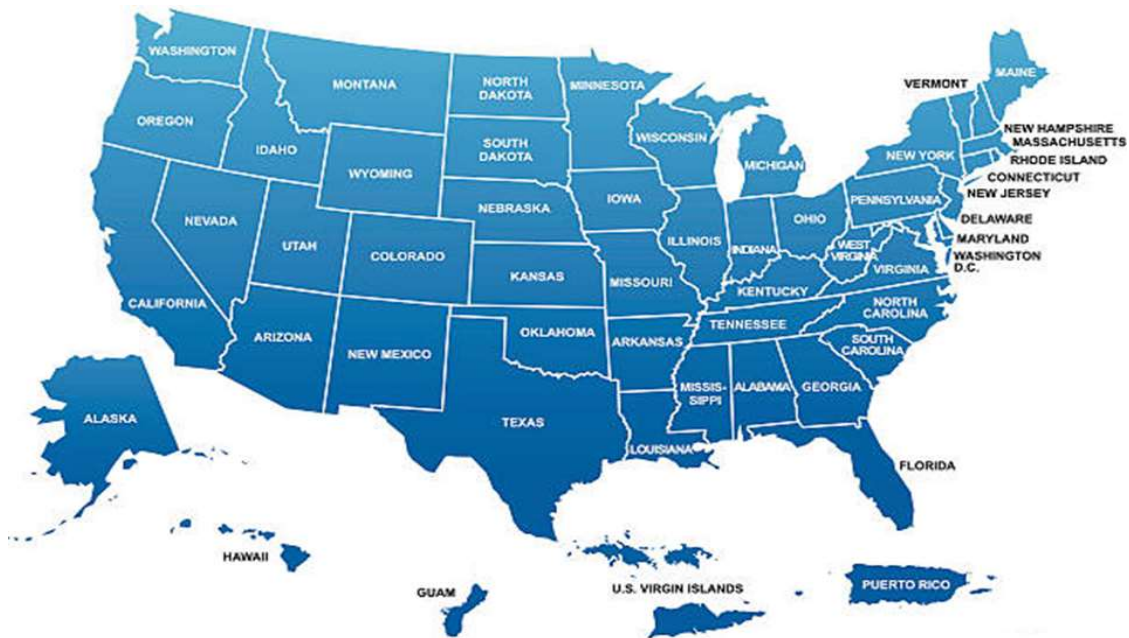
Q	State	Fermi Question	F.A.
1	Alabama	Claudette Colvin was arrested in Montgomery, Alabama for refusing to give her "whites only" seat on the bus. Rosa Parks copied her 9 months later. The mass of how many Claudette's is equal to the mass of that bus? A: If you didn't know about Claudette Colvin, look her up. She preceded Rosa Parks. Anyway, she was small woman so we estimate her weight at 120lbs. You can see the actual bus at the Henry Ford Museum. It's about the size of today's school buses and should weight around 25,000lbs. Hence, $25,000/120 \approx 2e2$	2
2	Alaska	Alaska is home to many grizzly bears and home of Denali. How many grizzly bears on top of each other standing on two legs are needed to equal the height of Denali? A: $20,000\text{feet}/9\text{feet} \approx 2.2e3$	3
3	Arkansas	Home of Hot Springs National Park. What is the thermal energy in Joules that a standard can of soda filled with water from one of those hot springs will give if put inside a freezer? A: mass of water in can of soda: $m=340\text{g}$, specific heat of water: $c=4.186 \text{ (J/gK)}$, Hot springs water temperature in Hot Springs= 62°C , freezer temperature= -18° , $\Delta T=62^\circ\text{C}-(-18^\circ\text{C})=80^\circ\text{C}$, Energy = $mc\Delta T=(340)(4.182)(80) \approx 1.1e5$	5
4	California	In eastern California, a Great Basin bristlecone pine (Pinus longaeva) known as Methuselah has long been considered Earth's oldest living thing. According to tree-ring data, Methuselah is how many fortnights old? A: One fortnight is and old unit of time measurement consisting of 2 weeks. Methuselah is $(4853 \text{ years})(52 \text{ weeks/year})(1 \text{ fortnight}/2 \text{ weeks}) \approx 1.3e5$	5
5	Colorado	Colorado is home to a lot of peaks that exceed 14,000 feet in elevation, also known as 14ers. How many 14ers does the Colorado Geological Survey says are there in Colorado? A: $58=5.8e1 \approx 1e2$	2
6	Delaware	Delaware was the first of the thirteen original colonies to ratify the U.S. Constitution on December 7, 1787. If you had put a single dollar in a bank back then at 6% interest per year, how many dollars would it be today? A: $(1+6\%)^{(2023-1787)}=(1.06)^{236} \approx 9.4e5=1e6$ You will have \$1M. But how do you calculate that without a calculator? Using the rule of 72. The rule of 72 is a financial estimate to find the number of periods that your money needs to double according to a rate. That is, you divide 72 by the rate as a percentage and the results is the number of periods to double your money. Thus, at 6% interest rate per year, the number of periods is $72/6=12$. This means that at 6% rate, your money will double every 12 years. This means that $(1.06)^{236} \approx 2^{236/12}$. Since you're a Fermi questions expert, you know that $\log_{10}2 \approx 0.301$. Hence, $\log_{10}(2^{236/12}) \approx (236/12)\log_{10}2 \approx (236/12)(0.301) \approx 5.92$. Since $0.9 > 0.699$, then 5.92 rounds to 6 and that's the Fermi Answer	6
7	Florida	My friend Hunter Leininger set a record last month by running the entire state of Florida from the Everglades to Pensacola. The clock for the official record time didn't stop when he was sleeping. How many seconds it took him? A: It was 1100 miles of trails with swamps, sand, and all sorts of horrible conditions including some major storms. He did it $21\frac{1}{2}\text{days}$ and he's not much older than you. $21\frac{1}{2}\text{days} * 24\text{hr/day} * 3600\text{s/hr} \approx 1.86e6$ https://fastestknowntime.com/route/florida-trail-fl But how do you estimate this without knowing Hunter or his record? You could have estimated the total length using the included map keeping in mind that Hunter had to go up North and then West to the NW side of the State. The trail was 1,100 miles. If you estimated the length at about 1000 miles a pace of 3mph and running time of 14 hours each day to account for sleeping and recovery, then $1000\text{miles}/3\text{mph}/(14 \text{ hours each day}) \approx 23 \text{ days}$ which is $2e6$ seconds and has the same Fermi Answer. Or you could have assumed 800 miles at 60 miles per day = 13.3 days which is $1.1e6$ seconds and has the same Fermi answer. Depending on your assumptions, you could have guessed anywhere between a ridiculous impossible super fast time of 6 days to as much as 50 days and still get the same Fermi Answer. Whether you estimated 600 miles at 100 miles per day or 1000 miles at 20 miles per day, it will still give you the sme Fermi Answer. So, this one was not as difficult as it seemed even if you didn't know about Hunter's record.	6
8	Georgia	Home of Coca Cola headquarters. How many molecules of caffeine in a standard can of Coca Cola? A: 34mg on each can. Molar mass of caffeine $\approx 200\text{g/mol}$. Hence, $(0.034\text{g})/(200\text{g/mol})(6e26 \text{ mol}^{-1}) \approx 1e20$	20
9	Hawaii	Hawaii is known for volcanoes. The area of how many US quarters is needed to be equal to how much land did the lava flow from the Kīlauea volcano added in Hawaii for the 30-year eruption? A: As lava reached the ocean, it cooled and formed new land and a new coastline. It added an approximate 1,000 acres of land over the last 30 years. $1,000 \text{ acres} \approx 4e6\text{m}^2$. US quarter is 24.26 mm in diameter. $4e6\text{m}^2 / (\frac{1}{4}\pi(24e-3\text{m})^2) \approx 9e9 \approx 1e10$	10

10	Idaho	Idaho produces about $\frac{1}{3}$ of the annual US production of potatoes. If I have a magic potato cannon that uses ALL of the energy from all of last year's Idaho potato yield and convert all of that energy to kinetic energy without losses to shoot a large potato from this cannon, what speed in m/s will a potato exit this cannon? A: Idaho produces 13 billion pounds of potato each year. That's $6e12g$. Each gram is 1 calorie. Each calorie is 4184 J. mass of one large potato is about 800 grams. $E = \frac{1}{2}mv^2$. Hence, $v = \sqrt{2E/m} = \sqrt{2 * 6e12 * 4184J / 0.8kg} \approx 2.5e8$ m/s which is 83% of the speed of light. But Fermi Questions don't necessarily have to make physical sense. That's why I wrote the question as a magic potato cannon!	8
11	Illinois	On 2 December 1942, the world's first artificial nuclear reactor was initiated in Chicago during an experiment led by Enrico Fermi, the scientist for which this event is named after. How many nuclear reactors in the US after that one? A: Just $92 \approx 1e2$ which is a very pathetic low number! We need more nuclear reactors.	2
12	Indiana	Home of the Indy 500. What is the kinetic energy in joules of an Indy 500 race car at the max speed ever recorded there during the Indy 500? A: fastest lap speed record was 235mph which is about 105m/s. Mass of one of those vehicles is about 3.5e3kg. Kinetic Energy = $\frac{1}{2}mv^2 = \frac{1}{2}(3500kg)(105m/s)^2 \approx 1.9e7$	7
13	Iowa	Born in Iowa, Norman Borlaug was an agronomist who led initiatives that contributed to the increases in agricultural production through genetic engineering. How many people worldwide is he credited with saving from starvation? Because he worked extensively in poor countries with genetics and agricultural technology it is estimated that his efforts saved about 1 billion people from starvation. He was one of the most underrated scientists. Read about him.	9
14	Kansas	Kansas is known for its tornados. What is the Kinetic Energy of the largest EF5 tornado in Joules ? A: over 100TJ = $1e14$. I looked it up. But how can you estimate that? Here's how: An EF5 tornado is about 1km in diameter, and 2000 meters tall, with speeds about 250mph. So we estimate its Volume by calculating the volume of a pyramid with square base: $V = (1e3m)^2(2e3m)/3 \approx 1e9m^3$. For simplicity we take the air density as $1Kg/m^3$, so the mass is $1e9kg$. We simplify 250mph to 100m/s. So, the kinetic energy = $(1e9m^3)(1e2m/s)^2/2 = 5e13$. We round up to $1e14$ because we're looking for largest	14
15	Kentucky	Home of Kentucky Fried Chicken (KFC). How many chickens are slaughtered in the US every year for human consumption? A: about 8 billion chickens $\approx 1e10$. But how do we estimate it? The US has about 350 million people and they eat A LOT OF chicken. But not everyone eats chicken and those who do, don't do it every day. And a whole chicken can be eaten by a family of five. So, you can estimate about 1 to 2 chicken per month per person. that's between 12 chicken to 24 chicken per person. $350e6 * 12 = 4.2e9$ and $350e6 * 12 = 8.4e9$. So you pick a number between those two and round up to $1e10$	10
16	Louisiana	What is the length of Louisiana's Lake Pontchartrain Causeway in Astronomical Units ? A: It's quite a long bridge at a little less than 24 miles = $38.6e3m$. One A.U. is the distance from Sun to Earth which is about $1.5e11m$. Hence, $38.6e3m / 1.5e11m \approx 2.5e-7$	-7
17	Maine	Steven King, a long time resident of Maine, has written a lot of books. Counting each novel once, how many words are printed in all of his novels? A: 65 novels ranging from 127 pages to 1152 with an average of 487 pages per novel as verified by the wiki source below. Hence, $(65 \text{ novels})(500 \text{ pages/novel})(300 \text{ words/page}) \approx 8.7e6 \approx 1e7$ https://en.wikipedia.org/wiki/Stephen_King_bibliography#Novels	7
18	Massachusetts	Home of the Boston Tea Party protest on December 16, 1773. How many pounds of tea were destroyed in that protest? A: A LOT!!! About 92,000 pounds tons $\approx 1e5$	5
19	Michigan	Michigan, the Great Lakes State. The state that I call home where you are taking this weird test. The mass of how many Michigan apples do you need to equal the mass of the water of all of the Great Lakes? To estimate the volume of all the great lakes you need to visualize their width and length for each lake. Find all of those areas and multiply each of those areas by their respective depths. Lake Superior is the deepest with an average depth of 200 meters. Lake Erie is the shallower with an average depth of 20 meters. An Apple is about 100 grams. $V \approx 22e12m^3$. Hence $22e12m^3(1000kg/m^3)/(1e-1kg) \approx 2.2e17$	17
20	Minnesota	How many lakes are there in Minnesota? (It's literally printed on their license plates) A: Although promoted as the "Land of 10,000 Lakes", Minnesota has 11,842 lakes of 10 acres or more. The 1968 state survey found 15,291 lake basins, of which 3,257 were dry. If all basins over 2.5 acres were counted, Minnesota would have 21,871 lakes. All of those counts have a Fermi Answer of 4	4
21	Mississippi	Assuming he never gets tired, never stops, and can swim at his fastest record speed from the Olympics, how many seconds will it take Michael Phelps to swim the entire length of the Mississippi River? A: Michael Phelps 100m freestyle record was 47.5s. Mississippi River Length is about $3.8e6m$. Hence $3.8e6m * (47.5s) / (100m) \approx 1.8e6$	6



22	Missouri	Dorothy Jean Johnson Vaughan, born in Missouri, was an American mathematician who worked for NASA and was one of the main characters depicted in the movie Hidden Figures. In her honor, what is..... A: $\sum_{k=0}^{2024} k^3 = \left(\frac{2024 \cdot 2025}{2}\right)^2 \approx (1e3 \cdot 2e3)^2 \approx (2e6)^2 \approx 4e12$	$\sum_{k=0}^{2024} k^3 ?$	12
23	Nebraska	Nebraska is where investor Warren Buffet lives. If he liquidated all of his assets and spread it out evenly amongst every human being in the world, how many US dollars will you receive from him? A: \$120billion/8billion people $\approx \$15 \approx 1.5e1$. That's it. Enough to buy you food for a day! You can't eat the rich!		1
24	Nevada	Home of Las Vegas. In the game of craps, a pair of dice is rolled several times. If you make a Pass Line bet, the more consecutive 7's you roll, the more money you make. What is the probability of rolling 100 consecutive 7's? A: There are 6 possibilities of getting a sum of 7 out of 36 from two dice. $P=(\frac{1}{6})^{100} \approx 1.5e-78$ But how do you estimate that? Well, since you're a Fermi expert you should know by memory that $\log_{10}2 \approx 0.301$ and $\log_{10}3 \approx 0.477$. Therefore $\log_{10}(6) = \log_{10}2 + \log_{10}3 \approx 0.778$; $\log_{10}(\frac{1}{6})^{100} = \log_{10}(6)^{-100} = -100 \log_{10}6 \approx -77.8$. For negative values since $0.8 > 0.301$, then -77.8 turns into -78, and that's the Fermi Answer		-78
25	New Jersey	New Jersey, where John Nash earned a Ph.D. in Math from Princeton with a key concept in game theory that earned him a Nobel Prize. In his honor, what is..... A: $\int_0^2 x^{2024} = \frac{2^{2025}}{2025}$; $\log_{10}\left(\frac{2^{2025}}{2025}\right) \approx 2025 \log_{10}2 - \log_{10}2000 \approx 2025 \cdot 0.301 - 3.301 \approx 606.24$ Since $0.24 < 0.699$, then 606.24 gives Fermi answer of 606. The actual answer is about 1.9e606 (see link below) https://www.wolframalpha.com/input?i=integrate+from+0+to+2+of+x%5E2024dx	$\int_0^2 x^{2024} dx ?$	606
26	New York	New York was home to the Twin Towers which were taken down by terrorist before you were born. How many mg of steel was sold as scrap from the Twin Towers? A: (700,000 tons)(1e3kg/ton)(1e6mg/kg) $\approx 7e14 \approx 1e15$		15
27	North Carolina	In this state, the Wright brothers made history by flying for the first time. Last year, including passenger, cargo, and military aircraft, how many flights happened? A: Every day is about 100,000 flights. Hence, $1e5 \cdot (360) \approx 3.6e7$		7
28	Ohio	How may airplanes in the USAF museum in Dayton, Ohio? A: About 360 airplanes in 4 hangars. If you haven't been there, you should. It's FREE!		2
29	Pennsylvania	Home of the Liberty bell. The weight of how many of those ring bells that you press for service at hotels is needed to equal the weight of the liberty bell? A: Liberty bell weighs 2080lbs. A ring bell weighs between 0.5 to 4 lb. So answer is between 520 to 4,000, which is $2e3$		3
30	Rhode Island	If I throw a dart on a US map of the 48 contiguous states and the dart will always land inside the area of those 48 states, what is the probability that the dart lands on Rhode Island? A: (Area of Rhode Island) / (Area of 48 contiguous states) = $(1.2e3mi^2)/(3e6mi^2) \approx 4e-4$ You could have also visually estimated and calculated the areas with the map that was included on the exam.		-4
31	South Dakota	Home of Mount Rushmore. How many grams of rock were blasted to create the presidents' head? A: about 400 million Kg = $4e11$ grams. You can calculate this by estimating the volume of each head and multiply that by the density of the rock.		11
32	Tennessee	Home of Jack Daniel's distillery. All of the water for their whiskey comes from the same spring in Lynchburg, TN. How many barrels of whiskey do they produce each year? A: 2500 barrels per day * 360 $\approx 9e5 \approx 1e6$		6
33	Texas	"Houston, we have a Fermi problem?" Ok, I changed the quote a little bit. When returning to Earth, spacecraft and their payloads re-enter the atmosphere at what speed in mph ? A: 17500mph. This sounds like a lot but you need to consider that one spin around the Earth is about 24,000 miles of circumference divided by 24 hours is about 1,000 mph that we're all traveling on the surface of the Earth. But the atmosphere is at 6,200 miles above the surface and the Earth radius is about 4,000 miles. So the atmosphere circumference is 63,000 miles over 24 hours is a speed of 2,600mph. Now we need to add the speed of the Earth around the sun which is 66,600 mph. So, we're all traveling very fast here while standing still.		4
34	Utah	Home of the Bonneville Salt Flats where people attempt land speed records. What's the current land speed record there in lightyears per second ? A: The land speed record broke the speed of sound on land which is close to 763mph. Hence $(763mph)(1hr/3600s)(1600m/miles)(1lightyear/1e16m) \approx 3.4e-14$		-14

35	Vermont	<p>Vermont's early industries included paper mills. Find Vermont on the map below. How many molecules of cellulose of paper are there in the section of this page that's covered by Vermont?</p> <p>A: To get more accurate measurements I used a vernier caliper and the formula for the area of a trapezoid and divided it by area of paper to get the fraction of Vermont to paper as: $(0.13\text{in}+0.05\text{in})(0.23\text{in})/2/(8.5\text{in}\cdot 11\text{in})\approx 2\text{e-}4$.</p> <p>But you don't have a vernier caliper with you. So you can use the width of your pencil to measure.</p> <p>Paper: 31 pencil widths x 40 pencil widths</p> <p>Vermont and New Hampshire form a rectangle of about 1 pencil width x $\frac{1}{2}$ pencil width. Divide that by 2 to get Vermont area. Hence fraction of Vermont to paper $\frac{1}{2}(1)(\frac{1}{2})/(31\cdot 40)\approx 2\text{e-}4$ which is the same fraction.</p> <p>Each paper has a mass of approximately 4.5grams. Paper is made out of cellulose with a molar mass of 162g/mol. Hence, $(2\text{e-}4)(4.5)/(162)(6\text{e}23)\approx 3\text{e}18$</p>	18
36	Virginia	<p>The John F. Kennedy Eternal Flame is a presidential memorial in Arlington National Cemetery in Virginia. How many nanoseconds has this flame been on assuming it was never off for maintenance?</p> <p>A: The eternal flame at the gravesite of President John F. Kennedy in Arlington National Cemetery was lit on November 25, 1963. That's 60 years.</p> <p>Hence, $60\cdot 3\text{e}7\cdot 1\text{e}9\approx 1.8\text{e}18$</p>	18
37	Washington	<p>Headquartered in Washington, what is Amazon market cap in US dollars?</p> <p>A: 1.5 trillion dollars. $1.5\text{e}12$</p>	12
38	West Virginia	<p>West Virginia is famous for coal mining. How many pounds of coal do we need to burn to charge the battery of a Tesla Model 3 every day for a whole year from 0% to 100%? (Yes, EV's need coal burning in certain regions)</p> <p>A: roughly about 1lb of coal produces 1kwh. Battery capacity of that Tesla is 50kwh. So $50\text{lbs}\cdot 365\approx 1.8\text{e}4$</p>	4
39	Wisconsin	<p>Wisconsin is famous for cheese. They produce about $\frac{1}{3}$ of all of the US cheese production. How many pounds of cheese per year does Wisconsin produce?</p> <p>A: 2.8 billion pounds. $2.8\text{e}9$. But how to estimate?</p> <p>I gave you that it is 20% of the total cheese production of the US. So about 3lbs of cheese per person in the US per month times 20%. Then times 12 months.</p> <p>$\frac{1}{3}\cdot 12\cdot 350\text{e}6\approx 2.5\text{e}9$</p>	9
40	Wyoming	<p>Home of Yellowstone National Park, how many gallons of water have erupted from Old Faithful Geyser last year?</p> <p>A: Old Faithful Geyser expels 3,700 to 8,400 gallons of water each time it erupts and it erupts every 90 minutes (1.5 hours)</p> <p>Hence, $3700\cdot 24\cdot 360/1.5\approx 2.13\text{e}7$</p>	7
41	Territories: D.C.	<p>Washington D.C. is where our politicians do their corruption and stealing, oops, I mean our governing. Assuming no vacancies, in how many ways can we arrange all of the US Senators in Congress on a single line?</p> <p>A: 100! Using Stirling approximation in \log_{10} and knowing that $\log_{10}(100)=2$.</p> <p>Hence, $F.A.(n!)\approx 0.4+(n+\frac{1}{2})\log_{10}(n)-n\cdot \log_{10}(e)$; $F.A.(100!)\approx 0.4+(100.5)(2)-100(0.4343)\approx 157.97$ which rounds to 158 because $0.97>0.699$. ($100!\approx 9.3\text{e}157$ see link below)</p> <p>https://www.wolframalpha.com/input?i=100%21</p>	158
42	Territories: Puerto Rico	<p>This is where I was born. Last year I set a record in Puerto Rico as the fastest run/hike from the Luquillo Beach to the top of El Toro, the highest peak on the El Yunque rainforest. How many seconds was my record climb?</p> <p>A: It was about 18 miles of trails with 4 river crossings an elevation gain of 4,000 feet, several less frequented trails and even a small path over a mudslide. I did it in less than 6 hours and it felt great. Any one of you is welcomed to break the record. YOU CAN DO IT!!!! $6\text{ hours}\cdot 3600\text{s/hr.}=2.1\text{e}4$</p> <p>https://fastestknowntime.com/route/beach-el-toro-summit</p> <p>But how do you estimate that if you didn't know anything about me or Puerto Rico? You could have used the map included in the exam with the note that Puerto Rico was about $\frac{1}{4}$ in length of what was shown and knowing how large are the 48 states, visually estimated the shortest distance from a beach to somewhere in the middle of the island to be roughly between 10 to 30 miles and assumed a 3mph rate which would have been between 3 hrs to 10 hrs which is between $1\text{e}4$ seconds to $3.6\text{e}4$ seconds which would have given you the same Fermi Answer.</p>	4
43	Other territories	<p>If you were to do a roundtrip flight in a Cessna airplane from US Virgin Islands to Guam to Northern Mariana Islands to American Samoa and back to the US Virgin islands, how many centuries will it take excluding stops?</p> <p>US Virgin Islands are next to Puerto Rico in the Caribbean. Guam and Northern Mariana Islands are next to each other in the Pacific Ocean. American Samoa is also on the Pacific but further South and on the Southern Hemisphere. The roundtrip is about 20,000 miles which is close to the circumference of the Earth. A Cessna flies at 140mph.</p> <p>Hence, $(20,000\text{miles})/(140\text{mph})/(24\text{hr/day}\cdot 365\text{ days/year}\cdot 100\text{ years / century})\approx 1.6\text{e-}4$</p> <p>Note: Since these Guam and Samoa are on the Pacific and the Virgin Islands are in the Caribbean, you could have guessed a trip around the circumference of the world and still gotten the correct Fermi Answer. A map with the flight path is included on this key for reference but not on the exam</p>	-4



* Map of the territories, Alaska, and Hawaii are not to scale with respect to the 48 states. Puerto Rico is about $\frac{1}{8}$ in length of what is shown *



*The map above WAS NOT included on the exam. I put it here as a reference for the last question *