How Many Golf Balls Can Fit In A Bus?

Fermi Problems and Competitions

Jason Smith

Oregon Tech

April 24, 2025

Prerequisite - Scientific Notation

Multiplying by 10 moves the decimal to the right.

$$1.23 \times 10 = 12.3$$

$$123{,}456 = 1.23456 \times 10^5$$

Dividing by 10 moves the decimal to the left.

$$98.7 \div 10 = \frac{98.7}{10} = 98.7 \times 10^{-1} = 9.87$$

$$0.0048 = 4.8 \times 10^{-3}$$

Prerequisite - Unit Conversions

Example: How many kilometers is 100 miles?

Conversion: 1 km $\approx$ 0.62 miles.

$$1 = \frac{1\text{km}}{0.62\text{mi}} = \frac{0.62\text{mi}}{1\text{km}}$$

Answer: $100\text{mi} = 100\text{mi} \cdot \frac{1\text{km}}{0.62\text{mi}} = \frac{100}{0.62}\ \text{km} = 161.3\ \text{km}$

Prerequisite - Unit Conversions

Example: Estimate the US National Debt in Big Macs.

Conversion: 1 Big Mac $= 12.72$ dollars $= 1.272 \times 10^1$ dollars.

US National Debt: 34 trillion dollars $= 3.4 \times 10^{13}$ dollars.

Answer: 3.4×10^{13} dollars $\cdot \frac{1 \text{ Big Mac}}{1.272 \times 10 \text{ dollars}} = \frac{3.4 \times 10^{13}}{1.272 \times 10}$ Big Macs

Prerequisite - Unit Conversions

Example: Estimate the US National Debt in Big Macs.

Conversion: 1 Big Mac $= 12.72$ dollars $= 1.272 \times 10^1$ dollars.

US National Debt: 34 trillion dollars $= 3.4 \times 10^{13}$ dollars.

Answer: 3.4×10^{13} dollars $\cdot \frac{1 \text{ Big Mac}}{1.272 \times 10 \text{ dollars}} = \frac{3.4 \times 10^{13}}{1.272 \times 10}$ Big Macs

THREE TRILLION BIG MACS!

A Fermi Problem

How many golf balls can fit into a bus?

A Fermi Problem

How many golf balls can fit into a bus?

Answer: 5

Fermi Problems

The answer to a **Fermi Problem** is the *exponent* of the actual (precise) answer, when written in scientific notation.

A Silly Example: If you were to put 5497 marbles in an empty pool, how many marbles would be in the pool?

Precise Answer: 5497

Fermi Answer: 3, since $5497 = 5.497 \times 10^3$.

An Overestimate: $9999 = 9.999 \times 10^3 \Rightarrow$ Still Correct!

An Underestimate: $1000 = 1.0 \times 10^3 \Rightarrow$ Still Correct!

How many golf balls can fit into a bus? - Internet Answers

Kansas Golf: $500,000 = 5.0 \times 10^5$
Fermi Answer: 5

youth4work.com: $366,000 = 3.66 \times 10^5$
Fermi Answer: 5

A YouTube Video: $884,520 = 8.84520 \times 10^5$
Fermi Answer: 5

How many golf balls can fit into a bus? - My Answer

Dimensions of a Standard Class C School Bus:

- Length: $21 - 39$ ft $\Rightarrow$ Assume 30 ft
- Width: 10 ft
- Height: 8 ft

Diameter of a Standard Golf Ball: 1.7 in $\Rightarrow$ Assume 2 in

$$(\text{Volume Bus}) \approx 30 \cdot 10 \cdot 8 = 2400 \text{ ft}^3 \cdot \frac{12^3 \text{ in}^3}{1 \text{ ft}^3} = 4147200 \text{ in}^3$$

$$(\text{Volume Golf Ball}) \approx 2 \text{ in} \times 2 \text{ in} \times 2 \text{ in} = 8 \text{ in}^3.$$

$$(\#\text{ Golf Balls in Bus}) = \frac{\text{Volume Bus}}{\text{Volume Golf Ball}} = \frac{4147200 \text{ in}^3}{8 \text{ in}^3} = 673920$$
$$= 6.73920 \times 10^5$$

Fermi Answer: 5

Why are they called Fermi Problems?

Named after the physicist Enrico Fermi (1901-1954):

- "Architect of the Nuclear Age"
- Created world's first artificial nuclear reactor.
- Member of Manhattan Project.
- Nobel Prize (1938)

Fermi Paradox: Seeks to explain why, if there are so many other advanced civilizations in the universe (see Drake equation), we have never seen any of them.

Fermi Competitions

Fermi Competitions involve a timed test consisting of Fermi Problems.

- No internet allowed.
- No graphing calculators allowed.

Scoring:

- 5 points for the correct exponent.
- 3 points for exponent within 1 of the correct exponent.
- 1 point for exponent within 2 of the correct exponent.

My Experience with Fermi Competitions

In January 2019, I was assigned the task of writing the Fermi Competition Exam for the Idaho Science Olympiad.

- I had never heard of Fermi problems before.
- Exam needed to be completed by April 2019.
- The Idaho Science Olympiad gave me just three things:
  - Short (1 page) explanation of Fermi Problems.
  - 2017 ISO Fermi Exam (with answers - no solutions).
  - Contact info for previous Fermi Exam writer.

This book saved me:
Guesstimation: Solving the World's Problems on the Back of a Cocktail Napkin, by Weinstein and Adam

Fermi Competition Strategies - Memorization

Units: SI and Metric units, common imperial units, units for baking and cooking, ancient units (talent, cubit, etc), mole and Coulomb, area (acre and hectare).

Scientific Constants: c, π, e, g, ϕ, Bohr, ...

Populations: World 8×10^9, USA 3×10^8, NYC 8.8×10^6, China 1.4×10^9.

Logarithms: $\log(2) \approx 0.3$, $\log(3) \approx 0.5$, $\log(5) \approx 0.7$, $\log(7) \approx 0.8$

Flight Times: NY, London, LA, Beijing.

Notable Heights: Burj Khalifa 2.7×10^3, Taipei 101 1.6×10^3.

US National Debt: 3.4×10^{13} dollars.

Fermi Competition Strategies - Memorization

From Caleb Chiang's *An Introduction to Fermi Questions*:

- Memorize a few specifics and be able to derive the rest.
- Example: Volume of Earth $\approx 10^{12}\text{km}^3$
  - Volume Jupiter $\approx 1000 \times$ Volume Earth.
  - Volume Sun $\approx 1000 \times$ Volume Jupiter.
  - Assuming spheres, we can derive radii and surface areas.

Fermi Problem Strategies

Derive Unknown Quantities

Problem: Estimate the area, in km^2, of the United States.

Flight time from LA to NY: 6 hours.

Airliner Average Speed: 900km/hr.

Average Length of US: $900 \cdot 6 = 5400 = 5.4 \cdot 10^3 \text{km}$.

Average Width of US: $\frac{1}{3} \cdot 5400\text{km} = 1800 = 1.8 \cdot 10^3 \text{km}$.

Fermi Answer: $5.4 \cdot 10^3 \cdot 1.8 \cdot 10^3 = 9.72 \cdot 10^6 = 10^7 \text{km}^2$.

Fermi Problem Strategies

Derive Unknown Quantities

Problem: Estimate the area, in km^2, of the United States.

Flight time from LA to NY: 6 hours.

Airliner Average Speed: 900km/hr.

Average Length of US: $900 \cdot 6 = 5400 = 5.4 \cdot 10^3 km$.

Average Width of US: $\frac{1}{3} \cdot 5400km = 1800 = 1.8 \cdot 10^3 km$.

Fermi Answer: $5.4 \cdot 10^3 \cdot 1.8 \cdot 10^3 = 9.72 \cdot 10^6 = 10^7 km^2$.

Google Answer: $9,830,000 = 9.83 \times 10^6$

Fermi Problem Strategies

Squeeze the Answer Between Powers of Ten

Problem: How many dogs in the United States?

Are there more than $10^6 = 1,000,000$ dogs in the US?

More than $10^7 = 10,000,000$ dogs in the US?

More than $10^8 = 100,000,000$ dogs in the US?

Recall Population of US: $3 \cdot 10^8$.

Fermi Problem Strategies

Squeeze the Answer Between Powers of Ten

Problem: How many dogs in the United States?

Are there more than $10^6 = 1,000,000$ dogs in the US?

More than $10^7 = 10,000,000$ dogs in the US?

More than $10^8 = 100,000,000$ dogs in the US?

Recall Population of US: $3 \cdot 10^8$.

Google Answer: $90,000,000 = 9 \times 10^7$

Use Logarithms

Problem: 7776^2

Solution: Set $x = 7776^2$.

$$\log x = \log 7776^2 = 2 \log 7776 = 2 \log(2^5 \cdot 3^5)$$

$$= 2(\log(2^5) + \log(3^5)) = 2(5 \log(2) + 5 \log(3))$$

$$= 10(0.3 + 0.5) = 8.$$

$$\log x = 8 \Rightarrow x = 10^8$$

Fermi Answer: 8

Use Logarithms

Problem: 7776^2

Solution: Set $x = 7776^2$.

$$\log x = \log 7776^2 = 2 \log 7776 = 2 \log(2^5 \cdot 3^5)$$

$$= 2(\log(2^5) + \log(3^5)) = 2(5 \log(2) + 5 \log(3))$$

$$= 10(0.3 + 0.5) = 8.$$

$$\log x = 8 \Rightarrow x = 10^8$$

Fermi Answer: 8

Calculator Answer: $60,466,176 \approx 6 \times 10^7 \approx 10^8$

2019 ISO Fermi Competition: Selected Problems

How many different ways can you make change for a dollar?

2019 ISO Fermi Competition: Selected Problems

How many different ways can you make change for a dollar?

Google Answer: 293 Ways $\Rightarrow$ Fermi Answer: 2

2019 ISO Fermi Competition: Selected Problems

How fast does the Earth spin in kilometers per hour?

2019 ISO Fermi Competition: Selected Problems

How fast does the Earth spin in kilometers per hour?

$$D = R \cdot T \Rightarrow R = \frac{D}{T}$$

2019 ISO Fermi Competition: Selected Problems

How fast does the Earth spin in kilometers per hour?

$D = R \cdot T \Rightarrow R = \frac{D}{T}$

$10^{12}\text{km}^3 = 4r^3$

2019 ISO Fermi Competition: Selected Problems

How fast does the Earth spin in kilometers per hour?

$D = R \cdot T \Rightarrow R = \frac{D}{T}$

$10^{12}\text{km}^3 = 4r^3$

Solving for r: $r = (\frac{1}{4})^{1/3} \cdot ((10^4)^3)^{1/3} = 0.63 \cdot 10^4 = 6.3 \cdot 10^3$

2019 ISO Fermi Competition: Selected Problems

How fast does the Earth spin in kilometers per hour?

$D = R \cdot T \Rightarrow R = \frac{D}{T}$

$10^{12}\text{km}^3 = 4r^3$

Solving for r: $r = (\frac{1}{4})^{1/3} \cdot ((10^4)^3)^{1/3} = 0.63 \cdot 10^4 = 6.3 \cdot 10^3$

$D = 2\pi r = 6 \cdot 6.3 \cdot 10^3 = 38 \cdot 10^3 = 4 \cdot 10^4\text{km}$

2019 ISO Fermi Competition: Selected Problems

How fast does the Earth spin in kilometers per hour?

$D = R \cdot T \Rightarrow R = \frac{D}{T}$

$10^{12}\text{km}^3 = 4r^3$

Solving for r: $r = (\frac{1}{4})^{1/3} \cdot ((10^4)^3)^{1/3} = 0.63 \cdot 10^4 = 6.3 \cdot 10^3$

$D = 2\pi r = 6 \cdot 6.3 \cdot 10^3 = 38 \cdot 10^3 = 4 \cdot 10^4\text{km}$

$R = \frac{D}{T} = \frac{4 \cdot 10^4\text{km}}{24\text{hours}} = \frac{4 \cdot 10^4\text{km}}{2.4 \cdot 10\text{hours}} = 1.7 \cdot 10^3$ km/hour.

2019 ISO Fermi Competition: Selected Problems

How fast does the Earth spin in kilometers per hour?

$D = R \cdot T \Rightarrow R = \frac{D}{T}$

$10^{12}\text{km}^3 = 4r^3$

Solving for r: $r = (\frac{1}{4})^{1/3} \cdot ((10^4)^3)^{1/3} = 0.63 \cdot 10^4 = 6.3 \cdot 10^3$

$D = 2\pi r = 6 \cdot 6.3 \cdot 10^3 = 38 \cdot 10^3 = 4 \cdot 10^4\text{km}$

$R = \frac{D}{T} = \frac{4 \cdot 10^4\text{km}}{24\text{hours}} = \frac{4 \cdot 10^4\text{km}}{2.4 \cdot 10\text{hours}} = 1.7 \cdot 10^3$ km/hour.

Google Answer: $1670 = 1.67 \cdot 10^3$ km/hour

2019 ISO Fermi Competition: Selected Problems

Suppose that you cover the Earth with one-dollar bills. How many Big Macs can you buy?

2019 ISO Fermi Competition: Selected Problems

Suppose that you cover the Earth with one-dollar bills. How many Big Macs can you buy?

SA Earth $= 12r^2 = 12 \cdot (6.3 \cdot 10^3)^2 = 476 \cdot 10^6 = 4.76 \cdot 10^8 \text{km}^2$.

2019 ISO Fermi Competition: Selected Problems

Suppose that you cover the Earth with one-dollar bills. How many Big Macs can you buy?

$$\text{SA Earth} = 12r^2 = 12 \cdot (6.3 \cdot 10^3)^2 = 476 \cdot 10^6 = 4.76 \cdot 10^8 \text{km}^2.$$

$$\text{Dollar Bill} = 6\text{in} \times 2.5\text{in} = 15\text{in}^2 = 1.5 \cdot 10\text{in}^2 = 10\text{in}^2.$$

2019 ISO Fermi Competition: Selected Problems

Suppose that you cover the Earth with one-dollar bills. How many Big Macs can you buy?

$$\text{SA Earth} = 12r^2 = 12 \cdot (6.3 \cdot 10^3)^2 = 476 \cdot 10^6 = 4.76 \cdot 10^8 \text{km}^2.$$

$$\text{Dollar Bill} = 6\text{in} \times 2.5\text{in} = 15\text{in}^2 = 1.5 \cdot 10\text{in}^2 = 10\text{in}^2.$$

$$\begin{aligned}\text{SA Earth} &= 4.76 \cdot 10^8 \text{km}^2 \cdot \frac{(1000)^2 \text{m}^2}{1\text{km}^2} \cdot \frac{(3.3)^2 \text{ft}^2}{1\text{m}^2} \cdot \frac{12^2 \text{in}^2}{1\text{ft}^2} \\ &= 4.76 \cdot 10^8 \cdot 10^6 \cdot 10.89 \cdot 144 \text{ in}^2 \\ &= 7464 \cdot 10^{14} \text{in}^2 = 7.5 \cdot 10^{17} \text{in}^2 = 10^{18} \text{in}^2.\end{aligned}$$

2019 ISO Fermi Competition: Selected Problems

Suppose that you cover the Earth with one-dollar bills. How many Big Macs can you buy?

$$\text{SA Earth} = 12r^2 = 12 \cdot (6.3 \cdot 10^3)^2 = 476 \cdot 10^6 = 4.76 \cdot 10^8 \text{km}^2.$$

$$\text{Dollar Bill} = 6\text{in} \times 2.5\text{in} = 15\text{in}^2 = 1.5 \cdot 10\text{in}^2 = 10\text{in}^2.$$

$$\begin{aligned}\text{SA Earth} &= 4.76 \cdot 10^8 \text{km}^2 \cdot \frac{(1000)^2\text{m}^2}{1\text{km}^2} \cdot \frac{(3.3)^2\text{ft}^2}{1\text{m}^2} \cdot \frac{12^2\text{in}^2}{1\text{ft}^2} \\ &= 4.76 \cdot 10^8 \cdot 10^6 \cdot 10.89 \cdot 144 \text{ in}^2 \\ &= 7464 \cdot 10^{14}\text{in}^2 = 7.5 \cdot 10^{17}\text{in}^2 = 10^{18}\text{in}^2.\end{aligned}$$

$$\text{Number of Dollar Bills} = \frac{10^{18} \text{ in}^2}{10 \text{ in}^2} = 10^{17} \text{ dollar bills.}$$

2019 ISO Fermi Competition: Selected Problems

Suppose that you cover the Earth with one-dollar bills. How many Big Macs can you buy?

$$\text{SA Earth} = 12r^2 = 12 \cdot (6.3 \cdot 10^3)^2 = 476 \cdot 10^6 = 4.76 \cdot 10^8 \text{km}^2.$$

$$\text{Dollar Bill} = 6\text{in} \times 2.5\text{in} = 15\text{in}^2 = 1.5 \cdot 10\text{in}^2 = 10\text{in}^2.$$

$$\begin{aligned}\text{SA Earth} &= 4.76 \cdot 10^8 \text{km}^2 \cdot \frac{(1000)^2\text{m}^2}{1\text{km}^2} \cdot \frac{(3.3)^2\text{ft}^2}{1\text{m}^2} \cdot \frac{12^2\text{in}^2}{1\text{ft}^2} \\ &= 4.76 \cdot 10^8 \cdot 10^6 \cdot 10.89 \cdot 144 \text{ in}^2 \\ &= 7464 \cdot 10^{14}\text{in}^2 = 7.5 \cdot 10^{17}\text{in}^2 = 10^{18}\text{in}^2.\end{aligned}$$

$$\text{Number of Dollar Bills} = \frac{10^{18} \text{ in}^2}{10 \text{ in}^2} = 10^{17} \text{ dollar bills.}$$

$$\text{Price Big Mac} = 12.72 = 1.272 \cdot 10 = 10 \text{ dollars.}$$

2019 ISO Fermi Competition: Selected Problems

Suppose that you cover the Earth with one-dollar bills. How many Big Macs can you buy?

$$\text{SA Earth} = 12r^2 = 12 \cdot (6.3 \cdot 10^3)^2 = 476 \cdot 10^6 = 4.76 \cdot 10^8 \text{km}^2.$$

$$\text{Dollar Bill} = 6\text{in} \times 2.5\text{in} = 15\text{in}^2 = 1.5 \cdot 10\text{in}^2 = 10\text{in}^2.$$

$$\begin{aligned}\text{SA Earth} &= 4.76 \cdot 10^8 \text{km}^2 \cdot \frac{(1000)^2\text{m}^2}{1\text{km}^2} \cdot \frac{(3.3)^2\text{ft}^2}{1\text{m}^2} \cdot \frac{12^2\text{in}^2}{1\text{ft}^2} \\ &= 4.76 \cdot 10^8 \cdot 10^6 \cdot 10.89 \cdot 144 \text{ in}^2 \\ &= 7464 \cdot 10^{14}\text{in}^2 = 7.5 \cdot 10^{17}\text{in}^2 = 10^{18}\text{in}^2.\end{aligned}$$

$$\text{Number of Dollar Bills} = \frac{10^{18} \text{ in}^2}{10 \text{ in}^2} = 10^{17} \text{ dollar bills.}$$

$$\text{Price Big Mac} = 12.72 = 1.272 \cdot 10 = 10 \text{ dollars.}$$

$$\text{Number of Big Macs} = \frac{10^{17}}{10} = 10^{16} \text{ Big Macs. Fermi Answer: 16}$$

2019 ISO Fermi Competition: Selected Problems

Suppose that you cover the Earth with one-dollar bills. How many Big Macs can you buy?

$$\text{SA Earth} = 12r^2 = 12 \cdot (6.3 \cdot 10^3)^2 = 476 \cdot 10^6 = 4.76 \cdot 10^8 \text{km}^2.$$

$$\text{Dollar Bill} = 6\text{in} \times 2.5\text{in} = 15\text{in}^2 = 1.5 \cdot 10\text{in}^2 = 10\text{in}^2.$$

$$\begin{aligned}\text{SA Earth} &= 4.76 \cdot 10^8 \text{km}^2 \cdot \frac{(1000)^2\text{m}^2}{1\text{km}^2} \cdot \frac{(3.3)^2\text{ft}^2}{1\text{m}^2} \cdot \frac{12^2\text{in}^2}{1\text{ft}^2} \\ &= 4.76 \cdot 10^8 \cdot 10^6 \cdot 10.89 \cdot 144 \text{ in}^2 \\ &= 7464 \cdot 10^{14}\text{in}^2 = 7.5 \cdot 10^{17}\text{in}^2 = 10^{18}\text{in}^2.\end{aligned}$$

$$\text{Number of Dollar Bills} = \frac{10^{18} \text{ in}^2}{10 \text{ in}^2} = 10^{17} \text{ dollar bills.}$$

$$\text{Price Big Mac} = 12.72 = 1.272 \cdot 10 = 10 \text{ dollars.}$$

$$\text{Number of Big Macs} = \frac{10^{17}}{10} = 10^{16} \text{ Big Macs. Fermi Answer: 16}$$

2019 ISO Fermi Competition: Selected Problems

$$(10^{10} + 10^9)^{10} \cdot (10^{10} + 10^8)^9 \cdot (10^{10} + 10^7)^8 \cdot (10^{10} + 10^6)^7$$

2019 ISO Fermi Competition: Selected Problems

$$(10^{10} + 10^9)^{10} \cdot (10^{10} + 10^8)^9 \cdot (10^{10} + 10^7)^8 \cdot (10^{10} + 10^6)^7$$

Notice that $10^{10} + 10^9 \approx 10^{10}$.

2019 ISO Fermi Competition: Selected Problems

$$(10^{10} + 10^9)^{10} \cdot (10^{10} + 10^8)^9 \cdot (10^{10} + 10^7)^8 \cdot (10^{10} + 10^6)^7$$

Notice that $10^{10} + 10^9 \approx 10^{10}$.

So, the sum reduces to $10^{100} \cdot 10^{90} \cdot 10^{80} \cdot 10^{70} = 10^{340}$.

2019 ISO Fermi Competition: Selected Problems

$$(10^{10} + 10^9)^{10} \cdot (10^{10} + 10^8)^9 \cdot (10^{10} + 10^7)^8 \cdot (10^{10} + 10^6)^7$$

Notice that $10^{10} + 10^9 \approx 10^{10}$.

So, the sum reduces to $10^{100} \cdot 10^{90} \cdot 10^{80} \cdot 10^{70} = 10^{340}$.

Fermi Answer: 340

2019 ISO Fermi Competition: Selected Problems

The sum of all numbers of the form $29^m \cdot 345^n$, where m and n are non-negative integers with $m + n = 10$.

2019 ISO Fermi Competition: Selected Problems

The sum of all numbers of the form $29^m \cdot 345^n$, where m and n are non-negative integers with $m + n = 10$.

$345 = 3.45 \cdot 10^2 \approx 3 \cdot 10^2$ and $29 = 2.9 \cdot 10 \approx 3 \cdot 10$.

2019 ISO Fermi Competition: Selected Problems

The sum of all numbers of the form $29^m \cdot 345^n$, where m and n are non-negative integers with $m + n = 10$.

$345 = 3.45 \cdot 10^2 \approx 3 \cdot 10^2$ and $29 = 2.9 \cdot 10 \approx 3 \cdot 10$.

$29^0 \cdot 345^{10} + 29^1 \cdot 345^9 + 29^2 \cdot 345^8 + ...$

2019 ISO Fermi Competition: Selected Problems

The sum of all numbers of the form $29^m \cdot 345^n$, where m and n are non-negative integers with $m + n = 10$.

$345 = 3.45 \cdot 10^2 \approx 3 \cdot 10^2$ and $29 = 2.9 \cdot 10 \approx 3 \cdot 10$.

$29^0 \cdot 345^{10} + 29^1 \cdot 345^9 + 29^2 \cdot 345^8 + ...$

$\approx (3 \cdot 10)^0 \cdot (3 \cdot 10^2)^{10} + (3 \cdot 10)^1 \cdot (3 \cdot 10^2)^9 + (3 \cdot 10)^2 \cdot (3 \cdot 10^2)^8 + ...$

2019 ISO Fermi Competition: Selected Problems

The sum of all numbers of the form $29^m \cdot 345^n$, where m and n are non-negative integers with $m + n = 10$.

$345 = 3.45 \cdot 10^2 \approx 3 \cdot 10^2$ and $29 = 2.9 \cdot 10 \approx 3 \cdot 10$.

$29^0 \cdot 345^{10} + 29^1 \cdot 345^9 + 29^2 \cdot 345^8 + ...$

$\approx (3 \cdot 10)^0 \cdot (3 \cdot 10^2)^{10} + (3 \cdot 10)^1 \cdot (3 \cdot 10^2)^9 + (3 \cdot 10)^2 \cdot (3 \cdot 10^2)^8 + ...$

$= 3^{10} \cdot 10^{20} + 3^{10} \cdot 10^{19} + 3^{10} \cdot 10^{18} + ...$

2019 ISO Fermi Competition: Selected Problems

The sum of all numbers of the form $29^m \cdot 345^n$, where m and n are non-negative integers with $m + n = 10$.

$345 = 3.45 \cdot 10^2 \approx 3 \cdot 10^2$ and $29 = 2.9 \cdot 10 \approx 3 \cdot 10$.

$29^0 \cdot 345^{10} + 29^1 \cdot 345^9 + 29^2 \cdot 345^8 + ...$

$\approx (3 \cdot 10)^0 \cdot (3 \cdot 10^2)^{10} + (3 \cdot 10)^1 \cdot (3 \cdot 10^2)^9 + (3 \cdot 10)^2 \cdot (3 \cdot 10^2)^8 + ...$

$= 3^{10} \cdot 10^{20} + 3^{10} \cdot 10^{19} + 3^{10} \cdot 10^{18} + ...$

$10 \log(345) = 10 \log(3 \cdot 5 \cdot 23) = 10(\log(3) + \log(5) + \log(23))$

2019 ISO Fermi Competition: Selected Problems

The sum of all numbers of the form $29^m \cdot 345^n$, where m and n are non-negative integers with $m + n = 10$.

$345 = 3.45 \cdot 10^2 \approx 3 \cdot 10^2$ and $29 = 2.9 \cdot 10 \approx 3 \cdot 10$.

$29^0 \cdot 345^{10} + 29^1 \cdot 345^9 + 29^2 \cdot 345^8 + ...$

$\approx (3 \cdot 10)^0 \cdot (3 \cdot 10^2)^{10} + (3 \cdot 10)^1 \cdot (3 \cdot 10^2)^9 + (3 \cdot 10)^2 \cdot (3 \cdot 10^2)^8 + ...$

$= 3^{10} \cdot 10^{20} + 3^{10} \cdot 10^{19} + 3^{10} \cdot 10^{18} + ...$

$10 \log(345) = 10 \log(3 \cdot 5 \cdot 23) = 10(\log(3) + \log(5) + \log(23))$

$= 10(2 \log(3) + \log(5) + \log(7)) = 10(1 + 0.7 + 0.8) = 25$

2019 ISO Fermi Competition: Selected Problems

The sum of all numbers of the form $29^m \cdot 345^n$, where m and n are non-negative integers with $m + n = 10$.

$345 = 3.45 \cdot 10^2 \approx 3 \cdot 10^2$ and $29 = 2.9 \cdot 10 \approx 3 \cdot 10$.

$29^0 \cdot 345^{10} + 29^1 \cdot 345^9 + 29^2 \cdot 345^8 + ...$

$\approx (3 \cdot 10)^0 \cdot (3 \cdot 10^2)^{10} + (3 \cdot 10)^1 \cdot (3 \cdot 10^2)^9 + (3 \cdot 10)^2 \cdot (3 \cdot 10^2)^8 + ...$

$= 3^{10} \cdot 10^{20} + 3^{10} \cdot 10^{19} + 3^{10} \cdot 10^{18} + ...$

$10 \log(345) = 10 \log(3 \cdot 5 \cdot 23) = 10(\log(3) + \log(5) + \log(23))$

$= 10(2 \log(3) + \log(5) + \log(7)) = 10(1 + 0.7 + 0.8) = 25$

Fermi Answer: 25

An Invitation

An Invitation

Oregon needs more Fermi Competition Teams.

An Invitation

Oregon needs more Fermi Competition Teams.

I need friends...

An Invitation

Oregon needs more Fermi Competition Teams.

I need friends...

who want to join me in solving Fermi Problems.