

Fermi Questions

2012 Athens Area Science Olympiad Invitational

School _____ Team# _____

1. How many 500 milliliter bottles of water laid end to end would it take to stretch across the state of Pennsylvania at its widest point?
2. How much water in femtoliters would be contained in the bottles in the question #1?
3. How much water in gallons will be used by the populace of Pennsylvania in a year?
4. According to the 2010 census what is the US population under the age of 18?
5. According to the 2010 census (and using the Per capita money income (2009 dollars)), what is the expected total annual income for the state of Pennsylvania's population?
6. If Pennsylvania's expected annual income (question #5) was available in \$20 dollar bills and was laid end to end, how far, in centimeters, would the bills reach?
7. 2^{47}
8. How many smart phones are owned by the US Population?
9. In light years, how tall is the tallest building in the world?

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10. How far, in centimeters, will light travel in one fortnight?
11. In millimeters, what is the distance across the Milky Way Galaxy?
12. How many barns (bn) are in 1 square attometer?
13. $23! \cdot 37! \cdot 41!$
14. How many hectares (hec) are there in the United States?
15. What is the circumference of the earth in petameters?
16. What is the circumference of the Earth's orbit in kilometers?
17. The average American born will need how many pounds of coal in a lifetime?
18. $\sqrt{\sqrt{49!}}$ (where $\sqrt{}$ represents square root)
19. If every person living in New York State donated a nickel to charity, how many dollars would have been donated?
20. How much would the mass of this donation (question #19) be in picograms?

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21. How high a stack, in miles, would be formed if the nickels in (question #19) were placed one atop the other?
22. 2^{87}
23. How many hours would it take Americans to consume enough bottled water to circle the entire equator with plastic bottles laid end to end?
24. How many jelly beans would it take to fill a regulation NBA basketball?
25. What is the surface area of Mars in square meters?
26. What fraction of one year is equal to one second?
27. What is the number of electrons in a liter of water?
28. How many points will be scored during the shortened 2011-2012 NBA season?
29. How many servings of Coca-Cola are served every year worldwide?
30. How many, on average, of servings of Coca Cola (question #29) is that per person in the world per year?
31. How many yoctoseconds did it take the 2011 New York Marathon top men's finisher to complete the race?

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32. What is the dollar total of the money that comes in a standard Monopoly game?
33. The odds in winning the Mega Millions lottery in the US are one in how many?
34. How many quills does the typical porcupine have?
35. How many males residing in the US are fully or partially color blind?
36. How many dogs are owned in the United States?
37. If all of the Division C Science Olympiad team members participating today had taken a 10 minute shower today, how many gallons of water would have been used? [UPLOADER'S NOTE: ATHENS' INVITATIONAL HAD 30 TEAMS COMPETING.]
38. How many seconds of television does the average American watch in a year?
39. If Subway decided to give a free sub to everyone in the US and everyone took them up on the offer at the same time, what would be the average number of people in line at each store in the US?
40. How many pop cans laid end to end would it take make a round trip between New York City and Los Angeles?
41. What is the mass, in zettagrams, of the average Division C Science Olympiad Team's "brain power" (i.e. grey matter)?
42. In cubic meters, what is the volume of the Sun?

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Names: _____ School: _____ Team # _____

Write your answers *** **EXPONENTS ONLY** *** to the right of the appropriate question number on this sheet. Calculators, slide rules, crib sheets, etc. are **NOT** allowed and will cause the team to be disqualified!!!

	<u>Score</u>		<u>Score</u>		<u>Score</u>
1. _____	5 3 1 0	15. _____	5 3 1 0	29. _____	5 3 1 0
2. _____	5 3 1 0	16. _____	5 3 1 0	30. _____	5 3 1 0
3. _____	5 3 1 0	17. _____	5 3 1 0	31. _____	5 3 1 0
4. _____	5 3 1 0	18. _____	5 3 1 0	32. _____	5 3 1 0
5. _____	5 3 1 0	19. _____	5 3 1 0	33. _____	5 3 1 0
6. _____	5 3 1 0	20. _____	5 3 1 0	34. _____	5 3 1 0
7. _____	5 3 1 0	21. _____	5 3 1 0	35. _____	5 3 1 0
8. _____	5 3 1 0	22. _____	5 3 1 0	36. _____	5 3 1 0
9. _____	5 3 1 0	23. _____	5 3 1 0	37. _____	5 3 1 0
10. _____	5 3 1 0	24. _____	5 3 1 0	38. _____	5 3 1 0
11. _____	5 3 1 0	25. _____	5 3 1 0	39. _____	5 3 1 0
12. _____	5 3 1 0	26. _____	5 3 1 0	40. _____	5 3 1 0
13. _____	5 3 1 0	27. _____	5 3 1 0	41. _____	5 3 1 0
14. _____	5 3 1 0	28. _____	5 3 1 0	42. _____	5 3 1 0
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	_____		_____		_____

Time: _____

Tie Breaker #1 _____ (# of 5's)

Score: _____

Tie Breaker #2 _____ (Time)

Place: _____

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ANSWER KEY

1. How many 500 milliliter bottles of water laid end to end would it take to stretch across the state of Pennsylvania at its widest point?

PA widest point = 283 miles

$$283 \text{ mi} \times 5280 \text{ ft per mi} \times 12 \text{ in per ft} / 8 \text{ in per bottle} = 2,241,360 = 2.24 \times 10^6$$

FA 6

http://www.netstate.com/states/geography/pa_geography.htm

2. How much water in femtoliters would be contained in the bottles in the question #1?

$$2,241,360 \text{ bottles} \times 500 \text{ mL per bottle} \times 10^{12} = 1.12 \times 10^9 \text{ mL} \times 10^{12} = 1.12 \times 10^{21}$$

FA 21

3. How much water in gallons will be used by the populace of Pennsylvania in a year?

$$12,702,379 \text{ people} \times 100 \text{ gallons per person per day} \times 365 \text{ days per year} = 4.64 \times 10^{11}$$

FA 11

<http://quickfacts.census.gov/qfd/states/42000.html>

<http://ga.water.usgs.gov/edu/qa-home-percapita.html>

4. According to the 2010 census what is the US population under the age of 18?

$$24\% \text{ are under the age of 18 thus } .24 \times 308,745,538 = 7.41 \times 10^7$$

FA 8

<http://quickfacts.census.gov/qfd/states/00000.html>

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5. According to the 2010 census (and using the Per capita money income (2009 dollars)), what is the expected total annual income for the state of Pennsylvania's population?

$$\$26,678 * 12,702,379 = \$3.39 \times 10^{11}$$

FA 11

<http://quickfacts.census.gov/qfd/states/00000.html>

6. If Pennsylvania's expected annual income (question #5) was available in \$20 dollar bills and was laid end to end, how far, in centimeters, would the bills reach?

$$\$3.39 \times 10^{11} / \$20 * 6 \text{ in per } \$ * 2.54 \text{ cm per in} = 2.58 \times 10^{11}$$

FA 11

7. 2^{47}

$$= 1.41 \times 10^{14}$$

FA 14

8. How many smart phones are owned by the US Population?

35% of American adults own a smart phone. So 35% of 76% of 308,745,538 (see #4)

$$.35 * .76 * 308,745,538 = 8.21 \times 10^7$$

FA 8

<http://pewinternet.org/Reports/2011/Cell-Phones.aspx>

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9. In light years, how tall is the tallest building in the world?

At over 828 meters, Burj Khalifa is the tallest building in the world.

A light year is 9.46×10^{15} meter. $8.28 \times 10^2 / 9.46 \times 10^{15} = 8.75 \times 10^{-14}$

FA -13

<http://heasarc.nasa.gov/docs/cosmic/glossary.html#kpc>

<http://www.burjkhalifa.ae/language/en-us/the-tower/fact-figures.aspx>

10. How far, in centimeters, will light travel in one fortnight?

14 days x 24 hrs per day x 3600 sec per hr x 299,792,458 m per sec x 100 cm per m = 3.63×10^{16}

FA 16

11. In millimeters, what is the distance across the Milky Way Galaxy?

The Milky Way is about 1,000,000,000,000,000 km

1×10^{18} km x 10^6 mm per km = 10^{24}

FA 24

http://heasarc.nasa.gov/docs/cosmic/milkyway_info.html

12. How many barns (bn) are in 1 square attometer?

1 sq attometer = 1×10^{-8} barns.

FA -8

13. $23! \cdot 37! \cdot 41!$

= 1.19×10^{115}

FA 115

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14. How many hectares (hec) are there in the United States?

$$3,531,905.43 \text{ sq mi is } 914759307.053 \text{ hec} = 9.15 \times 10^8$$

FA 9

<http://quickfacts.census.gov/qfd/states/42000.html>

15. What is the circumference of the earth in petameters?

$$40,075 \text{ km} \times 10^{-12} \text{ km per pentameters} = 4 \times 10^4 \times 10^{-12} = 4 \times 10^{-8}$$

FA -8

<http://www.universetoday.com/26461/circumference-of-the-earth/>

16. What is the circumference of the Earth's orbit in kilometers?

$$\text{The circumference of the Earth's orbit is about } 940 \text{ million kilometers} = 9.4 \times 10^8$$

FA 9

http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/970401c.html

17. The average American born will need how many pounds of coal in a lifetime?

The average American born will need how many pounds of coal in a lifetime?

$$529,097 \text{ lbs} = 5.29 \times 10^5$$

FA 6

<http://www.mii.org/pdfs/baby.pdf>

18. $\sqrt{\sqrt{49!}}$ (where $\sqrt{\quad}$ represents square root)

$$= 7.05 \times 10^7$$

FA 8

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19. If every person living in New York State donated a nickel to charity, how many dollars would have been donated?

$$19,378,102 \text{ people} \times \$0.05 = 1.94 \times 10^7 * 5 \times 10^{-2} \text{ \$/person} = 9.70 \times 10^5$$

FA 6

20. How much would the mass of this donation (question #19) be in picograms?

$$19,378,102 \text{ nickels} \times 5 \text{ g per nickel} \times 10^{12} \text{ picograms per gram} = 1.94 \times 10^7 \times 5 \times 10^{12} = 9.70 \times 10^{19}$$

FA 20

http://www.usmint.gov/about_the_mint/?action=coin_specifications

21. How high a stack, in miles, would be formed if the nickels in (question #19) were placed one atop the other?

$$1.94 \times 10^7 \times 1.95 \text{ mm} \times 6.21 \times 10^{-7} \text{ mile/mm} = 2.35 \times 10$$

FA 1

http://www.usmint.gov/about_the_mint/?action=coin_specifications

22. 2^{87}

$$= 1.55 \times 10^{26}$$

FA 26

23. How many hours would it take Americans to consume enough bottled water to circle the entire equator with plastic bottles laid end to end.

Every 27 hours Americans consume enough bottled water to circle the entire equator with plastic bottles stacked end to end.

FA 1

<http://static.ewg.org/reports/2010/bottledwater2010/pdf/2011-bottledwater-scorecard-report.pdf>

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24. How many jelly beans would it take to fill a regulation NBA basketball?

= A 1 inch cube will fit about 4 jelly beans

= A basketball's radius is 4.7 inches, thus the volume of the ball is $(4/3)\pi * r^3$

$$4.34 \times 10^2 \text{ in}^3 \cdot 4 \text{ jelly beans per in}^3 = 1.74 \times 10^3$$

FA 3

<http://www.insidehoops.com/new-composite-official-nba-game-ball.shtml>

25. What is the surface area of Mars in square meters?

Mars' radius is 3,389.5 km = 3.39×10^6 m

$$\text{Surface area is } 4\pi r^2 = 1.44 \times 10^{14}$$

FA 14

<http://www.universetoday.com/22673/size-of-mars/>

26. What fraction of one year is equal to one second?

$$1/(365 * 24 * 60 * 60) = 3.17 \times 10^{-8}$$

FA -8

27. What is the number of electrons in a liter of water?

mass water = 1000 g

moles water = $1000 / 18.0 = 55.6$

molecules = $55.6 \times 6.02 \times 10^{23} = 3.35 \times 10^{25}$

electrons = $10 \times 3.35 \times 10^{25} = 3.35 \times 10^{26}$

FA 26

28. How many points will be scored during the shortened 2011-2012 NBA season?

$$990 \text{ games} * \text{avg } 95 \text{ pts/team/game} * 2 \text{ teams/game} = 188100 = 1.89 \times 10^5$$

FA 5

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29. How many servings of Coca-Cola are served every year worldwide?

$$1.6 \text{ billion/day} * 365 \text{ days /year} = 5.84 \times 10^{11}$$

FA 12

<http://www.coca-cola.co.uk/about-us/coca-cola-by-numbers.html>

30. How many, on average, of servings of Coca Cola (question #29) is that per person in the world per year?

$$5.84 \times 10^{11} / 6.99 \times 10^9 = 8.35 \times 10^1$$

FA 2

<http://www.census.gov/main/www/popclock.html>

31. How many yoctoseconds did it take the 2011 New York Marathon top men's finisher to complete the race?

$$\text{Finish } 2 \text{ hrs } 5 \text{ min } 5 \text{ sec} = 7.51 \times 10^3 \text{ seconds} \times 10^{24} \text{ yoctoseconds per second} = 7.51 \times 10^{27}$$

FA 28

<http://www.nycmarathon.org/Results.htm>

32. What is the dollar total of the money that comes in a standard Monopoly game?

\$15,140

FA 4

<http://www.funtrivia.com/en/Hobbies/Monopoly-5458.html>

33. The odds in winning the Mega Millions lottery in the US are one in how many?

175,711,536

FA 8

http://www.michigan.gov/lottery/0,4603,7-110-46442_812_15265---,00.html

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34. How many quills does the typical porcupine have?

30,000

FA 4

<http://www.nhptv.org/natureworks/porcupine.htm>

35. How many males residing in the US are fully or partially color blind?

1 in 10 males in the US are fully or partially color blind.

Thus 10% of 49.2% (% of population that is male) of 308,745,538 = 1.52×10^7

FA 7

<http://www.vischeck.com/info/wade.php>

36. How many dogs are owned in the United States?

78.2 million = 7.82×10^7

FA 8

http://www.humanesociety.org/issues/pet_overpopulation/facts/pet_ownership_statistics.html

37. If all of the Division C Science Olympiad team members participating today had taken a 10 minute shower today, how many gallons of water would have been used?

30 teams x 15 team members x 10 min/shower x 2 gallons / min = 9,000 = 9×10^3

FA 4

<http://ga.water.usgs.gov/edu/qa-home-percapita.html>

38. How many seconds of television does the average American watch in a year?

34 hrs/week * 3600 sec/hr * 52 wks/yr = 6364800 = 6.36×10^6

FA 7

<http://www.tv.com/news/how-much-television-do-you-watch-per-week-24833/>

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39. If Subway decided to give a free sub to everyone in the US and everyone took them up on the offer at the same time, what would be the average number of people in line at each store in the US?

24705 stores. US population 308,745,538

$$3.09 \times 10^8 / 2.47 \times 10^4 = 1.25 \times 10^4$$

FA 4

<http://www.subway.com/subwayroot/exploreourworld.aspx>

40. How many pop cans laid end to end would it take make a round trip between New York City and Los Angeles?

$$2443.79 \text{ miles} \times 2 \text{ (round trip)} \times 63360 \text{ in per mile} / 4.75 \text{ in per can} = 6.52 \times 10^7$$

FA 8

http://www.mapcrow.info/Distance_between_New_York_US_and_Los_Angeles_US.html

41. What is the mass, in zettagrams, of the average Division C Science Olympiad Team's "brain power" (i.e. grey matter)?

$$1300 \text{ grams/brain} \times 15 \text{ team members} = 19500 \text{ g}$$

$$1 \text{ gram} = 1.0 \times 10^{-21} \text{ zettagrams}$$

$$19500 \text{ g} = 1.9 \times 10^{17} \text{ zettagram}$$

FA 17

<http://faculty.washington.edu/chudler/facts.html>

42. In cubic meters, what is the volume of the Sun?

The total volume of the Sun is 1.4×10^{27} cubic meters

FA 27

<http://www.universetoday.com/18132/how-big-is-the-sun/>