# Captains Tryouts 2017 · Fermi Questions

### Written by Aditya Shah/Seven Lakes High School

Name(s): _____

Total Score:_____/250

**Directions:** Determine the answer to the following problems to the best of your ability to the **nearest power of 10**. For example, if you estimate the answer to a certain question to be $3 \times 10^4$, then the **Fermi Answer** is **4**. Likewise, if you estimate the answer to a certain question to be $9 \times 10^6$, then the **Fermi Answer** is **7**. Write your answers in the blank to the right of the question. Only numbers written in these blanks will be scored! You may use any whitespace on the test for scratch work.

**Scoring:** A correct Fermi Answer is worth 5 points, a Fermi Answer 1 off is worth 3 points, and a Fermi Answer 2 off is worth 1 point. Fermi Answers off by 3 or more are worth 0 points. There is no penalty for guessing. All questions are weighted the same, but may not necessarily be of the same difficulty.

1. What is $\log_{2017} 2$?

   1. _____

2. Evaluate 15!

   2. _____

3. What is $^3 3$? Hint: this does not mean $3^3$, nor is it a typo.

   3. _____

4. What is $19^{25}$?

   4. _____

5. What is $123456 \times 123456789$?

   5. _____

6. What is $\pi^{123}$?

   6. _____

7. What is $137^9$?

   7. _____

8. What is $75^{56}$?

   8. _____

9. How many different ways are there to arrange 8 objects in a circle?

9. _____

10. What is 4 ↑↑ 3? Note: The double up arrow (↑↑) signifies iterated exponentiation (referred to as tetration). Just like multiplication is repeated addition and exponentiation is repeated multiplication, tetration is repeated exponentiation.

10. _____

11. How many different ways are there to shuffle a deck of cards? A deck of cards has 52 cards in it.

11. _____

12. What is the height of the Great Pyramid of Giza, as a multiple of the width of a water droplet within a cloud?

12. _____

13. How many bowling balls would it take to fill the Atlantic Ocean?

13. _____

14. How many bacterial cells reside in or on the human body?

14. _____

15. How many steps would it take an average human to travel from Stockholm to Moscow?

15. _____

16. How many times more massive is the Sun than the Moon?

16. _____

17. Some people like to say that Jupiter is a "very small failed star" that isn't quite big enough to begin fusing hydrogen. However, such a statement is somewhat misleading, since the least massive stars we know are still much more massive than Jupiter. How many Jupiter masses are the lowest mass stars?

17. _____

18. How many cells are in the human body?

18. _____

19. Aquaporin is a transport protein that transports water across a cell membrane through facilitated diffusion. How many water molecules can one of them transport in one second?

19. _____

20. Based on the question above, how long, in years, would it take for one aquaporin protein to transport an Avogadro's number of water molecules?

20. _____

21. How many US dollar coins would it take in order to create a stack from Paris to Mumbai?

21. _____

22. What number of M&Ms would you have to lay on the surface area of the star Betelgeuse (which has 18 times the mass of the Sun) in order to fully cover it?

22. _____

23. How many bytes of data do Facebook users produce per day?

23. _____

24. How tall is the Eiffel Tower, in meters?

24. _____

25. How tall is the tallest tree on Earth, in centimeters?

25. _____

26. What is the width of a protein $\alpha$ helix, in meters?

26. _____

27. How many golf balls would it take to equal the mass of Earth?

27. _____

28. How thick is a bacterial flagellum, in nanometers?

28. _____

29. How much does an HIV-1 virus weigh, in Newtons?

29. _____

30. How many grand pianos would it take to equal the weight of the Hubble Space Telescope?

30. _____

31. What is the mass of all of the fish on Earth, in kilograms?

31. _____

32. Divide the price of a McDonald's double cheeseburger by the price of Burj Khalifa (the world's tallest building).

32. _____

33. How many carbon atoms would it take in order to create a single-file line of atoms around the Earth?

33. _____

34. How many years would it take an empty cement mixer truck to travel from Washington DC to Juneau AK?

34. _____

35. How many milliliters are in the average blood donation?

35. _____

36. How many caffeine molecules does it take to equal the weight of a US dime?

36. _____

37. How many insects live on the earth?

37. _____

38. How many red blood cells are needed to blanket the surface area of the Indian Ocean?

38. _____

39. How many bacteria live in your mouth?

39. _____

40. What is the land area of the United States, in square centimeters?

40. _____

41. How much mass, in kilograms, is the Sun losing every second?

41. _____

42. How many moles of phenolphthalein ($C_{20}H_{14}O_4$) are needed to equal the mass found the question above?

42. _____

43. Find the number of oxygen molecules inhaled in one human breath multiplied by the number of hemoglobins it would take to bind them all, assuming all hemoglobins used become fully saturated.

43. _____

44. Determine the ratio of the kinetic energy of 4 moles of $H_2$ gas (molar mass: 2 g/mol) to that of 5 moles of $N_2$ gas (molar mass: 28.0 g/mol) at STP.

44. _____

45. How many moles of of ammonia that could be produced by the Haber Process, using all the hydrogen gas in the sun and an equal number of moles of nitrogen gas?

45. _____

46. How many structural isomers would $C_{99}H_{200}$ have?

46. _____

47. What is the molar concentration of aqueous $Cu(NO_3)_3$ with an absorbance of 0.35 as measured by a spectrophotometer with a path length of 0.01? The solution has a molar absorptivity constant of 7.8 $M^{-1}cm^{-1}$.

47. _____

48. What is the wavelength, in meters, likely used by the spectrophotometer to determine absorbance of the above solution?

48. _____

49. What is the melting point of Helium, in Kelvin?

49. _____

50. What is the force required to break a covalent bond, in Newtons?

50. _____