

# Captains Tryouts 2017 · Fermi Questions · Key

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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.     **-1**    

2. Evaluate  $15!$

2.     **12**    

3. What is  $^33$ ? Hint: this does not mean  $3^3$ , nor is it a typo.

3.     **13**    

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

4.     **32**    

5. What is  $123456 \times 123456789$ ?

5.     **13**    

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

6.     **61**    

7. What is  $137^9$ ?

7.     **19**    

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

8.     **105**

9. How many different ways are there to arrange 8 objects in a circle?  
9. 3
10. What is  $4 \uparrow\uparrow 3$ ? Note: The double up arrow ( $\uparrow\uparrow$ ) signifies iterated exponentiation (referred to as tetration). Just like multiplication is repeated addition and exponentiation is repeated multiplication, tetration is repeated exponentiation.  
10. 154
11. How many different ways are there to shuffle a deck of cards? A deck of cards has 52 cards in it.  
11. 68
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. 7
13. How many bowling balls would it take to fill the Atlantic Ocean?  
13. 20
14. How many bacterial cells reside in or on the human body?  
14. 14
15. How many steps would it take an average human to travel from Stockholm to Moscow?  
15. 6
16. How many times more massive is the Sun than the Moon?  
16. 7
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. 2
18. How many cells are in the human body?  
18. 14
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. 9
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. 7

21. How many US dollar coins would it take in order to create a stack from Paris to Mumbai?  
21. 9
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. 29
23. How many bytes of data do Facebook users produce per day?  
23. 15
24. How tall is the Eiffel Tower, in meters?  
24. 2
25. How tall is the tallest tree on Earth, in centimeters?  
25. 4
26. What is the width of a protein  $\alpha$  helix, in meters?  
26. -10
27. How many golf balls would it take to equal the mass of Earth?  
27. 26
28. How thick is a bacterial flagellum, in nanometers?  
28. 1
29. How much does an HIV-1 virus weigh, in Newtons?  
29. -17
30. How many grand pianos would it take to equal the weight of the Hubble Space Telescope?  
30. 1
31. What is the mass of all of the fish on Earth, in kilograms?  
31. 12
32. Divide the price of a McDonald's double cheeseburger by the price of Burj Khalifa (the world's tallest building).  
32. -9
33. How many carbon atoms would it take in order to create a single-file line of atoms around the Earth?  
33. 17
34. How many years would it take an empty cement mixer truck to travel from Washington DC to Juneau AK?  
34. -2

35. How many milliliters are in the average blood donation?  
35. 2
36. How many caffeine molecules does it take to equal the weight of a US dime?  
36. 22
37. How many insects live on the earth?  
37. 19
38. How many red blood cells are needed to blanket the surface area of the Indian Ocean?  
38. 24
39. How many bacteria live in your mouth?  
39. 10
40. What is the land area of the United States, in square centimeters?  
40. 17
41. How much mass, in kilograms, is the Sun losing every second?  
41. 9
42. How many moles of phenolphthalein ( $C_{20}H_{14}O_4$ ) are needed to equal the mass found the question above?  
42. 10
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. 24
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. 0
45. How many moles 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. 22
46. How many structural isomers would  $C_{99}H_{200}$  have?  
46. 39
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. -2

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

48.       -7      

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

49.       0      

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

50.       -9