

Welcome to Fermi Questions! Give your answers in powers of 10. For example the number 1000 would be  $10^3$  and therefore 3. You will receive 5 points for an exact answer, 3 points for an answer that is one magnitude off, and 1 point for an answer that is 2 magnitudes off. This exam will contain 50 questions, for a maximum of 250 points. The number of questions that earn 5 points will be used as the primary tiebreaker, and the time taken to complete the test will be used as the secondary tiebreaker.

To keep this fair, this is a solo test. Please do not take this with a partner. Additionally, calculators, notes, and all online resources are banned. The only materials allowed are scrap paper.

The question difficulty will vary drastically. I'd suggest trying to solve the easier problems first as all questions are worth the same amount. Good luck!

#### The Rules

1. How many drops of water are there in Lake Erie? 19
2. What is the mass of helium gas, in grams, required to fill the Goodyear Blimp? 7
3. How many species of birds are in the Amazon Rainforest? 3
4. How many characters, including spaces, are in the Fermi Question rules? 3

#### Basics

5. How many questions are on this test? 2
6. How many millibits are in a megabyte? 10
7. What is the distance to the sun, in meters? 11
8. What is the mass of the earth, in kg? 25
9. How many earths can fit in the sun by volume? 6
10. How much energy is in one ton of tnt in Joules? 9
11.  $2^{100}$  30
12. 26! 26
13. How many ergs are in a foe? 51
14. How many different ways can a pack of cards be shuffled? 68
15. How many miles would you need to walk to burn off the calories in one single patty cheeseburger? 1

#### Other Things

16. On average, how many people in the US are struck by lightning every year? 2
17. The richter scale measured the strength of an earthquake, which can be converted into an approximate equivalent in energy output. If a hypothetical earthquake had an energy output equal to that of a supernova, what would the earthquake register as on the richter scale? 2
18.  $10^{2.69897}$  2
19. How many seconds does it take on average for light from the sun to reach the earth? 2
20. How many times more known insect species are there on earth than bird species? 2
21. How fast, in miles per hour, would you need to throw a baseball to equal the kinetic energy of the Oh-My-God particle, which was the highest cosmic ray that had ever been detected? 2
22. What percent of the total atoms on earth does the average human being make up? -20
23. How many buckets of paint would it take to paint the entire moon red? 12
24. A proton and an electron are located one nanoparsec away from each other. How many times stronger is the electric force between the electron and proton compared to the gravitational force? 39
25. How many cups of coffee would you need to drink to reach the lethal dose of caffeine? 2
26. Sum of all integers from 1 to 1 billion 18
27. How many times more calories does an average elephant consume in a day compared to an average mouse? 4
28. What percent of the words said in the Bee Movie was the word "Bee"? 0

29. How many websites are there, including both active and inactive websites? 9
30. Woodchucks can't chuck wood, but woodchucks can chuck dirt when digging a burrow. How much dirt can a woodchuck chuck if a woodchuck could chuck dirt in the duration of the woodchuck digging a burrow? Give your answers in US Bushels. 1
31. A blue whale can swim in water, why not in air? What would the volume of an average weight blue whale have to be in liters so that its density is equal to that of air? Assume the additional volume does not mean any mass is added on. 8
32. How many gallons of gasoline would you need to power the sun for one galactic year? 34
33. If you had a mole of moles (animal), how many pounds would this weigh? 23
34. Calculate the mass-energy total of the entire observable universe in kg. Include baryonic matter, dark matter, and dark energy. 54
35. Suppose you stare directly at the sun. How many watts of sunlight are hitting your retina? 0
36. If we define the jiffy as the amount of time it takes for light to travel 1 cm in a vacuum, how many babies are born in the world in 1 jiffy? -10

Planck units: given that the Planck length is approximately  $1.6\text{E-}35$  meters, Planck mass is  $2.1\text{E-}8$  kg, and Planck time is  $5.4\text{E-}44$  seconds:

37. Calculate the Planck frequency in Hz. 43
38. Calculate the Planck density in  $\text{kg/m}^3$ . 96
39. Calculate the Planck energy in Joules. 9

Harder?

40. (meme) A squirrel's terminal velocity prevents it from dying due to a large fall. Therefore, how many meters would you need to drop a squirrel for to kill it? (Hint: the squirrel doesn't necessarily need to die from falling, because well, it can't). Also assume that any forces on the squirrel remains constant after reaching terminal velocity. 6
41. Given: the probability of winning the Powerball lotto is  $1/292,201,338$  per play. How many dollars would you have to spend in USD to buy enough tickets so that the probability of you not winning is equal to the probability of one ticket you buy winning? 10
42. 1,1,2,3,5,8,13,21... I think you know where this is going. Find the 140th number in this sequence. 29
43. Estimate the number of ATP molecules a human uses during the course of a day. 26
44. Let's say for some reason, humans started to emit 1 nm x rays instead of infrared (assume everything else remains constant). How many photons would an average person emit per fortnight? 24
45. Given that  $\log(e)$  equals .434294482... Calculate  $1000000!$  5565709

Black Holes

46. What is the Schwarzschild radius of a baseball? -28
47. In the black hole created by only one baseball, I throw in a bowling ball. By what factor does the density of the black hole increase? -3
48. I start to pile baseballs in deep space with no outside source of mass. Assuming a random packing density, how many baseballs are required for the pile to collapse into a black hole? 40
49. The lifespan of a black hole is given by the following equation:  $t = M^3(5120\pi G^2 / (\text{reduced planks constant} \cdot c^4))$  (apologies for formatting). Estimate the lifespan of a black hole with a mass of 1 solar mass in years. 67
50. Estimate the luminosity of the black hole's due to hawking radiation. (Hint: while this isn't exact, assuming the mass lost throughout gives you an approximate answer that if done correctly is within the same order of magnitude as the real answer). -28