[2020 UT Invitational]

Fermi Questions C - Test

1. What is the height of the Empire State Building, in meters?

2. How far is Los Angeles from San Diego, in light years?

3. What is the thickness of a cell membrane, in meters?

4. What is the mass of an electron, in kilograms?

5. How many transistors does Apple's latest A14 Bionic CPU have?

6. What is the military budget of the United States, in US Dollars?

7. How many years ago did the Quaternary Period of the geologic time scale start?

8. How many pothole complaints have been made to New York City’s 311 service line since its launch in 2003?

9. How many times closer to the sun would Mercury have to be to be pulled apart by tidal forces?

10. If the entirety of Avengers: Endgame was printed on a single film reel, how long would that reel be in femtometers?

11. What concentration of phosphine was detected on Venus in mol/L?

12. How many years would it take for an element with a half-life of 5730 years to decay by 99.9%?

13. About how many unique species do we know of?

14. What is the mass of the asteroid belt divided by the mass of an electron?

15. What is the thickness of a cell membrane, in meters?

16. What is the sum of all the prime numbers less than two million?

17. How many cardiac muscle cells are found in the typical human heart?

18. How many more years do scientists estimate Saturn’s rings will last?

19. How fast does a raindrop fall at terminal velocity, in centimeters per second?

20. A lover of Costco’s food court decides to eat their body weight in cheese pizza. How many miles would this person have to run to burn all of the calories off?

21. What is the distance between the Earth and the Moon, in multiples of regulation NBA basketballs?

22. It's almost Halloween! If all the farmland in the US were converted into pumpkin patches, how many pumpkins could the country produce annually?

23. How many beaver dams are there in North America?

24. From the energy produced by a coal power plant in one year, how many coal power plants would it take to equal the amount of energy produced by the sun in one second?

25. `Oumuamua is the first interstellar object we've discovered passing through the Solar System. Its perihelion (closest approach to the Sun) was on September 9, 2017 at a distance of 0.255 AU from the Sun. What was its velocity, in kilometers per second, at perihelion?

26. How much energy, in Joules, would it take to boil all of the water contained in Europa's subsurface ocean? Assume that the water would be boiled at standard Earth temperature and pressure, not on Europa itself.

27. The gene that encodes preproinsulin, the precursor of insulin, consists of how many base pairs?

28. What is the absolute value of the total mechanical energy, in Joules, of the Earth-Sun system?

29. How many ways are there to arrange 8 queens on a standard 8x8 chessboard?

30. Suppose that the queens must be arranged in a manner such that none of the queens could capture another (i.e. none of the queens can be under attack). How

many such configurations are possible? Do not include boards that are reflections, rotations, etc.

31. How many neutrinos are produced by nuclear reactions at the center of the Sun every second?

32. 2520 is the smallest number that can be divided by each of the numbers from 1 to 10 without any remainder. What is the smallest positive number that is evenly divisible by all of the numbers from 1 to 20?

33. How many times higher is the pressure at the bottom of an oceanic trench compared to the surface?

34. How much does the DNA content of a single cell weigh, in Newtons?

35. What thickness, in inches, of rubber tread is worn off of the tire of a typical automobile as it travels one mile?

36. At the population density of Texas, how many people could live on the Moon?

37. How many millennia would it take a garden snail to cross the Colorado River at Pennybacker Bridge in Austin?

38. An action potential conducted from the eye to the human brain has how many times as much energy as the few photons of light that triggered it?

39. How many times larger is the acceleration due to gravity on the Moon's surface than the acceleration of a bullet in the barrel of a gun?

40. How many times greater is the population density of the densest city in the world than the population density of the entire Pacific Ocean (including both islands and water)?

41. How many forward rolls would it take Link to travel the diameter of the Milky Way?

42. How many hot air balloons can fit in the atmosphere?

43. What is the length of all the DNA in the human body in meters?

44. How many seconds will it take for a bullet to travel the length of the Great Wall of China?

45. What would be the kinetic energy in joules of a human moving at the speed of an airplane?

46. If all the living pianists in the world decide to play all three movements of Beethoven's Moonlight Sonata, how many notes would be played in total?

47. How much water in liters is lost from breathing and perspiration during one football game at AT&T Stadium (the Dallas cowboys stadium) if every seat is filled and the breathing/perspiration rate is average?

48. What is the magnitude of the resting potential of a neuron, in volts?

49. How many psi of pressure can the human bite exert via the molars?

50. How many micrometers are between each turn of a protein alpha helix?

51. If the entire volume of the ocean was placed over a typical kitchen stove, how many seconds would it take for the overall temperature of the water to rise one degree?

52. Suppose we have a liter of ideal gas at STP and we put a partition perfectly down the middle of the container, dividing the container exactly into halves. By what proportion of the original pressure are the new pressures of the two halves expected to deviate from the original pressure?

53. What is the nanomolar concentration of glucose in human blood?

54. What is the magnitude of free energy produced by a single round of glycolysis, in kilojoules?

55. What is the expected glomerular filtration rate for a normal adult, in L/s/1.73 m2?

56. The series expansion of $\pi/4 = 1-1/3+1/5-1/7+1/9-\cdots \approx 0.785398$. How many series terms are needed to approximate $\pi/4$ correctly to the first thirty decimal places?

57. By comparison, the series expansion of e = 1+1/2!+1/3!+1/4!+···≈2.718282, where n! = (n)(n−1). . .(2)(1). How many series terms are needed to approximate e correctly to the first thirty decimal places?

58. Within the Sun, the total outwards pressure comes from gas and radiation. At the center, what is the ratio between the pressure contributed by radiation to the pressure contributed by gas?

59. Hexane is an alkane with six carbons while hexadecane has sixteen. What is the ratio of the number of constitutional isomers of hexadecane to those of hexane? Do not disregard stereochemistry.

60. At room temperature, what would be the ratio of the number of molecules in the diequatorial chair conformation of 1, 4-dimethylcyclohexane to the number of molecules in the diaxial conformation? Recall that higher energy conformations are less stable.

61. Suppose an alien civilization is observing the Sun. What is the probability that Earth would be transiting from their perspective?

62. Suppose two 5 kilogram masses are on either side of a pulley, attached by a very light string. As the mass of one of them is increased indefinitely, what will the tension in the string approach, in Newtons?

63. Starting in the top left corner of a 2×2 grid, there are 6 routes (without backtracking) to the bottom right corner. How many routes are there through a 20×20 grid?

64. What is the value of the first triangular number to have over five hundred divisors?

65. How many times stronger is a carbon-carbon triple bond than an iodine-iodine single bond?

66. What is the surface area to volume ratio in meters^-1 of a 100-dimensional hypersphere with a radius of 10 meters?

67. What is the inner volume ratio between a 100-dimensional unit hypersphere and a 100-dimensional unit hypercube?

68. In a barn, 100,000,000 chicks sit peacefully in a circle (they are very small). Suddenly, each chick randomly pecks the chick immediately to its left or right. What is the expected standard deviation of the number of pecks each chick receives?

69. When the sun inevitably becomes a red giant, by what fraction of the original value would its total angular momentum increase? (Hint: Angular momentum is a conserved quantity, think about possible sources of angular momentum.)