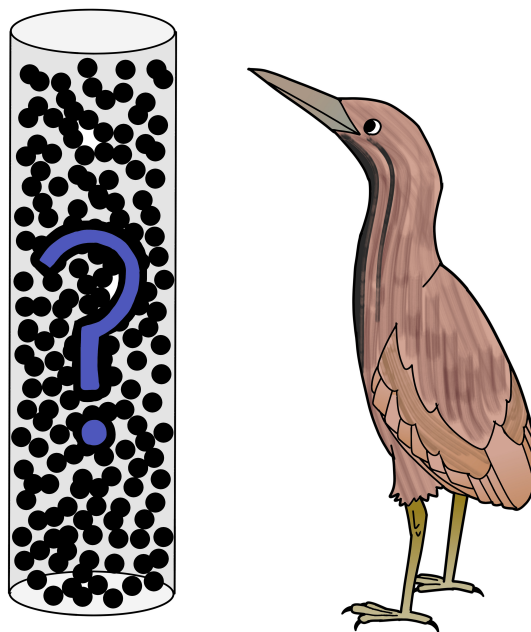# BirdSO Mini Invitational

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Directions:

Welcome to Fermi Questions C at the BirdSO 2022 Mini Invitational! Please read through all of the following instructions in its entirety before you begin the exam.

- You will have 50 minutes to take the exam. You are not expected to answer all the questions. Do the best you can.

- Only a writing utensils, and your brain are permitted.

- This test is composed of 60 questions. Your answer should be given in order of magnitude. Each question can be answered in the scientific form $\alpha \times 10\beta$. If $\alpha < 5$, your answer should be β; if $\alpha \geq 5$, your answer should be $\beta + 1$. For example, if the number was 4.99×102, the answer would be 2, but if the number was 5×102, the answer would be 3.

- Scoring: A correct answer is worth 5 points. An answer off one order of magnitude is worth 3 points. An answer off by two orders of magnitude is worth 1 point. Any other answer is worth 0 points. If the answer is negative, you MUST put a negative symbol.

Page	Points	Score
3	55	
4	50	
5	50	
6	50	
7	45	
8	25	
9	25	
Total:	300	

1. (5 points) Assuming notes actually get that high, what is the frequency of E300?

> **Solution:** 91

2. (5 points) What would the minimum population of the United States be so that the GDP per capita would be below 1?

> **Solution:** 13

3. (5 points) How many people would need to be in a room so that the probability 2 people randomly selected from the room share a birthday is at least 99.9999

> **Solution:** 2 (Note: apologies for the awkward wording)

4. (5 points) How many characters are in this bizarre sentence?

> **Solution:** 1

5. (5 points) How many keys are on the standard US keyboard layout?

> **Solution:** 2

6. (5 points) How many times older is the first bird-line archosaurs compared to BirdSO?

> **Solution:** 8

7. (5 points) How many atoms are in a human body?

> **Solution:** 28

8. (5 points) What is the circumference of the sun in millimeters?

> **Solution:** 12

9. (5 points) What is the mass of the moon in tons?

> **Solution:** 20

10. (5 points) How many cows are in the world?

> **Solution:** 9

11. (5 points) On average, how many feathers are on a pigeon?

> **Solution:** 4

12. (5 points) In Iowa 2020, how many ears of corn were harvested per baby ear born?

> **Solution:** 6

13. (5 points) What is the average frequency of light emitted by an American robin egg, in hertz?

> **Solution:** 15

14. (5 points) How many creases are in a brown paper bag?

> **Solution:** 1

15. (5 points) If each mango tree leaf was $1, how many bluefin tunas can you buy with one mango tree?

> **Solution:** 0

16. (5 points) How many crows would actually be needed for a murder, that is, how many crows would it take so that their combined weight would crush a human being by breaking their bones?

> **Solution:** 3

17. (5 points) How many direct airplane flights between Los Angeles (LAX) and New York City (JFK) could you take back and forth in the time since the end of the Mesozoic Era?

> **Solution:** 11

18. (5 points) How many Quiz Bowl Tossups can someone read aloud in the time it takes a top-5 Super Mario Odyssey speedrunner to complete the game Any%?

> **Solution:** 2

19. (5 points) Twister Feast starts a campaign called teamteas. If they are successful in their goal in dumping 40 million cups of tea into the world ocean, by what percent does the world ocean's total volume increase?

> **Solution:** -12

20. (5 points) Suppose that Starbucks buys out The Roost (Brewster's coffee shop) in Animal Crossing: New Leaf. If one cup of coffee costs 200 Bells, how much money, in US dollars, does one need to pay to Tom Nook in order to completely expand their house?

> **Solution:** 5

21. (5 points) How many characters are in the source code for the official YouTube video of "Never Gonna Give You Up"?

> **Solution:** 6

22. (5 points) How many Olympic-sized swimming pools would you have to dig out of the ground in order to have a pile of dirt weighing the same as an adult blue whale?

> **Solution:** -2

23. (5 points) I have a wall that is the size of Greenland. How many 2-gallon buckets of paint do I need to completely paint my wall?

> **Solution:** 10

24. (5 points) How many hairs are on all the heads at a typical NFL game?

> **Solution:** 10

25. (5 points) How many Amazon boxes could be made from all the trees in the Amazon rainforest?

> **Solution:** 14

26. (5 points) What percentage of food produced worldwide are poultry and other products derived from domesticated birds?

> **Solution:** 0

27. (5 points) Express the ideal gas constant in units of (volume of the Pacific Ocean)(pressure at the bottom of the Mariana Trench)/((Rankine)(mol))

> **Solution:** -25

28. (5 points) How many traffic lights are there in the United States?

> **Solution:** 5

29. (5 points) What is the worldwide sugar consumption in grams per year?

> **Solution:** 14

30. (5 points) What is the tensile strength of Kevlar rope in Pascals?

> **Solution:** 9

31. (5 points) How many unique ways are there to arrange 5 red, 5 blue, 5 green, and 5 yellow marbles?

> **Solution:** 10

32. (5 points) In Squid Game, assuming the players cooperate, what is the probability of everyone dying on the game glass bridge? (16 players, 18 tiles)

> **Solution:** -3

33. (5 points) How many atoms of Hydrogen do humans intake due to the consumption of Aspirin?

> **Solution:** 22 or 33 (the time frame was not initially specified)

34. (5 points) What is the temperature of the cosmic microwave background in degrees Delisle?

> **Solution:** 3

35. (5 points) What is the volume of a Minecraft world in 1.18 in blocks?

> **Solution:** 18

36. (5 points) Let "A" map to 1, "B" to 2, and so on, up to "Z" to 26. What is the expected product of 10 letters taken from any English text?

> **Solution:** 9

37. (5 points) Take the current 3-6-3 cup stacking world record (1 stack of 6 cups and 2 stacks of 3 cups) as the speed at which 12 cups can be placed. Assuming you have to stack in a pyramid (each row down must have one additional cup), how long would it take to stack from Earth to the asteroid belt, in seconds?

> **Solution:** 23

38. (5 points) How many times greater is the average separation of water molecules than the covalent bond within them?

> **Solution:** 0

39. (5 points) What is the additional acceleration of Voyager 1 by shining a red laser pointer at it, in meters per second squared?

> **Solution:** -15

40. (5 points) How many satellites are currently orbiting the Earth for every moon of Uranus?

> **Solution:** 3

41. (5 points) How many sievert of radiation were in the 2002 production of bananas in Uganda?

> **Solution:** 3

42. (5 points) How many grains of tapioca starch fit into the volume of one boba pearl?

> **Solution:** 8

43. (5 points) Assuming constant area density of cells and a laboratory setting, what is the average speed of expansion of a 2 meter diameter flat circle of E. coli, in miles per Pentium 4 clock cycle?

> **Solution:** -17

44. (5 points) Assuming a Bluetooth 4 connection, how many Airpod earbuds would you need to cover the entire Earth?

> **Solution:** 10

45. (5 points) If we provide every bird in the world with a bird house, how many Congo rainforests would we need to chop down?

> **Solution:** -4

46. (5 points) How many Dyck paths are there from (0, 0) to (420, 420)?

    A Dyck path from (0, 0) to (n, n) is a path in which the only legal moves are to move 1 unit right or 1 unit up and the path does not cross the main diagonal (the line $y = x$).

> **Solution:** 248

47. (5 points) Compute $5^{5^5} \cdot 4^{4^4} \cdot 3^{3^3} \cdot 2^{2^2} \cdot 1^{1^1}$.

> **Solution:** 2352

48. (5 points) Define a sequence of sums as follows: $S_n n + 2n^2 + 3n^3 + \cdots + 21n^{21} = \sum_{k=1}^{21} kn^k$. Compute $\sum_{i=1}^{20} S_i$.

> **Solution:** 29

49. (5 points) What is the 100-volume in (beard seconds)^{100} of a 100-dimensional hypersphere with radius 1 angstrom?

> **Solution:** -210 or -240 (beard seconds have two slightly different definitions)

50. (5 points) In thermodynamics, Boltzmann–Planck equation describes the relationship between entropy and the total number of microstates in the macrostate of an ideal gas. It is given as the equation: $S = K_B \ln(W)$ where K_B is the Boltzmann constant. (Boltzmann's constant is also equivalent to the ideal gas constant / Avogadro's constant)

    Let n = number of molecules present and e = total energy, where the energy of a molecule is at least 1.

    In a system where $n = 2$ and $e = 4$, W is found to be 3.

    Similarly, in a system where $n = 4$ and $e = 8$, W is found to be 35.

Find the entropy of a system in J/K where $n = 10^{24}$ and $e = 2 \times 10^{24}$

Solution: 1

51. (5 points) Take the density of the observable universe to be approximately 6 protons/m³. Find the radius of a Schwarzschild black hole such that the density of the black hole is the same as the density of the observable universe.

Solution: 26

52. (5 points) Given Information:

1 Planck Temperature $= 1.416784 \times 10^{32}$ K 1 Planck Length $= 1.616255 \times 10^{-35}$ m 1 Planck Mass $= 2.176434 \times 10^{-8}$ Kg 1 Planck Time $= 5.391247 \times 10^{-44}$ s

The R-value is a measure of how well a 2-D barrier can resist the conductivity of heat. The SI units for R-value is Kelvin meters squared per Watt, where the units for Watts are kilogram meters squared per seconds cubed. Convert 1 R-value to Planck R-value, where Planck R-value is the R-value expressed in Planck units.

Solution: -90

53. (5 points) The peak wavelength emitted due to Hawking radiation (in meters), the temperature (Kelvins) of a black hole, Stefan-Boltzmann's Law, and the Schwarzschild radius (meters) are given. Find how many photons are released per second of a 1 solar mass Schwarzschild black hole.

Lambert's W function $W\left(-4e^{-4}\right)$ can be approximated as 0. $\hbar = h/2$, where $h = 6.626 \times 10^{-34}$. Boltmann's constant = ideal gas constant/Avogadro's constant.

Calculate temperature and then use Stefan-Boltzmann's law to find the power per unit area. Find the Schwarzschild radius and use it to calculate the surface area of the black hole. Multiply that by the power per unit area to find the total power. Find the peak wavelength of the photons emitted. Determine the frequency of the corresponding wavelength. Multiply by Planck's constant to find the energy of the photons emitted. Divide the total power by the energy per photons to find the number of photons released per second.

Equations:

$\lambda_{\text{logpeak}} = M \frac{16\pi^2 G}{c^2(W(-4e^{-4})+4)}$

$T = \frac{1}{M} \frac{\hbar c^3}{8\pi k_b G}$

$\frac{P}{A} = \sigma T^4$ J/m²s, $\quad \sigma = 5.6703 \times 10^{-8}$ W/m²K⁴

$R = M \frac{2G}{c^2}$

Solution: 1

54. (5 points) Observe the previous problem. How many times more photons are released per second for a 1 billion solar mass Schwarzschild supermassive black hole compared to the 1 solar mass Schwarzschild black hole?

Solution: -9

55. (5 points) A 10 watt light emits only 10 micron photons. These photons all hit a polar bear. How many are reflected off the polar bear in one second?

Solution: 19

56. (5 points) How many of the smallest Nintendo DS game cards would you need to store one image displayed on the largest Times Square digital billboard?

Solution: 1

57. (5 points) Sandy sells seashells by the seashore. If she sells a seashell for every selenium atom in the Sargasso Sea in seventy seconds and each seashell scoops the sea and scares a squid, how many sverdrups of ink are secreted?

Solution: 21

58. (5 points) Wing loading is the total mass of an object divided by the area of its wing. Calculate the ratio of the wing loading of a Boeing 747 to that of a Monarch butterfly and multiply it by the ratio of the average flight speed of a Boeing 747 to that of a Monarch butterfly.

Solution: 5

59. (5 points) In the board game Risk, each of the six players receive armies that consist of infantry, cavalry, and artillery. Suppose each of them were their full size equivalent. If all infantry (from all six armies) were running, all cavalry were galloping, and all artillery fired a cannonball, what is the total kinetic energy, in eV?

Solution: 26

60. (5 points) What is the product of all the scores (aside from this question) of all teams taking this test?

Solution: accept -infinity (due to 0 scores or 131)

Conclusion: Written by:

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Feedback? Test Code: 2022BirdSOMini-FermiQuestionsC-Pelican