

2017 SSSS Fermi Questions Test Answer Key

1. 12

- a. A laptop computer is about 10 inches by 8 inches, so we estimate the length to 10 inches. We convert from inches to centimeters through $1 \text{ inch} = 2.54 \text{ centimeters}$, approximated to $1 \text{ inch} = 2 \text{ centimeters}$, which gives the length as 20 centimeters. We take the distance from the Sun to the Earth as 149 million kilometers which approximates to 150 million kilometers converted to $1.5E8$ kilometers. We convert from kilometers to meters and then from meters to centimeters through $1 \text{ kilometer} = 1000 \text{ meters}$ and $1 \text{ meter} = 100 \text{ centimeters}$, thus giving us a distance of $1.5E13$ centimeters. We divide that total by the length of the laptop computer, 20 centimeters, giving us $7.5E11$ laptop computers.

2. 2

- a. A car runs at about 60 miles per hour on a highway. The circumference of the earth is about 25000 miles, so let's approximate that as 20000 miles. We can take the 60 miles per hour and estimate that to be 100 miles per hour. Divide the 20000 miles by the 100 miles per hour through $\text{distance} = \text{rate} * \text{time}$ and we get the total length of time for the car to circle the Earth to be 200 hours, thus being $2E2$.

3. 5

- a. The average number of calories in a donut is about 200 calories and the average number of calories in a hamburger is about 400 calories, so the total is about $200 * 10 + 400 * 10 = 2000 + 4000 = 6000$ calories. We estimate that at 10000 calories. It takes you about 600 calories. Take that total and estimate it to be 1000 calories. We take the 10000 calories and divide it by the 1000 calories burned per hour to get 10 hours. We can then convert the number of hours into seconds through $10 \text{ hours} * (60 \text{ minutes}/1 \text{ hour}) * (60 \text{ seconds}/1 \text{ minute})$ and approximate it through 100 each time to get $10 * 100 * 100$ to get 100000, or $1E5$ seconds.

4. 30

5. 7

- a. An Olympic-sized swimming pool is about 50 meters in length and has about 8 lanes, so approximate that to 10, with each lane being about 10 meters across, so make the dimensions 50 meters by 80 meters which approximates to 50 meters by 100 meters by 5 meters, which the volume then goes to 25000 meters cubed. A textbook is about 0.2 by 0.1 meters by 0.2 meters, which approximates to 0.1 by 0.1 by 0.1, the area of which is 0.001 meters cubed. You divide the 25000 meters by 0.001 meters and you get 25000000 textbooks, or $2.5E7$.

6. 16

- a. Usain Bolt runs 100 meters in about 10 seconds, so make the rate 10 meters per second. The distance from the Earth to Alpha Centauri is about 5 light years, with a light year being $1E16$ meters. Therefore, the total distance would be about $5E16$ meters. Divide the distance by the rate to get the time, so $5E16$ meters divided by 10 meters per second gives you $5E15$ seconds.

7. 2

- a. An apple is about 5 centimeters by 7 centimeters by 5 centimeters, so approximate that to 10 by 10 by 10, giving you a volume of 1000 cubic centimeters. A trash can is about 1 meters by 0.3 meters by 0.3 meters, so approximate that to 1 by 0.5 by 0.5, moving it to centimeters to make it 100 by 50 by 50. Use that to find the volume of the trash can which is 250000 cubic centimeters and divide by 1000 cubic centimeters to get the number of apples that can be fitted inside, which is 250 apples, or $2.5E2$.

8. 26

- a. The Sun is about $2E30$ kg and an elephant is about 10000 pounds, which approximates to 5000 kg. Divide the Sun's weight by the elephant's weight to get the number of elephants needed, so divide $2E30$ by $5E3$ to get $0.4E27$, or $4E26$.

9. -5

- a. A photon travels at the speed of light, or $3E8$ meters per second. The distance from the pitcher's mound to home plate of a normal MLB stadium is 18.39 m, so approximate that to 20 m. You take distance = rate * time and rearrange the terms to get time = distance / rate which then gives you 20 meters / $3E8$ meters per second to get $6.67E-8$ seconds.

10. 1

- a. An Amtrak train can go about an average speed of 125 mph, so average that to 100 mph. The distance from San Francisco to New York City is about 3000 miles, so take 3000 miles and divide by 100 mph to get 30 hours, or $3E1$.

11. 8

- a. The total population of the United States is about 300 million people, of which about 5 percent are college students. Of that, the average amount of sleep is about 6.5 hours of sleep, so approximate that to 5. Take 300 million and multiply by 5% to get 300 million multiplied by $5/100$ which is $1/20$ so you get 300 million divided by 20 which is $3E8$ divided by $2E1$ which is $1.5E7$ and then multiply that by 5 to get $7.5E7$.

12. 6

- a. A snail can go at a speed of about 0.1 km/hour. The distance across the Atlantic Ocean is about 4000 meters which is 4 km, so approximate that to 5 km. Take the 5 km and divide by the 0.1 km/hour to get the number of hours which is 50 hours. Take the 50 hours and multiply that by 60 minutes/1hour which is about 100 and then 60 second/1 hour which is about 100 to get 50000 or $5E5$.

13. 14

- a. There are 7 billion people on this planet so approximate that to be 10 billion. About 30% of people have cars and on average have 2 cars, so find out how many cars which would be $10 \text{ billion} * 3/10 * 2$ which is $1E10 * 3E-1 * 2$ which is $3E9 * 2$ which is $6E9$. The car is used on average 6 hours a day so make that 5. With there being 365 days a year approximated to 300, that means a car is used on average 1500 hours a year. The average MPG for a car is 15 so make that 20. The car runs at about 45 mph so make that 50. Multiple the 50 mph by the number of hours which is 1500 and the 50 and 1500 approximated to 100 and

2000 respectively to get 200000 miles driven. The average gas mileage as aforementioned is 20 MPG so divide 200000 by the 20 MPG to get on average per car 10000 gallons used a year. The average cost of a gallon is 2.5 so approximate to 2. Multiple that cost to the 10000 gallons per year per car on average to get 20000 dollars spent on gasoline per car per year on average. Multiple that number by the number of cars which is $6E9$ to give you $6E9 * 2E4$ for $12E13$ which is $1.2E14$.

14. 38

- a. The Milky Way Galaxy is 100000 light years and a light year is about 10 trillion km so the length of the Milky Way Galaxy in km is $1E5 * 1E13$ to get $1E18$ km. The radius of that circle would about $0.5E18$ or $5E17$ km and so the area would be $A=(\pi)*(radius)^2$ to give you $3.14 * (5E17)^2$ or $3*(5E17)^2$ or $3*(25E34)$ or $75E34$ or $7.5E35$. The depth is about 1 light year so multiple that to the $7.5E35$ to get $7.5E35$ by $1E13$ to get $7.5E48$ cubic kilometers. The Earth is about 6000 km in radius so approximate to 5000 km. The volume of the Earth is measured through $V=(4/3)*(\pi)*(radius)^3$ so $(4/3)*(3)*(5000)^3$ or $3*(5E3)^3$ or $3*(5E3*5E3*5E3)$ or $15E3*5E3*5E3$ or $1.5E4*5E3*5E3$ or $7.5E7*5E3$ or $1E8*5E3$ or $5E11$. Divide the $7.5E48$ by the $5E11$ to get about $1E49$ divided by $1E11$ to get $1E38$ Earths.

15. 11

- a. The Sun is about 700000 km in radius so get the diameters which is $2*7E5$ which is $1.4E6$ km which approximates to $1E6$ km. The average cellphone is about 10 cm across so make that 0.01 meters or 0.00001 kilometers. Divide $1E6$ by $1E-5$ to get $1E11$.

16. 3

- a. A human teeth is about 1 cm by 1 cm by 1 cm so make that volume 1 cubic centimeter. The size of a Mason jar is about 20 centimeters by 10 centimeters by 10 centimeters, so make that volume 2000 cubic centimeters. Divide the Mason jar volume by the human teeth volume to get $2000 \text{ cm}^3 / 1 \text{ cm}^3$ to get 2000 human teeth needed, or $2E3$.

17. 6

- a. A blue whale is about 80 feet so approximate that to 100 feet. The circumference of the Earth is 25000 is about 25000 miles. 5200 feet are in a mile so approximate to 5000 feet. $25000 * 5000 = 2.5E4 * 5E3 = 12.5E7 = 1.25E8$. Divide the number of feet by the length of a blue whale so $1.25E8/1E2$ to get $1.25E6$.

18. 5

- a. A tuna can is about 3 centimeters tall. The distance from sea level to Mount Everest is 29000 feet or about 10000 meters. Convert 10000 meters or $1E4$ meters to centimeters to get $1E6$. Divide $1E6$ by 3 to get $1E6/3E0$ to get $0.33E6$ or $3.3E5$.

19. 8

- a. A fastball on average is thrown at 95 mph so approximate to 100. The distance from Earth to Pluto is about 50 AU which an AU is 99 million miles, so

approximate to $50 * 100$ million to get 5 billion miles or $5E9$ miles. Divide $5E9$ by $1E2$ to get $5E7$.

20. 20

- a. Water covers approximately $\frac{2}{3}$ of the Earth's surface and the average depth of the Earth's oceans is 10000 feet. Approximate the body of water as a rectangular prism of 10000 feet by 15000 miles by 15000 miles (because $\frac{2}{3} * 25000$ miles = about 15000 miles). Take the 15000 miles and convert to feet to get $1.5E4 * 5E3$ to get $7.5E7$ feet by $7.5E7$ feet by $1E4$ feet to get about $1E8$ by $1E8$ by $1E4$ to get $1E20$.

21. 10

- a. A newspaper is about 15 inches by 10 inches so make the length 15 inches and approximate to 20 inches. The Sun is 432,288 miles so approximate to 400000 miles. Take $4E5$ miles and convert to inches to get $4E5 * 5E3 * 1E1 = 20E8 * 1E1 = 2E9 * 1E1 = 2E10$. Use circumference = $2 * \pi * \text{radius} = 2 * 3 * 2E10 = 12E10 = 1.2E11$. Divide $1.2E11$ by $2E1$ to get $0.6E10$ or $6E9$.

22. 7

- a. A car sunshield is about 30 inches by 20 inches to give an area of 600 cubic inches, which approximate to $1E3$ cubic inches. The Earth's atmosphere can be approximated as a sphere with the radius equal to the radius of the Earth plus the height of 400 kilometers. The radius of the Earth is about 6371 kilometers so we add that to 400 to get 6700, or about 5000 kilometers. We take surface area = $4 * \pi * (\text{radius})^2 = 4 * 3 * (5000)^2 = 4 * 3 * (5E3)^2 = 12 * 25E9 = 1E1 * 1E9 = 1E10$. Divide surface area by area of sunshield to get $1E10$ by $1E3$ to get $1E7$.

23. -32

- a. An electron weighs $9.1E-31$ kilograms so approximate to $1E-30$. A human weighs about 137 pounds or 62 kg so approximate to 50. Divide $1E-30$ by $5E1$ to get $0.2E-31$ or $2E-32$.

24. -5

- a. A bullet travels in 1 second 2500 feet. The stirrup is about 0.1 inches long. Convert the 2500 feet per second to inches per second to get $2500 \text{ ft/sec} * 12 \text{ inches/foot} = 2000 * 10 = 2E3 * 1E1 = 2E4$ inches/second. Take distance = rate * time and convert to time to get time = distance/rate = $0.1 \text{ inch} / 2E4 \text{ inches/second} = 1E-1 / 2E4 = 0.5E-5 = 5E-6$.

25. 25

- a. The Pacific Ocean can be approximated as a rectangular prism with the depth at 10000 feet and the length and width being 10000 miles and 12000 miles so approximate as $1E4$ by $1E4$ by $1E4$. Convert miles to inches through $1E4 \text{ miles} * 5000 \text{ feet/1 mile} * 10 \text{ inches/1 foot} = 1E4 * 5E3 * 1E1 = 5E8$ inches. Approximate to $1E9$ to get a volume of $1E9 * 1E9 * 1E9 = 1E27$ cubic inches. A soup can has a radius of about 3 centimeters and a depth of about 10 centimeters so convert centimeter to inches by divide by about 2 so we get a radius of 1.5 inches and a depth of 5 inches so approximate to 2 by 5. Volume = height * $2 * \pi * \text{radius} = 5 * 2 * 3 * 2 = 10 * 6 = 60$ so approximate to $5E1$. Divide $1E27$ by $5E1$ to get $0.2E26$ or $2E25$.

26. -2

- a. A cell phone is about 5 centimeters by 2 centimeters by 3 centimeters which approximates to 10 by 1 by 1 to get a volume of 10 cubic centimeters. A basketball is about 5 centimeters in radius to get a volume of volume = $(\frac{4}{3}) * (\pi) * (\text{radius})^3 = 1 * 3 * 5 * 5 * 5 = 1 * 1 * 10 * 10 * 10 = 1000$. You divide the cell phone volume by the basketball volume to get 10/1000 or 1E1/1E3 or 1E-2.

27. 7

- a. The Empire State Building is 1500 feet by 100 feet by 100 feet which estimates as 2000 by 100 by 100. A trumpet case is about 1.5 feet by 0.5 feet by 0.5 feet so approximate as 1 by 1 by 1. Volume of the Empire State Building = $2000 * 100 * 100 = 2E3 * 1E2 * 1E2 = 2E7$ and the volume of the trumpet case is 1. Divide $V(\text{ESB})$ by $V(\text{T}) = 2E7/1 = 2E7$.