

Fermi Questions Quiz 9-23-18

1. How many raindrops fall globally each day?

Answer: according to a mailbag question response published in the Smithsonian magazine, the average precipitation over Earth's surface is approximately 2 millimeters per day. Multiplying this 2×10^{-3} m by the planet's surface area of approximately $5 \times 10^8 \text{ km}^2 = 5 \times 10^{14} \text{ m}^2$, we find that the total volume precipitated is approximately $1 \times 10^{12} \text{ m}^3$. A typical raindrop has a diameter of 2 mm \rightarrow a radius of 1 mm \rightarrow a volume of $4.2 \text{ mm}^3 = 4.2 \times 10^{-9} \text{ m}^3$. Dividing the volume of $1 \times 10^{12} \text{ m}^3$ of water per day by $4.2 \times 10^{-9} \text{ m}^3$ of water per drop gives us an answer of 2.4×10^{20} drops per day. FA=20.

2. What is the energy equivalent of the mass of the average human, in joules?

Answer: use $E=mc^2$. $M=7 \times 10^1 \text{ kg}$. $c=3 \times 10^8 \text{ m/s}$. $E=(7 \times 10^1 \text{ kg})(3 \times 10^8 \text{ m/s})^2=(7 \times 10^1 \text{ kg})(9 \times 10^{16} \text{ m}^2/\text{s}^2)=6.3 \times 10^{18}$ joules. FA=19.

3. How many tonnes of dissolved salts are in the world's oceans?

Answer: seawater has a salinity of approximately 3.5% by mass. The oceans, with a volume of approximately 1.4×10^{18} cubic meters, have a mass of about 1.4×10^{18} tonnes. 3.5% of this mass is roughly 4.9×10^{16} tonnes. FA=16.

4. What fraction of Earth's mass is the mass of salts in the previous question?

Answer: Earth has a mass of about $6 \times 10^{24} \text{ kg}$, or 6×10^{21} tonnes. Dividing the result from the previous question by this yields a proportion of approximately 8×10^{-6} . FA=5.

5. If the sun's gravity were to stop pulling on Earth today, how far from the sun, in meters, would the Earth be tomorrow?

Answer: the orbital speed of Earth around the sun is approximately $\sqrt{(6.67 \times 10^{-11})(2 \times 10^{30})/(1.5 \times 10^{11})}=3 \times 10^4$ m/s. So, in the day, the Earth would travel 2.5×10^9 meters out of orbit. However, even if the Earth was moving directly away from the sun (which it would not), this would be negligible in comparison to the Earth's normal orbital distance of 1.5×10^{11} meters. FA=11.