PSET 1

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3/26/2025

1

$0.039\% = 0.00039 = 3.9 \times 10^{-4} \approx \pi \times 10^{-4} =$ fraction of CO_2 molecules
From class, we estimate the atmosphere's mass as $\pi \times 10^{21}$ g
Thus, we have $\pi \times 10^{-4} \times \pi \times 10^{21} = \pi^2 \times 10^{17}$ g of CO_2
Using $\pi^2 \approx 10$, we then have 10^{18} g of CO_2 in the atmosphere
We estimate the density of dry ice to be $1564 \frac{\text{kg}}{\text{m}^3} \approx 10^3 \frac{\text{kg}}{\text{m}^3} = 10^6 \frac{\text{g}}{\text{m}^3}$
This then gives us $\dfrac{10^{18}\text{g}}{10^6 \frac{\text{g}}{\text{m}^3}} = 10^{12}$ m^3 of CO_2 as dry ice
From class, we know estimate the Earth's surface area as $\pi \times 10^{14}$ m^2
Thus, to find the snowfall depth, we calculate V/SA:
$$\frac{10^{12}\ \text{m}^3}{\pi \times 10^{14}\ \text{m}^2} = \frac{10}{\pi} \cdot \frac{10^{11}}{10^{14}} \cdot \frac{\text{m}^3}{\text{m}^2}$$
Using $\frac{10}{\pi} \approx \pi$ we finally get $\pi \times 10^{-3}$ m of snowfall depth.

2

We estimate O_2 to be $21\% \approx 20\%$ of the Earth's atmosphere.
From class, we estimate the atmosphere's mass as $\pi \times 10^{21}$ g.
Thus, we have $2 \times 10^{-1} \times \pi \times 10^{21} = 2\pi \times 10^{20}$ g of O_2 in the atmosphere, and 10% of such would be $2\pi \times 10^{19}$ g.
From class, we estimate the average human breath to be 1 L $= 10^{-3}$ m^3, with a mass of 1 g.
Assuming a human breathes a normal consistency of air and not pure O_2, a single human breath would also be 20% O_2, which would be 2×10^{-1} g of O_2.
Thus, it would take $\dfrac{2\pi \times 10^{19}}{2 \times 10^{-1}} = \pi \times 10^{20}$ breaths for a single human to use up 10% of all atmospheric O_2.
We estimate the average human breath to take $2 - 3$ sec $\approx \pi$ sec.
Thus, $\pi \times 10^{20}$ breaths would take $\pi \times \pi \times 10^{20}$ sec.
Using $\pi^2 \approx 10$, we finally get 10^{21} seconds.