# Q2

Sunday, March 6, 2022 6:05 PM

2. a) Calculate the total mass of a uniform layer of frozen water covering the entire Martian surface to a height of 50 m (i.e., add a 50m layer of ice to the existing surface). Assume the density of frozen water. Express your answer in kilograms and also as a fraction of total mass of Mars. (For comparison water makes up about 0.02 percent of the mass of Earth). /3

$\rho = \frac{m}{V}$

Density of ice:
$917\ kg/m^3$

$m = \rho \cdot V$

$V_{ice} = V_{planet\ with\ ice} - V_{planet\ without\ ice}$

$= \frac{4}{3}\pi R^3 - \frac{4}{3}\pi r^3$ $\quad R = r + 50$

$= \frac{4}{3}\pi (R^3 - r^3)$

$$= \frac{4}{3}\pi\left((r+50)^3 - r^3\right) \qquad r_{mars} = 3390000\,m$$

$$= \frac{4}{3}\pi\left((3.39\times10^6 + 50)^3 - (3.39\times10^6)^3\right)$$

$$= 7.22\times10^{15}\ m^3$$

$$m_{ice} = (917)(7.22\times10^{15})$$

$$= 6.6\times10^{18}\ kg$$

$$m_{mars} = 6.39\times10^{23}\ kg$$

$m_{ice} = 6.6 \times 10^{18}$ kg

$\text{ratio} = \frac{6.6 \times 10^{18}}{6.39 \times 10^{23}} = 1.03 \times 10^{-5}$

∴ the mass of ice is $6.6 \times 10^{18}$ kg and the ratio is $1.03 \times 10^{-5}$ or $1.03 \times 10^{-3}$ %.

b) If this water was delivered to Mars by comets (assume each comet is spherical with a diameter of 10 km), estimate how many of these comets would need to have struck Mars. Assume that the entire mass of each comet is in the form of water ice. (Note that this is not the only theory for how to deliver water to a planet.) /2

$m = \rho V$ $\quad V_{comet} = \frac{4}{3}\pi(5000)^3$

$= (917)\left(\frac{4}{3} \cdot 3.14 \cdot 5000^3\right)$

$= 4.8 \times 10^{14}$ kg

how many comets $= \frac{6.6 \times 10^{18}}{4.8 \times 10^{14}}$

$= 13750$ comets

∴ 13750 comets delivered the water.