

## Fermi Questions Quiz 8-4-18

### Key

1. How many trees are in the United States?

Answer: The US has about  $7.5E8$  acres of forest. Most sources estimate usual forests to have a density of approximately 40-60 trees per acre, yielding a range of  $3E10$  trees to  $4.5E10$  trees. FA=10.

2. If all the water in the Great Lakes we turned into a cumulus cloud, what volume (in milliliters) would it occupy?

Answer: in the Great Lakes, there is roughly  $2.3E4$  cubic km  $\approx 2.3E16$  L  $\approx 2.3E19$  g of water, divided by a liquid water content of approximately  $0.3$  g/m<sup>3</sup> for a cumulus cloud to get a volume of  $\approx 7.5E19$  m<sup>3</sup> =  $7.5E25$  mL. FA=26.

3. If the earth was actually a hollow sphere with no mantle or core, only crust, what would its mass be, in kilograms?

Answer: the crust is approximately 0.473% of Earth's mass.  $6E24$  kg \* 0.00473 =  $2.8E22$  kg. FA=22.

4. How many gallons of 100°C water could a barrel of oil vaporize?

Answer: The energy of oil in a barrel varies slightly by grade, but in general it is around  $6E9$  joules. A gallon of water, with a mass of about 3,800 grams and a heat of vaporization of 2,200 J/g, will require about  $8.5E6$  joules/gallon.  $(6E9 \text{ joules}) / (8.5E6 \text{ joules/gallon}) \approx 700$  gallons. FA=3.

5. How many moles of gas comprise Jupiter?

Answer: about 75% of Jupiter is hydrogen by mass ( $1.4E30$  g H<sub>2</sub>), which divided by the molar mass of 2 g/mol for H<sub>2</sub> gives  $7E29$  moles of H<sub>2</sub>. The remaining 25% ( $5E29$  grams) is mainly helium. Dividing this by the molar mass of 4 g/mol for He gives about  $1E29$  moles of He. In total, there's about  $8E29$  moles. FA=30.