Chapter 1 - Physics and Measurement

Note Title 9/17/2004

Problems pp. 17-22

1. $V = \pi r^2 h = \pi (0.0195)^2 (0.0390) = 4.66 \times 10^{-5}\ m^3$

$$\rho = m/V = \frac{1\ kg}{4.66 \times 10^{-5}\ m^3} = 2.15 \times 10^4\ kg/m^3$$

3. $V = \frac{4}{3}\pi \left(r_2^3 - r_1^3\right) = \frac{4}{3}\pi \left(5.75^3 - 5.70^3\right) = 20.6\ cm^3$

$$m = \rho V = (8.92\ g/cm^3)(2.06\ cm^3) = 184\ g$$

5. (a) $\rho_{Fe} = 7.86 \times 10^3\ kg/m^3$ (Table 1.5, p. 9)

$$= \left(7.86 \times 10^3 \frac{kg}{m^3}\right)\left(10^3 \frac{g}{kg}\right)\left(10^{-2} \frac{m}{cm}\right)^3 = 7.86\ g/cm^3$$

$$V_{1\ mole} = \frac{m}{\rho} = \frac{(55.8\ g/mol)}{7.86\ g/cm^3} = 7.10 \frac{cm^3}{mol}$$

(b) $$\frac{\left(7.10 \frac{cm^3}{mole}\right)\left(10^{-2} \frac{m}{cm}\right)^3}{6.02 \times 10^{23} \frac{atoms}{mol}} = 1.18 \times 10^{-29} \frac{m^3}{atom}$$

(c). $\left(1.18\times10^{-29}\ \frac{m^3}{atom}\right)^{\frac{1}{3}} = 2.28\times10^{-10}\ m$

(d). $\rho_U = 18.7\ g/cm^3$ (Table 1.5, p. 9)

$$V_{1\,mol} = \frac{m}{\rho} = \frac{238\ g/mol}{18.7\ g/cm^3} = 12.7\ cm^3/mol$$

$$Vol_{atom} = \frac{(12.7\ cm^3/mol)(10^{-2}\ m/cm)^3}{6.02\times10^{23}\ atoms/mol} = 2.11\times10^{-29}\ \frac{m^3}{atom}$$

$$Radius_{atom} = \left(21.1\times10^{-30}\ \frac{m^3}{atom}\right)^{\frac{1}{3}} = 2.76\times10^{-10}\ m$$

7. (a) He: $4.00\ u = (4.00u)(1.66\times10^{-24}\ g/u) = 6.64\times10^{-24}\ g$

Fe: $55.9u = (55.7u)(1.66\times10^{-24}\ g/u) = 9.28\times10^{-23}\ g$

Pb: $207u = (2.07\times10^{2}u)(1.66\times10^{-24}\ g/u) = 3.44\times10^{-23}\ g$

9. (a) Mass of Fe Cube

$$(5.00\times10^{-6}\ cm)^3\ (7.86\ g/cm^3) = 9.83\times10^{-16}\ g$$

(b) # atoms $= \dfrac{9.83 \times 10^{-16}\ g}{55.9\ g/mol} \times 6.02 \times 10^{23}\ \dfrac{atoms}{mol}$

$= 1.06 \times 10^{7}$ atoms

11. (a) $1.20\ kg\ H_2O = \dfrac{1.20\ kg}{1.80 \times 10^{-2}\ kg/mol} \times 6.02 \times 10^{23}\ \dfrac{atom}{mol} =$

4.01×10^{25} atoms

(b) % of all H_2O on Earth: $\dfrac{1.20\ kg}{1.32 \times 10^{21}\ kg}$

By random chance, same % likely to have been in any volume some time ago. The longer the time in past, greater likelihood for mixing.

$\therefore (4.01 \times 10^{25}\ atoms)\left(\dfrac{1.20\ kg}{1.32 \times 10^{21}\ kg}\right) = 3.64 \times 10^{4}$ molecs.

20. a. $Vol = (40.0\ m)(20.0\ m)(12.0\ m)$

$= 9.6 \times 10^{3}\ m^3 \left(3.28\ \dfrac{ft}{m}\right)^3 = 3.39 \times 10^{5}\ ft^3$

6. $\text{mass} = \rho V = \left(1.20 \frac{\text{kg}}{\text{m}^3}\right)\left(9.6 \times 10^3 \text{ m}^3\right) = 1.15 \times 10^4 \text{ kg}$

$\text{Weight} = mg = (1.15 \times 10^4 \text{ kg})(9.80 \text{ m/sec}^2)$

$= 1.13 \times 10^5 \text{ N} \left(\frac{0.22415 \text{ lbs}}{\text{N}}\right)$

$= 2.53 \times 10^4 \text{ lbs.}$

23. $1 \text{ mi} = 1.61 \text{ km}, \quad 1 \text{ mi}^2 = (1.61 \times 10^3 \text{ m})^2 = 2.59 \times 10^6 \text{ m}^2$

$640 \text{ acres} = 2.59 \times 10^6 \text{ m}^2$

$1 \text{ acre} = = 4.05 \times 10^3 \text{ m}^2 = 40.5 \times 10^2 \text{ m}^2$

or 63.6 m on a side.

30. Seconds in 1 year

(a) $\left(60 \frac{\text{sec}}{\text{min}}\right)\left(\frac{60 \text{ min}}{\text{hr}}\right)\left(\frac{24 \text{ hr}}{\text{day}}\right)\left(\frac{365 \text{ days}}{\text{yr}}\right) = 3.15 \times 10^7 \frac{\text{sec}}{\text{yr}}$

(b). $\frac{4}{3}\pi r^3 = \frac{4}{3}\pi\left(\frac{d}{2}\right)^3 = \frac{\pi}{6} d^3$

$\text{Vol. micrometeorite} = \frac{\pi}{6}\left(10^{-6} \text{ m}\right)^3 = 0.524 \times 10^{-18} \text{ m}^3$

$\therefore \frac{1 \text{ m}^3}{0.524 \times 10^{-18} \frac{\text{m}^3}{\text{sec}}} = 1.91 \times 10^{18} \text{ sec} = \frac{1.91 \times 10^{18}}{3.15 \times 10^7} = 6.06 \times 10^{10} \text{ yrs}$

44. # raindrops on 1 acre during 1 in rainfall.

Raindrop $\simeq \frac{1}{4}$" diameter, so $(0.25)^3 \text{ in} \simeq (0.3)^3 \simeq .03 \text{ in}^3$

$1 \text{ Acre} = 44{,}000 \text{ ft}^2 = 4.4 \times 10^4 \text{ ft}^2 \simeq 4.4 \times 10^6 \text{ in}^2$

So, acre-in $\simeq 4.4 \times 10^6 \text{ in}^3$. $\dfrac{4.4 \times 10^6 \text{ in}^3}{.03 \text{ in}^3/\text{raindrop}} \simeq 10^8$ raindrops

53. $Vol = (6.50 \times 10^{-2} \text{ m} \pm 0.2 \times 10^{-2})^3 \frac{4}{3}\pi$

$= 1.15 \times 10^{-3} \text{ m}^3 \pm \frac{4}{3}\pi \left[3(0.2)^2(6.5) \times 10^{-6} \pm 3(0.2)(6.5)^2 \times 10^{-4}\right]$

$= 1.15 \times 10^{-3} \text{ m}^3 \pm \frac{4}{3}\pi \cdot 26.1 \times 10^{-6}$

$= 1.15 \times 10^{-3} \text{ m}^3 \pm 0.11 \times 10^{-3} \text{ m}^3$

$\text{Mass/Vol} = \dfrac{(1.85 \pm 0.02 \text{ kg})}{(1.15 \pm 0.11) \times 10^{-3} \text{ m}^3} = 1.61 \times 10^3$

The uncertainty is: $\dfrac{[(1.85)(0.11) + (1.15)(0.02)] \times 10^{-3}}{(1.15 \times 10^{-3})^2}$

$= 0.17 \times 10^3$

So $\rho = [1.61 \pm 0.17] \times 10^3 \text{ kg/m}^3$