Physics 3 Homework Due 25 Jun 03 YSB

From Hecth Ch 1.

7. 3.00 ft x 2.54 cm/ft x 10 mm/ft = 76.2 mm

8. 1.00 ft x 12 in/ft x 2.54 cm/in x 10 mm/in = 304.8 mm
   but to three sig figs, this is 305 mm

9. 200.0 mm x $\frac{1}{10}$ cm/mm x $\frac{1}{2.54}$ cm/in = 7.874 in

13. $5.88 \times 10^{12}$ mi $\times \frac{5280 \text{ ft}}{1 \text{ mi}} \times \frac{12 \text{ in}}{\text{ ft}} \times 2.54 \text{ cm/in}$
   $\times \frac{1}{100 \text{ in/cm}} = 9.46 \times 10^5 \text{ m}

29. Note that the 125000 hairs/head figure is irrelevant to the problem.
   We need hairs/day for a year.

45 hairs/day $\times 10 \text{ cm/hair} \times 365.24 \text{ days/year}$

$= 1.6 \times 10^5 \text{ cm/yr} \times 10^{-2} \text{ m/cm}$

$= 1.6 \times 10^3 \text{ m/yr} = 1.6 \text{ km/yr}$

So after 1 year, 1.6 km of lost hair.
   More for me.
41. a) \(0.0020 = 2.0 \times 10^{-3}\)

b) \(0.99 = 9.9 \times 10^{-1}\)

c) \(1.75 \pm 0.02\) All 3 figs significant

d) \(\frac{1.001}{4}\) All 4 figs significant

e) \(4.44 \times 10^4\) All 3 sig.

f) \(0.01 \times 10^{34} = 1 \times 10^{-32}\) \(\approx 1.5 \times \) fig

42. \(299.792.45 \text{ m/s} \) (9 sig. figs)

\(= 2.99792.45 \times 10^2 \text{ m/s} \) (9 sig. figs)

\(\approx 2.9979246 \times 10^2 \text{ m/s} \) (8 sig. figs)

\(\approx 2.998 \times 10^2 \text{ m/s} \) (4 sig. figs)

\(\approx 3.00 \times 10^2 \text{ m/s} \) (3 sig. figs)

\(\approx 3.0 \times 10^2 \text{ m/s} \) (2 sig. figs)

\(\approx 3 \times 10^2 \text{ m/s} \) (1 sig fig)

A useful number to know. Interesting how close c is to \(3 \times 10^8 \text{ m/s}\).
44. \[ 1,000 \text{ ft}^2 \times \left( \frac{12 \text{ ft}}{1 \text{ ft}} \right)^2 \times \left( 2.54 \text{ cm} / \text{ in} \right)^2 \]

\[ \times \left( \frac{1}{100 \text{ m}} \right)^2 = 9,290 \text{ m}^2 \]

47.

\[ R = 1.738 \times 10^3 \text{ km} \]

Moon is sphere, so volume of moon is volume of sphere

\[ V = \frac{4}{3} \pi R^3 \]

\[ = \frac{4}{3} \pi \left( 1.738 \times 10^3 \text{ km} \right)^3 \]

\[ = 4.189 \times 10^9 + 10^{10} \text{ km}^3 \]

\[ = 2.190 \times 10^9 \text{ km}^3 \]

\[ = 2.190 \times 10^{10} \text{ km}^3 \]

\[ = 2.2 \times 10^{10} \text{ km}^3 \text{ to 2 significant figures} \]
48. Assuming the tank is full, its volume is

\[ V = 4.19 \text{ m}^3 \]

\[ V = \frac{4}{3} \pi r^3 \]

\[ r = \left( \frac{3 V}{4 \pi} \right)^{1/3} \]

Its diameter is

\[ d = 2r = 2 \left( \frac{3 V}{4 \pi} \right)^{1/3} \]

\[ = 2 \left( \frac{3 \times 4.19 \text{ m}^3}{4 \pi} \right)^{1/3} \]

\[ = 2.00 \text{ m} \]

49.

[Diagram of a cuboid and a sphere]

The side of the box, \( a \), is twice the radius of the sphere, \( r \)

\[ V_{\text{sph}} = \frac{4}{3} \pi r^3 \]

\[ r = \left( \frac{3 V_{\text{sph}}}{4 \pi} \right)^{1/3} \]

\[ V_{\text{box}} = a^3 = (2r)^3 = 8 \frac{3 V_{\text{sph}}}{4 \pi} \]

\[ = \frac{6}{\pi} 1.00 \text{ m}^3 = 1.91 \text{ m}^3 \]
Questions 67 and 69 are order-of-magnitude calculations.

67. From experience, sand grain sizes are highly variable, but on the order of

\[ V_S \approx 1 \text{mm}^3/\text{grain} \times (10^{-3} \text{m}/\text{mm})^3 = 10^{-9} \text{m}^3/\text{grain} \]

Volume of the Earth \( V_\oplus = \frac{4}{3} \pi R_\oplus^3 \)

Number of grains that would fit in the volume of the earth is

\[ N = \frac{V_\oplus}{V_S} = \frac{4}{3} \pi R_\oplus^3 \frac{1}{V_S} \]

\[ \pi \approx 3 \]

\[ N = 4 \times (0.6 \times 10^{-7} \text{m})^3 \]

\[ = \frac{4 \times 10^{-21} \text{m}^3}{10^{-9} \text{m}^3/\text{grain}} \]

\[ = 0.8 \times 10^{12} \text{grain} \]

\[ \approx 10^{30} \text{grains} \]

OK to leave off "grains" as a unit. In this case, \( N \) is a pure number. But it helps to keep track of what \( N \) is counting.
69. \( V_B = 10 \text{ cm} = 10^{-1} \text{ m} \)

\[
\begin{align*}
V_B &= \pi r_b^2 h \\
A_B &= 2\pi r_b h
\end{align*}
\]

\[
V_B \approx 3 \times 2 \ \text{m} \times (10^{-1} \ \text{m})^2 = 6 \times 10^{-2} \ \text{m}^3
\]

\[= 0.06 \ \text{m}^3\]

Sanity check:

Box of volume 6 \times 10^{-2} \ m^3 has sides

\[
3\sqrt{6 \times 10^{-2} \ \text{m}^2} = 0.4 \ \text{m} \quad \text{Could you fit}
\]

A body in a box that size? I think so. It would hurt a little...

\[
A_B = 2\pi r_b h \approx 2 \times 3 \times 10^{-1} \ \text{m} \times 2 \ \text{m}
\]

\[= 12 \times 10^{-1} \ \text{m}^2 \approx 1 \ \text{m}^2\]

Sanity Check:

How big is a bearskin rug?
\[ V_c = \frac{30 \text{mm}}{2} = 15 \text{mm} \times 10^{-6} \text{m}^3/\text{mm} \]

\[ = 1.5 \times 10^{-5} \text{ m} \]

Volume of cell is \( V_c = \frac{4}{3} \pi r_c^3 \)

Packing fraction is \( \nu_1 \) so \( V_c \) is volume per cell.

\[ \frac{V_c}{1 \text{ cell}} = \frac{4}{3} \pi (1.5 \times 10^{-5} \text{ m})^3 = 10^{-14} \text{ m}^3/\text{cell} \]

Number of cells in the body is

\[ N = \frac{V_B}{V_c} = \frac{6 \times 10^{-2} \text{ m}^3}{10^{-19} \text{ m}^3/\text{cell}} = 6 \times 10^{12} \text{ cells} \]

\( \approx 10^{13} \text{ cells} \)