ASSIGNMENT #1

NOTE : Numbers in boxes are different for each student.

① Giancoli 1.P.003

Write the following numbers in powers of ten notation.

(a) $\boxed{0.0001156}$ = 0.0001156 = 1.156×10^{-4}

(b) $\boxed{0.00000218}$ = 0.00000218 = 2.18×10^{-6}

(c) $\boxed{68}$ = 68. = 6.8×10^{1}

(d) $\boxed{0.00027635}$ = 0.00027635 = 2.7635×10^{-4}

(e) $\boxed{219000}$ = 219000 = 2.19×10^{5}

(f) $\boxed{444}$ = 444. = 4.44×10^{2}

② What, roughly, is the percent uncertainty in the volume of a spherical beach ball whose radius is $r = \boxed{2.36 \pm 0.08}$ m.

Sol Volume of the spherical beach ball

$$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(\boxed{2.36})^3 = \boxed{55.058}\, m^3$$

Uncertainty in volume

$$\Delta V_{\pm} = \frac{4}{3}\pi(r \pm \Delta r)^3 - \frac{4}{3}\pi r^3$$

$$= \frac{4}{3}\pi(\boxed{2.36 \pm 0.08})^3 - \frac{4}{3}\pi(\boxed{2.36})^3 = \begin{array}{l}\boxed{+\ 5.79}\ m^3 \\ \boxed{-\ 5.41}\ m^3\end{array}$$

Average uncertainty in volume (absolute values) $\Delta V = \frac{|\Delta V_+| + |\Delta V_-|}{2} = \frac{\boxed{5.79} + \boxed{5.41}}{2}\, m^3 = \boxed{5.6}\, m^3$

% uncertainty in volume $= \frac{\Delta V}{V} \times 100 = \frac{\boxed{5.6}}{\boxed{55.058}} \times 100 = \boxed{10.2}\,\%$

<u>Note:</u> Since problem asks for percent uncertainty in volume, roughly, we can use ΔV_+ or ΔV_- to calculate it without going ~~to~~ the averaging of ΔV_+ and ΔV_-.

<u>Variation</u> (slightly).

$$\Delta V_{\pm} = \frac{4}{3}\pi\,(r \pm \Delta r)^3 - \frac{4}{3}\pi r^3$$

$$= \frac{4}{3}\pi\left[r^3 \pm 3r^2\Delta r + 3r(\Delta r)^2 \pm (\Delta r)^3 \right] - \frac{4}{3}\pi r^3$$

$$= \cancel{\frac{4}{3}\pi r^3} \pm \frac{4}{3}\pi\,(3r^2\Delta r) + \frac{4}{3}\pi\; 3r(\Delta r)^2 \pm \frac{4}{3}\pi(\Delta r)^3 - \cancel{\frac{4}{3}\pi r^3}$$

$$\sim \pm \frac{4}{3}\pi\; 3r^2\Delta r \qquad \text{since } (\Delta r)^2, (\Delta r)^3 \text{ are negligibly small.}$$

$$\%\text{ uncertainty in volume} = \frac{|\Delta V_{\pm}|}{V} \times 100$$

$$= \frac{\cancel{\frac{4}{3}}\cancel{\pi}\; 3\cancel{r^2}\,\Delta r}{\cancel{\frac{4}{3}}\cancel{\pi}\; r^{\cancel{3}}} \times 100$$

$$= \frac{3\Delta r}{r} \times 100$$

$$= \frac{3\,(\boxed{0.08})}{\boxed{2.36}} \times 100$$

$$= \boxed{10.2}\,\% \;\checkmark$$

3 Giancoli 1.P.016

What is the conversion factor between the following?

(a) ft^2 and yd^2

$$1\,yd = 3\,ft$$

$$\Rightarrow \quad 1\,ft^2 = 1\,\cancel{ft^2}\left|\frac{1\,yd}{3\,\cancel{ft}}\right|\frac{1\,yd}{3\,\cancel{ft}}\Big| = \frac{1}{9}\,yd^2 = \underline{\underline{0.111\,yd^2}}$$

(b) m^2 and ft^2

$$1\,in = 2.54\,cm.$$

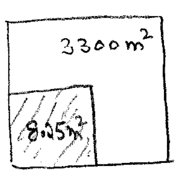
$$1\,m^2 = 1\,\cancel{m^2}\left|\frac{100\,\cancel{cm}}{1\,\cancel{m}}\right|\frac{100\,\cancel{cm}}{1\,\cancel{m}}\left|\frac{1\,in}{2.54\,\cancel{cm}}\right|\frac{1\,\cancel{in}}{2.54\,\cancel{cm}}\left|\frac{1\,ft}{12\,\cancel{in}}\right|\frac{1\,ft}{12\,\cancel{in}}\Big|$$

$$1\,m^2 = \frac{100 \times 100}{2.54 \times 2.54 \times 12 \times 12}\,ft^2 = \underline{\underline{10.8\,ft^2}}$$

4 Giancoli 1 P.025

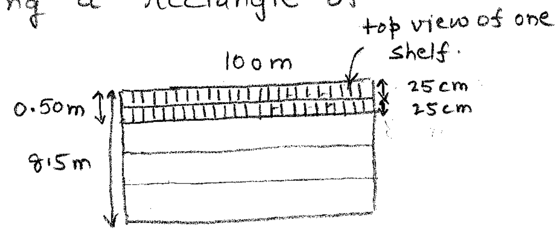
Estimate how many books can be shelved in a college Library with $\boxed{3300}$ square meters of floor space. Assume $\boxed{9}$ shelves high, having books on both sides, with each side 25 cm wide, and $\frac{1}{4}$ of total floor space covered by shelving. Assume books are about the size of this one (20cm wide, 4cm thick), on average.

<u>Sol</u> Floor area used by bookshelves $= \frac{1}{4} \times 3300\,m^2 = \boxed{8.25}\,m^2$



Sol 4 cont.

This area can be obtained by assuming a rectangle of dimensions 100 m × $\boxed{8.25}$ m, which is completely occupied with book shelves.



Place one bookshelf along 100 m dimension. It can hold books on both sides.

One book shelf 100 m long can hold

$$= \frac{100 \text{ m}}{.04 \text{ m}} \times 2 = 5000 \text{ books.}$$

$\boxed{9}$ bookshelves of such kind can hold. [One book case].

$$= \boxed{9} \times 5000 = \boxed{45,000} \text{ books. per bookcase}$$

Number of bookshelves, 0.5 m wide, that can be placed along $\boxed{8.25}$ m side

$$= \frac{\boxed{8.25}\text{ m}}{0.5 \text{ m}} = \boxed{16.5} \text{ bookshelves}$$

Total number of books that $\boxed{17}$ book cases of $\boxed{9}$ shelves high can hold

$$= \boxed{16.5} \cancel{\text{bookcase}} \times \boxed{45,000} \frac{\text{books}}{\cancel{\text{bookcase}}}$$

$$= \boxed{7.42 \times 10^5} \text{ books}$$

Lots of books !!

5 Giancoli 1.P.0.32

The speed, v, of an object is given by the equation $v = At^{\boxed{5}} - Bt^{\boxed{6}}$ where t refers to time. What are the dimensions of A and B? (Express your answers using only m for distance and s for time.

Sol. Units of speed, v, is m/s (meters per second)

Units of time, t, is s (second)

In dimensional notations $[v] = \left[\frac{L}{T}\right]$ sq. brackets represents dimensions.

$[t] = [T]$

$$v\left(\frac{m}{s}\right) = At^{\boxed{5}}(s^{\boxed{5}}) - Bt^{\boxed{6}}(s^{\boxed{6}})$$

dimensionally.

$$\left[\frac{L}{T}\right] = [A][T]^{\boxed{5}} - [B][T]^{\boxed{6}}$$

This can be dimensionally correct only if each term on right hand side has same dimensions as left hand side.

$$\Rightarrow \quad [A][T]^5 = \left[\frac{L}{T}\right]$$

dimension of A, $[A]\frac{\cancel{[T]^{\boxed{5}}}}{\cancel{[T]^{\boxed{5}}}} = \frac{\left[\frac{L}{T}\right]}{[T]^{\boxed{5}}}$

$$\Rightarrow [A] = \frac{[L]}{[T]^{\boxed{6}}} = \frac{m}{s^{\boxed{6}}}$$ in terms of units.

dimension of B, $[B]\frac{\cancel{[T]^{\boxed{6}}}}{\cancel{[T]^{\boxed{6}}}} = \frac{\left[\frac{L}{T}\right]}{[T]^{\boxed{6}}}$

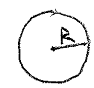
$$[B] = \frac{[L]}{[T]^{\boxed{7}}} = \frac{m}{s^{\boxed{7}}}$$ in terms of units.

6 Giancoli 1. P. 037.

A typical adult human lung contains about $\boxed{300}$ millions tiny cavities called alveoli. Estimate the average diameter of a single alveolus. Assume the alveoli are spherical and a typical human lung is about $\boxed{2.05}$ liters.

Sol. Volume of a single alveolus of radius R

$$= \frac{4}{3} \pi R^3$$



alveolus

Human lung of volume $\boxed{2.05}$ liters is filled with $\boxed{300}$ millions of such tiny alveoli.

$\Rightarrow$ Volume of $\boxed{300 \times 10^6}$ million alveoli $= \boxed{2.05}$ liters.

Volume of 1 alveolus $= \boxed{\frac{2.05}{300 \times 10^6}}$ liters.

$$1 \text{ liter} = 1000 \text{ cm}^3 = 1.0 \times 10^{-3} \text{ m}^3.$$

$$\Rightarrow \quad \frac{4}{3} \pi R^3 = \boxed{\frac{2.05}{300 \times 10^6}} \cancel{\text{liters}} \left| \frac{1.0 \times 10^{-3} \text{ m}^3}{\cancel{\text{liters}}} \right|$$

$$\frac{\frac{4}{3} \cancel{\pi} R^3}{\cancel{\frac{4}{3}} \pi} = \frac{\boxed{6.833 \times 10^{-12}} \text{ m}^3}{\frac{4}{3}\pi}$$

$$R^3 = \boxed{1.6313 \times 10^{-12}} \text{ m}^3$$

$$\text{Radius, } \quad R = \left(\boxed{1.6313 \times 10^{-12}} \text{m}^3\right)^{1/3} = \boxed{1.1772} \times 10^{-4} \text{ m}$$

$$\text{Diameter of a single alveolus} = 2R = \boxed{2.35 \times 10^{-4}} \text{ m}$$

7 Giancoli 1. P. 033.

Three students derive the following equations in which x - refers to distance traveled, v the speed, a the acceleration and t the time, and the subscrip $(_0)$ means a quantity at time $t = 0$. Which of these could possibly be correct according to a dimensional check?

Sol We have to check each equation dimensionally. Table on RHS gives units and dimensions for each variable.

Variable		units	dimensions
distance	x	m	$[L]$
speed	v	m/s	$[L]/[T]$
acceleration	a	m/s^2	$[L]/[T]^2$
time	t	s	$[T]$

(a) $x = vt^2 + 2at$

dimensionally it reads.

$$[L] = \frac{[L]}{\cancel{[T]}}[T]^{\cancel{2}} + 2\frac{[L]}{[T]^{\cancel{2}}}\cancel{[T]}$$

when checking dimensionality we do not worry about constant numbers

$$= \underline{[L][T]} + \underline{\frac{[L]}{[T]}}$$

Each term on RHS, has different dimension than LHS. Therefore this equation <u>can not be correct</u>.

(b) $x = v_0 t + \frac{1}{2}at^2$

$$[L] = \frac{[L]}{\cancel{[T]}}\cancel{[T]} + \frac{1}{2}\frac{[L]}{\cancel{[T]^2}}\cancel{[T]^2} = \underline{[L]} + \underline{[L]}$$

each term on RHS has same dimensions as LHS. Therefore this equation <u>can be correct</u>.

Sol 7 cont.

(c) $x = v_0 t + 2at^2$

$$[L] = \frac{[L]}{\cancel{[T]}}\cancel{[T]} + 2\frac{[L]}{\cancel{[T]^2}}\cancel{[T]^2} = \underline{[L]} + \underline{[L]}$$

Each term on RHS has same dimensions as LHS. Therefore, this equation <u>can be correct.</u>

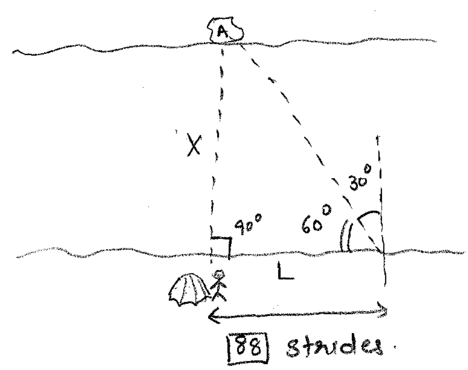
(8) Giancoli 1.P.049.

Jean camps beside a wide river and wonders how wide it is. She spots a large rock on the bank directly across from her. She then walks upstream untill she judges that the angle between her and the rock, which she can still see clearly, is now at an angle of 30° downstream (fig.). Jean measures her stride to be about one yard long. The distance back to her camp is $\boxed{88}$ strides. About how far across, both in yards and in meters, is the river?

<u>Sol</u> [Note: Picture given in book/webassign is slightly misleading.]

Let the width of the river be x

From figure on RHS.



$$\tan 60° = \frac{opp}{adj} = \frac{x}{L}$$

where, $L = \boxed{88}$ strides.

$= \boxed{88}$ yards.

Sol 8 cont . . .

$$\frac{x}{\boxed{88}\,yd} = \tan 60^\circ = 1.7321$$

$$\frac{x}{\cancel{88\,yd}}\ \cancel{88\,yd} = 1.7321 \times \boxed{88}\ yd$$

$$x = \boxed{152.4}\ yd$$ This is the width of river in yds.

convert yd → m.

$$x = \boxed{152.4}\ \cancel{yd} \left| \frac{3\ \cancel{ft}}{1\ \cancel{yd}} \right| \frac{12\ \cancel{in}}{1\ \cancel{ft}} \left| \frac{2.54\ \cancel{cm}}{1\ \cancel{in}} \right| \frac{1\ m}{100\ \cancel{cm}} \right|$$

$$x = \frac{\boxed{152.4} \times 3 \times 12 \times 2.54}{100}\ m$$

$$x = \boxed{139.4}\ m$$ This is the width of river in meters.

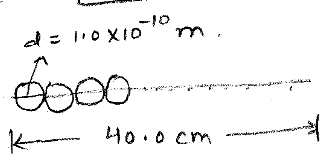
(9) Giancoli 1. P. 018

A typical atom has a diameter of about 1.0×10^{-10} m.

(a) What is this in inches?

$$1.0 \times 10^{-10}\ \cancel{m} \left| \frac{100\ \cancel{cm}}{1\ \cancel{m}} \right| \frac{1\ in}{2.54\ \cancel{cm}} \right| = \frac{1.0 \times 100}{2.54} \times 10^{-10} = 3.90 \times 10^{-9}\ in.$$

(b) How many atoms are there along a $\boxed{40.0}$ cm line?



1.0×10^{-10} meter will have = 1 atom.

40 cm " " =

$$\frac{1\ atom \times \boxed{40}\ cm}{1.0 \times 10^{-10}\ m} = \frac{1\ atom \times \boxed{40}\ \cancel{cm}}{1.0 \times 10^{-10}\ \cancel{m}} \times \left| \frac{1\ \cancel{m}}{100\ \cancel{cm}} \right| = \boxed{4.0 \times 10^{+9}}\ atoms.$$