SOLNS - 1

CHAPTER 1

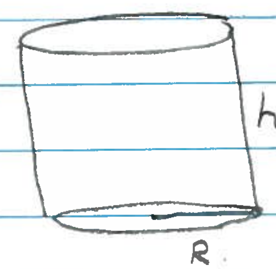
1 - 1 FROM OUR MASTER TABLE

AREA	L^2	m^2	(A).
Volume	L^3	m^3	
Length	L^1	m	(h)

So $V = Ah$ $L^3 \Rightarrow L^3$

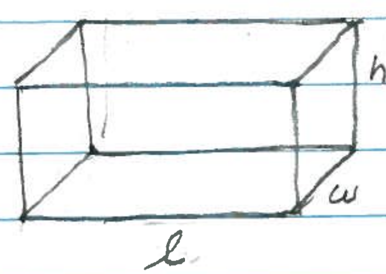
Cylinder : Move ⊙ of radius R by amount h creates

$V_{cyl} = \pi R^2 h.$



Box

$V_{Box} = l \times w \times h$



1 - 3 Period of pendulum in secs. so Dimension → T

acc. g in m/sec^2 Dimension $L T^{-2}$

2π is a number and has no dimensions

$\sqrt{\frac{l}{g}}$ has dimensions $\sqrt{\frac{L}{L T^{-2}}} = \sqrt{T^2} = T$

Hence $T = 2\pi\sqrt{\frac{l}{g}}$ is dimensionally correct.

Note: This is the Eqn. you will use in Expt. #1

1-12 Area of a circle of radius R is

$$A = \pi R^2$$

Here we are told that

$$R = (10.5 \pm 0.2)\, m$$

That is, high value of R is 10.7 m

low value of R is 10.3 m

a) $A = 3.14\,(10.5)^2 = 346\ m^2$

[To 3 significant figures)

b) Circumference $= 2\pi \times 10.5 = 65.9 m$

To obtain uncertainties

a) $A \pm \Delta A = \pi\,(R \pm \Delta R)^2$

$= \pi\,[R^2 \pm 2R\Delta R + (\Delta R)^2]$

$(\Delta R)^2$ is very small so we neglect it

$\Delta A = 2\pi R\,\Delta R = 2\pi \times 10.5 \times 0.2$

$= 65.9 m^2$

so $A \pm \Delta A = (346 \pm 65.9)\, m^2$

b) Circumference $= 2\pi\,(R \pm \Delta R)$

uncertainty is $= 2\pi\,\Delta R = 2 \times 3.14 \times 0.2$

$= 1.3 m$

ce $= (65.9 \pm 1.3)\, m$

1-27 Given Vol Mass

$1\ cm^3$ $10^{-3}\ kg.$

$1\ m^3 = 100\ cm \times 100\ cm \times 100\ cm = 10^6\ cm^3$

so mass of $1 m^3$ of water $= 10^{-3} \times 10^{6}\ kg$

$= 10^3\ kg.$

Biological material is 98% water so mass is $0.98 \times 10^3\ kg/m^3$

CELL Diam = $1\ \mu m$

sphere $V_{cell} = \frac{4\pi}{3} r^3 = \frac{4\pi}{3}\left[0.5 \times 10^{-6}\right]^3 m^3$

$= \frac{4\pi}{3} \times 0.125 \times 10^{-18}\ m^3$

$M_{cell} = 0.98 \times 10^3 \times \frac{4\pi}{3} \times 0.125 \times 10^{-18}\ kg$

$= 5.13 \times 10^{-16}\ kg$

Kidney Radius = 4.0 cm.

sphere $V_{kidney} = \frac{4\pi}{3}\left[4 \times 10^{-2}\right]^3 m^3 = \frac{4\pi}{3} \times 64 \times 10^{-6}\ m^3$

$M_{kidney} = 0.98 \times 10^3 \times \frac{4\pi}{3} \times 64 \times 10^{-6}\ kg$

$= 0.262\ kg$

Fly h = 4.00 mm, dia = 2mm.

cylinder $V_{Fly} = \pi \times (10^{-3})^2 \times 4 \times 10^{-3} = 4\pi \times 10^{-9}\ m^3$

$M_{Fly} = 0.98 \times 10^3 \times 4\pi \times 10^{-9} = 1.23 \times 10^{-5}\ kg$

1-33 To solve this we need two estimates.

(i) Dimensions of typical room

$(15 \times 15 \times 8)\ ft^3$

(ii) Diameter of Ping-Pong Ball $= 1\ in = \frac{1}{12}\ ft.$

$$V_{room} = 15 \times 15 \times 8 = 1800\ ft^3$$

$$V_{Ball} = \frac{4\pi}{3}\left(\frac{1}{24}\right)^3 = 3 \times 10^{-4}\ ft^3$$

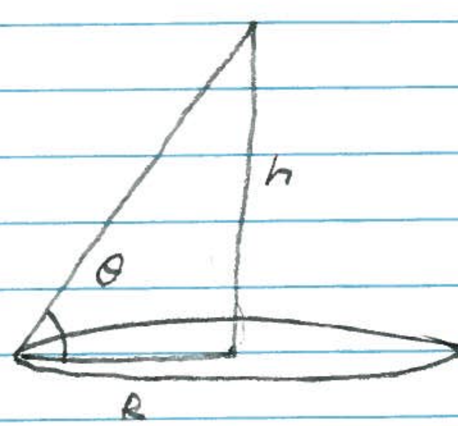
let us assume that the spheres can fill up the entire room (actully there will be gaps in between the packing may be around 70 %)

$$N = \frac{V_{room}}{V_{Ball}} = \frac{1800}{3 \times 10^{-4}} = 6 \times 10^6$$

1-41 Circumference is 15m

so

$$R = \frac{15}{2\pi}\ m.$$



$$\theta = 55^\circ.$$

$$\frac{h}{R} = \tan\theta$$

$$h = R\tan\theta$$

$$= \frac{15}{2\pi} \times 1.43 = 3.41\ m$$

1-48 SATURN (R) Radius $= 5.85 \times 10^7 m = 5.85 \times 10^7 \times 10^2$ cm

(M) Mass $= 5.68 \times 10^{26}$ kg $= 5.68 \times 10^{26} \times 10^3$ gm

$$\text{density} = \frac{\text{Mass}}{\text{Vol}} = \frac{M}{\frac{4\pi}{3}R^3}$$

$$= \frac{3M}{4\pi R^3} = \frac{3 \times 5.68 \times 10^{26} \times 10^3 \text{ gm}}{4\pi (5.85)^3 \times 10^{27} \text{ cm}^3}$$

$$= 677 \times 10^{-3} \text{ gm/cm}^3$$

Surface area of a sphere – SATURN

$$A = 4\pi R^2 = 4\pi (5.85 \times 10^9)^2$$

$$= 4 \times 3.142 \times (5.85 \times 10^9)^2$$

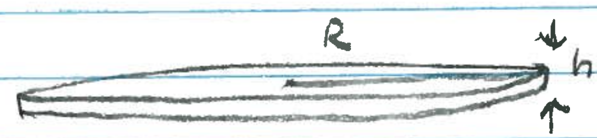
$$= 4.30 \times 10^{20} \text{ cm}^2$$

1ft = 30 cm

$$A = \frac{4.30 \times 10^{20}}{900} \text{ ft}^2$$

$$= 4.8 \times 10^{17} \text{ ft}^2$$

1-51 The oil slick is a very thin disk which is one molecule thick.



$$V = \pi R^2 h$$

$$R = 0.418 m$$

$$\text{Mass} = 9 \times 10^{-7} \text{ kg}$$

$$(\text{Rho}) \quad \rho = \frac{\text{Mass}}{\text{Volume}} = 918 \text{ kg/m}^3$$

$$h = \frac{M}{\pi R^2 \rho}$$

$$= \frac{9 \times 10^{-7}}{3.142 \times (0.418)^2 \times 918}$$

For getting order of magnitude it is o.k. to set $R = 1m$.

$M = 10^{-6} kg$

and $\rho = 10^3 kg/m^3$

to obtain $\pi \sim 1$

$$h \cong \frac{10^{-6}}{10^3 \times 1 \times 1} \simeq 10^{-9} m$$

CHAPTER 2

2-2 CONVERT UNITS – SPEED IS A SCALAR.

DUNE – WALKING.

$$S_{AV} = \frac{20\,ft}{yr} = \frac{20\,ft}{yr} \times \frac{1\,m}{3.281\,ft} \times \frac{1\,yr}{3.156\times10^{7}\,sec} = 2\times10^{-7}\,m/s$$

DUNE – WINDY

$$S_{AV} = \frac{100\,ft}{yr} = 5\times2\times10^{-7}\,m/s = 10^{-6}\,m/s$$

DRIFTING CONTINENT $\quad S_{AV} = 10\,mm/yr. = \dfrac{10}{10^{3}\times1609} = 6.125\times10^{-6}$ mi/yr

d = distance = 3000 mi

$[1609\,m = 1\,mi]$

$$\text{time of travel} = \frac{d}{S_{AV}} = \frac{3000}{6.125\times10^{-6}}$$

$$\simeq 5\times10^{8}\,yr$$

2-6 VELOCITY IS A VECTOR. MOTION ALONG x SO

$$\underset{\rightarrow}{V} = \pm\, v\,\hat{x}$$

$$\langle \underset{\rightarrow}{V} \rangle = \frac{x_2\,\hat{x} - x_1\,\hat{x}}{t_2 - t_1}$$

a) 0 to 2s

$$\langle \underset{\rightarrow}{V} \rangle = \frac{10\,\hat{x} - 0\,\hat{x}}{2}$$

$$= 5\,m/s\,\hat{x}$$

6. A graph of position versus time for a certain particle moving along the x-axis is shown in Figure P2.6. Find the average velocity in the time intervals from (a) 0 to 2.00 s, (b) 0 to 4.00 s, (c) 2.00 s to 4.00 s, (d) 4.00 s to 7.00 s, and (e) 0 to 8.00 s.

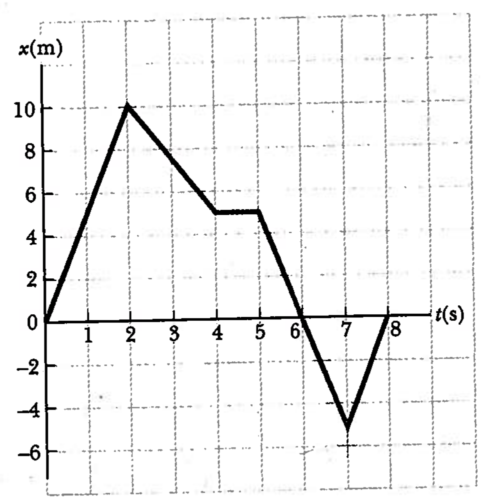


Figure P2.6 (Problems 6 and 15)

2-6 (contd)

b) 0 to 4 sec.

$$\langle \vec{V} \rangle = \frac{5-0}{4}\,\hat{x} = 1.25\,m/s\,\hat{x}$$

c) 2 to 4 sec

$$\langle \vec{V} \rangle = \frac{5-10}{2}\,\hat{x} = -2.5\,m/s\,\hat{x}$$

d) 4 to 7 sec

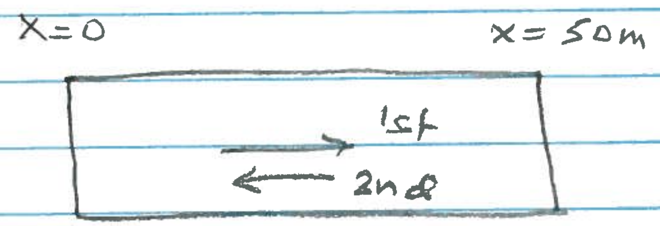
$$\langle \vec{V} \rangle = -\frac{5-5}{3}\,\hat{x} = -3.3\,m/s\,\hat{x}$$

e) 0 to 8 sec.

$$\langle \vec{V} \rangle = 0$$

2-9

$$\langle \vec{V} \rangle = \frac{\vec{x}_{fin} - \vec{x}_{in}}{t_{fin} - t_{in}}$$



a) 1st half $\langle \vec{V} \rangle = \frac{50}{20}\,m/s\,\hat{x} = 2.5\,m/s\,\hat{x}$

b) 2n half $\langle \vec{V} \rangle = \frac{0-50}{22}\,m/s\,\hat{x} = -\frac{50}{22}\,m/s\,\hat{x}$

$$= -2.27\,m/s\,\hat{x}$$

(c) Total trip $\langle \vec{V} \rangle = \frac{0-0}{42} = 0\,m/s$

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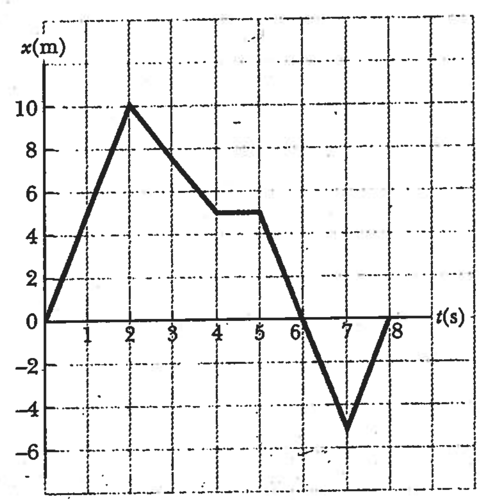

Figure P2.6 (Problems 6 and 15)

2 – 11 This is like the turnpike situation
speed when travelling is 89.5 km/h.
b/c she stops for 22.0 min, average
reduces to 77.8 km/h.

Let actual driving time be t hrs
Total time of trip $\left(t + \frac{22}{60}\right) = t_t$ hrs
Then

$$89.5\,t = 77.8\left(t + \frac{22}{60}\right)$$

$$t\,[89.5 - 77.8] = \frac{77.8 \times 22}{60}$$

$$t = \frac{77.8 \times 22}{60 \times 11.7} = 2.44 \text{ hrs}$$

$$t_t = \left(2.44 + \frac{22}{60}\right) \text{hrs} = 2.44 + 0.37 = 2.81 \text{ hrs}$$

travel distance $89.5 \times 2.44 = 218$ km

2 – 13 needs av. speed 250 km/hr to qualify
for driving on a 1600 m circuit.
Total time of travel must be $\frac{1.6}{250}$ hrs $= 6.4 \times 10^{-3}$ hrs.

first half av. speed is 230 km/hr
first half time of travel $\frac{0.8}{230}$ hrs $= 3.48 \times 10^{-3}$ hrs

time remaining $= \frac{1.6}{250} - \frac{0.8}{230} = 2.92 \times 10^{-3}$ hrs

2-13 (contd).

He needs to go 0.8 km in 2.92×10^{-3} hrs to qualify

so speed must be

$$\frac{0.8}{2.92 \times 10^{-3}} = 274 \text{ km/hr}$$

during second half