Homework Assignment 1 - Solutions

Note Title 1/3/2006

(5) $\frac{60 s}{MIN} \frac{60 MIN}{HOUR} \frac{24 HOURS}{DAY} \frac{365 DAYS}{YEAR} 22 YEARS = ?$

$\downarrow$ TAKING ORDERS OF MAGNITUDE

$10 \cdot 10 \cdot 10 \cdot 10^2 \cdot 10 \approx 10^6$ SECONDS.

$6 \cdot 6 \cdot 2 \cdot 3 \cdot 2 \Rightarrow 36 \cdot 12 \approx 10^2$

$10^2 \cdot 10^6 \simeq 10^8$

(10) HOW FAR DO I BIKE TO SCHOOL?

1 BLOCK $\cong \frac{1}{4}$ MILE

MY HOUSE $\rightarrow$ UCSD IS ~ 15 BLOCKS

$15 \cdot \frac{1}{4} \simeq 4$ MILES.

A BETTER CALCULATION WOULD BE THE NUMBER OF REVOLUTIONS THE WHEELS MAKE ON THAT RIDE. 4 MILES IS ABOUT 6 KM. MY WHEEL IS ABOUT $\frac{1}{2}$ METER ACROSS.

$C = 2\pi r$ (GEOMETRY)

≈ 3 METERS/REVOLUTION.

$6000\,m \cdot \frac{\text{REVOLUTION}}{3\text{ METERS}} = 2000$ REVOLUTIONS.

1.1)

A = AREA = m^2

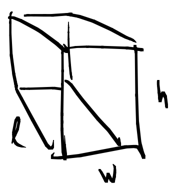
h = height = m

V MUST BE m^3.

$V = Ah = m^2 \cdot m = m^3$.

DIMENSIONALLY CORRECT!

V OF A BOX:



$l \cdot w \cdot h = (m)(m)(m) = m^3$

But, $l \cdot w = A = m^2$.

So, $V = Ah = (l \cdot w)(h)$.

V OF A CYLINDER:

$V = \pi r^2 h = m^2 \cdot m = m^3$

AREA OF A CIRCLE = πr^2,

SO $V = Ah. = (\pi r^2)(h)$.

1.2)

X IS DISPLACEMENT, WITH UNITS OF METERS.

t is time, UNITS OF SECONDS.

$x = Bt^2 \Rightarrow m = (\ )s^2$

WE WANT TO CANCEL s^2, SO B MUST BE PROPORTIONAL TO $1/s^2$. ALSO, WE WANT TO END UP WITH UNITS OF METERS. THUS,

$x = Bt^2 \Rightarrow$ METERS $= \left(\frac{\text{METERS}}{s^2}\right) \cdot s^2$

B HAS UNITS OF $\frac{m}{s^2}$.

1.6

(a) Given that $a \propto F/m$, we have $F \propto ma$. Therefore, the units of force are those of *ma*,
$F = M(L/T^2) = \boxed{MLT^{-2}}$.

1.7 (a) 78.9 ± 0.2 has $\boxed{\text{3 significant figures}}$.

(b) 3.788×10^9 has $\boxed{\text{4 significant figures}}$.

(c) 2.46×10^{-6} has $\boxed{\text{3 significant figures}}$.

(d) $0.0032 = 3.2 \times 10^{-3}$ has $\boxed{\text{2 significant figures}}$.

1.16 (a) $=(348 \text{ mi})\left(\dfrac{1.609 \text{ km}}{1.000 \text{ mi}}\right)=\boxed{5.60\times10^{2} \text{ km}}=\boxed{5.60\times10^{5} \text{ m}}=\boxed{5.60\times10^{7} \text{ cm}}$

(b) $h=(1612 \text{ ft})\left(\dfrac{1.609 \text{ km}}{5280 \text{ ft}}\right)=\boxed{0.4912 \text{ km}}=\boxed{491.2 \text{ m}}=\boxed{4.912\times10^{4} \text{ cm}}$

(c) $h=(20\,320 \text{ ft})\left(\dfrac{1.609 \text{ km}}{5280 \text{ ft}}\right)=\boxed{6.192 \text{ km}}=\boxed{6.192\times10^{3} \text{ m}}=\boxed{6.192\times10^{5} \text{ cm}}$

(d) $d=(8\,200 \text{ ft})\left(\dfrac{1.609 \text{ km}}{5280 \text{ ft}}\right)=\boxed{2.499 \text{ km}}=\boxed{2.499\times10^{3} \text{ m}}=\boxed{2.499\times10^{5} \text{ cm}}$

In (a), the answer is limited to three significant figures because of the accuracy of the original data value, 348 miles. In (b), (c), and (d), the answers are limited to four significant figures because of the accuracy to which the kilometers-to-feet conversion factor is given.

18. Your hair grows at a rate of $\dfrac{1}{32}\dfrac{\text{inches}}{\text{day}}$. Find the rate in $\dfrac{\text{nm}}{\text{s}}$ (nanometers per second).

$\rightarrow \dfrac{1 \text{ } \cancel{\text{inches}}}{32 \text{ day}}\cdot\dfrac{2.54 \text{ } \cancel{\text{cm}}}{1 \text{ } \cancel{\text{inch}}}\cdot\dfrac{1 \text{ } \cancel{\text{m}}}{100 \text{ } \cancel{\text{cm}}}\cdot\dfrac{10^{9} \text{ nm}}{1 \text{ } \cancel{\text{m}}}=\dfrac{2.54\times10^{7} \text{ nm}}{32 \text{ days}}$

$\rightarrow \dfrac{2.54\times10^{7} \text{ nm}}{32 \text{ } \cancel{\text{days}}}\cdot\dfrac{1 \text{ } \cancel{\text{day}}}{24 \text{ } \cancel{\text{hr}}}\cdot\dfrac{1 \text{ } \cancel{\text{hr}}}{60 \text{ } \cancel{\text{min}}}\cdot\dfrac{1 \text{ } \cancel{\text{min}}}{60 \text{ s}}=9.1869 \dfrac{\text{nm}}{\text{s}}=9.2 \dfrac{\text{nm}}{\text{s}}$

Your hair grows at about $9.2 \dfrac{\text{nm}}{\text{s}}$

1.27 (a) $\text{mass}=(\text{density})(\text{volume})=\left(\dfrac{1.0\times10^{-3} \text{ kg}}{1.0 \text{ cm}^3}\right)(1.0 \text{ m}^3)$

$$=\left(1.0\times10^{-3}\frac{\text{kg}}{\text{cm}^3}\right)(1.0 \text{ m}^3)\left(\frac{10^2 \text{ cm}}{1 \text{ m}}\right)^3=\boxed{1.0\times10^{3} \text{ kg}}$$

(b) As rough calculation, treat as if 100% water. ← NOTE THAT THIS IS AN EXTREMELY BAD ASSUMPTION.

cell: $\text{mass}=\text{density}\times\text{volume}=\left(10^3 \dfrac{\text{kg}}{\text{m}^3}\right)\dfrac{4}{3}\pi(0.50\times10^{-6} \text{ m})^3=\boxed{5.2\times10^{-16} \text{ kg}}$

kidney: $\text{mass}=\text{density}\times\text{volume}=\left(10^3 \dfrac{\text{kg}}{\text{m}^3}\right)\dfrac{4}{3}\pi(4.0\times10^{-2} \text{ m})^3=\boxed{0.27 \text{ kg}}$

fly: $\text{mass}=\text{density}\times\text{volume}=(\text{density})(\pi r^2 h)$

$$=\left(10^3 \frac{\text{kg}}{\text{m}^3}\right)\pi(1.0\times10^{-3} \text{ m})^2(4.0\times10^{-3} \text{ m})=\boxed{1.3\times10^{-5} \text{ kg}}$$

30. Assume a hamburger contains a quarter pound of meat.

Then for 50 billion hamburgers, we have $(50\times10^9 \text{ hamburgers})(0.25 \text{ lb/hamburger}) = 12.5\times10^9$ lbs

Thus the hamburger chain must have used about 12.5 billion pounds of meat.

Now, assume that one cow (i.e. one head of cattle) furnishes about 1000 pounds of usable meat.

Then the hamburger chain must have used about $\left(\frac{12.5\times10^9 \text{ lbs}}{10^3 \text{ lbs/cow}}\right) = 12.5\times10^6$ cows

which is about 12.5 million cows.

1.33 Consider a room that is 12 ft square with an 8.0 ft high ceiling. The volume of this room is

$$V_{room} = (12\text{ ft})(12\text{ ft})(8.0\text{ ft})\left(\frac{1\text{ m}}{3.281\text{ ft}}\right)^3 = 33\text{ m}^3.$$

A ping pong ball has a radius of about 2.0 cm, so its volume is

$$V_{ball} = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi\left(2.0\times10^{-2}\text{ m}\right)^3 = 3.4\times10^{-5}\text{ m}^3.$$

The number of balls that would easily fit into the room is therefore

$$n = \frac{V_{room}}{V_{ball}} = \frac{33\text{ m}^3}{3.4\times10^{-5}\text{ m}^3} = 9.7\times10^5 \text{ or } \boxed{\sim10^6}$$

1.34 Assume an average of 1 can per person each week and a population of 250 million.

$$\text{number cans/year} = \left(\frac{\text{number cans/person}}{\text{week}}\right)(\text{population})(\text{weeks/year})$$

$$= \left(1\ \frac{\text{can/person}}{\text{week}}\right)\left(2.5\times10^8\text{ people}\right)(52\text{ weeks/yr})$$

$$= 1.3\times10^{10}\text{ cans/yr , or } \boxed{\sim10^{10}\text{ cans/yr}}$$

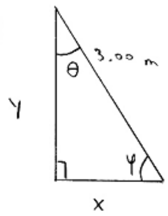
$$\text{number of tons} = (\text{weight/can})(\text{number cans/year})$$

$$= \left[\left(0.5\ \frac{\text{oz}}{\text{can}}\right)\left(\frac{1\text{ lb}}{16\text{ oz}}\right)\left(\frac{1\text{ ton}}{2000\text{ lb}}\right)\right]\left(1.3\times10^{10}\ \frac{\text{can}}{\text{yr}}\right)$$

$$= 2\times10^5\text{ ton/yr, or } \boxed{\sim10^5\text{ ton/yr}}$$

Assumes an average weight of 0.5 oz of aluminum per can.

[42.]



θ = 30° (a) Find x.
(b) Find y.

First, observe that φ must be 60°.

(a) Using SOHCAHTOA, we remember $\sin\theta = \frac{x}{3.00\,\text{m}}$ $\boxed{\Rightarrow x = (3.00\,\text{m})\sin 30° = 1.50\,\text{m}}$

(b) Remember $\cos\theta = \frac{y}{3.00\,\text{m}}$ $\boxed{\Rightarrow y = (3.00\,\text{m})\cos 30° = 2.60\,\text{m}}$

Just for reference, observe that $\sin\varphi = \frac{y}{3.00\,\text{m}}$, $\cos\varphi = \frac{x}{3.00\,\text{m}}$

CHAPTER 2

C8) a) OBJECT ACCELS (+) THEN DECELS (-)
b.) CONSTANT VELOCITY (EQUAL SPACING)
c) ACCELERATION. (+).

C10) No. VELOCITY IS A VECTOR, SO BOTH SPEED AND DIRECTION MATTER

2.2 (a) $$\overline{v} = \frac{\Delta x}{\Delta t} = \frac{20\text{ ft}}{1\text{ yr}}\left(\frac{1\text{ m}}{3.281\text{ ft}}\right)\left(\frac{1\text{ yr}}{3.156\times 10^7\text{ s}}\right) = \boxed{2\times 10^{-7}\text{ m/s}},$$

or in particularly windy times

$$\overline{v} = \frac{\Delta x}{\Delta t} = \frac{100\text{ ft}}{1\text{ yr}}\left(\frac{1\text{ m}}{3.281\text{ ft}}\right)\left(\frac{1\text{ yr}}{3.156\times 10^7\text{ s}}\right) = \boxed{1\times 10^{-6}\text{ m/s}}$$

(b) The time required must have been

$$\Delta t = \frac{\Delta x}{\overline{v}} = \frac{3\times 10^3\text{ mi}}{10\text{ mm/yr}}\left(\frac{1609\text{ m}}{1\text{ mi}}\right)\left(\frac{10^3\text{ mm}}{1\text{ m}}\right) = \boxed{5\times 10^8\text{ yr}}.$$

2.4) $2{:}09.21 = 2 \text{ hrs} + 9 \text{ min} + 21 \text{ sec}$

$$= 2 \text{ hrs} + 9 \text{ min} \cdot \frac{1 \text{ hour}}{60 \text{ min}} + \frac{21 \text{ sec}}{} \left| \frac{1 \text{ hour}}{3600} \right.$$

$$= 2.15 \text{ hours.}$$

$$\frac{26.2 \text{ mi}}{2.15 \text{ hours}} = 12.1 \text{ mph.}$$

Problem 6

a) We know that $\bar{v} = \frac{\Delta x}{\Delta t}$ (eqn. 2.2 again)

$\Delta x = x_{final} - x_{initial}$ $\Delta t = t_{final} - t_{initial}$

$\Delta x = x(t=2.00) - x(t=0.00) = 10.0 - 0.00 = 10.0 m$

$\Delta t = 2.00 - 0.00 = 2.00 s$

$\bar{v} = \frac{10.00 m}{2.00 s} = \boxed{5.00 \frac{m}{s}}$

b) $\Delta x = x(4.00) - x(0.00) = 5.00 - 0.00 = 5.00 m$

$\Delta t = 4.00 s - 0.00 s = 4.00 s$

$\bar{v}$ $\frac{5.00 m}{4.00 s} = \boxed{1.25 \frac{m}{s}}$

c) $\Delta x = x(4.00) - x(2.00) = 5.00 - 10.0 = -5.00 m$

$\Delta t = 4.00 - 2.00 = 2.00 s$

$\bar{v} = \frac{-5.00 m}{2.00 s} = \boxed{-2.50 \frac{m}{s}}$

d) $\Delta x = x(7.00) - x(4.00) = -5.00 - 5.00 = -10.0 m$

$7.00 s - 4.00 s = 3.00 s$

$\bar{v}$ $\frac{-10.0 m}{3.00 s} = \boxed{-3.33 \frac{m}{s}}$

e) $\Delta x = x(8.00 s) - x(0.00 s) = 0.00 - 0.00 = 0.00 m$

$\Delta t = 8.00 s - 0.00 s = 8.00 s$

$\bar{v}$ $\frac{0.00 m}{8.00 s} = \boxed{0.00 \frac{m}{s}}$

Problem 18

The average speed is $|\bar{v}| = \frac{|\Delta x|}{\Delta t}$

First quarter mile: $\frac{.25\,mi}{25.2\,\cancel{s}} \cdot \frac{3600\,\cancel{s}}{1\,h} = 35.7\,\frac{mi}{h}$

Second quarter mile: $\frac{.25\,mi}{24.0\,\cancel{s}} \cdot \frac{3600\,\cancel{s}}{1\,h} = 37.5\,\frac{mi}{h}$

Third quarter mile: $\frac{.25\,mi}{23.8\,\cancel{s}} \cdot \frac{3600\,\cancel{s}}{1\,h} = 37.8\,\frac{mi}{h}$

Fourth quarter mile: $\frac{.25\,mi}{23.0\,s} \cdot \frac{3600\,s}{1\,h} = 39.1\,\frac{mi}{h}$

b) We assume that the instantaneous velocity is $39.1\,\frac{mi}{h}$

The total race time is: $25.2s + 24.0s + 23.8s + 23.0s = 96.0s$

So Secretariat gained $39.1\,\frac{mi}{h}$ in 0.0258 hours $\quad 96.0s \cdot \frac{1h}{3600s} = 0.026$

$\bar{a} = \frac{\Delta v}{\Delta t}$ (Equation 2.4)

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{39.1\,mi/h}{0.0267\,h} = 1470\,\frac{\cancel{mi}}{\cancel{hr^2}} \cdot \frac{5280\,ft}{\cancel{mi}} \cdot \frac{1^2\,\cancel{hr^2}}{3600^2\,s^2} = \boxed{.597\,\frac{ft}{s^2}} = 1470\,\frac{mi}{hr^2}$$

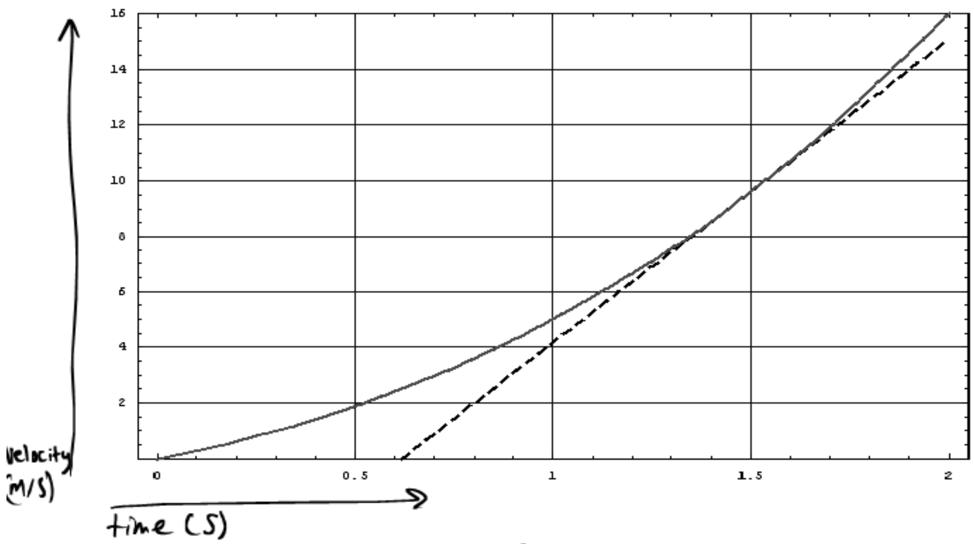
Problem 21

We know that $\bar{a} = \frac{\Delta v}{\Delta t}$. Solving for Δt gives $\Delta t = \frac{\Delta v}{\bar{a}}$

In this case, $\Delta v = \left(60\,\frac{mi}{h} - 55\,\frac{mi}{h}\right) = 5\,\frac{mi}{h}$

$$\frac{\Delta v}{\bar{a}} = 5\,\frac{\cancel{mi}}{\cancel{h}} \cdot \frac{1}{0.60\,\frac{\cancel{m}}{s^{\cancel{2}}}} \cdot \frac{1609.3\,\cancel{meters}}{1\,\cancel{mile}} \cdot \frac{1\cancel{h}}{3600\,\cancel{s}} = \boxed{3.7 \text{ seconds}}$$

Problem 23



a) $\bar{a} = \frac{\Delta v}{\Delta t} = \frac{16\,\frac{m}{s}}{2.0\,s} = \boxed{8.0\ m/s^2}$

b) The instantaneous acceleration is the slope of the tangent to the graph at $t = 1.5$ s. The tangent line has been plotted as the dashed line.
Its slope is about $\boxed{11\ m/s^2}$