PHYS 6A HW1 Solutions

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(1.4) A computer can do 136.8 teracalculations per second. How many calculations can it do in a microsecond?

Prefixes: tera $= 10^{12}$ micro $= 10^{-6}$ $\Rightarrow$ there are 10^6 microseconds (μs) in 1 second.

$$136.8\times10^{12}\,\frac{\text{calculations}}{\text{second}} = 136.8\times10^{12}\,\frac{\text{calculations}}{10^6\,\mu s} = 136.8\times10^6\,\frac{\text{calculations}}{\mu s}$$

$\Rightarrow$ it can do 136.8×10^6 calculations in a microsecond

or

136.8 megacalculations in a microsecond

(1.6) Which of the following quantities have dimensions of distance?

a) vt. $\quad v = \frac{[L]}{[T]} \quad t = [T] \Rightarrow vt = \frac{[L]}{[T]}[T] = [L] =$ distance

b) $\frac{1}{2}at^2$. $\quad a = \frac{[L]}{[T^2]} \quad t^2 = [T^2] \Rightarrow \frac{1}{2}at^2 = \frac{[L]}{[T^2]}[T^2] = [L] =$ distance

c) $2at$. $\quad at = \frac{[L]}{[T^2]}[T] = \frac{[L]}{[T]} =$ velocity $\neq$ distance

d) $\frac{v^2}{a}$. $\quad v^2 = \frac{[L^2]}{[T^2]} \Rightarrow \frac{v^2}{a} = \frac{[L^2]}{[T^2]}\frac{[T^2]}{[L]} = [L] =$ distance

$\Rightarrow$ a), b), and d) have units of distance

(1.12) $T = 2\pi\sqrt{\frac{m}{k}}$. Find the dimensions of k for this equation to be dimensionally correct.

$\Rightarrow \sqrt{\frac{m}{k}}$ must have units of time $\Rightarrow \frac{m}{k} = [T^2] \Rightarrow$ $\boxed{k = \frac{[M]}{[T^2]}}$

(1.14) The speed of light to five significant figures is 2.9978×10^8 m/s. What is the speed of light to three significant figures?

we don't just keep the first two decimal places; we must round them.

2.9978×10^8 m/s $\rightarrow$ $\boxed{3.00 \times 10^8 \text{ m/s}}$

(1.20) A building measures approx. 631 m × 707 yards × 110 ft.

a) what is the volume in cubic feet?

First, convert each measurement into ft.

1 m = 3.281 ft $\Rightarrow$ 631 m $= (631 \text{ m})\left(\frac{3.281 \text{ ft}}{1 \text{ m}}\right) = 2.07 \times 10^3$ ft

1 yd = 3 ft $\Rightarrow$ 707 yd $= (707 \text{ yd})\left(\frac{3 \text{ ft}}{1 \text{ yd}}\right) = 2.12 \times 10^3$ ft

$\Rightarrow$ Volume $= (2.07 \times 10^3 \text{ ft})(2.12 \times 10^3 \text{ ft})(110 \text{ ft}) = \boxed{4.83 \times 10^8 \text{ ft}^3}$

b) Convert the result from part a) to cubic meters.

1 m = 3.281 ft $\Rightarrow$ 1 ft = 0.305 m $\Rightarrow 1 \text{ ft}^3 = (0.305)^3 \text{ m}^3$

$= 2.84 \times 10^{-2} \text{ m}^3$

$\Rightarrow 4.83 \times 10^8 \text{ ft}^3 = (4.83 \times 10^8)(2.84 \times 10^{-2}) \text{ m}^3$

$= \boxed{1.37 \times 10^7 \text{ m}^3}$

(1.30) 1 jiffy = the time it takes light to travel one centimeter.

a) 1 jiffy = how many seconds?

$$1 \text{ jiffy} = \frac{\text{one centimeter}}{\text{speed of light}} = \frac{1 \text{ cm}}{2.9979\times10^{8} \text{ m/s}} = \frac{1\times10^{-2} \text{ m}}{2.9979\times10^{8} \text{ m/s}} = \frac{1\times10^{-2}}{2.9979\times10^{8}} \text{ s}$$

$\Rightarrow$ **1 jiffy = 3.3357×10^{-11} s**

b) How many jiffys are in one minute?

$$1 \text{ jiffy} = 3.3357\times10^{-11} \text{ s} \Rightarrow 1 \text{ s} = \frac{1}{3.3357\times10^{-11}} \text{ jiffy} = 2.9979\times10^{10} \text{ jiffy}$$

There are 60 seconds in one minute

$\Rightarrow$ 1 minute $= (60)(2.9979\times10^{10}$ jiffy$) =$ **1.7987×10^{12} jiffys in 1 minute**

(1.38) New York is roughly 3000 miles from Seattle. When it is 10:00 am in Seattle, it is 1:00 pm in New York. Using this information, estimate:

a) the rotational speed of the surface of the Earth.

The info we are given means that it takes 3 hours for a point on Earth's surface to travel 3000 miles.

$\Rightarrow$ rotational speed of surface $= \frac{3000 \text{ miles}}{3 \text{ hours}} =$ **$1000 \frac{\text{miles}}{\text{hour}}$**

b) the circumference of the Earth.

We are given that it takes 3 hours for a point on Earth's surface to travel 3000 miles and we know that it takes 24 hours for a complete rotation. We can then estimate the circumference as follows:

3000 miles in 3 hours $\rightarrow$ 24,000 miles in 24 hours.

$\Rightarrow$ **Circumference of Earth $\approx$ 24000 miles**

(1.38)

c) the radius of the Earth.

We can take our estimation of the circumference and divide by 2π to obtain an estimate for the radius.

$$\Rightarrow \text{radius} \approx \frac{24000 \text{ miles}}{2\pi} \approx \boxed{3800 \text{ miles}}$$

(2.4)

You walk from the park to your friend's house, then back to your house.

a) What is the distance traveled?

Just add each distance: park to friend's house = 0.95 mi

friend's house to your house = 0.95 mi + 0.75 m = 1.7 mi

$$\Rightarrow \text{total distance} = 0.95\text{mi} + 1.7\text{mi} = \boxed{2.65 \text{ mi}}$$

b) What is the displacement?

Displacement is the distance between the starting and ending points, i.e. the distance between the park and your house.

$$\Rightarrow \boxed{\text{displacement} = 0.75 \text{ mi}}$$

(2.16) Estimate how fast your hair grows in miles per hour.

Lets say human hair grows 1 cm in a month. Now convert cm to miles and months to hours.

$1 \text{ cm} \approx 6\times10^{-6}$ miles   1 month $\approx$ 730 hours

$$\Rightarrow \frac{1 \text{ cm}}{\text{month}} \approx \frac{6\times10^{-6} \text{ miles}}{730 \text{ hours}} \approx \boxed{1\times10^{-8} \frac{\text{miles}}{\text{hour}}}$$

(2.18) You jog at 9.5 km/h for 8.0 km, then you jump into a car and drive an additional 16 km. With what average speed must you drive your car if your average speed for the entire 24 km is to be 22 km/h?

$$\text{average speed} = \frac{\text{total distance}}{\text{total time}} = \frac{24\text{ km}}{T} = 22\text{ km/h}$$

$$\Rightarrow T = \frac{24\text{ km}}{22\text{ km/h}} = 1.1\text{ h}$$ is the total time.

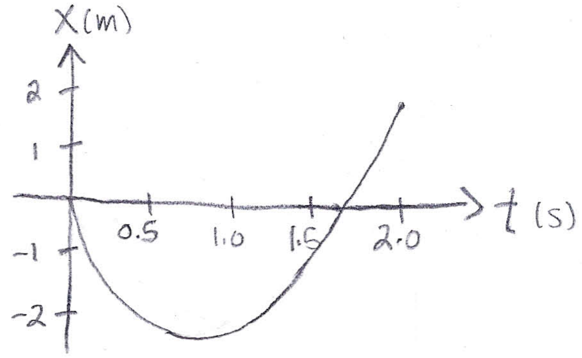
The time it takes to jog is $\frac{8.0\text{ km}}{9.5\text{ km/h}} = 0.84\text{ h}$.

Therefore it must take $1.1\text{ h} - 0.84\text{ h} = 0.26\text{ h}$ to drive the 16 km.

$$\Rightarrow \text{average driving speed} = \frac{16\text{ km}}{0.26\text{ h}} = \boxed{62\ \frac{\text{km}}{\text{h}}}$$

(2.24) $x(t) = (-5\text{ m/s})t + (3\text{ m/s}^2)t^2$

a) Plot x versus t for t=0 to t=2s.



b) Find the average velocity from t=0 to t=1s.

$$V_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_1 - x_0}{t_1 - t_0}$$

$x_1 = x(1) = -5(1) + 3(1)^2 = -2$ $\quad x_0 = x(0) = 0$

$$\Rightarrow V_{avg} = \frac{-2-0}{1-0} = -2 \quad \Rightarrow \boxed{\vec{V}_{avg} = -2\text{ m/s}\ \hat{x}}$$

c) Find the average speed from t=0 to t=1s.

$$\text{average speed} = \frac{\text{distance traveled}}{\text{time}} = \frac{2\text{ m}}{1\text{ s}} = \boxed{2\text{ m/s} = \text{average speed}}$$