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PHY 113

Workshop 1

Giancoli 1-6

$\boxed{\text{Order of Magnitude estimate}}$

Rounding off all numbers to one significant figure and its power of 10, after calcu... again only one significant figure is kept

160
$\times$ 9
0

#1. Average
8 hours per day
5 days per week
4 weeks per month

$\Big\}\ \sim 10^2$

160

180

9 months per year
20 16 years

$\Big\}\ \sim 2\times10^2$

40
$\times$ 4
100
$\times$ 9
900
$\times$ 16
10000 hr

on

144

16
$\times$ 9
144
$\times$ 9
1000

10^4 hours

#2. The unit of Force is N (= kg m/s²)

Giancoli 1-7
Dimension and Dimensional Analysis

$$F = -G\frac{Mm}{r^2} \Leftrightarrow G = -F\frac{r^2}{Mm}$$

The unit of RHS except the unit of G is

Dimension = type of base units

$$kg\,m/s^2 = G \cdot kg^2/m^2$$

$$G\,\frac{kg^2}{m^2}$$

Comparing this with the unit of Force, (kg m/s²)

$$G \sim \frac{\cancel{kg}\,m/s^2}{kg^{\cancel{2}}/m^2} = \frac{m^3}{kg\cdot s^2}$$

#3. Theory $f(x,y,z)$

$$(\Delta F)^2 = (\Delta x)^2\left(\frac{\partial F}{\partial x}\right)^2 + (\Delta y)^2\left(\frac{\partial f}{\partial y}\right)^2 + (\Delta z)^2\left(\frac{\partial f}{\partial z}\right)^2$$

$$F = k\frac{Qq}{r^2} \iff q = \frac{Fr^2}{kQ}$$

$q(F, r, Q)$

$$(\Delta q)^2 = (\Delta F)^2\left(\frac{\partial q}{\partial F}\right)^2 + (\Delta r)^2\left(\frac{\partial q}{\partial r}\right)^2 + (\Delta Q)^2\left(\frac{\partial q}{\partial Q}\right)^2$$

$$(\Delta q)^2 = (\Delta F)^2\left(\underbrace{\frac{r^2}{kQ}}_{=\frac{q}{F}}\right)^2 + (\Delta r)^2\left(\frac{2Fr}{kQ}\right)^2 + (\Delta Q)^2\left(-\frac{Fr^2}{kQ^2}\right)^2$$

$$(\Delta q)^2 = (\Delta F)^2\left(\frac{q}{F}\right)^2 + (\Delta r)^2 4\left(\frac{q}{r}\right)^2 + (\Delta Q)^2\left(-\frac{q}{Q}\right)^2$$

$$\therefore \frac{(\Delta q)^2}{q^2} = \frac{(\Delta F)^2}{F^2} + 4\frac{(\Delta r)^2}{r^2} + \frac{(\Delta Q)^2}{Q^2}$$

$$\frac{\Delta q}{q} = \sqrt{\frac{(\Delta F)^2}{F^2} + \frac{4(\Delta r)^2}{r^2} + \frac{(\Delta Q)^2}{Q^2}}$$

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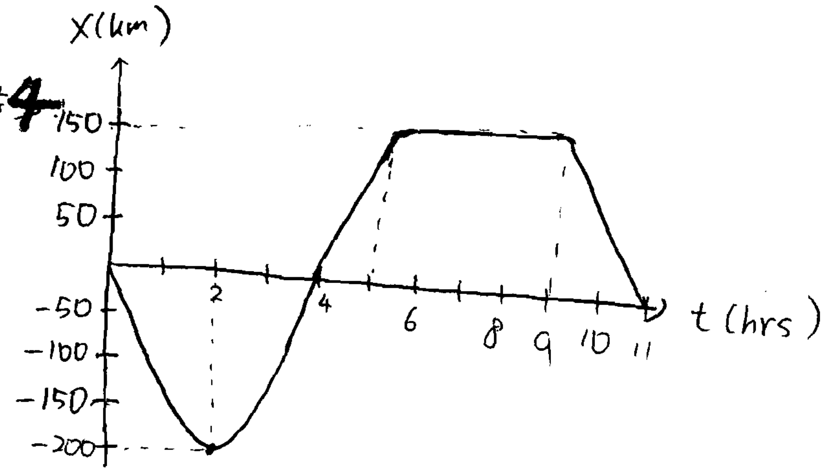
#4



(a) At t = 2 hour, from t=5 to t=9

~~X~~ Speed = $\frac{\text{distance traveled}}{\text{time elapsed}}$ Eq. 2-1 (Giancoli)

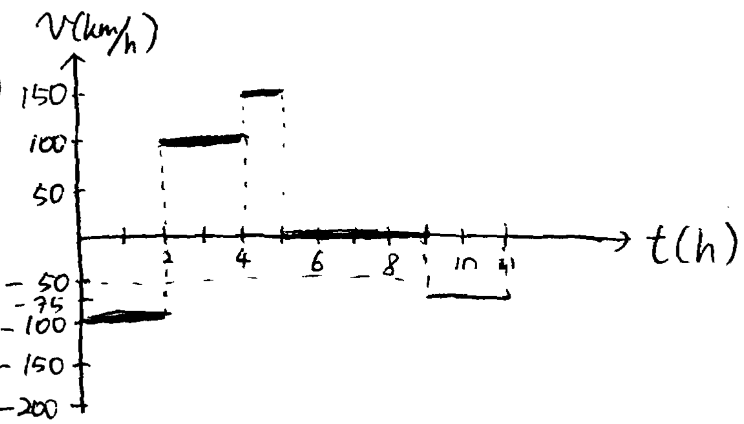
(b) Average velocity = $\frac{\text{displacement}}{\text{time elapsed}}$

i. $\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x|_{t=6h} - x|_{t=0h}}{6hrs - 0hr} = \frac{150km - 0km}{6hr} = 25\ km/hr$ (North)

ii. $\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x|_{t=4} - x|_{t=2}}{4hrs - 2hrs} = \frac{0km - (-200km)}{2hrs} = 100\ km/hr$ (N)

iii. $\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x|_{t=11} - x|_{t=4}}{11hrs - 4hrs} = 0\ km/hr$

(c)



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(d) $$\text{Average Speed} = \frac{\text{distance traveled}}{\text{time elapsed}}$$

$$\text{distance traveled} = |-200| + 200 + 150 + |-150| = 700 \text{ (km)}$$

$$\therefore \text{Average Speed} = \frac{700 \text{ km}}{11 \text{ hr}} \simeq 63.67 \text{ km/hr}$$

(e) $$\bar{a} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}. \quad (2\text{-}5)$$

$$\bar{a} = \frac{v|_{t=3h} - v|_{t=h}}{3hr - 1hr} = \frac{[100-(-100)] \text{ km/h}}{2hr} = 100 \text{ km/h}^2 \text{ (North)}$$

(f) $$a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$

At $t = 2$ hrs, we have the positive largest acceleration.

At $t = 5$ hrs, we have the largest magnitude of acceleration in negative value.

#5 Read 2-5. Motion at Constant Acceleration in Giancoli

$$x = x_0 + v_0 t + \frac{1}{2} a t^2 \quad (2\text{-}12)$$

In the figure, you have three different accelerations (slopes)

$a = 0 \text{ m/s}^2$ ($t: 0 \sim 4$ s)

$a = 15 m/s^2 \ (t: 4 \sim 8s)$

$a = -25 m/s^2 \ (t: 8 \sim 12s)$

Since we are interested in the distance that is traveled during 12 seconds, we can set $x_0 = 0$.

For $t = 0 \sim 4s$,

$$x_{0\sim4} = \underset{v_0}{40 m/s} \times \underset{t}{4s} = \underline{160m}$$

For $t = 4 \sim 8s$,

$$x_{4\sim8} = 40m/s \times 4s + \frac{1}{2} \times 15 m/s^2 \times 16 s^2 = \underline{280 m}$$

For $t = 8 \sim 12s$,

$$x_{8\sim12s} = v_0\Big|_{t=8s} \times t + \frac{1}{2} \times (-25 m/s^2) \times 16 s^2$$

$$= 100 \times 4 m - 200 m$$

$$= \underline{200m}$$

$$\therefore x = x_{0\sim4s} + x_{4\sim8s} + x_{8\sim12s} = \underline{640m}$$