WebAssign code : wm 0615 7410

* Scientific notation

$10^9 = 1000\,000\,000 = 1$ billion

10^9 : giga , G ($Gm = 10^9\ m$)
10^6 : mega , M
10^3 : kilo, k
1
10^{-2} : centi, c $1\,cm = 10^{-2}\,m = 0.01\,m$
10^{-3} : milli, m
10^{-6} : micro, μ
10^{-9} : nano, n
10^{-12} : pico, p

$E5 = \times 10^5$

$10^5 = 1 \times 10^5 = 1E5$

$10 \times 10^5 = 10^6$

$1\,m^3 = (100\,cm)^3 = (100)^3\,cm^3$
$= 10^6\,cm^3$
$= 1000\,000\,cm^3$

* Unit conversion : "multiply by 1"

$30 \text{ mpg} \rightarrow \text{km}/\ell$

~~(30 mpg) x (~~

$$\left(30 \; \frac{\cancel{\text{miles}}}{\cancel{\text{gallon}}}\right) \times \underbrace{\left(\frac{1.609 \text{ km}}{1 \cancel{\text{ mile}}}\right)}_{} \times \left(\frac{1 \cancel{\text{ gallon}}}{3.786 \; \ell}\right)$$

$$1 = \frac{1.609 \text{ km}}{1 \text{ mile}}, \quad 1 = \frac{1 \text{ gallon}}{3.786 \; \ell}$$

$$= \left(30 \times 1.609 \times \frac{1}{3.786}\right) \text{km}/\ell$$

$$= 12.8 \; \text{km}/\ell$$

* Scaling laws:

1) Why aren't there huge ants?

ant 1 (small) $L_1 = 1$ cm

ant 2 (large) $L_2 = 1$ m $= 100$ cm

$$\text{Weight} \sim \text{Volume} \sim (\text{Length})^3 \sim L^3$$
$$\text{Strength} \sim \underset{\text{(of legs)}}{\text{Area}} \sim (\text{Length})^2 \sim L^2$$

$$\text{Relative Strength} \sim \frac{\text{Strength}}{\text{Weight}} \sim \frac{(\text{Length})^2}{(\text{Length})^3} \sim \frac{1}{\text{Length}}$$

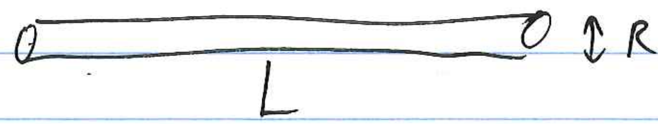
large ant 2 has Relative Strength that is 100 x smaller than ant 1

2) Cell viability, cell radius R

$$\text{oxygen use} \sim \text{Volume} \sim R^3$$
$$\text{oxygen absorption} \sim \text{Area} \sim R^2$$

$$\text{Viability factor} \sim \frac{\text{Oxygen absorption}}{\text{Oxygen use}} \sim \frac{1}{R}$$

low viability} → cell can't survive
large cells }



oxygen absorption $\sim$ Area $\sim L \cdot 2\pi R$
Oxygen use $\sim$ Volume $\sim \pi R^2 L$

viability factor $\sim \dfrac{\text{Area}}{\text{Volume}} \sim \dfrac{2\pi \cancel{L} R}{\pi R^2 \cancel{L}} \sim \dfrac{1}{R}$

* Scalars vs. vector

scalar = quantity without direction
↳ only has a magnitude
time, mass, temperature

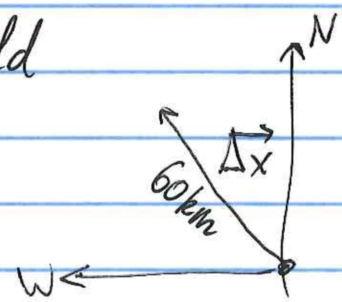
vectors = quantities with both <u>magnitude and a direction</u>

velocity, displacement, force
change in position

Example: magnitude = 60 km
direction = NW

$\Delta\vec{x}$, $\Delta\bar{x}$, $\underline{\Delta x}$, bold

coordinate system



vector are the same if magnitude AND direction is the same
regardless of where they apply

$|\Delta\vec{x}|$ = magnitude of displacement vector
60 km = scalar

* Kinematics vs. Dynamics

kinematics = study of motion without regards to its origins
chapter 2-3

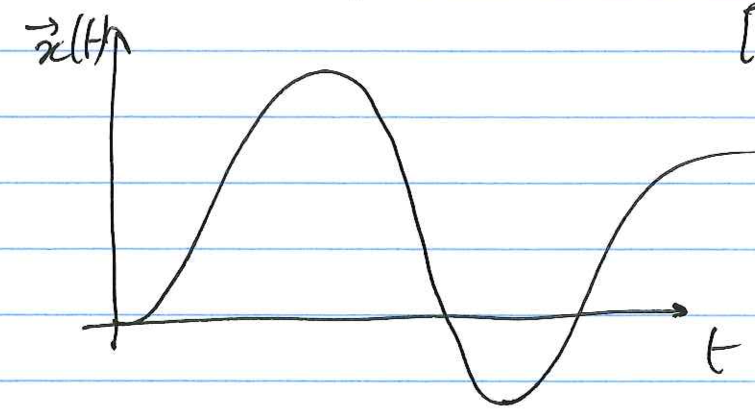
dynamics = study of motion and it's causes
chapter 4-5

↓

Galileo, Newton (1600-1675)

* 1D kinematics

direction of vectors in 1D = + or - sign



[m] $x(t)$	t [s]
0	0
1	1
2	2
-1	3
-3	4
-5	⋮

$$\text{average speed} = \frac{\text{total distance}}{\text{total time}} = \frac{d}{\Delta t}$$

$$= \text{scalar}$$

$$\text{average velocity} = \frac{\overrightarrow{\text{displacement}}}{\text{total time}} = \frac{\Delta \vec{x}}{\Delta t}$$

$$= \text{vector} = \vec{v}_{avg}$$