PHYS 107 - Week 1 - Friday

* Scientific notation :

10^9 : giga, G
10^6 : mega, M
10^3 : kilo, k
- - - - - - - - - - - - -
10^{-2} : centi, c
10^{-3} : milli, m
10^{-6} : micro, μ
10^{-9} : nano, n
10^{-12} : pico, p

Q Basic 3 Question Basic 3 : 10^5 = 1E5 in scientific notation

Q Basic 2 Question Basic 2 : $1\,m^3 = (100\,cm)^3 = 10^6\,cm^3$

* Unit conversion: "multiply by 1"

$$30\,mpg = \left(30\,\frac{\cancel{miles}}{\cancel{gallon}}\right) \times \left(\frac{1.609\,km}{1\,\cancel{mile}}\right) \times \left(\frac{1\,\cancel{gallon}}{3.786\,\ell}\right)$$
$$= 12.8\,km/\ell$$

* Scaling laws :

1) Why aren't ants bigger ? "Them" (1950's)

exoskeleton of chitin

ant 1 — $L = \underline{1\ cm}$ (small)

ant 2 — $L = \underline{1\ m}$ (large)

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

↓

$$\text{Relative Strength} \sim \frac{\text{Strength}}{\text{Weight}} \sim \frac{1}{\text{Length}}$$

→ ant 2 has a 100 times <u>smaller</u> relative strength

Question Basic 1 (?)

2) Cell viability for cell radius R (length)

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

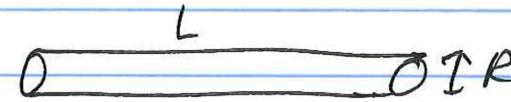
↓

$$\text{Viability Factor} \sim \frac{\text{Area}}{\text{Volume}} \sim \frac{1}{R}$$

Viability factor lower → less likely that cell is able to absorb oxygen for its survival

→ larger cells are less viable

Note: nerve cells are cylinders



$$\left.\begin{array}{l} \text{Area} = 2\pi R L \\ \text{Volume} = \pi R^2 L \end{array}\right\} \quad \frac{\text{Area}}{\text{Volume}} \text{ is independent } \underline{\text{on } L}$$

Q Basic 1 Question Basic 1

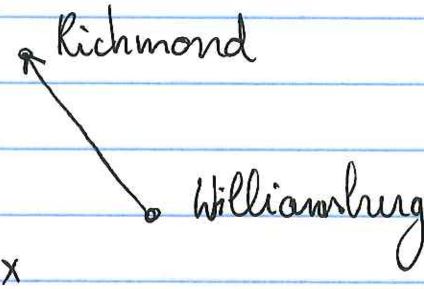
* Scalars and vectors

<u>scalar</u> = quantity without a direction
it only has a magnitude
examples: mass, temperature, time, <u>speed</u>

<u>vector</u> = quantity with a direction <u>and</u> magnitude
examples: <u>velocity</u>, force, displacement
change in position

Example of a vector: displacement when going to Richmond
60 km in NW (direction)
(magnitude)

→ notation $\Delta\vec{x}$
(also $\Delta\bar{x}$, $\underline{\Delta x}$, bold)
→ coordinate system



→ magnitude $|\Delta\vec{x}| = \Delta x$
$\uparrow$
scalar

Q Vectors 1a 2D vectors: magnitude and 1 angle
Q Vectors 1b 3D vectors: magnitude and 2 angles

Vectors are equal if → magnitude is equal
→ direction is equal

Independent of where in space! Origin.

* Kinematics versus Dynamics

kinematics = description of motion without considering the causes (chapter 2-3)

dynamics = study of the causes of motion $\rightarrow$ forces (chapter 4)

$\downarrow$

started with Newton and Galileo (1600-1675)

* 1-dimensional kinematics :

direction of vectors means + or − sign

$\vec{x}(t)$, magnitude $x(t)$, with + or − sign

$\downarrow$

Q 1D Kin 1a tabulate, graph, function

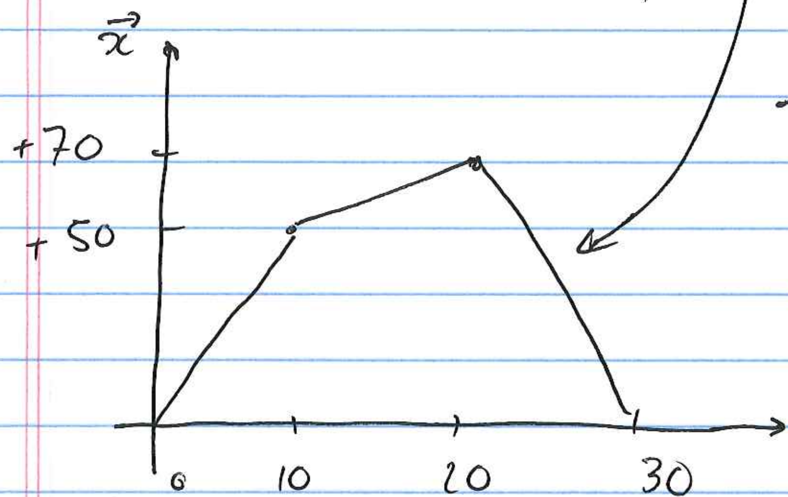
average speed = $\frac{\text{total distance}}{\text{total time}}$ (= scalar)

average velocity = $\frac{\text{displacement}}{\text{time}}$ (= vector)

$= \frac{\Delta \vec{x}}{\Delta t}$

Example : Mars curiosity rover

t [s]	$\vec{x}$ [cm]	$\vec{v}$ [cm/s]
0	0	
		+5 cm/s
10	+50	
		+ 2 cm/s
20	+70	
		- 7 cm/s
30	0	



speed = slope of position graph versus time

$$\vec{v}_{avg} \text{ (average velocity)} = \frac{\Delta \vec{x}}{\Delta t} = 0 \text{ cm/s}$$

$$\text{average speed} = \frac{50 + 20 + 70}{30} = 46.7 \text{ cm/s}$$