## Standard course of physics

Classical physics:

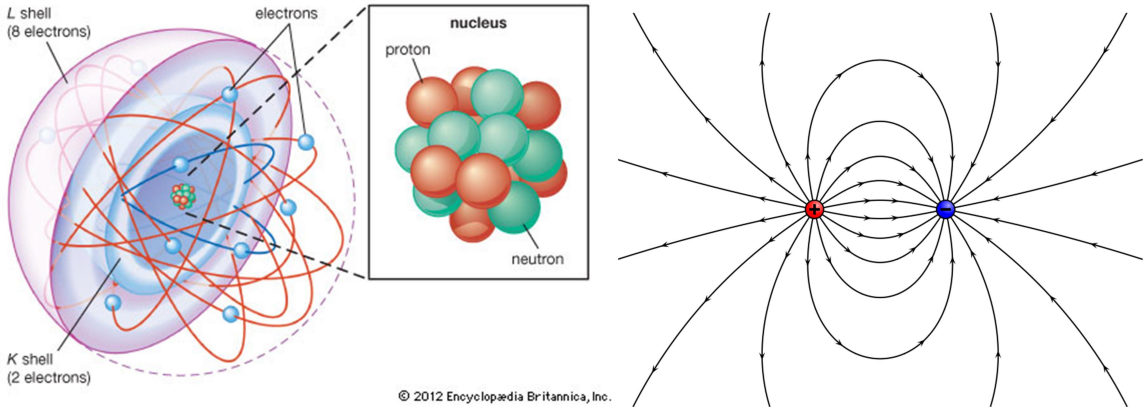
- ***Mechanics, Hydrodynamics***
- ***Thermodynamics, Statistical Physics, Physical Kinetics, Condensed Matter Physics***
- ***Electrodynamics,***
- ***Optics***

Quantum physics:

- ***Quantum Mechanics***
- ***Quantum Statistical Physics, Condensed Matter Physics***
- ***Quantum Electrodynamics and Quantum Field Theory***
- ***Quantum Optics***

Relativity

## Few words on how is everything around us….




### Forces in Nature

| *Interaction* | *Relative strength* | *Radius of action, cm* | *Observed in* |
|---|---|---|---|
| Gravitational | $10^{-39}$ | $\infty$ | Cosmos |
| Strong | 100 | $10^{-13}$ | Nuclei, Elementary particles |
| Weak | $10^{-14}$ | $10^{-16}$ | Elementary particles transformations |
| Electromagnetic | 1 | $\infty$ | From Nucleus to Cosmos |

**Physical quantities, their units and dimensions. Measurement.**

Physical quantity is a product of a number and a unit of measurement.

$M_{Horse}$ = 200 kg $M_{Rider}$ =100 kg

$M_{Horse+Rider}$ = 200 kg + 100 kg = (200+100) kg = 300 kg

Dimensions – for example dimensions of mass, distance and time

[M] [L] [T]

Do we need separate dimensions for speed? Say [V] ? We might, but we know (or will learn soon) that

$$Speed = \frac{\text{Distance}}{\text{Time}}$$

Thus we may use

$$[V] = \frac{[\text{L}]}{[\text{T}]}$$

Check dimensions when solving physics problems! If your dimensions / units do not make sense – you made error in your calculations!

Two most popular systems of units :

- International System of Units , SI : Meter, Kilogram, Second
- CGS : Centimeter, Gram, Second

***Homework problem #1. Inches.***

*In the US, people measure sizes in Inches. 1 Inch is 2.54 cm. Car mechanic fixes American car (everything in Inches) using European sockets (everything in millimeters, 1mm=0.1cm). Would 8mm socket work for 5/16" bolt? Would 14mm socket work on 9/16" bolt?*

Measurement may be direct or indirect. We will discuss measuring distance in class – both directly and indirectly. Every measurement has measurement error! Measurements are repeated several / many times to find average.

$$\bar{X} = \frac{X_1 + X_2 + X_3 + \cdots + X_n}{n}$$

***Homework problem #2. Indirect measurement.***

*Pick the tree outside your house and measure the circumference of its trunk 5 times at approximately the same height. For each measurement compute the diameter of the tree. What is the average diameter? Does your result visually look reasonable? Do you think you could estimate the error of this measurement?*

*FYI :* $C = \pi d$ *, where d is the diameter, C is the circumference, and* $\pi$ *is approximately equal to 3.14*

***Homework problem #3. Units of mass.***

*Imagine that there are no units of mass in the world (there are units of length and time). Suggest your own unit of mass.*

**Moments of Math: Vectors**

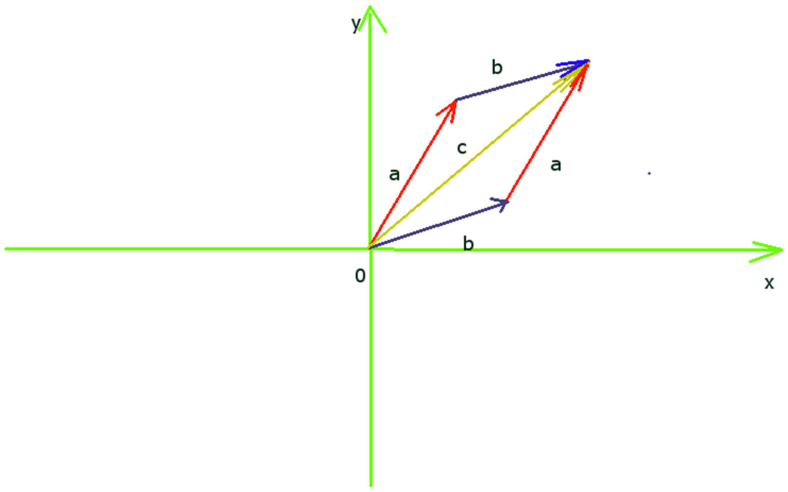
Physics is not Mathematics. But without Math it would be very hard to study physics. During every class we will try to allocate some time for Math topics which we will need in Physics.

One-dimensional vectors: Number Line

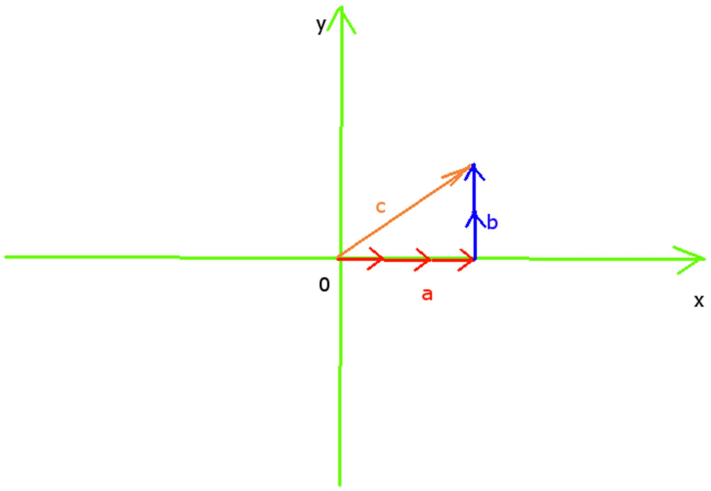

**2** + **1** = 3


**1** + **2** = 3

Same works for two-dimensional vectors:




$$\vec{c} = \vec{a} + \vec{b} = \vec{b} + \vec{a}$$




$$\vec{c} = \vec{a} + \vec{b} = 3\,\overrightarrow{e_x} + 2\,\overrightarrow{e_y}$$

These small red vectors $\overrightarrow{e_x}$ are each of the length 1. These small blue vectors $\overrightarrow{e_y}$ are each of the length 1 as well. Any vector can be represented as a number times $\overrightarrow{e_x}$ plus another number times $\overrightarrow{e_y}$. Those two numbers are called *coordinates* of the vector – in our case coordinates are (3,2).

***Homework problem #4. Coordinates of the sum vector.***

*Prove that each coordinate of the sum $\vec{c}$ of two vectors $\vec{a}$ and $\vec{b}$ can be computed as sum of the coordinates of these vectors.*