PHYSICAL QUANTITIES AND UNITS

1. SI system of units

The word „physics“ comes from the Greek word physis which means „nature“. When describing things we have to agree on some terms in order to understand each other. Physical states, processes and their changes we are able to measure are called **physical quantities**. To measure some quantity means to compare its value with some **unit.** Each physical quantity must have some numerical magnitude (value) and unit so that we know by how much it is bigger or smaller than its unit.

A mass equal to five kilograms can be written like

$$m = 5\,\text{kg}$$

where

m is the symbol of the physical quantity of the mass

$\{m\} = 5$ is the numerical magnitude of the mass of the object

$[m] = \text{kg}$ is the unit of mass – kilogram

SI system of units is the international system now used by the scientists in the whole world.

a) Basic units

UNIT	SYMBOL	QUANTITY
metre	m	length, distance, ...
kilogram	kg	mass
second	s	time
ampére	A	electric current
kelvin	K	temperature
mole	mol	amount of substance
candela	cd	luminous intensity

b) Derived units

Units derived from the basic ones using equations, e.g.:

$$v = \frac{s}{t} \Rightarrow [v] = \left[\frac{s}{t}\right] = \text{m} \cdot \text{s}^{-1}$$ ... combined name

$$p = \frac{F}{A} \Rightarrow [p] = \left[\frac{F}{A}\right] = \text{N} \cdot \text{m}^{-2} = \text{Pa}$$ ... specific name

Derived units are as well **radian** (planar angle) and **steradian** (space angle). They cannot be represented as a product of some basic units as we will mention later.

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c) Multiples and submultiples

standard prefix		multiple
name	symbol	
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
piko	p	10^{-12}

2. Scalar and vector quantities

Scalar quantities or **scalars** are determined by their numerical magnitude and unit only. Examples are time, length, density, temperature, speed, work, energy, electric current, ...

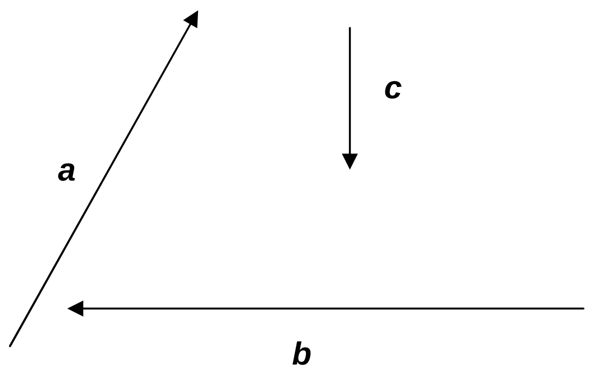
To determine **vector quantities** or **vectors** the magnitude and unit is not enough, we have to know their direction as well. Examples are velocity, acceleration, force, moment of a force, momentum, magnetic flux density, electric and magnetic field strength, ... To emphasise the vector nature of the quantity we use either bold letters or arrows above – ***v*** or $\vec{v}$.

Size of the vector $\left|\vec{v}\right| = v$

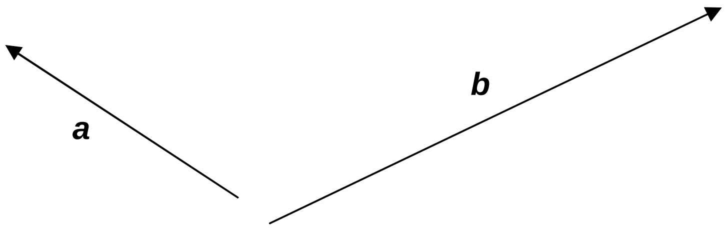
Vectors can be connected with a certain point (velocity in certain point of the curved trajectory), line of action (force acting on a rigid body) or they can be even free (moment of a couple of forces).

Vectors in maths (geometrical) differ from the physical vectors.

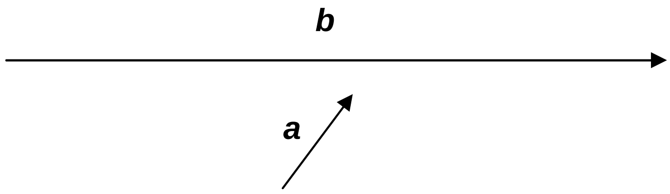
1. Add 3 vectors: ***x = a + b + 2c***



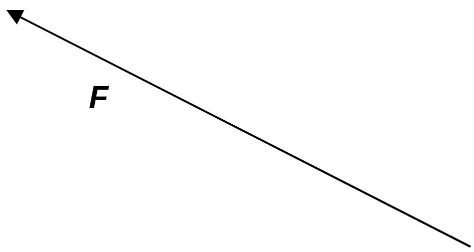
2. Find vector ***z = 2a + b/2***



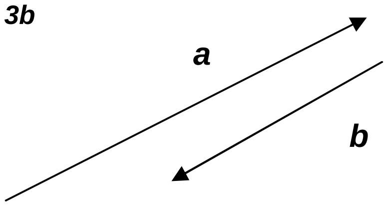
3. Subtract vectors: ***y = b – 3a***



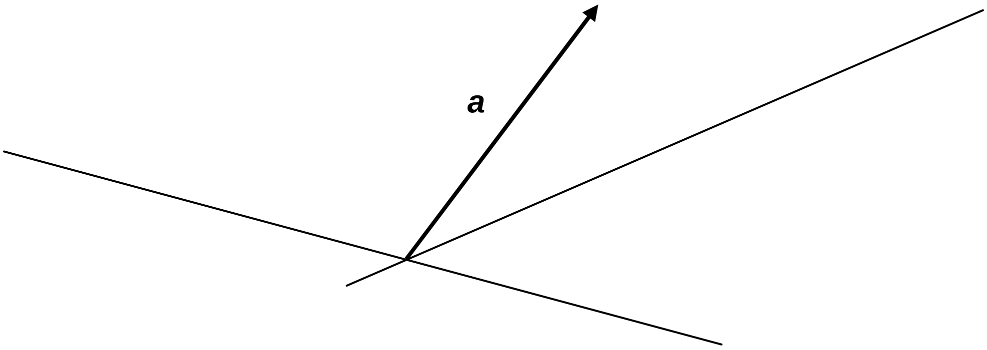
4. Resolve the given vector into two perpendicular components $\boldsymbol{F_1}$, $\boldsymbol{F_2}$. Express these components using the magnitude of the original vector and trigonometric functions of an angle included.



5. Add vectors: ***x = 2a + 3b***
   $\boldsymbol{a} \parallel \boldsymbol{b}$



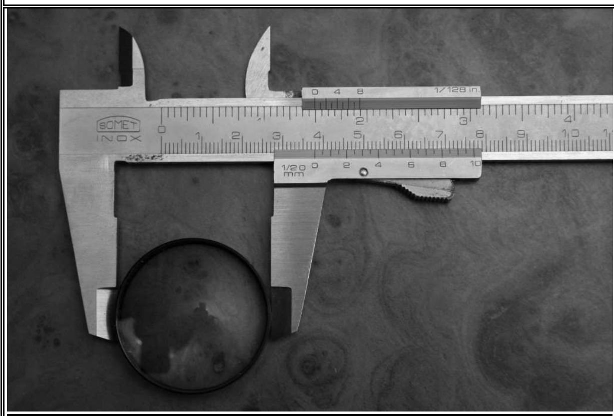
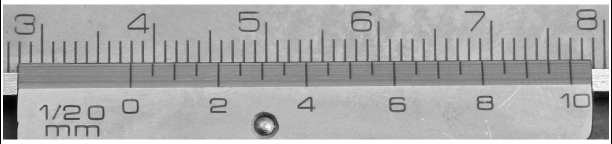
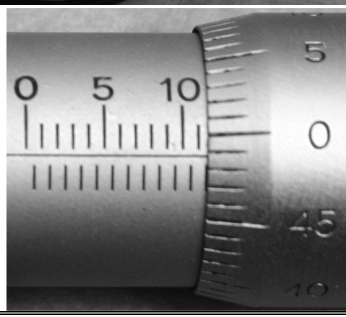
6. Resolve vector ***a*** into given directions:

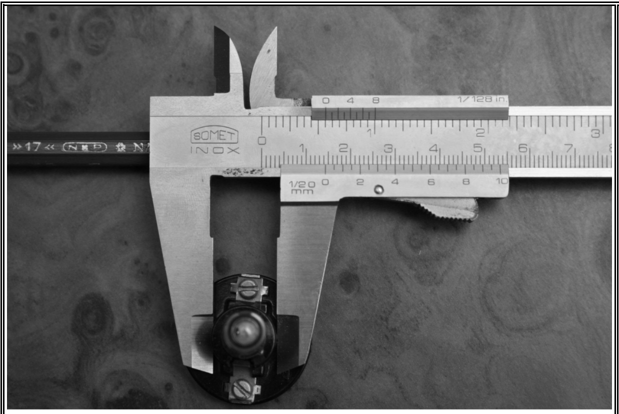


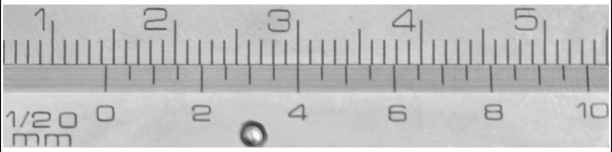
3. Physical measurements

Length can be measured using simple equipment like a ruler or some more accurate specialised devices like vernier callipers or a micrometer screw gauge.

http://kabinet.fyzika.net/dilna/prezentace/vyukove-prezentace.php

Vernier callipers	Micrometer screw gauge
What is the length measured?	
	
	


SOMET
INOX
1/128 in
1/20 mm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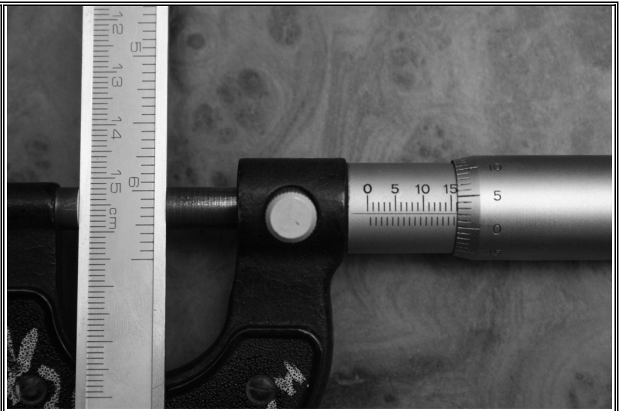
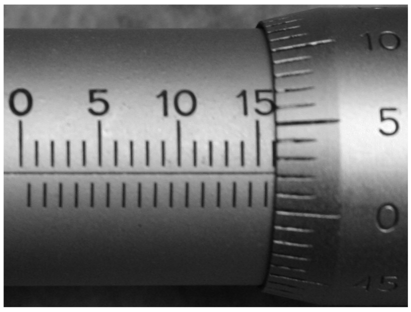
mm






SOMET
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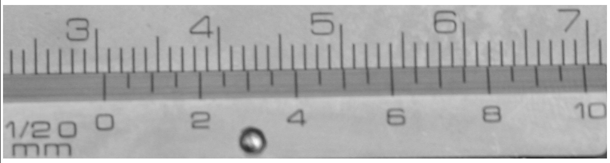
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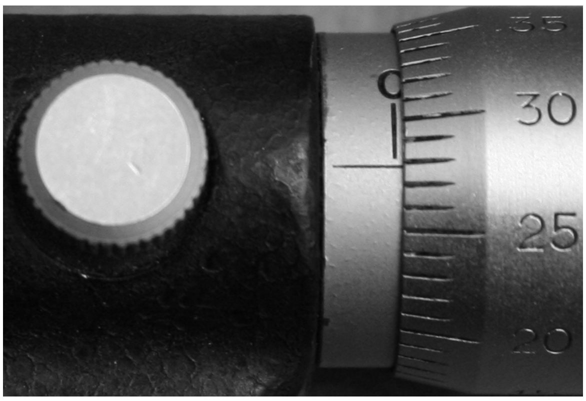
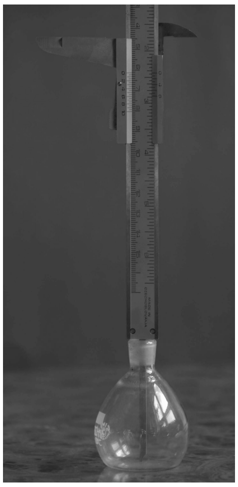
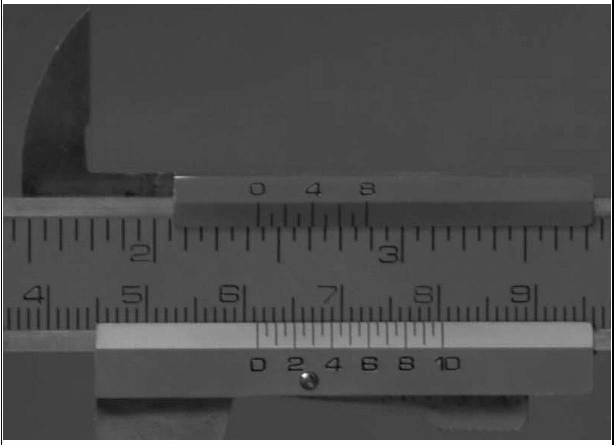
mm






45
40
35
30


0 4 8
2
3
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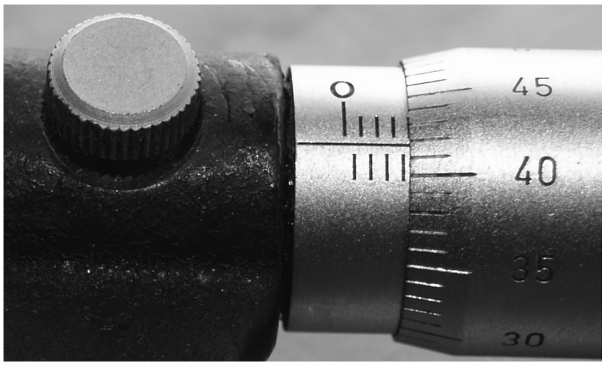
9
0 2 4 6 8 10


0
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School year:	Gymnázium Olomouc-Hejčín	Class:
Date:	**Basic Measurements**	Report No.
Name:		Teacher's signature:
Cooperator:		

Task: Compare the precision of vernier callipers and micrometer screw gauge

Equipment:

Method:

Results:

1) Vernier callipers

No.	***l*/cm**	**Δ*l*/cm**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Arithmetic mean: $\bar{l}$ =		
Possible error Δ*l* = (p.e. = průměrná abs. odchylka)	**Percentage possible error δ*l* =** (p.p.e. = relativní odchylka)	
Result: *l* = (±) cm, δ*l* = %		

2) Micrometer screw gauge

No.	d_0/mm	Δd_0/mm	d_1/mm	Δd_1/mm
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Arithmetic mean: $\bar{d}_0$ =	Arithmetic mean: $\bar{d}_1$ =
p.e. Δd_0 =	p.e. Δd_1 =
Arithmetic mean: $\bar{d} = \bar{d}_1 - \bar{d}_0$	p.e. $\Delta d = \Delta d_0 + \Delta d_1$
Result: d = (±) mm, δd = %	

Conclusion:

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