Wrocław University of Science and Technology

Physics

JZL1001913C

summer semester

2020/2021

Wednesday, 18:20 - 19:50

Friday, 18:20 - 19:50

virtual room (ZOOM)

Sylwia Majchrowska

sylwia.majchrowska@pwr.edu.pl

https://majsylw.netlify.app/

room 213, building L-1

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About me

Sylwia Majchrowska, PhD Student at Wroclaw University of Science and Technology.

https://majsylw.netlify.app/

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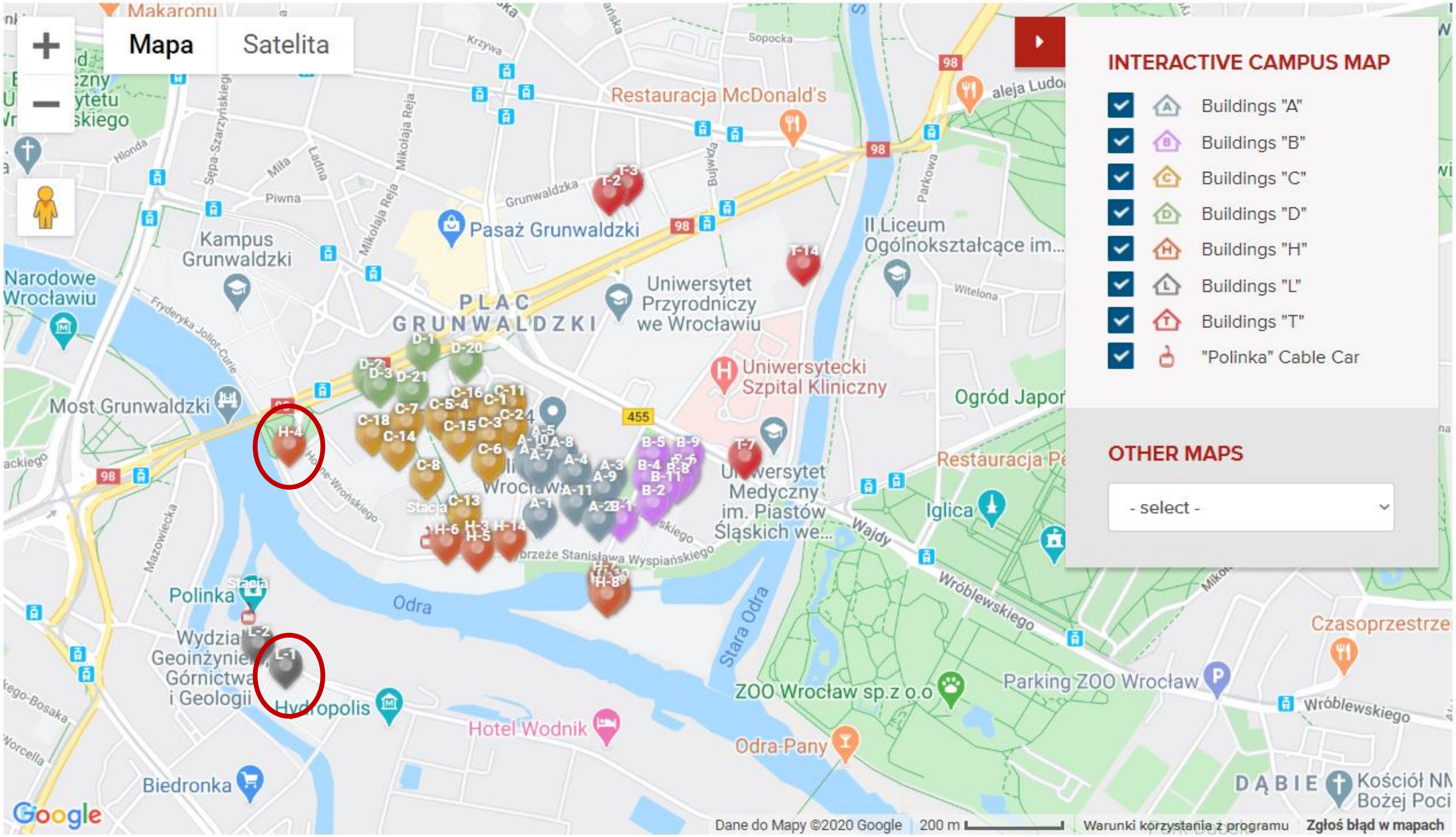
Campus map



https://pwr.edu.pl/en/university/campus-map
http://knbgis.pwr.edu.pl/kampus/L1.html

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What about you?

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Comunication

- Virtual classes – via zoom (get link in email)

- Sending homeworks at my email adres: sylwia.majchrowska(at)pwr.edu.pl

- Check the websites

https://majsylw.netlify.app/teaching/
https://github.com/majsylw/Physics-preparatory-course-2021

https://docs.google.com/spreadsheets/d/1IK8AE2Pe77JtQBnO-fBYLQZ87U3I5z5a7VCKhyHGU7I/edit?usp=sharing

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Completion rules

- **Q**uizes (at least 50%) – 10 x 3 points
- **H**omeworks – 2 x 10 points
- **A**ctivity and Participation:
  - Below 3 absences – 10 points
  - Below 6 absences – 6 points
  - Below 10 absences – 2 points
  - Otherwise – 0 points
- **F**inal **e**xam – 40 points:
  - 30 points writting
  - 10 points oral (at last classes)

Final points:

Points = **Q** + **H** + **A** + **Fe**

Late homeworks are not accepted.
Class participation is required.

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Closer look at calendar

	FEBRUARY		MARCH					APRIL					MAY				JUNE		JULY	
MON	22	1	8	15	22	29	5	12 Mon O	19	26	3	10	17	24	31	7	14	21	28	5
TUE	23	2	9	16	23	30 Fri E	6	13	20	27	4	11	18	25	1	8	15	22	29	6
WED	24	3	10	17	24	31	7	14	21	28	5	12	19	26	2 Thu E	9	16	23	30	7
THU	25	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8
FRI	26	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9
SAT	27	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	10
SUN	28	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11
E - EVEN O - ODD	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E	O	E

Lecture
Exercise
Revision/exam

Wednesday, 18:20 - 19:50
Friday, 18:20 - 19:50

Office hours:
Monday, 20:30 - 21:30
virtual room

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Total grade

- 50 – 59 points → 3,0 satisfactory
- 60 – 69 points → 3,5 satisfactory+
- 70 – 79 points → 4,0 good
- 80 – 89 points → 4,5 good+
- 90 – 99 points → 5,0 very good
- 100 and more → 5,5 excellent

Final points:
Points = Q + H + A + Fe

Contact the instructor if expecting problems to take an exam.

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Literature

- Halliday, Resnick & Walker, *Fundamentals of Physics*
- Feynman Richard, *Feynman Lectures on Physics*
- Ramamurti Shankar, *Fundamentals of Physics I and II* (https://www.youtube.com/watch?v=KOKnWaLiL8w&list=PLFE3074A4CB751B2B https://www.youtube.com/watch?v=NK-BxowMIfg&list=PLD07B2225BB40E582)

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Outline

- Introduction - Physics rules the world
- Motion phenomena - Kinematics
- Motion phenomena - Dynamics
- Rotational motion
- Harmonic motion
- Gravitational field
- Relativistic phenomena
- Basics of Thermodynamics
- Principles of Thermodynamics
- Fluids
- Electrostatics
- Electric current
- Magnetic field
- Vibrations and electromagnetic waves
- *Optics**
- *Quantum nature of radiation**
- *Nuclear Physics**

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TO DO…

- Get a calculator, **especially for tests**.

- Regularly visit out web page for the schedule, **lecture notes**, **assignments**, solutions, tables.

https://majsylw.netlify.app/teaching/
https://github.com/majsylw/Physics-preparatory-course-2021

https://docs.google.com/spreadsheets/d/1IK8AE2Pe77JtQBnO-fBYLQZ87U3I5z5a7VCKhyHGU7I/edit?usp=sharing

- Regularly **prepare your homework**.

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What is Physics?

Science and engineering are based on measurements and comparisons. Thus, we need rules about how things are measured and compared, and we need experiments to establish the units for those measurements and comparisons. One purpose of physics (and engineering) is to design and conduct those experiments.

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Measuring Things

We discover physics by learning how to measure the quantities involved in physics. Among these quantities are length, time, mass, temperature, pressure, and electric current.

We measure each physical quantity in its own units, by comparison with a **standard**. The **unit** is a unique name we assign to measures of that quantity—for example, meter (m) for the quantity length. The standard corresponds to exactly 1.0 unit of the quantity. As you will see, the standard for length, which corresponds to exactly 1.0 m, is the distance traveled by light in a vacuum during a certain fraction of a second.

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Units for SI Base Quantities

In 1971, the 14th General Conference on Weights and Measures picked seven quantities as base quantities, thereby forming the basis of the International System of Units, abbreviated SI from its French name and popularly known as the *metric system.*

Quantity	Unit Name	Unit Symbol
Time	second	s
Length	metre	m
Mass	kilogram	kg
electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	Cd

Many SI *derived units* are defined in terms of these base units. For example, the SI unit for power, called the **watt** (W), is defined in terms of the base units for mass, length, and time.

1 watt =1 W = 1 kg m^2/s^3

One kilogram-meter squared per second cubed

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Scientific notation

To express the very large and very small quantities we often run into in physics, we use *scientific notation*, which employs powers of 10.

3 560 000 000 m = 3.56×10^{9} m = 3.56 E9 m

0.000 000 492 s = 4.92×10^{-7} s = 4.92 E-7 s

Prefixes

2.35×10^{9} s = 2.35 nanoseconds = 2.35 ns.

Factor	Prefix[a]	Symbol
10^{24}	yotta-	Y
10^{21}	zetta-	Z
10^{18}	exa-	E
10^{15}	peta-	P
10^{12}	tera-	T
10^{9}	**giga-**	**G**
10^{6}	**mega-**	**M**
10^{3}	**kilo-**	**k**
10^{2}	hecto-	h
10^{1}	deka-	da
10^{-1}	deci-	d
10^{-2}	**centi-**	**c**
10^{-3}	**milli-**	**m**
10^{-6}	**micro-**	**μ**
10^{-9}	**nano-**	**n**
10^{-12}	**pico-**	**p**
10^{-15}	femto-	f
10^{-18}	atto-	a
10^{-21}	zepto-	z
10^{-24}	yocto-	y

The most frequently used prefixes are shown in **bold type**.

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Significant Figures and Decimal Places

Suppose that you work out a problem in which each value consists of two digits. Those digits are called **significant figures** and they set the number of digits that you can use in reporting your final answer. With data given in two significant figures, your final answer should have only two significant figures. However, depending on the mode setting of your calculator, many more digits might be displayed. Those extra digits are meaningless.

When a number such as 3.15 or 3.15×10^3 is provided in a problem, the numer of significant figures is apparent, but how about the number 3000? Is it known to only one significant figure (3×10^3)? Or is it known to as many as four significant figures (3.000×10^3)? We assume that all the zeros in such given numbers as 3000 are significant, but you had better not make that assumption elsewhere, like in case of 0.0003. Here we have only one significant figures.

Don't confuse *significant figures* with *decimal places*. Consider the lengths 35.6 mm, 3.56 m, and 0.00356 m. They all have three significant figures but they have one, two, and five decimal places, respectively.

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Length

The meter is the length of the path traveled by light in a vacuum during a time interval of 1/299 792 458 of a second.

Measurement	Length in Meters
Distance to the first galaxies formed	2×10^{26}
Distance to the Andromeda galaxy	2×10^{22}
Distance to the nearby star Proxima Centauri	4×10^{16}
Distance to Pluto	6×10^{12}
Radius of Earth	6×10^{6}
Height of Mt. Everest	9×10^{3}
Thickness of this page	1×10^{-4}
Length of a typical virus	1×10^{-8}
Radius of a hydrogen atom	5×10^{-11}
Radius of a proton	1×10^{-15}

This time interval was chosen so that the speed of light c is exactly

$$c = 299\,792\,458 \text{ m/s}.$$

Measurements of the speed of light had become extremely precise, so it made sense to adopt the speed of light as a defined quantity and to use it to redefine the meter.

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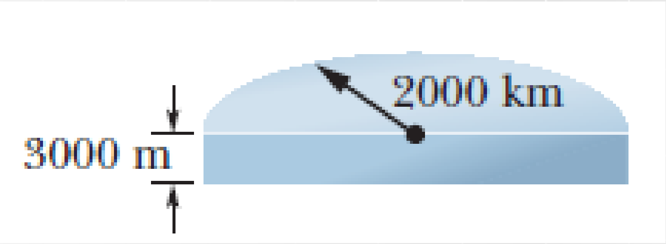
Length - examples

1. Horses are to race over a certain English meadow for a distance of 4.0 furlongs. What is the race distance in (a) rods and (b) chains?

   (1 furlong 201.168 m, 1 rod 5.0292 m, and 1 chain 20.117 m.)

2. Antarctica is roughly semicircular, with a radius of 2000 km. The average thickness of its ice cover is 3000 m. How many cubic centimeters of ice does Antarctica contain? (Ignore the curvature of Earth.)



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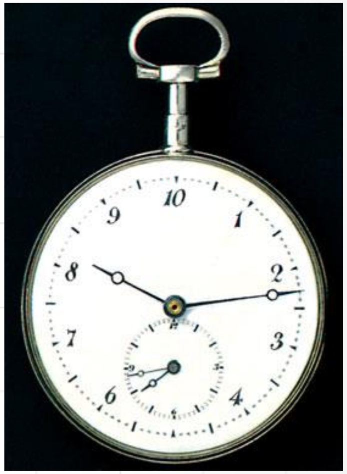
Time

One second is the time taken by 9 192 631 770 oscillations of the light (of a specified wavelength) emitted by a cesium-133 atom.

"*When* did it happen?"
"What is its *duration*?"



Measurement	Time Interval in Seconds	Measurement	Time Interval in Seconds
Lifetime of the proton (predicted)	3×10^{40}	Time between human heartbeats	8×10^{-1}
Age of the universe	5×10^{17}	Lifetime of the muon	2×10^{-6}
Age of the pyramid of Cheops	1×10^{11}	Shortest lab light pulse	1×10^{-16}
Human life expectancy	2×10^{9}	Lifetime of the most unstable particle	1×10^{-23}
Length of a day	9×10^{4}	The Planck time[a]	1×10^{-43}

[a]This is the earliest time after the big bang at which the laws of physics as we know them can be applied.

Time - examples

1. Convert 2 min to seconds.

2. The fastest growing plant on record is a Hesperoyucca whipplei that grew 3.7 m in 14 days. What was its growth rate in micrometers per second?

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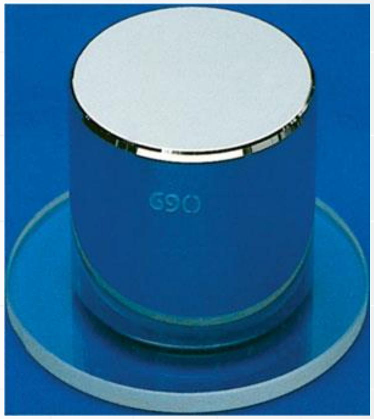
Mass

The kilogram is defined by taking the fixed numerical value of the Planck constant h to be 6.626 070 15 × 10^{-34} when expressed in the unit J s, which is equal to kg m^2 s^{-1}, where the metre and the second are defined in terms of c and $\Delta\nu_{Cs}$.

Earlier, kilogram was defined in terms of a platinum–iridium standard mass kept near Paris. For measurements on an atomic scale, the atomic mass unit, defined in terms of the atom carbon-12, is usually used.



The international 1 kg standard of mass, a platinum–iridium cylinder 3.9 cm in height and in diameter.

Object	Mass in Kilograms
Known universe	1×10^{53}
Our galaxy	2×10^{41}
Sun	2×10^{30}
Moon	7×10^{22}
Asteroid Eros	5×10^{15}
Small mountain	1×10^{12}
Ocean liner	7×10^{7}
Elephant	5×10^{3}
Grape	3×10^{-3}
Speck of dust	7×10^{-10}
Penicillin molecule	5×10^{-17}
Uranium atom	4×10^{-25}
Proton	2×10^{-27}
Electron	9×10^{-31}

Mass - examples

1. Earth has a mass of 5.98×10^{24} kg. The average mass of the atoms that make up Earth is 40 u. How many atoms are there in Earth? (1 u = $1.660\,538\,86 \times 10^{-27}$ kg)

2. Diamonds are measured in carats, and 1 carat = 0.2 g. The density of diamond is 3.51 g/cm3. What is the volume of 5.0-carat diamond?