## Module 1: Tools for the study of Physics

### Topic 1: History of Physics

**Teaching notes for the face-to-face mode (teacher):**

**Dear colleague:**

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We respect your experience and ability to help our students in building their learning based on previous knowledge, as well as the strategies you apply so they can relate their study field with different subjects that impact in all organization in which they will be involved in the short term.

For a better development of this topic, we invite you to consider some of these practices:

- Explain the origins of Physics.
- Go deeper about important physicists and add some others you consider relevant in the history of Physics.
- Emphasize that this is a classic mechanics course and the importance of the related topics they studied in high school and college.

This topic is an introduction to the course; we recommend you to be very dynamic and show to the students the videos located in the resources section, so that they feel more interested in the topics.

Also, we recommend you to use the free software to create concept maps: CMAP TOOLS (http://cmap.ihmc.us/).

### Topic 2: Measurements and Units

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For a better development of this topic, we invite you to consider some of these practices:

- Explain in detail the seven fundamental units and focus in those that are going to be used in this course.
- Show how all derived units can be decomposed into fundamental units.
- Try to use derived units that are going to be used in future topics of this course.

- Share more units from other systems and their equivalents to the metric system.
- Conduct a detailed review about the scientific notation using as much pencil and paper as the scientific calculator, in order that students remember the use of both methods.
- Enhance the ability to memorize the main conversion factors that are going to be used in this course.
- Do plenty examples of conversions by the parenthesis methods, using easy, intermediate and hard level.
- Prevent that your students use *regla de tres* method or apps/calculators that perform automatically the conversion. These can be helpful to check results but don't have to be the main method to use.

## Topic 3: Scalar and Vector Quantities

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For a better development of this topic, we invite you to consider some of these practices:

- Provide more examples of vector and scalar quantities but emphasize the ones that will be the most used.
- Start with a vector and show how its components are obtained, and also that with them we can return to the same vector.

## Topic 4: Operations with Vectors

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For a better development of this topic, we invite you to consider some of these practices:

- Before doing operations with vectors, make sure that your students understand the scale to represent vector on their notebooks, and also the direction of them. It is suggested to provide several examples of vector directions using degrees, cardinal points and a mix of both.

- Go first to the vector addition with graphical methods, beginning with two-vector exercises and showing how the same exercise can be solved by the parallelogram and the tail-to-tip methods.

- Emphasize in the interpretation of the resultant vector using the proper scale and its direction.

- Continue with the graphical addition only, now with three or more vectors exercises. Add more examples where not only displacements are required, but also other vector quantities like force. Show that the order of the sum doesn't change the final result.

- Use the same examples that you used for the graphical methods now with the component method, emphasizing the precision of it and checking the obtained results.

- It is suggested to mention the importance of the vector products, without going further with them, because they are not needed for this course.

## Topic 5: Description of Movement in one dimension

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For a better development of this topic, we invite you to consider some of these practices:

- Make more simple examples of the differences between distance, displacement, speed and velocity.

- Do more exercises where you show the use of the five kinematics equations and prove that there are many ways to solve the same exercise. It is suggested to remember how to solve equations.

- Encourage the comprehension and use of the sign convention.

- Emphasize in the use of the proper units of the exercise data in order that the student identifies and used the right variables.

- It is suggested to analyze graphs in a simple way, because the student is also taking a Geometry course, so his knowledge about the line and the parabola is limited.

- Use the free app **the moving man** for the graphs: (https://phet.colorado.edu/es/simulation/moving-man).

Also we invite you to watch the videos located in the course resources, which we have selected specially for you and that will allow your students to improve what you explained for them. These videos are specially chosen for the topics and they are from verified sources and also many of them are brand new.

## Module 2. Geometry of Motion with Constant Acceleration and its Causes

### Topic 6: One dimensional motion with constant acceleration

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For a better development of this topic, we invite you to consider some of these practices:

- Mention the use of gravity with negative sign in both unit systems.
- Show how the exercise solving and procedures of free fall/vertical throw exercises is very similar to the last topic.
- Emphasize the sign convention.
- Begin the topic by solving free fall exercises so the student understands how time is the factor that is causing the change in the other variables.
- Continue with vertical throw downwards, emphasizing the differences with free fall.
- Discuss the topic of vertical throw upwards and the maximum height concept, showing how it is obtained and the other special features of this kind of motion.
- Solve exercises using both unit systems.

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### Topic 7: Two-dimensional motion with constant acceleration

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For a better development of this topic, we invite you to consider some of these practices:

- Start topic 7 with horizontal projection exercises, emphasizing the initial position and how it changes in both axis through time.
- Show how equations allow us to obtain the components of position and velocity at any given instant.
- Show how these components can be used to find the magnitude and direction of the final velocity.
- Continue with simple examples of parabolic throw, where the student obtains position and velocity beginning from an initial velocity and its angle.
- With several exercises, exemplify the concepts of maximum height, time of flight, and reach.
- Solve exercises that imply the use of the quadratic formula.
- Practice conversions to radians, revolutions, degrees, etc.
- Provide examples where the linear displacement changes to angular and vice versa.
- Solve examples where the tangential velocity is passed to angular and also the other way around.

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## Topic 8: Newton's Laws of motion

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For a better development of this topic, we invite you to consider some of these practices:

- Emphasize the units to be used in the topics related to mechanics.
- Explain Newton's laws with real examples.
- Show the concepts of matter and weight with simple examples.

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## Topic 9: Graphical, qualitative and quantitative description of forces

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For a better development of this topic, we invite you to consider some of these practices:

- Show the different ways in which the normal and tension can appear.
- Exemplify free-body diagrams, including inclined plane where the axis rotation is shown.
- Show several real examples and exercises of the two kinds of friction, in order that the student can differentiate between them.

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### Topic 10: Applications of Newton's Laws

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For a better development of this topic, we invite you to consider some of these practices:

- Solve several exercises of the multiple applications of the Newton’s second law.
- Conduct a detailed review about equations with two unknowns.
- Solve tension problems that involve two unknowns.

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## Module 3. Work, Energy and Rotational Movement

### Topic 11: Mechanical Work and Kinetic Energy

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For a better development of this topic, we invite you to consider some of these practices:

- Start with very simple examples of work in the same axis.
- Add examples with angles.
- Include examples with friction.
- Solve work exercises on an inclined plane.
- Solve simple exercises of kinetic energy.

Also we invite you to watch the videos located in the course resources, which we have selected specially for you and that will allow your students to improve what you explained for them. These videos are specially chosen for the topics and they are from verified sources and also many of them are brand new.

## Topic 12: Potential Energy and the Principle of Conservation of Mechanical Energy

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For a better development of this topic, we invite you to consider some of these practices:

- Solve simple exercises of potential energy.
- Show exercises that equal work to any other kind of energy. Prove that these also can be solved with Newton’s second law.
- Solve simple exercises of power and conversions.
- Solve exercises that involve power, work, and energies.
- Show energy conservation exercises using the theorem.

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## Topic 13: Kinematics of Rotational Motion

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For a better development of this topic, we invite you to consider some of these practices:

- Do equilibrium exercises that involve ropes and poles, remembering equations systems with two unknowns.
- Explain briefly the period and frequency and its relationship with circular motion.
- Remind the concepts of topic 7 and explain with them angular acceleration.
- Make an analogy of the linear kinematic equations with the rotational ones, showing how the procedure is very similar.
- Remember conversions with the units of the topic, and the formulas for changing rotational to linear.
- Solve several examples that use kinematic rotational equations and increase difficulty and use conversions and other formulas.

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## Topic 14: Rotational Motion dynamics

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For a better development of this topic, we invite you to consider some of these practices:

- Show real examples of the use of torque.
- Explain the two ways to obtain torque: decomposing the applied force or with the moment arm and its angle.
- Solve examples of resultant torque.
- Solve rotational inertia example of several figures.
- Stablish the relationship with Newton's second law.

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## Topic 15: Equilibrium for Non-punctual Bodies

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For a better development of this topic, we invite you to consider some of these practices:

- Remember the sum of forces
- Remember equations systems with two unknowns.
- Introduce the concept of beam balance problems.
- Solve several exercises that involve ropes and poles.
- Introduce rotational equilibrium.

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