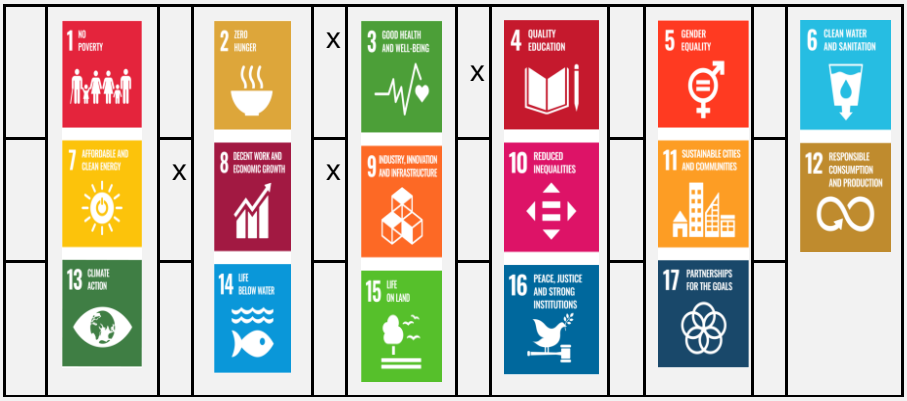
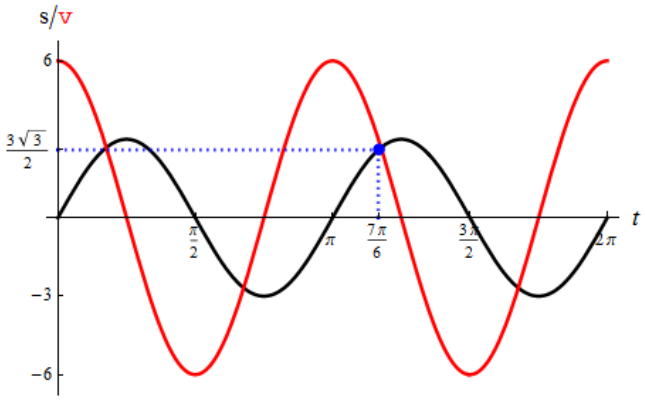
Mini-PBL project	
Teacher data sheet: Teaching Guide	
Title	The movement of the car on the simulated roadway
SDG attended	Using this UN graphics, we mark such SDG which this project works. 
Content units	Functions of one real variable
Sessions	10 sessions of 100 min
Hours of autonomous work	20 min
Competences to be developed	**Reasoning and modelling** ● Develop thinking strategies to solve real life problems ● Explore, analyse, and apply mathematical ideas ● Estimate reasonably and demonstrate fluent, flexible, and strategic thinking about graphs ● Model with mathematics in situational contexts ● Think creatively and with curiosity and wonder when exploring problems **Understanding and solving** ● Develop, demonstrate, and apply conceptual understanding of mathematical ideas through story, inquiry, and problem solving ● Visualize to explore and illustrate mathematical concepts and relationships ● Apply flexible and strategic approaches to solve problems ● Solve problems with persistence and a positive disposition ● Engage in problem-solving experiences connected with real-life examples. **Communicating and representing** ● Explain and justify mathematical ideas and decisions in many ways ● Represent mathematical ideas in concrete, pictorial, and symbolic forms

	• Use mathematical vocabulary and language to contribute to discussions in the classroom • Take risks when offering ideas in classroom discourse **Connecting and reflecting** • Reflect on mathematical thinking • Connect mathematical concepts with each other, other areas, and personal interests • Use mistakes as opportunities to advance learning • Incorporate First Peoples worldviews, perspectives, knowledge, and practices to make connections with mathematical concepts
ICT tools to be used	
Context: project statement	The production of car industry with respect to a safety of the produced cars is very much depending on understanding the behaviour if a car while moving on the road. Especially dangerous are unexpected movements of cars when arriving to various kinds of road surfaces, for example on bridges, in tunnels or simply at junctions with specific profiles. Many professionals employed in the car producing plants deal with experiments where the car movement characteristics as velocity, stability, shaking, trembling, and others are tested under changing conditions of the road surface. Based on these experiments and analysis of the measured data, factories can produce more safe cars and lives of drivers will be more protected.
Tasks and problems	**TASK** Car is moving on horizontal surface. Roadway $s(t)$ before the junction and through the junction has the form of profiles, which are modeled by function $f(t) = 3\sin 2t$, while velocity $v(t)$ of the moving car is determined by function $v(t) = 6\cos 2t$. **TASK 1.** Sketch the graph of the roadway function *s*(*t*) and the velocity function *v*(*t*) into one diagram, for time interval $[0,2\pi]$, while $t = 0$ is the time when car will start its motion on profiles. ***Solution***:  **TASK 2.**

	At the time $t = 7\pi/6$ calculate value of $s(t)$, length of car trajectory, and velocity $v(t)$ of the car movement, and mark these in the graphs. ***Solution***: $$s\left(t=\frac{7\pi}{6}\right)=\frac{3\sqrt{3}}{2}\ ;\ v\left(t=\frac{7\pi}{6}\right)=3$$
Outcomes expected	- Graphics fitting the solution; - Numerical results explained and put in context; - Capture of ICT tools solutions used; - Sequence of steps followed; - Remark computations done by hand and done by ICT tools; - Provide complete answer to questions; - All the results must be presented in the context of the problem;
Guide for Learning	At the beginning of the course, the students need guides on new activities, and feel your support on a well-structured pack of suggestions on how to address the problems posted. Namely: - Read carefully the problem statement and the tasks posted. Always maintain a global view of all the projects. - Identify, or try to do a first draft match, the content units of your lecture notes involved in every task. - Take your lecture notes open and review before starting to solve the problems. - Match output expected with the tasks posted, at least as first draft approach. - Follow the order of the tasks, try to increase the knowledge of the problem while you are solving the activities. - Always think that maybe there are different ways to solve a problem. - Use ICT tools to avoid hard computations and check your solutions are correct in different ways if possible. - The solutions are always part of a context, expressing such a final solution totally integrated in the problem posted. - Be sure you answer the complete questions. - Always try to solve the questions by yourself. - If the project can be done in groups, discuss with the groups the proposed problem, to confirm and detect fails or weaknesses, confront strategies, discuss presentation format, etc. - Working in groups doesn't mean work less but work better.
Guide for Teaching	Some hints needed to present and launch the mini-PBL to students - Do a small Introduction concerning safety on the roads, improvements in the car industry leading to saving human lives. - Students will form groups of 4 students and solve the mini-PBL using the eduScrum methodology. - The students should do each exercise in a sequential order, starting from Task 1. - The students should be able to thoroughly read and interpret the numerical results from a mathematical and the real-life example point of view. They should include also a discussion of

	the climate change crisis and enumerate some strategies they could apply at home or even at university to save resources, namely reduce energy consumption. They should also mention how this mini-PBL helps them identify the indicated Sustainable Development Goals.
Assessment	- Final report; - Oral presentation; - Peer-assessment: students will apply peer-assessment for their periodic performance using online peer assessment tools used and available at the respective institution.
Others: References	The task was created by Institute Mathematics and Physics of FME STU in Bratislava, 2019.

Mini-PBL project	
Student data sheet: Learning Guide	
Title	The movement of the car on the simulated roadway
SDG attended	Using this UN graphics, we mark such SDG which this project works. 
Content units	Functions of one real variable
Sessions	10 sessions of 100 min
Hours of autonomous work	20 min
Competences to be developed	**Reasoning and modelling** ● Develop thinking strategies to solve real life problems ● Explore, analyse, and apply mathematical ideas ● Estimate reasonably and demonstrate fluent, flexible, and strategic thinking about graphs ● Model with mathematics in situational contexts ● Think creatively and with curiosity and wonder when exploring problems **Understanding and solving** ● Develop, demonstrate, and apply conceptual understanding of mathematical ideas through story, inquiry, and problem solving ● Visualize to explore and illustrate mathematical concepts and relationships ● Apply flexible and strategic approaches to solve problems ● Solve problems with persistence and a positive disposition ● Engage in problem-solving experiences connected with real-life examples. **Communicating and representing** ● Explain and justify mathematical ideas and decisions in many ways ● Represent mathematical ideas in concrete, pictorial, and symbolic forms

	● Use mathematical vocabulary and language to contribute to discussions in the classroom ● Take risks when offering ideas in classroom discourse **Connecting and reflecting** ● Reflect on mathematical thinking ● Connect mathematical concepts with each other, other areas, and personal interests ● Use mistakes as opportunities to advance learning ● Incorporate First Peoples worldviews, perspectives, knowledge, and practices to make connections with mathematical concepts
ICT tools to be used	
Context: project statement	The production of car industry with respect to a safety of the produced cars is very much depending on understanding the behaviour if a car while moving on the road. Especially dangerous are unexpected movements of cars when arriving to various kinds of road surfaces, for example on bridges, in tunnels or simply at junctions with specific profiles. Many professionals employed in the car producing plants deal with experiments where the car movement characteristics as velocity, stability, shaking, trembling, and others are tested under changing conditions of the road surface. Based on these experiments and analysis of the measured data, factories can produce more safe cars and lives of drivers will be more protected.
Tasks and problems	**TASK** Car is moving on horizontal surface. Roadway $s(t)$ before the junction and through the junction has the form of profiles, which are modeled by function $f(t) = 3\sin 2t$, while velocity $v(t)$ of the moving car is determined by function $v(t) = 6\cos 2t$. **TASK 1.** Sketch the graph of the roadway function *s*(*t*) and the velocity function *v*(*t*) into one diagram, for time interval $[0,2\pi]$, while $t = 0$ is the time when car will start its motion on profiles. **TASK 2.** At the time $t = 7\pi/6$ calculate value of *s*(*t*), length of car trajectory, and velocity *v*(*t*) of the car movement, and mark these in the graphs.
Outcomes expected	- Graphics fitting the solution; - Numerical results explained and put in context; - Capture of ICT tools solutions used; - Sequence of steps followed; - Remark computations done by hand and done by ICT tools; - Provide complete answer to questions; - All the results must be presented in the context of the problem;
Guide for Learning	- Read carefully the problem statement and the tasks posted. Always maintain a global view of all the projects. - Identify, or try to do a first draft match, the content units of your lecture notes involved in every task.

	- Take your lecture notes open and review before starting to solve the problems. - Match output expected with the tasks posted, at least as first draft approach. - Follow the order of the tasks, try to increase the knowledge of the problem while you are solving the activities. - Always think that maybe there are different ways to solve a problem. - Use ICT tools to avoid hard computations and check your solutions are correct in different ways if possible. - The solutions are always part of a context, expressing such a final solution totally integrated in the problem posted. - Be sure you answer the complete questions. - Always try to solve the questions by yourself. - If the project can be done in groups, discuss with the groups the proposed problem, to confirm and detect fails or weaknesses, confront strategies, discuss presentation format, etc. - Working in groups doesn't mean work less but work better.
Assessment	- Final report; - Oral presentation; - Peer-assessment: students will apply peer-assessment for their periodic performance using online peer assessment tools used and available at the respective institution.
Others: References	The task was created by Institute Mathematics and Physics of FME STU in Bratislava, 2019.