Projects in Physics and Applied maths (4a)

Goals:

- Work in a team
- Do research on theoretical background
- Plan and finish your project in time
- Set up, carry out and analyse experiments
- Compare theoretical predictions to measurements
- Evaluate and reflect your project

Subject:

Every team selects a topic in the area *mathematical curves and their application in physics*. Some ideas can be found on the extra sheet. In order to be accepted, a project has to include challenging aspects from both mathematics and physics. Projects purely based on literature research are not appropriate, they must contain a „practical" part of some kind (experiments, simulation, …). Only one team can work on the same project.

Organisation:

The teams work autonomously and independently from each other. The teachers' job is to guide you and to answer open questions.

It is allowed to give help to other teams, but not to exchange data or texts.

Time Budget:

Of the 13 double lessons, one is reserved for administration (build teams, select projects, …), two for the presentations and the last one for an evaluation and a reflexion of your project. During the remaining nine sessions you work on the selected project. It is very important to plan ahead what you want to do in order to make best use of the limited time.

Location:

Generally, you work at the MNG (physics or maths room, physics lab, computer room, library, …), unless this is not possible (e.g. because you have to do outdoor experiments). In any case you have to check in at the beginning and to check out at the end of every session and to report what you are going to do during the following session.

Material:

Inform the physics teacher at least one week in advance if you plan to set up experiments with material from the MNG physics institute.

If you need material the school cannot supply, you have to organise it yourself.

Books from the mathematics and physics departments' libraries can be used during the project sessions. For further research, do not entirely rely on information found on web sites, but make use of public libraries, too.

Concept:

At the end of the second session, you hand in a written concept for your project (about two pages). It should include a description of what you intend to do, the required maths and physics you intend to use, and a tentative schedule. You update the schedule regularly, according to the progress (or lack of it) of your project.

Journal:

Every team documents the process (project plan, sketches, experimental data, calculations, program listings, drafts, etc.) in a journal. This has to be handed in with the project report.

The journal is a book (A4 format).

Progress Reports:

During the project phases, every team has to orally report their progress (what you have done so far, problems, what you still have to do) to the teachers at regular intervals. The journal and the updated schedule have to be presented at every progress report.

Final Report:

The final results are presented in a written report (about ten pages per student). The structure should be comparable to a typical physics lab report.

A good report includes a discussion of the curve under investigation and compares several of its properties (e.g. curve length, area, …) to the values found in your experiments (with error calculation).

Presentation and poster:

Every group has to present their project in a talk (ten to fifteen minutes per student). After a short introduction on the mathematics and physics of your project, the focus should be put on your own contribution. This presentation is followed by a discussion. Active participation in this part is also assessed.

Every team designs a poster summarising the most important results of the project.

Evaluation and Reflexion

At the end of the semester you critically think about your project. Evaluate the different parts (planning, process, results, report, presentation, …) and propose how they could be improved. You hand in a short evaluation report (about two pages).

Grading:

The mark for the project is based on the process, the report, the presentation (with poster) and the evaluation. It counts as one third towards the semester mark both in Applied Maths and in Physics.

Schedule:

Date	Phase	Deadlines
4 March	Administration	Build teams and choose project by the end of the session
11 March	Concept	Hand in the concept by the end of the session
18 March	Project Work	
25 March	Project Work	
1 April	Project Work	
8 April	Project Work	
15 April	Project Work	
13 Mai	Project Work	
20 Mai	Project Work	
10 June	Project Work	Hand in the final report and the poster by the end of the session
17 June	Presentations	
24 June	Presentations	
1 July	Evaluation	

Ideas for Projects

You find some propositions for possible projects in the list below.

Tea Cup	The light spot in a tea cup has a characteristic shape. You find out how this shape can be described and investigate its properties.
Dog on a Leash	What is the path of a dog trying to get as close to a tree as possible when his master is walking along a straight line? Try to find an experimental representation of this process. There are a number of related problems you could also investigate.
Chains	How can the shape of a chain suspended from its ends be described? Is the idealisation valid for real chains?
Sundial	A good sundial includes a way to correct for the sun's different elevation angles through the year. Build a simple sundial.
Lissajous Curves	Lissajous curves can easily be created using two frequency generators and an oscilloscope set to xy-mode. Investigate the properties of Lissajous curves. Try to build a mechanical "Lissajous generator".
Bicycle Wheel	Observe the path of different points on a bicycle wheel. Similar curves can be found in cogwheels or in Wankel engines.
Planetary motion	How can planetary motion be described in the geocentric theory? Use real data (e.g. from an astronomy software) to describe the motion of a planet both in the heliocentric and the geocentric theory.
Mandelbrot Monk	A part of the well-known shape in the Mandelbrot set can be approximated by a mathematical function, the cardioid. Use a program to create the Mandelbrot set and investigate this statement.
Sliding Ladder	What is the path defined by the envelope of a ladder sliding down a vertical wall? Can you think of other examples where the same curve can be found?
Smooth Curve	To avoid abrupt changes, the transition between a straight street segment and a curve has to be made as smooth as possible. How can this be realised? Use blueprints of real streets for your investigation.
Brachystochrone	The goal is to optimise the track between a starting point and a destination in such a way that the time a moveable point sliding down the track needs to reach the end of the track becomes minimal. The point moves frictionless by means of its own gravity. You build a brachystochrone track and compare it to other tracks.
Tautochrone	A tautochrone is a curved line, such that a heavy body, descending along it by the action of gravity, will always arrive at the lowest point in the same time, wherever in the curve it may begin to fall. You set up a tautochronous pendulum and investigate it.