**How to measure time – pendulum clocks**

**Younger students**

1. Qualitatively: No watch, no cell phone. Open experiment: Identify relevant parameters – include/exclude

2. Quantitatively: Using a cell phone to study the same relationships as in 1, e.g. period versus mass, period vs length

3. Data analysis. Scatter plot, Power regression.

Math part: Finding the relationship between *T* and *L*, studying power functions

Physics part: Doing the experiments, no theory.

**More advanced students**

1. Head on: measuring the distance from the motion sensor to the pendulum as a function of time.

Study influence, if any, of mass, length, amplitude and damping on the period *T*.

2. Data analysis: Study the graph, fit a harmonic function.

Math part: study trig functions including amplitude, frequency, period.

Physics part: Doing the experiments, no theory (maybe study the forces to arrive at the formula)



The physics behind the pendulum is: $T=2 . π. \sqrt{\frac{l}{g}}$ with l the length of the pendulum and g the gravitational acceleration 9,81 m/s2.

For large deviations there has to be a correction as mentioned by Christian Huygens (1658). See picture beside.

Equipment that can be used for experiments:

* Ranger for motion
* Stopwatch for time measurement
* App for video measurements

Extra reading materials: John Harrison clock maker from 17 th century and inventor of the marine chronometer.