# The Physics Experiments of Robert Wichard Pohl (1884–1976)

For decades, Robert Wichard Pohl taught his famous lectures of introductory physics in the old lecture hall of the Physics Institute at Goettingen University. These lectures became the foundation for three volumes entitled „Introduction into Physics". Now, using Professor Pohl's original instruments in the same lecture hall in which he taught, this set of videos captures his extraordinary ingenuity and once more brings to life Pohl's great experimental skills.

## Free and driven oscillations of a torsional pendulum (Pohl's wheel)

**Video title:** Free and driven oscillations of a torsional pendulum (Pohl's wheel)

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**Series title:** The Physics Experiments of Robert Wichard Pohl (1884-1976)

**Abstract:** To demonstrate the basic properties of harmonic oscillators on a torsional pendulum (Pohl's wheel), specifically their free and driven oscillations. For the latter, the transient oscillations will be shown, before the steady state has been reached.

**Source:** Pohls Einführung in die Physik: Mechanik, Akustik und Wärmelehre, K. Lüders und R. O. Pohl (eds.), Springer-Verlag, 19th edn, 2004, § 105, Fig. 289 - 292

**Key words:** Mechanics, harmonic oscillator, torsional pendulum, Pohl's wheel, damped oscillations, free and driven oscillations, resonance

**Goal of the experiment:** To demonstrate the basic properties of harmonic oscillators on a torsional pendulum (Pohl's wheel), specifically their free and driven oscillations. For the latter, the transient oscillations will be shown, before the steady state has been reached.

**Experimental setup:** The torsional pendulum consists of a circular copper ring with an eddy current brake, and a torsional spring. One end of the spring is attached to the copper ring, the other end to a motor via an eccentric-and-rod mechanism. First shown in the movie is an historical model. For the experiment, another pendulum, also specifically designed for lecture demonstrations, will be used. It sits on an optical bench and is projected onto the front wall of the lecture hall, together with a meter indicating the exciting frequencies used for the driven oscillations.

**Experiment:**

1. Free, damped oscillations:

The pendulum oscillates at its resonant frequency. Three different dampings are used: For the smallest damping, the amplitude decays very slowly, while for the largest damping the amplitude drops to zero after only a few oscillations.

2. Driven Oscillations :

a) For the case of the smallest damping, the pendulum is excited with different frequencies, first with a frequency smaller than the resonant frequency, then at the resonant frequency, and finally at one larger than the resonant frequency. It is seen that in all three cases, the oscillator oscillates at the driving frequency, after the transients have died out. At the smallest frequency, the amplitude is small, the phase difference vanishes. At the resonant frequency, the amplitude becomes very large, the phase difference is 90 degrees. At high frequency, the amplitude drops to zero, and the phase difference grows to 180 degrees.

b) The influence of the damping on the steady state amplitude is shown for excitation at the resonant frequency: For this, the frequency is decreased to the resonant frequency. The amplitude increases, and the phase difference approaches again 90 degrees. Then, the damping is increased in two steps: It is seen that the amplitude decreases, the phase difference, however, stays 90 degrees.

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