PHY117 HS2026

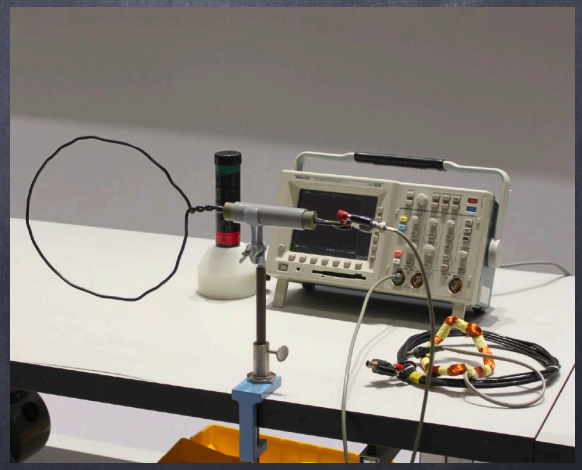
Week 11, Lecture 1

Nov. 24th, 2026

Prof. Ben Kilminster

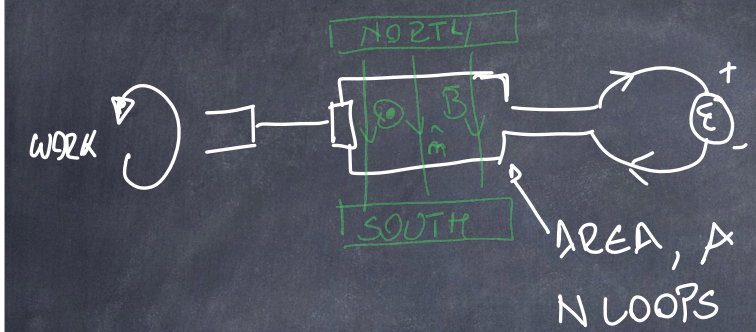
Prof. Florencia Canelli

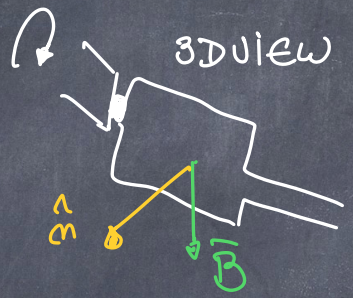
Today: electric generators + motors
magnetization
hysteresis
magnetic materials
magnetic moments atoms
superconductors



MOST ELECTRICAL ENERGY USED TODAY PRODUCED BY

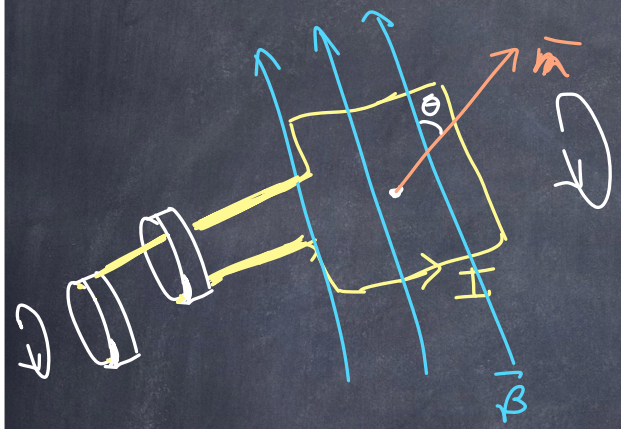
AC (ALTERATING CURRENT) ELECTRIC GENERATORS





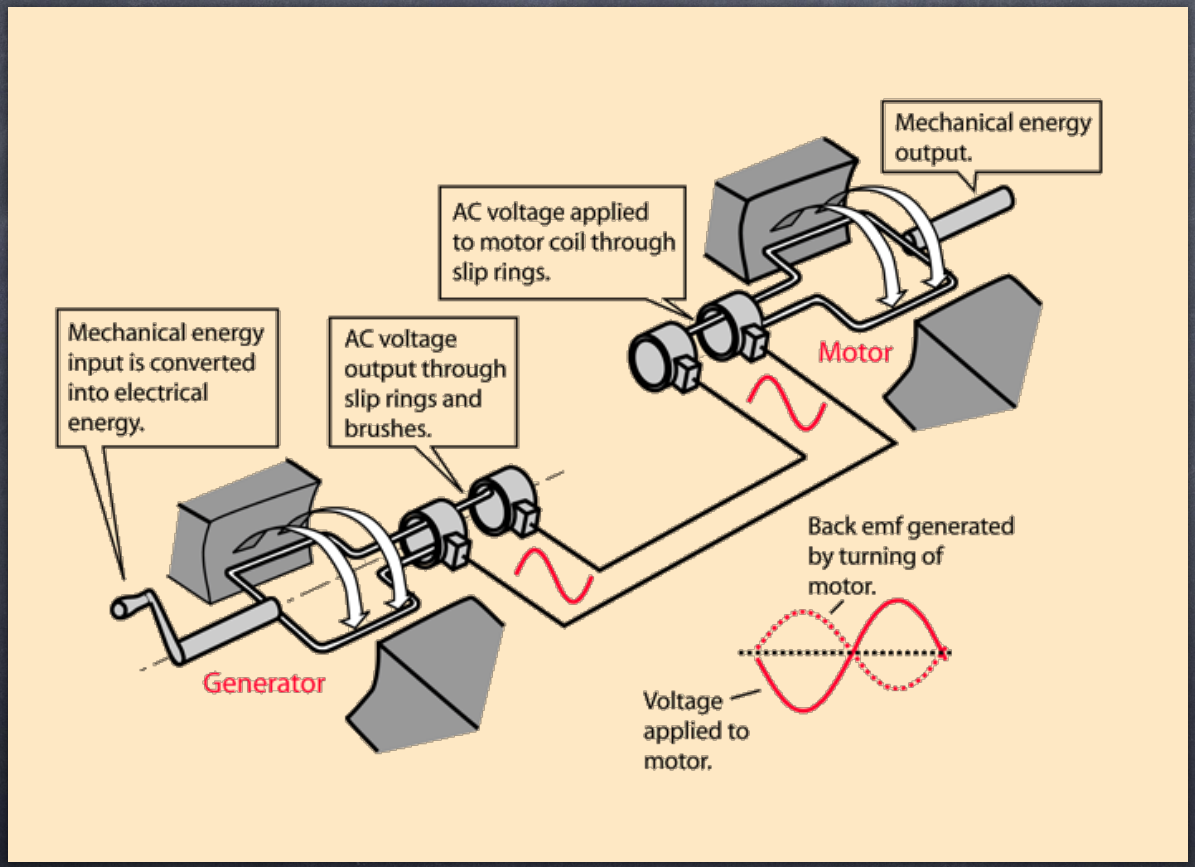
IF WE FEED AC IN THE LOOP INSTEAD OF TAKING IT OUT:

MOTORS



ALTERNATING CURRENT GENERATOR AND MOTOR RUN IN SERIES:

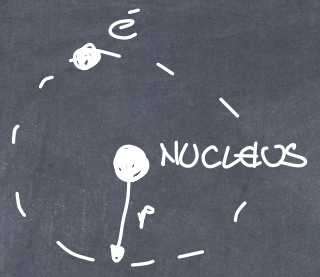
work →



→ work

ATOMIC MAGNETIC MOMENTS

EVERY ELECTRON CIRCLING A NUCLEUS IS A TINY CURRENT LOOP



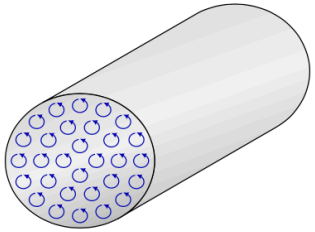
FOR A POSITIVE CHARGE $\bar{m} = \frac{q\bar{L}}{2m_q}$ SAME DIRECTION

NEGATIVE CHARGE (ELECTRON) $\bar{m} = -\frac{q\bar{L}}{2m_q}$ OPPOSITE DIR

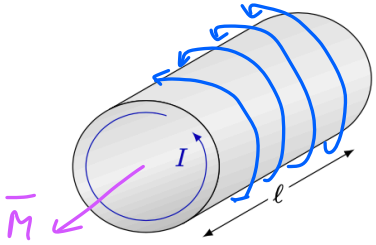
L_z IS QUANTIZED $\Rightarrow$ COMES IN WHOLE STEPS OF $\hbar$

$$L_z = m\hbar \qquad m = 0, \pm 1, \pm 2, \pm 3, \ldots$$

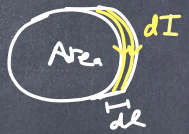
IN A MACROSCOPIC MATERIAL

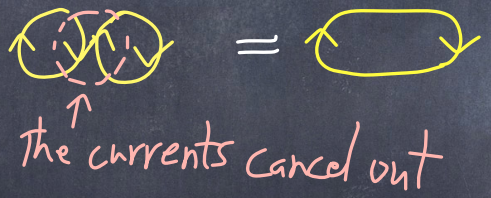


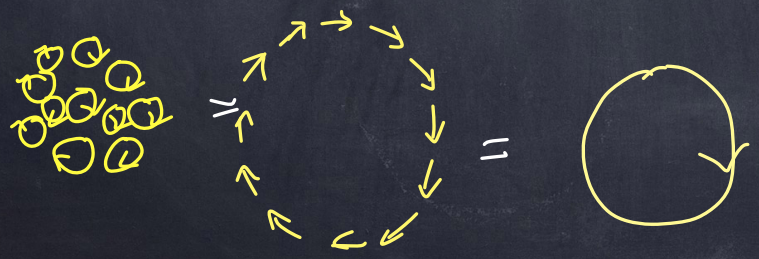
(a) Each atom has its own small current loops, and their own magnetic moment.



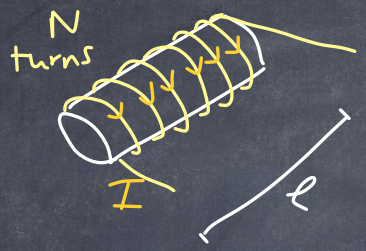
(b) One can think of the microscopic currents adding up to one big one.





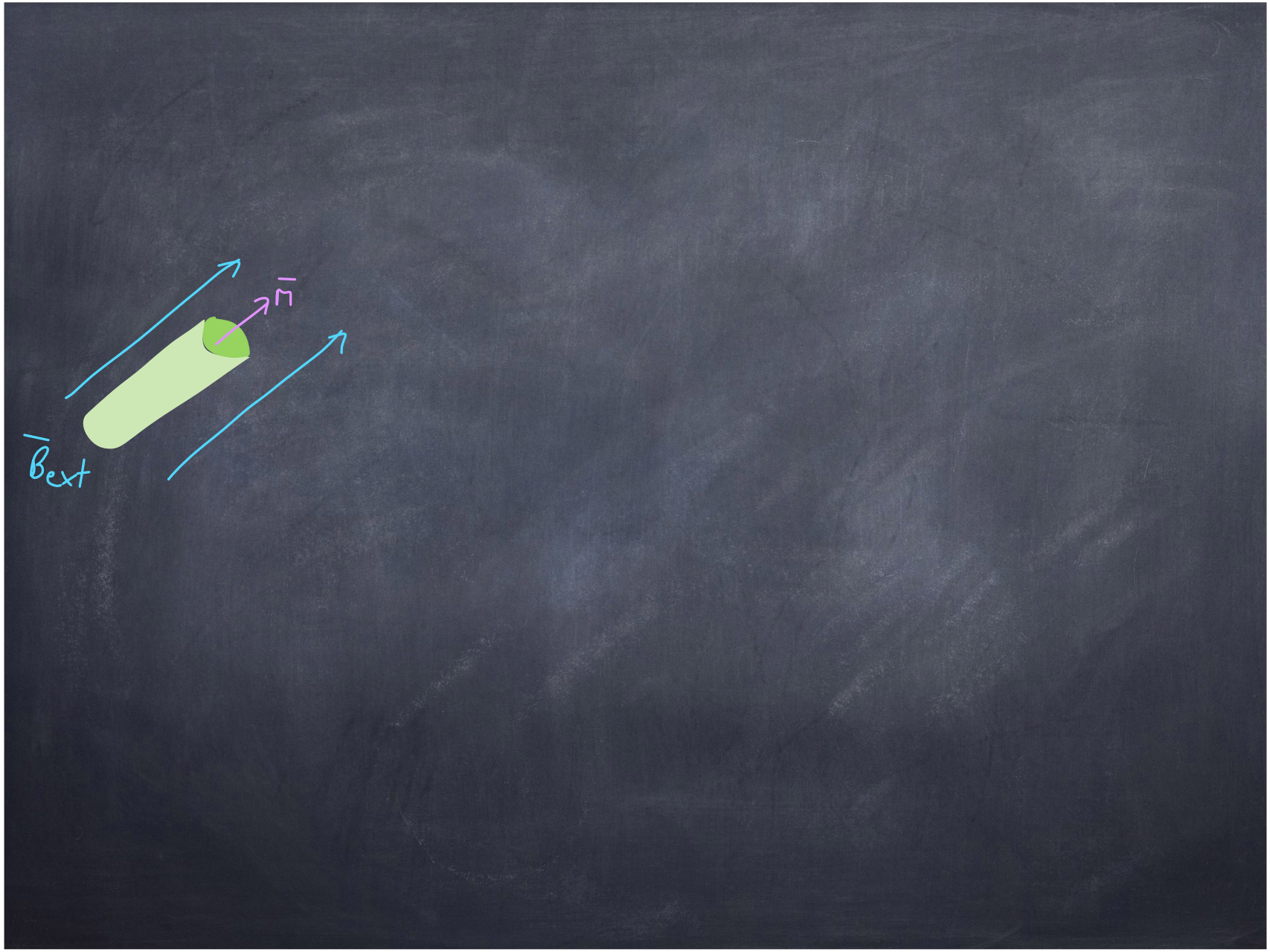


MAGNETIZATION OF A HOLLOW SOLENOID:



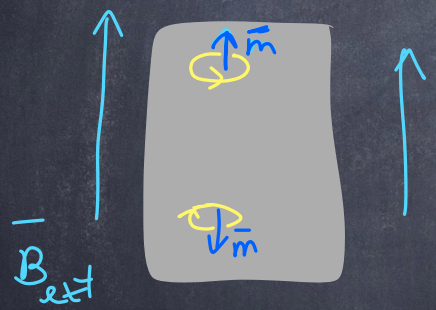
χ_m : MAGNETIC SOSCEPTIBICITY

HOW READILY A MATERIAL MAGNETIZES


$\vec{M}$
$\vec{B}_{ext}$

PARAMAGNETISM

MATERIALS WITH SMALL POSITIVE χ_m

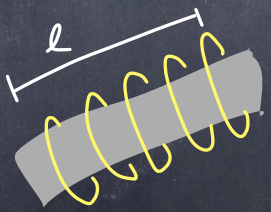


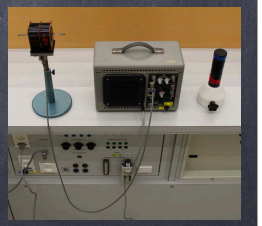


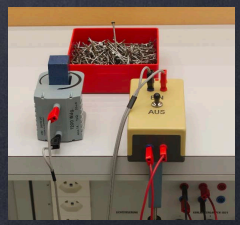
FERROMAGNETISM

MATERIALS WITH LARGE POSITIVE VALUES OF χ_m

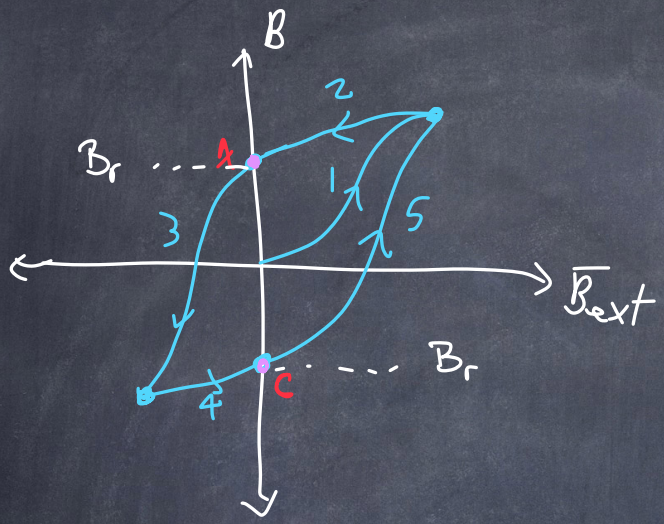


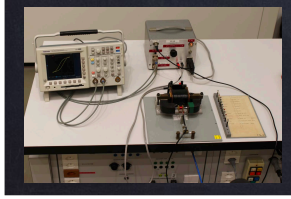






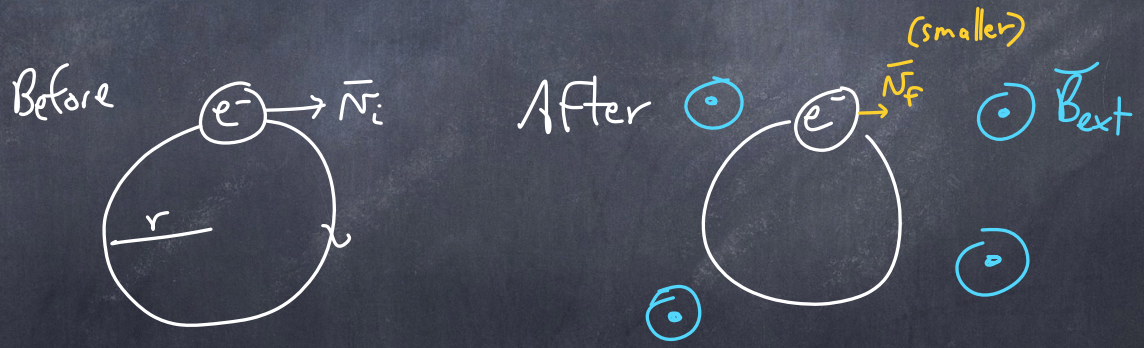
ANOTHER PROPERTY OF FERROMAGNETS IS THEIR MEMORY

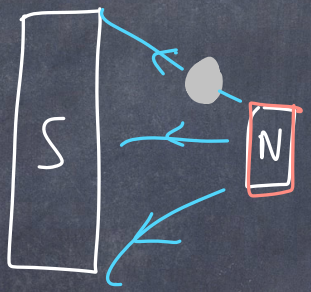


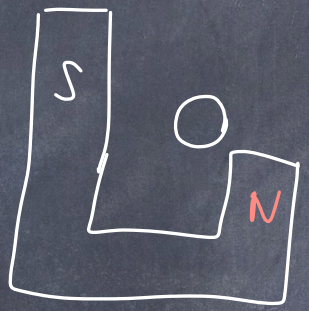


DIAMAGNETISM

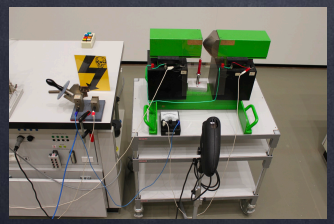
MATERIALS WITH A SMALL NEGATIVE VALUE OF χ_m







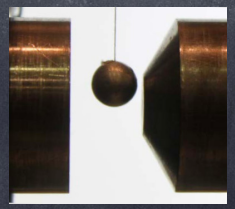
BISMUTH



CARBON DIOXIDE AND WATER VAPOR

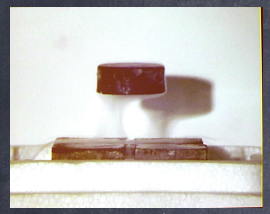


GRAPHITE ON MAGNET

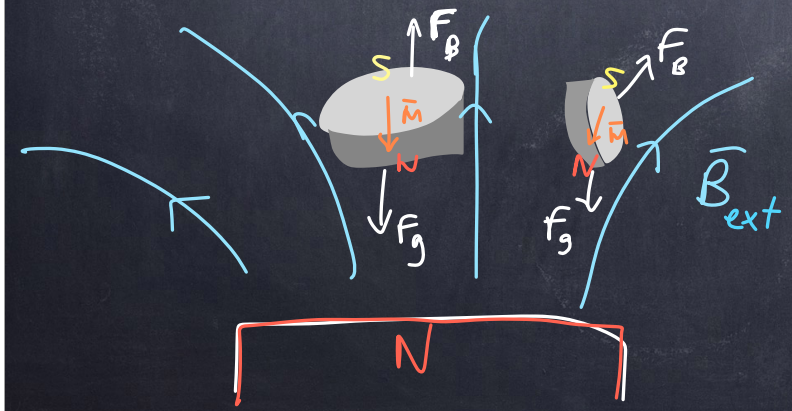


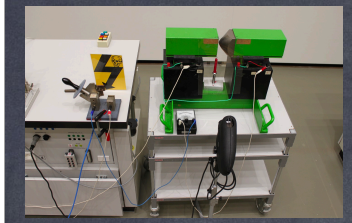
THE PERFECT DIAMAGNET – SUPERCONDUCTOR

ORDINARY DIAMAGNETS REDUCE FIELD INSIDE BY A FEW PARTS IN A MILLION



GRAPHITE

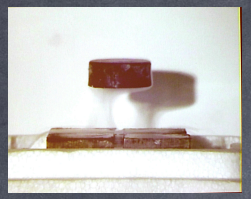




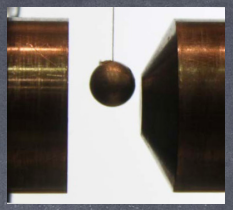
ED28



ED29



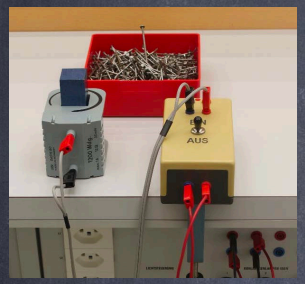
ED30



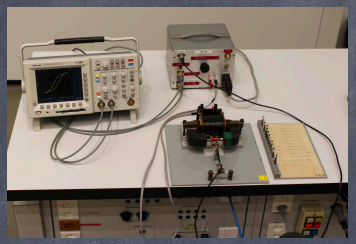
ED32



ED34



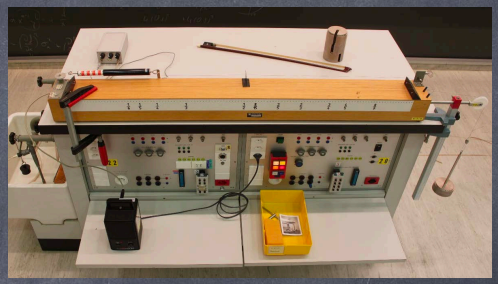
ED35



ED40



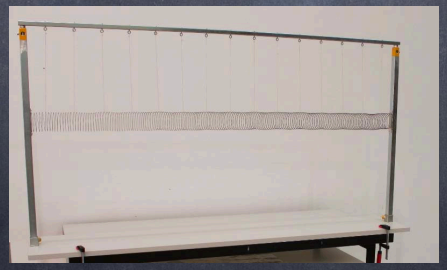
ED41



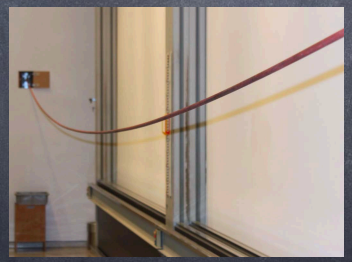
W14



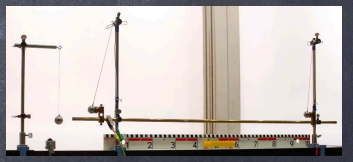
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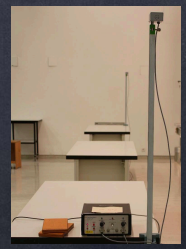
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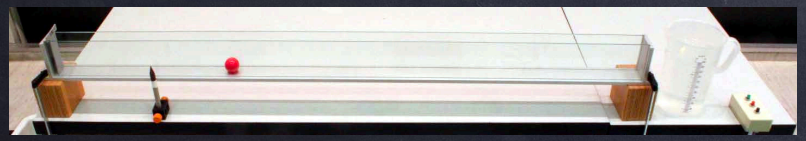
W28



W32



W33



W31