PHY117 HS2024

Find the lecture notes for today here:

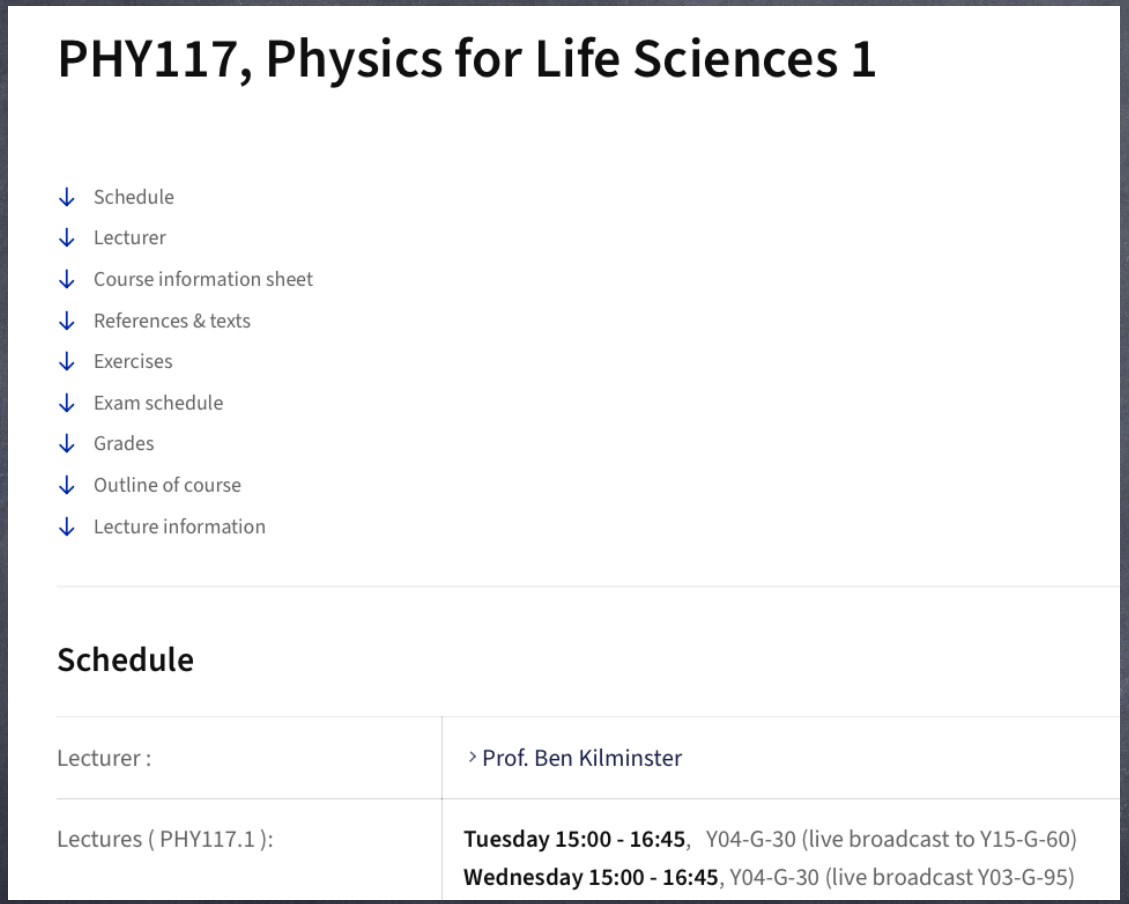
https://www.physik.uzh.ch/de/lehre/PHY117/HS2024.html

Prof. Ben Kilminster

Sept. 17th, 2024

Week 1, Lecture 1

Web page : https://www.physik.uzh.ch/de/lehre/PHY117/HS2024.html



PHY117, Physics for Life Sciences 1

- Schedule
- Lecturer
- Course information sheet
- References & texts
- Exercises
- Exam schedule
- Grades
- Outline of course
- Lecture information

Schedule

Lecturer :	› Prof. Ben Kilminster
Lectures (PHY117.1):	**Tuesday 15:00 - 16:45**, Y04-G-30 (live broadcast to Y15-G-60) **Wednesday 15:00 - 16:45**, Y04-G-30 (live broadcast Y03-G-95)

Lectures and reference materials will be uploaded here

Course sheet (1): (on website)

PHY 117 HS 2024

Physics II for Biomed (Modern Physics)
Lectures: Tuesdays 13:00-15:00, Wednesdays 13:00-15:00 **Y04-G-30** (overflow Tues: Y15-G-60, Wed: Y03-G-95)

Professor Ben Kilminster (Email ben.kilminster@physik.uzh.ch)
Prof. K's office hours : 36-J-50 Tuesdays 12:00-13:00 (or by appointment)
Class page: https://www.physik.uzh.ch/de/lehre/PHY117/HS2024.html (user: physik-phy117, pass: einstein5%)

Teachers assistants :
Frau Ruth Bründler (ruth.bruendler@physik.uzh.ch) (English/German speaking) (In charge of exercises & sessions)
Fanqiang Meng (fanqiang.meng@uzh.ch) (English/Mandarin/Cantonese speaking) In-class TA

Exercise session groups :

1	**Classes**	Alessio Tassone	atassone@student.ethz.ch
2		Anson Kwok	tsz.hong.kwok@physik.uzh.ch
3		David Ulloa	dulloa@student.ethz.ch
4		Erin Barillier	erinbari@umich.edu
5		Eslam Shokr	eslam.shokr@physik.uzh.ch
6		Haojie Geng	haojie.geng@uzh.ch
7		Martha Rösler	martha.roesler@uzh.ch
8		Martin Schweighoffer	martin.schweighoffer2@uzh.ch
9		Miguel Hernandez	miguel.hernandez@physik.uzh.ch
10		Ozan Zeray	ozan.zeray@uzh.ch
11		Samuel Hauser	samuel.hauser@uzh.ch
12		Thomas Maher	thomas.maher@uzh.ch
13		Urs Boison	urs.boison@uzh.ch
14		Valeriia Lukashenko	valeriia.lukashenko@physik.uzh.ch
15		Yannic Göldi	yannic.goeldi@uzh.ch

Course sheet (2):

References:
Kilminster Physics 1 & 2 scripts (available on the course web site)
Introductory university physics text book. I use the following :

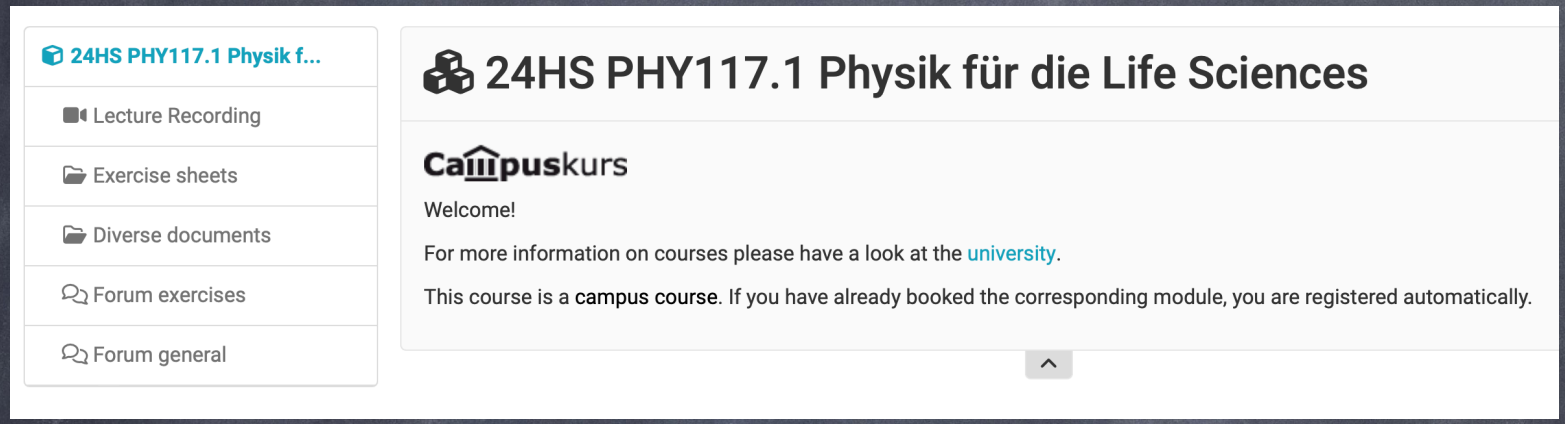
Tipler (Very good explanations, main text I follow)
Halliday & Resnick
Young & Freedman

(But these are all very similar. Find any one that explains the physics well for you.)

Assessments : **Please register on OLAT:** https://lms.uzh.ch/ This is how we send you assignments
Please log in to see if you can access the course. If not, check your UZH email is registered properly.

1) You will be assigned to one exercise session: Monday 13:00-15:00, 15:00-17:00, Thursday 8:00-10:00, 13:00-15:00, 15:00-17:00; Friday 8:00-10:00, 13:00-15:00. First exercise session: Monday Sept. 23rd.
2) Written exercises: New exercise sheet every week, assigned on Monday/Tuesday. First homework assigned Sept. 25th/26th. You will not be graded on these. You should attempt to **solve the problems on your own** since this develops the neutral circuitry necessary to solve exercises. (To pass final exam!!)
3) TAs will show how to solve assigned weekly exercise sheets, answer questions, and go through additional exercises if time. TAs will keep an attendance list. **Note: You really have to go to the exercise sessions.** This is where you learn how to solve problems. In your exams, you will have to solve very similar problems. One problem will be almost the same. Remember, you will need to practice solving exercises **yourself.**
4) **Final exam. (Jan. 15th).** UZH exam schedule
    a. Exam style :
        1. **Similar style to written exercises, but different.** (Memorizing solutions doesn't help)
        2. Will be in German and English
        3. Expect question from exercise sessions & relating to experiments shown in lecture
        4. Formula sheet will be provided. (No private information allowed.)
5) Grade : 100% final exam

Make sure you are registered for OLAT at lms.uzh.ch



FAQ

Q: When do I get assigned to an exercise session?
A: Registration ends Sept. 20th, assignments will be published Sept. 23rd.
First exercise sessions: Sept. 26th.

For all questions not directly related to the lecture PHY 117 (e.g. Questions about booking chemistry, mathematics or biology modules):
-> Studienberatung from biologists/biomedical scientists or the relevant subject

For other questions related to the booking of PHY 117 (e.g. late booking), exercise group assignments:
-> Frau Bründler (ruth.bruendler@physik.uzh.ch)

For questions about the content of the exercises:
-> Frau Bründler (ruth.bruendler@physik.uzh.ch)

For questions about how to solve exercises:
-> Contact the TA of your assigned exercise group

For questions about the transfer of credits from previous physics lectures (e.g. PHY 118 or lectures at ETH):
-> Christof Aegerter (aegerter@physik.uzh.ch)

Reference materials

Physics I:
Introduction to physics

Prof. Ben Kilminster

Introduction to mechanics, waves, and fluid dynamics

This script is the first part of an undergraduate course in introductory physics. It is typically taught in the first semester, with part 2 often taught in the second semester. The level of material is appropriate for physics majors as well as those in the life sciences. The latter may not be expected to learn the full level of detail included that would be expected of physics majors, but may still benefit from the additional material in order to understand better. It is recommended that students should be already familiar with geometry and also take or have taken a class in mathematics that covers vectors and calculus (derivatives and integrals).

3 Vectors & Reference Frames **21**
3.1 Vectors in coordinate systems 21
3.2 Vector length 22
3.3 Vector sum 22
3.4 Scalar multiplication 22
3.5 Scalar product 23
3.6 Vector product 24
3.7 Reference frames 25
3.8 Extra: Vector transformations 26

9 Torque & Angular Momentum **85**
9.1 Torque 85
9.2 Angular acceleration 86
9.3 Rotational equilibrium & moment of inertia 87
9.3.1 Example 1: Balancing two masses on a seesaw 89

II Oscillations and Waves **127**

12 Harmonic Oscillations **129**
12.1 Interlude: Taylor expansion 129
12.1.1 Example 1: Cubic function . . 129
12.1.2 Example 2: Sine 130
12.1.3 Example 3: Cosine 131
12.2 Simple harmonic oscillator 131

III Fluid dynamics **201**

16 Hydrostatics & Pressure **203**
16.1 Atmospheric pressure 203
16.2 Microscopic description 204
16.3 Bulk modulus 205
16.4 Pressure variation with depth 205

Reference materials

Physics II:
Introduction to physics

PHYSIK INSTITUT
UNIVERSITÄT ZÜRICH

PROF. BEN KILMINSTER

INTRODUCTION TO ELECTRICITY, MAGNETISM, ELECTROMAGNETISM, AND THERMODYNAMICS

This script is the second part of an undergraduate course in introductory physics. It is typically taught in the second semester, with part 1 often taught in the previous semester. The level of material is appropriate for physics majors as well as those in the life sciences. The latter may not be expected to learn the full level of detail that would be expected of physics majors, but may still benefit from the additional material in order to understand some concepts in more depth. It is recommended that students should be already familiar with geometry and also take or have taken a class in mathematics that covers vectors and calculus (derivatives and integrals).

1 Electric Charges & Fields 11
1.1 Charges . . . 11
1.1.1 Elementary charges . . . 11
1.1.2 Conductors & insulators . . . 14
1.2 The Coulomb force . . . 14
1.3 Electric fields . . . 16
1.3.1 Electric field lines . . . 16
1.4 Electric dipoles . . . 18
1.5 Charge distributions . . . 20
1.5.1 Electric field of a charged rod . . . 22
1.5.2 Electric field of a charged ring 24
1.5.3 Electric field of a charged sheet 24

7 Magnetism 73
7.1 Gauss's law for magnetic fields . . . 74
7.2 Magnetic force on an electric charge . 75
7.2.1 Lorentz force . . . 76
7.2.2 Application: Velocity selector . 76
7.2.3 Application: Mass spectrometer 77
7.2.4 Application: Cathode-ray tube 78
7.3 Currents in magnetic fields . . . 78
7.3.1 Force on a current loop in a magnetic field . . . 79
7.3.2 Torque on a current loop in a magnetic field . . . 80
7.3.3 Magnetic moment . . . 80

14 Optics 133
14.1 Huygens' principle . . . 133
14.2 Reflection and refraction of light . . . 134
14.2.1 Total internal reflection . . . 135
14.2.2 Mirage . . . 136
14.2.3 Refraction wavelength . . . 136
14.2.4 Dispersion & prisms . . . 137
14.2.5 Rainbow . . . 137

21 Thermodynamic Processes 179
21.1 PV diagrams . . . 179
21.2 Relation between heat capacities . . . 180
21.3 Adiabatic expansion . . . 182
21.3.1 Adiabatic free expansion & enthalpy . . . 184

Reference materials

PHY 117 — Physics Terms helper — Prof. Ben Kilminster

physical quantity (SI base units in blue) (radiation physics units)	Deutsch	Symbol	SI unit	Simplified Formula to help with units	in other SI units	typical units in radiation physics	conversions
Length	Länge	ℓ	meter = m				
time	Zeit	t	second = s				
velocity	Geschwindigkeit	v	m/s			c=~3E8 m/s	
acceleration	Beschleunigung	a	m/s^2				
mass	Masse	m	kilogram = kg			$1eV/c^2$	$1eV/c^2$ = 1.78E-36 kg
momentum	Impuls	p	kg*m/s	p=mv			
force	Kraft	F	Newton = N	F = ma	$1N = kg*m/s^2$		
torque	Drehmoment	τ	N*m	$\tau = rF \sin\theta$	$kg*m^2/s^2$		
energy, work	Energie, Arbeit	E, W	Joule = J	W = Fx	$1J = kg*m^2/s^2$	1eV	1eV = 1.602E-19J
power	Leistung	P	Watt = W	P = E/t	$1W = kg*m^2/s$		
pressure	Druck	p	Pascal = Pa	p = F/area	$1Pa=1N/m^2$		
Electrical charge	Elektrische Ladung	q	Coulomb = C			e = electron charge	1e = 1.602E-19C

German-english helper

physical quantity (SI base units in blue) (radiation physics units)	Deutsch	Symbol	SI unit	Simplified Formula to help with units	in other SI units
Electrical current	Stromstärke	I	Ampere = Amp = A	I = q/t	1A=1C/s
Electric potential	Elektrische Spannung	V or ϕ	Volt = V	Power = IV	1V = 1W/A
Electric field	Elektrisches Feld	E	N/C = V/m		
Magnetic field	Magnetische Flussdichte	B	Tesla = T	$F=BI\ell$	1T=1N/(A*m)
Resistance	Elektrischer Widerstand	R	Ohms = Ω	V = IR	1Ω = 1V/A
Capacitance	Elektrische Kapazität	C	Farad = F	C=q/V	1F = 1C/V
Temperature	Temperatur	T	Kelvin = K		
amount of substance	Stoffmenge	N	Mol		
luminous intensity	Lichtstärke	I_v	Candela = cd		
radioactivity	Radioaktivität	A_{Bq}	Becquerel = Bq		1/s
Absorbed dose	Energiedosis	D_T	Gray = Gy		m^2/s^2 = J/kg
Equivalent dose	Åquivalentdosis	H_T	Sievert = Sv		m^2/s^2 = J/kg

Formula sheet (same as final exam)

PHY117 Formula Sheet

Mechanics

Velocity	$\vec{v} = \frac{d\vec{r}}{dt}$
Speed	$v = \lvert\vec{v}\rvert$
Acceleration	$\vec{a} = \frac{d\vec{v}}{dt}$
Acceleration components	$a_r = \frac{v^2}{r}$ and $a_T = \frac{d\lvert\vec{v}\rvert}{dt}$
Position	$x(t) = x_0 + v_0 t + \frac{1}{2}at^2$
Velocity	$v^2 = v_0^2 + 2a\Delta x$ and $v(t) = v_0 + at$
Newton's second law	$\sum \vec{F} = m\,\vec{a}$
Newton's third law	$\vec{F}_{12} = -\vec{F}_{21}$
Gravitational force	$\vec{F}_g = m\vec{g}$
Gravitational force law	$\vec{F}_g = \frac{Gm_1m_2}{r^2}$
Newtons second law of rotation	$\sum \tau = I\alpha$
Centripetal force	$F_r = \frac{m\,v^2}{r} = mr\omega^2$
Centripetal acceleration	$a_r = \frac{-v^2}{r}\hat{r} = -r\omega^2\hat{r}$
Angular position	$\Delta s = r\Delta\theta$ and $\theta(t) = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
Angular velocity	$\omega = \frac{d\vartheta}{dt} = \frac{v}{r}$ and $\omega = \frac{2\pi}{T}$ and $\omega = \omega_0 + \alpha t$
Angular acceleration	$\alpha = d\omega/dt$
Angular momentum	$\vec{L} = \vec{r} \times \vec{p}$ and $\vec{L} = I\vec{\omega}$
Coordinates center of mass	$r_{cm} = \frac{\sum_i^n m_i\, r_i}{\sum_i^n m_i}$
Torque	$\vec{\tau} = \vec{r} \times \vec{F}$ and $\vec{\tau} = \frac{d\vec{L}}{dt}$
Impulse	$\vec{F}\Delta t = \Delta\vec{p} = m\Delta\vec{v}$

Energy and work

Kinetic energy:	$K = \frac{1}{2}mv^2$
Potential energy (gravity)	$U = mgh$
Potential energy (spring)	$U = \frac{1}{2}kx^2$
Work	$W_{1\to2} = \int_1^2 \vec{F}d\vec{r}$ and $W_{1\to2} = \int_1^2 \tau d\theta$
Work-energy theorem	$W_{1\to2} = K_2 - K_1$ and $W = \Delta K = -\Delta U$
Work and potential energy	$\Delta U = -W$
Law of conservation of energy	$K + U =$ constant

Fluids

Hydrostatic

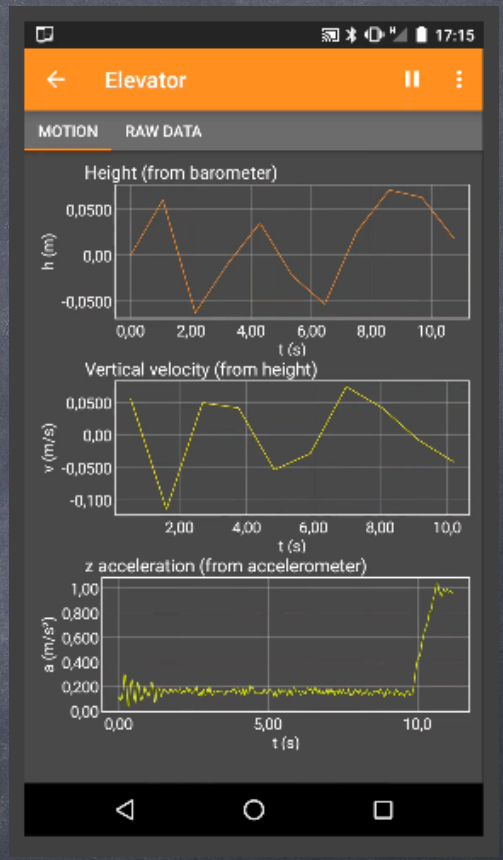
Pressure	$p = \frac{F}{A}$
Compressibility	$B = -\frac{p}{\frac{\Delta V}{V}}$
Pressure distribution in liquids	$p = p_0 + \rho gh$
Capillarity	$\Delta h = \frac{2\gamma\,\cos\theta_c}{\rho g r}$
Buoyancy	$F_b = \rho_l V_{\text{dis}} g$
Bouyancy in centrifuge	$F_b = m_l\omega^2 r$
Centrifugal "force"	$F_c = m_o\omega^2 r$

Hydrodynamics

Flow rate	$I_V = \frac{\Delta V}{\Delta t} = Av$ v: homogeneous velocity
Continuity equation	$I_V =$ constant $\Rightarrow v_1 A_1 = v_2 A_2$

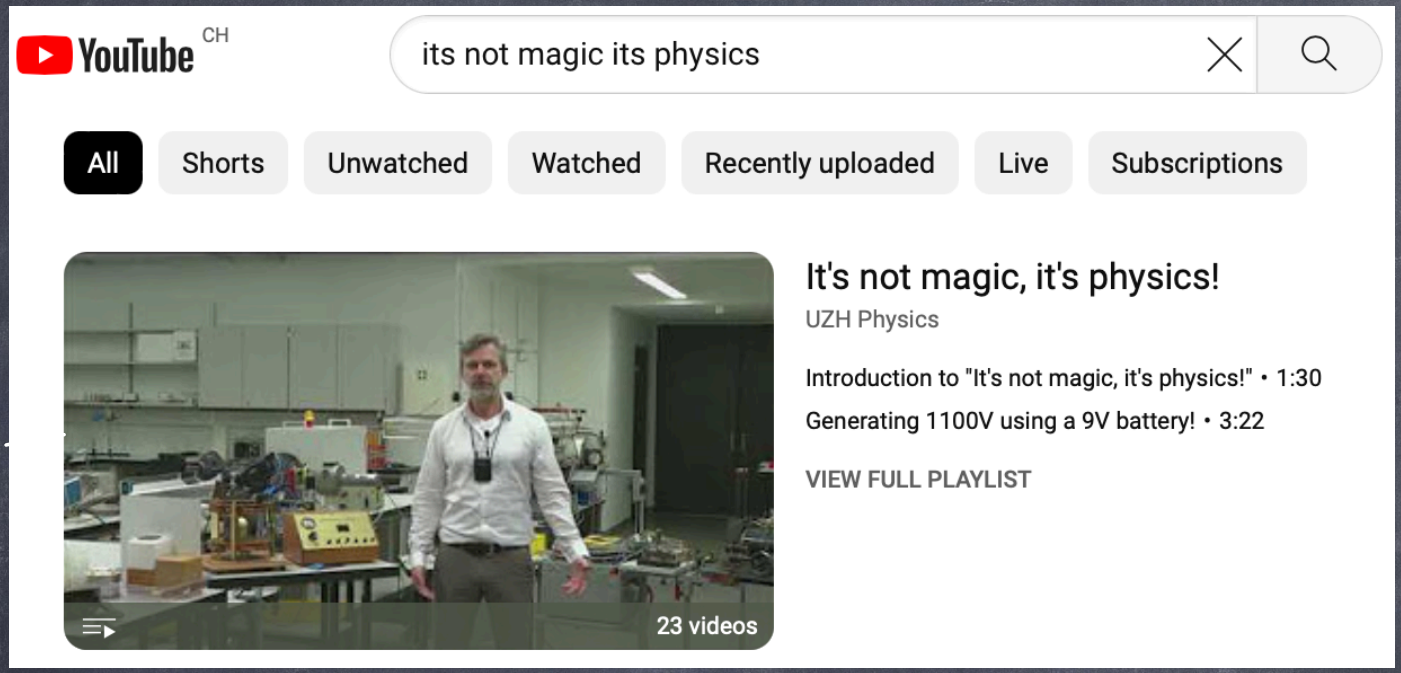

atomoi
UNIVERSITÄT ZÜRICH
NACHHILFE HS24
Mittwoch 17:00 - 19:00
Grundlagen Chemie
Y19 J-94
Grundlagen Physik
Y19 J-98
Fragen: nachhilfe@atomoi.ch

Tools for exercises

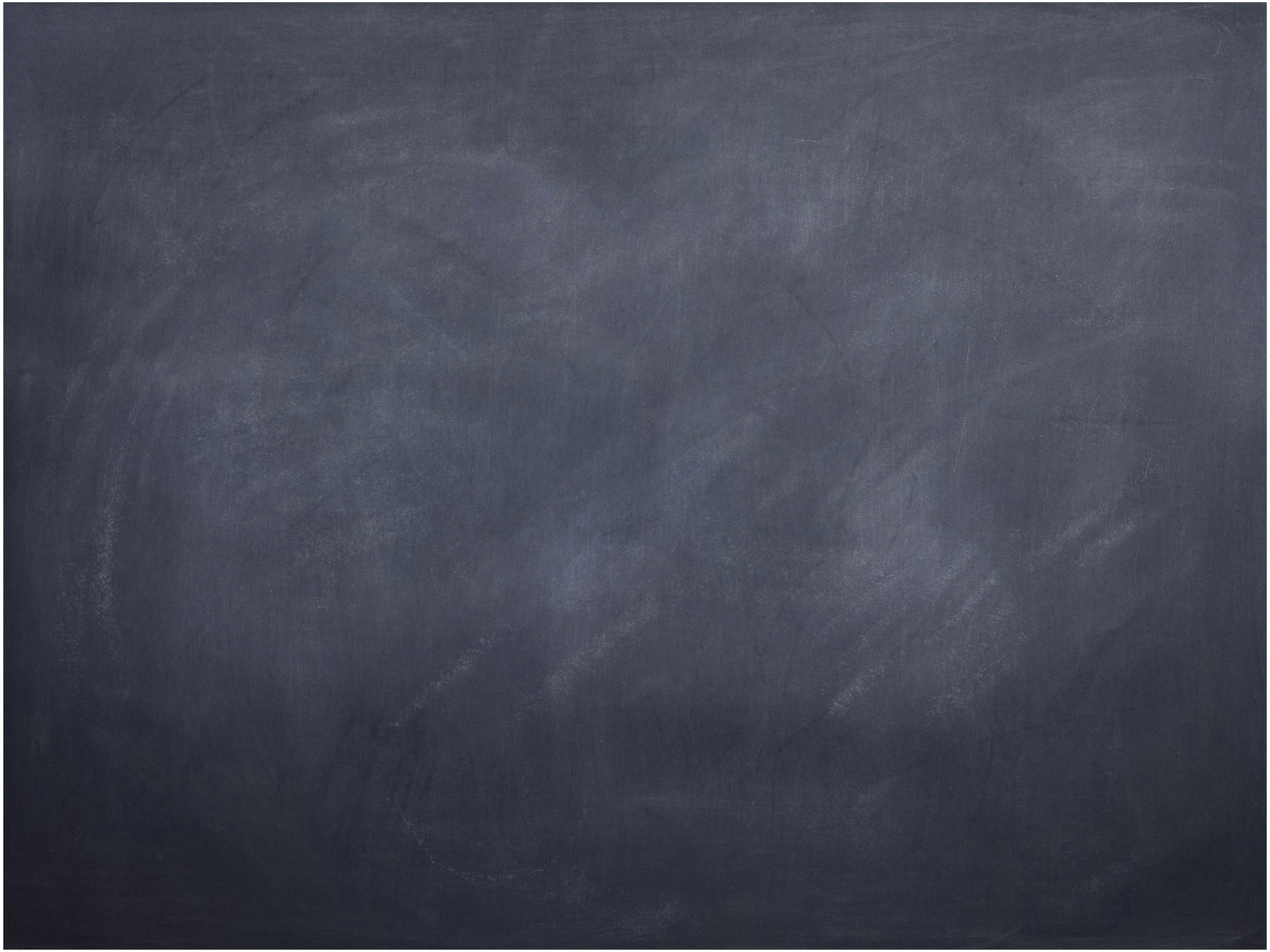


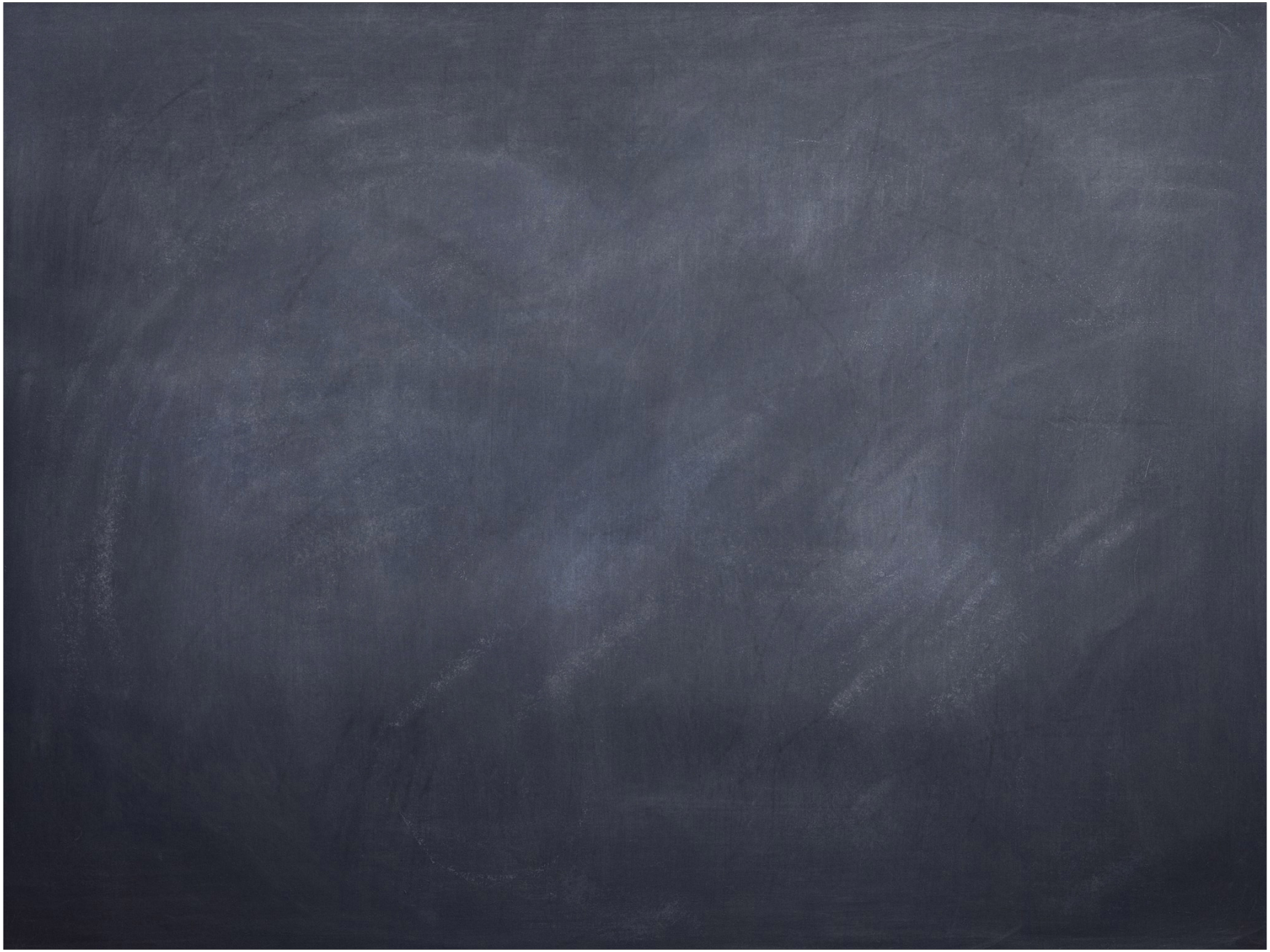
Download for your smartphone:
(If your handy is not so handy, find a partner)

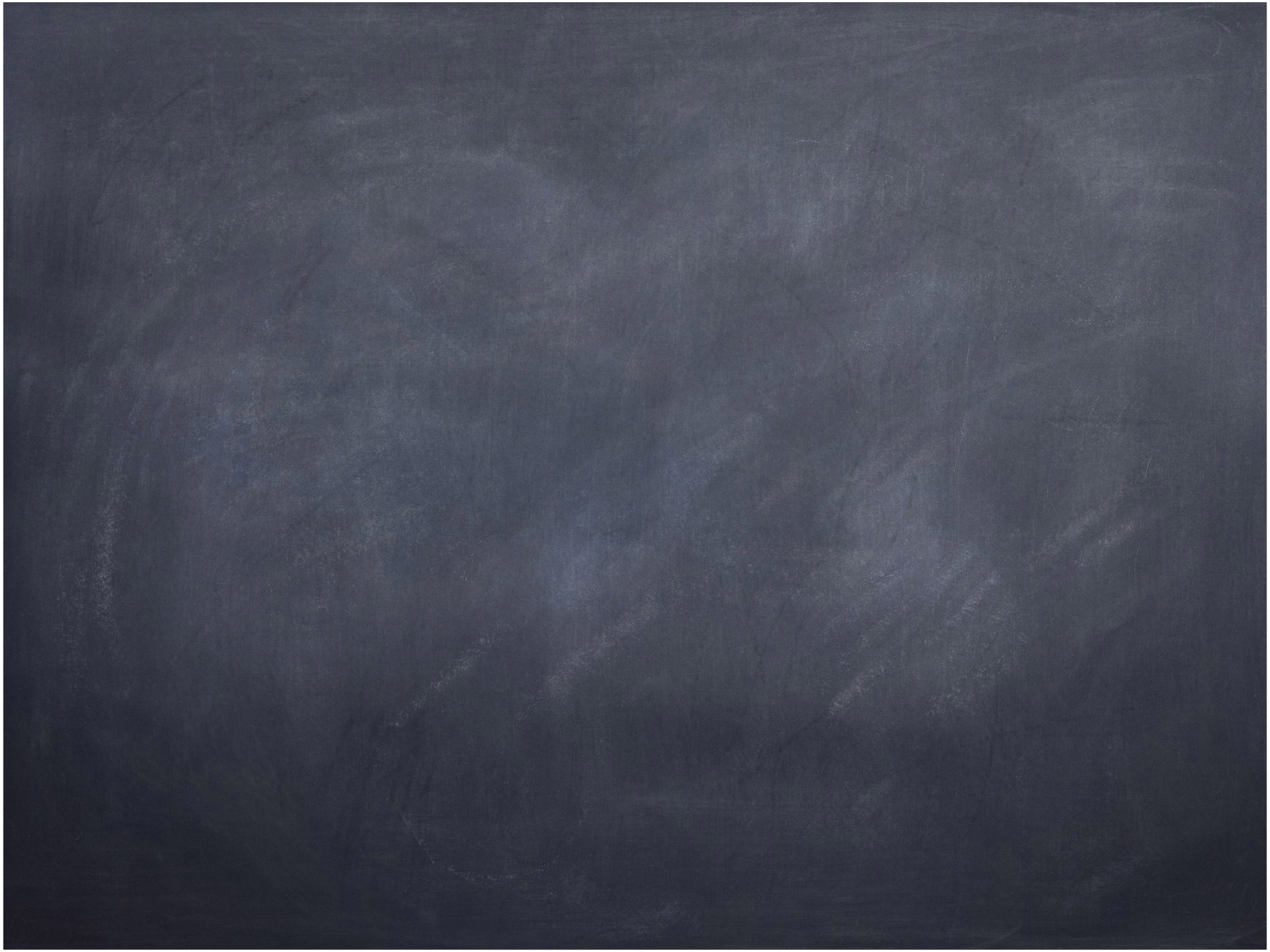
Youtube channel



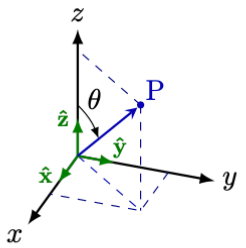
https://youtu.be/tR4B0jQ0DPU?feature=shared



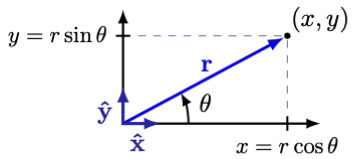




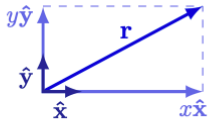
$$\mathbf{r} = x\hat{\mathbf{x}} + y\hat{\mathbf{y}} + z\hat{\mathbf{z}}$$



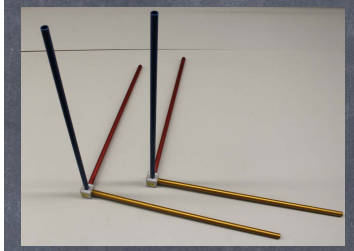
(a) Position vector in a 3D Cartesian coordinate system.

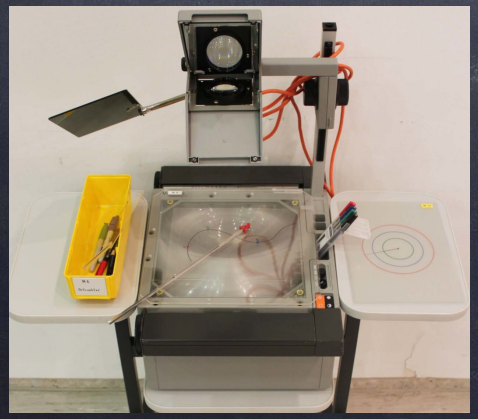


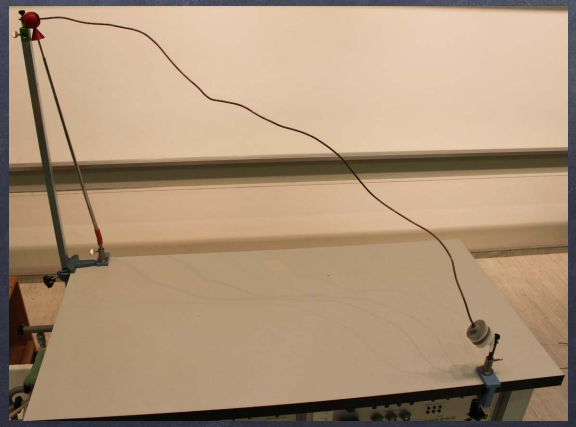
(b) Position vector in a 2D Cartesian coordinate system.

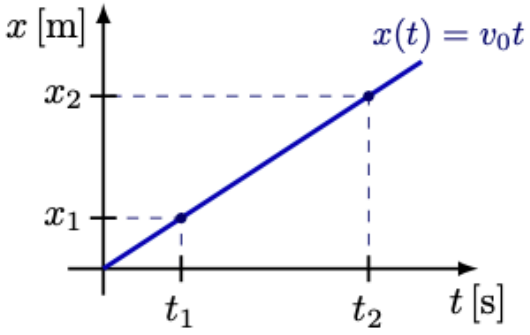


(c) A vector can be broken down into its x and y vector components.

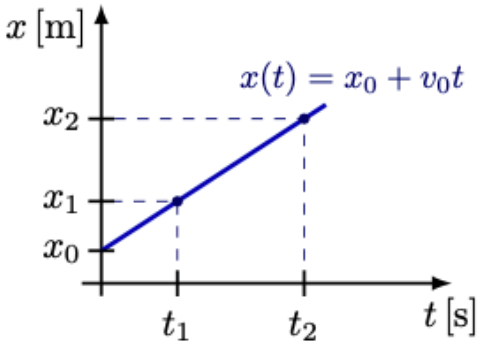




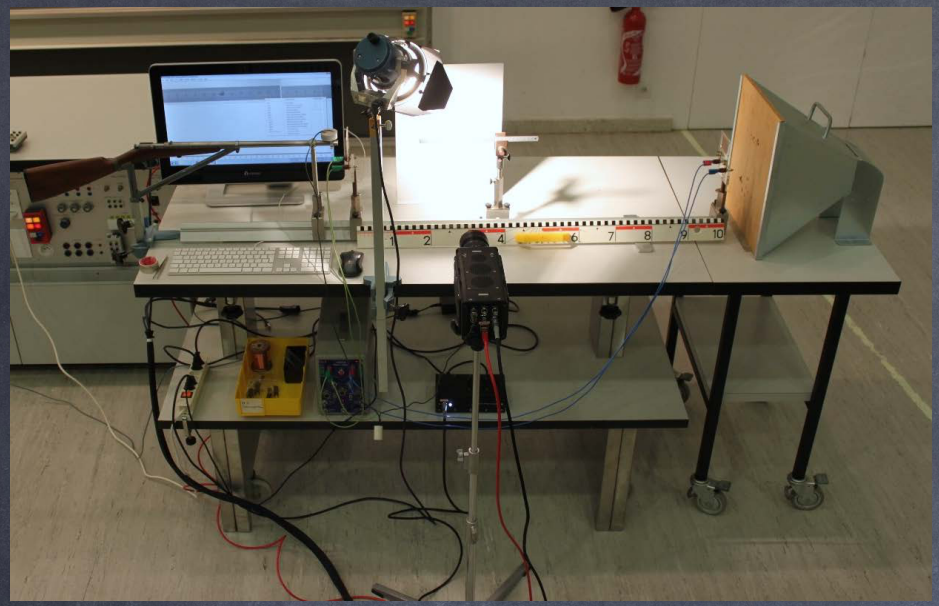


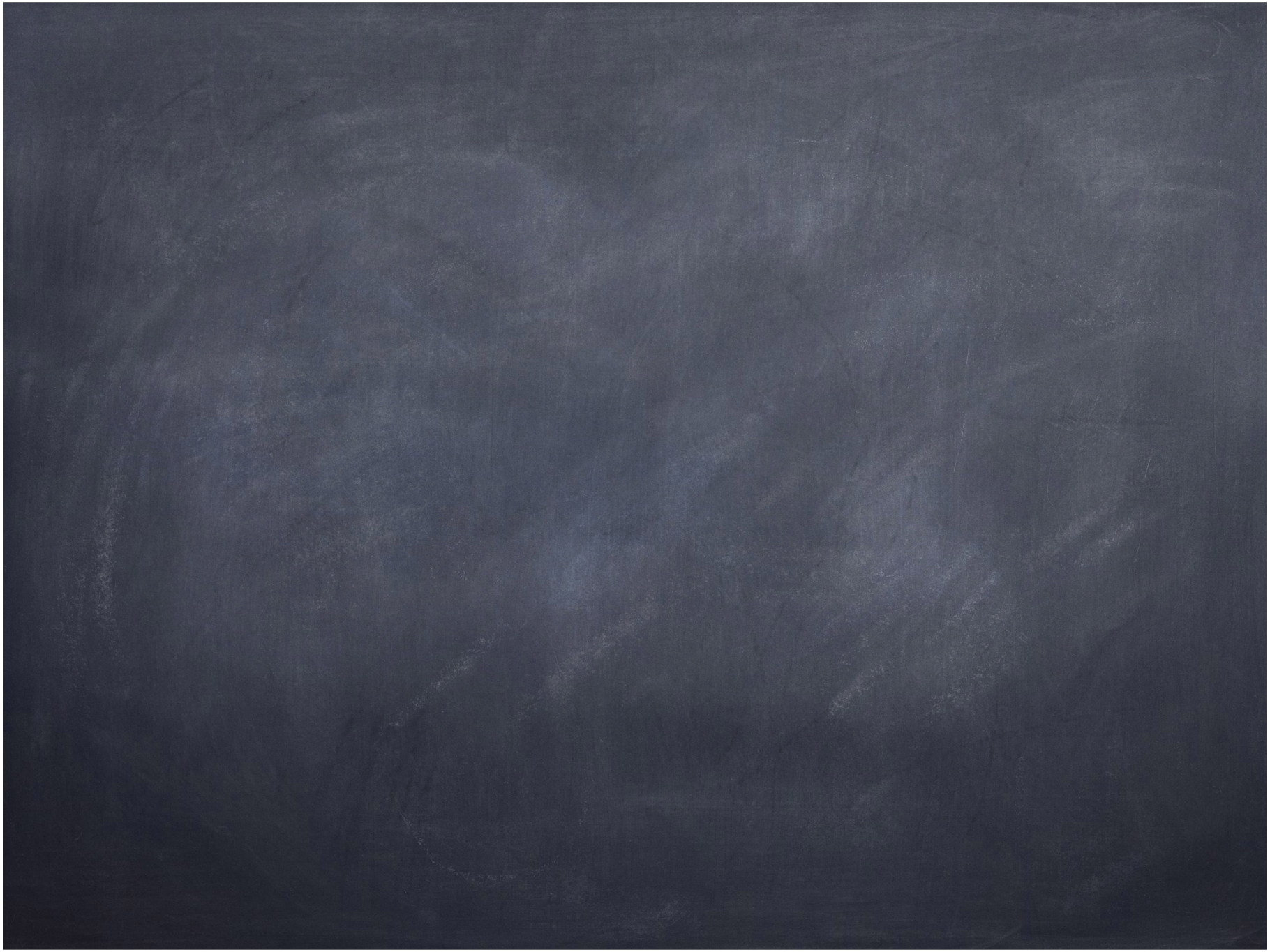


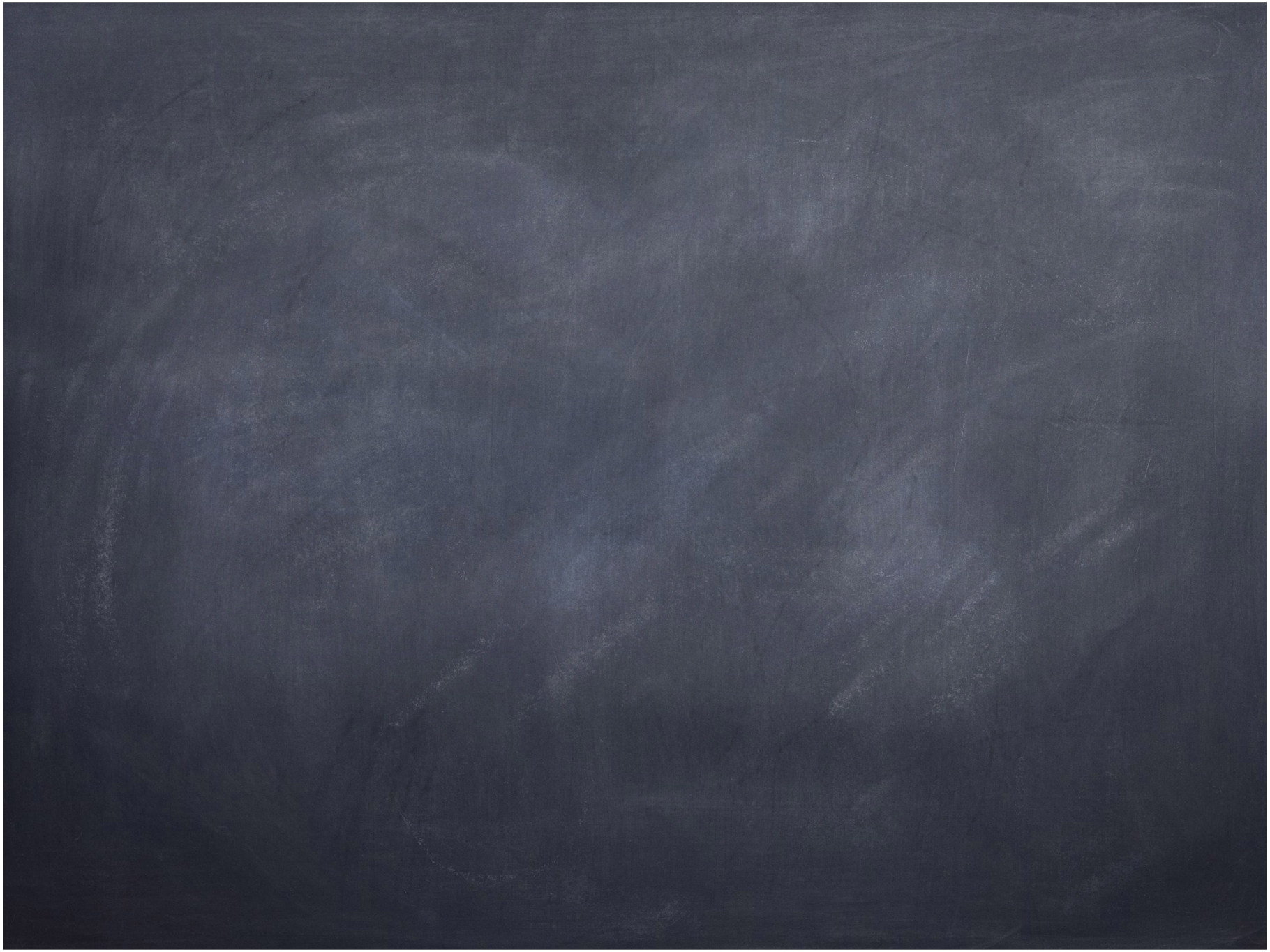
(a) Starting at $x(0) = 0$ at $t = 0$.

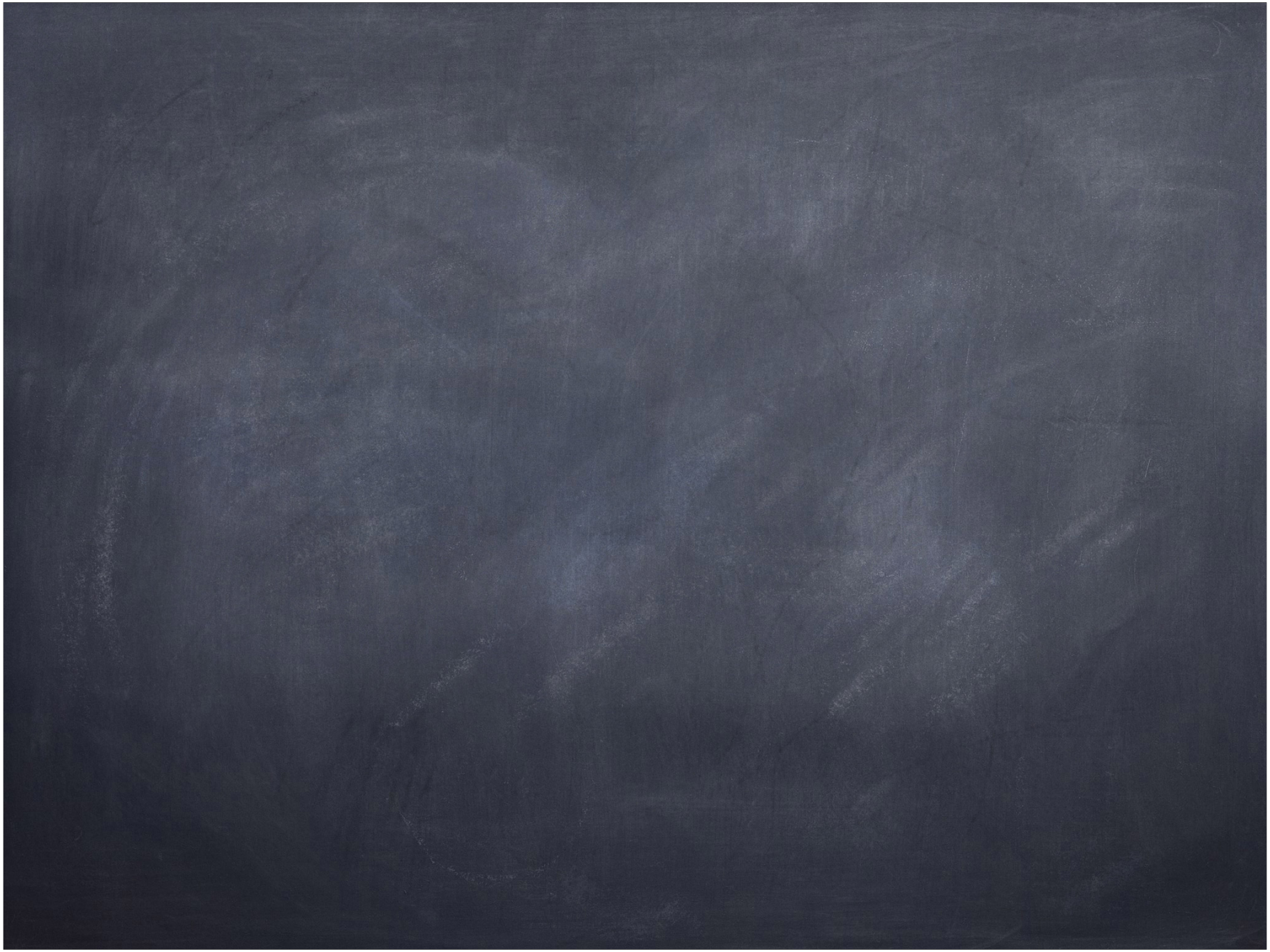


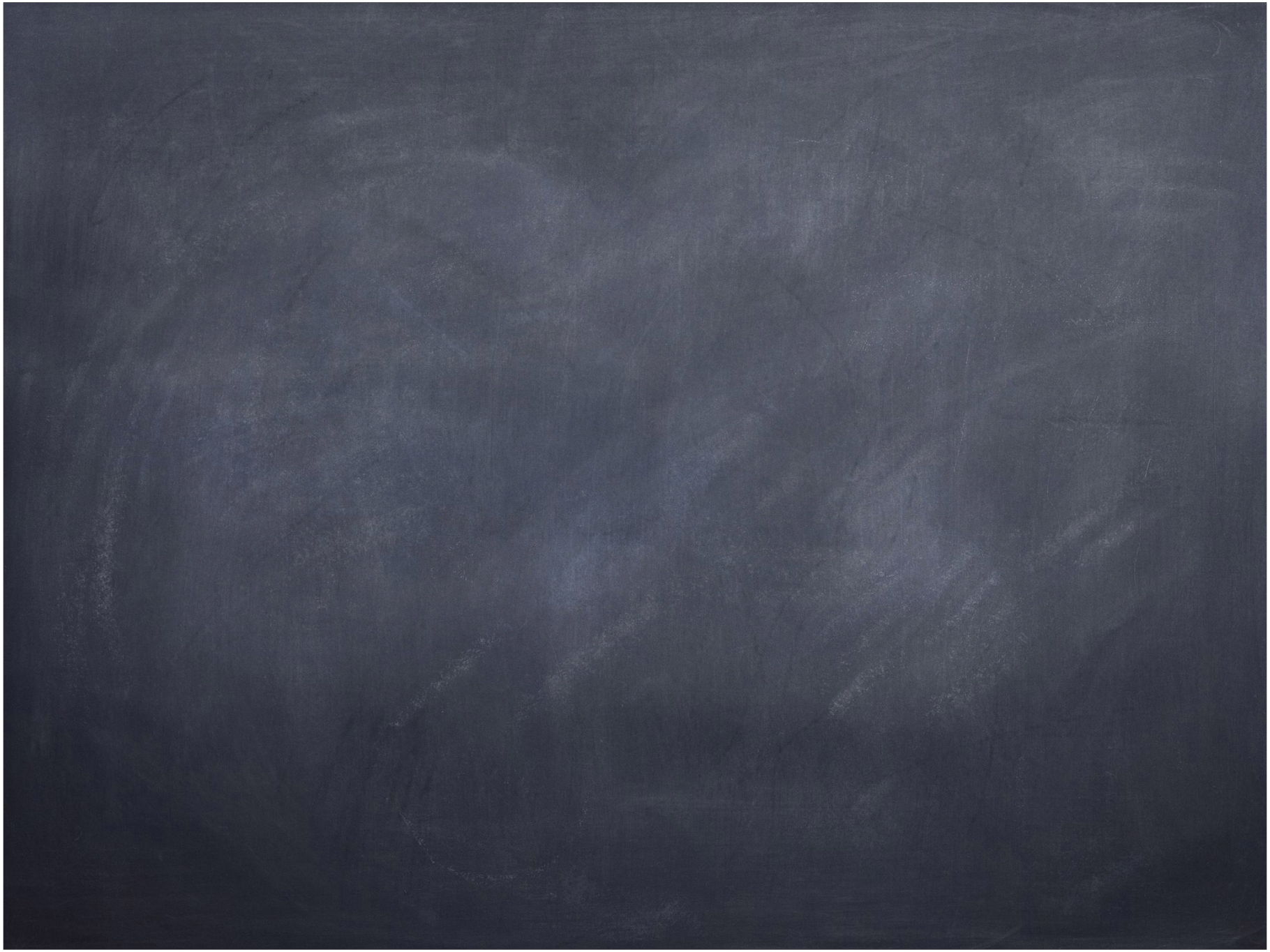
(b) Starting at an offset $x(0) = x_0$ at $t = 0$

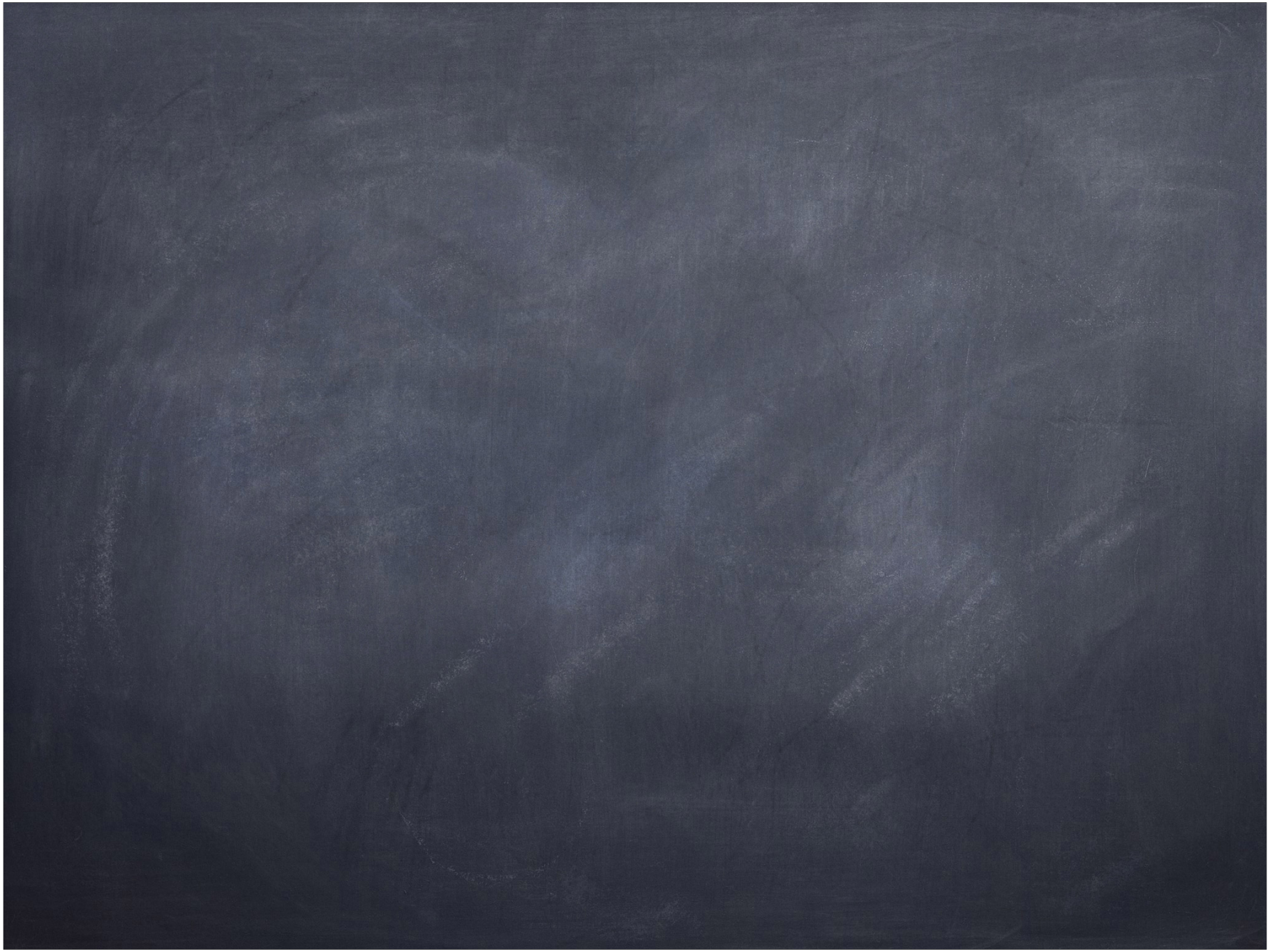


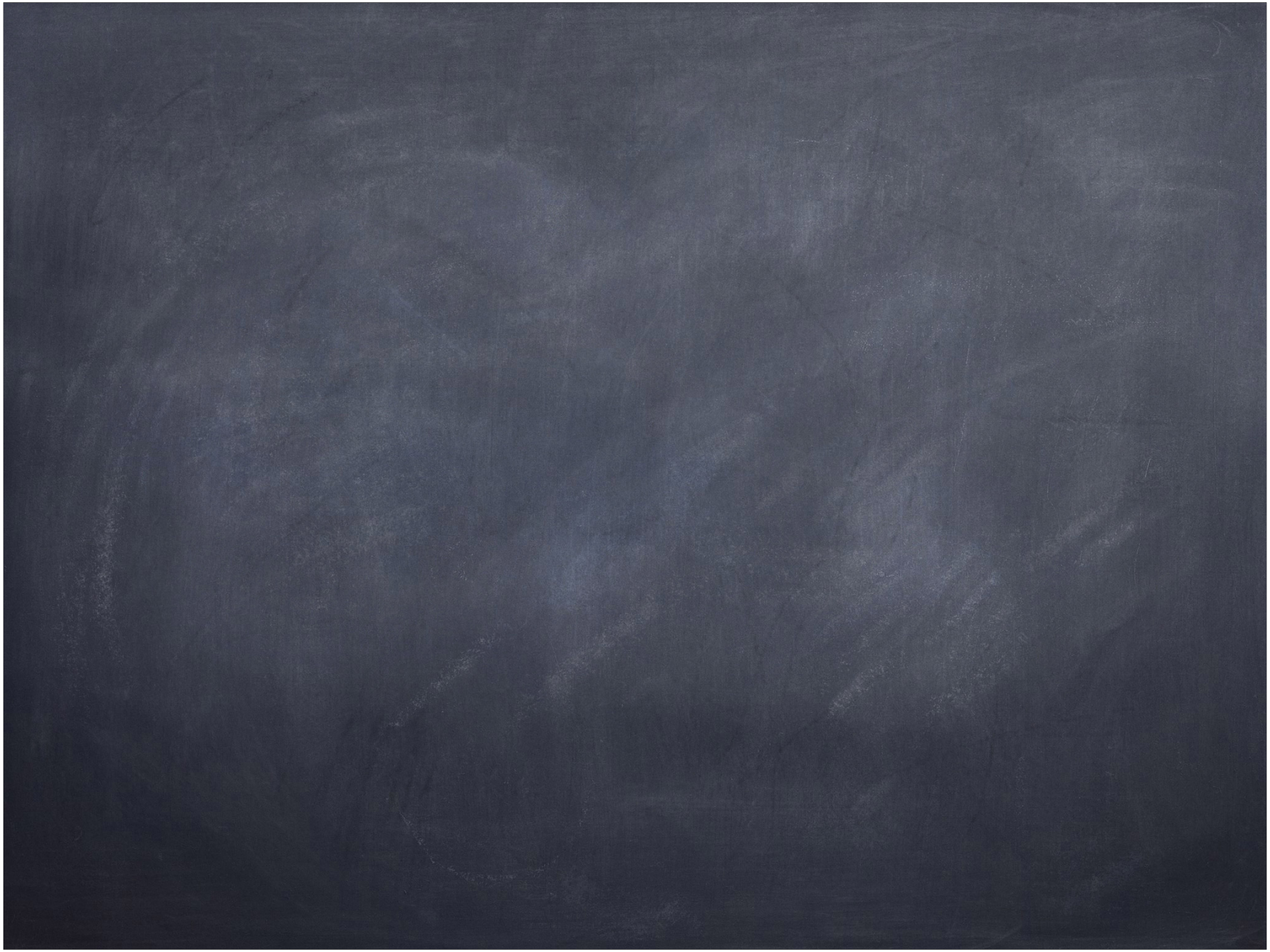






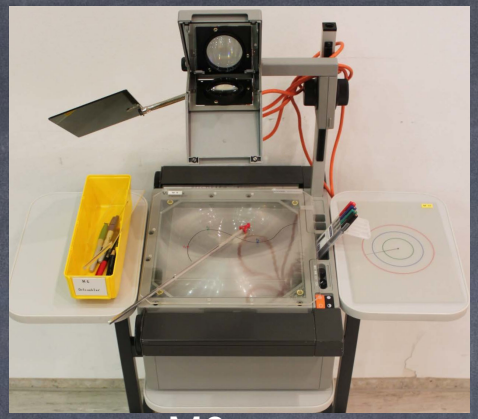




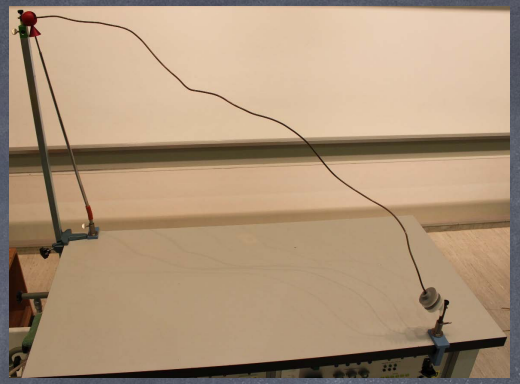


Experiments

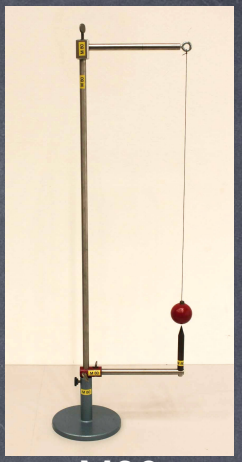
M1



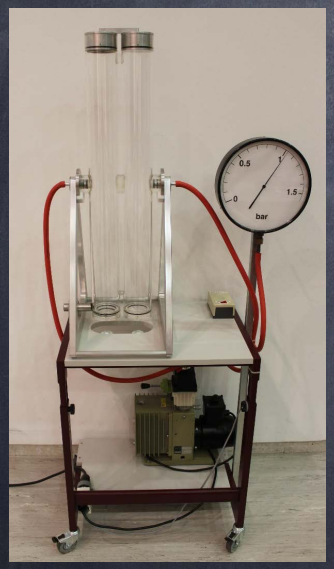
M6



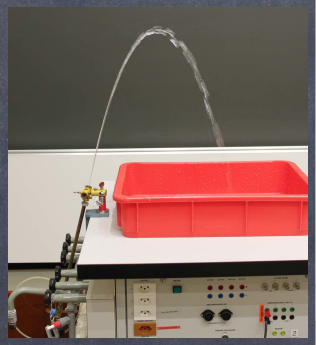
M10



M80

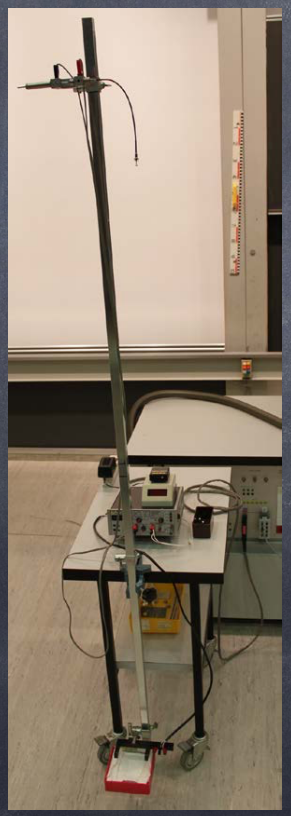


M46



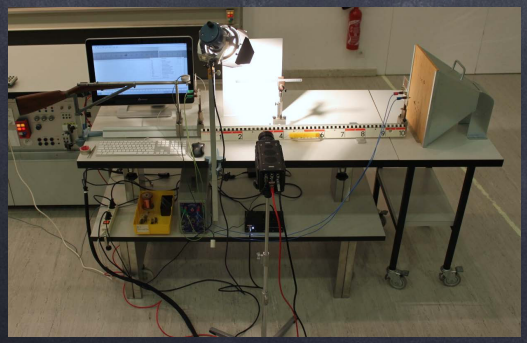
M48

M82



M40

M198



M12

M27