Reflections

OSA Leadership Meeting
Washington, DC, 7 February 2017

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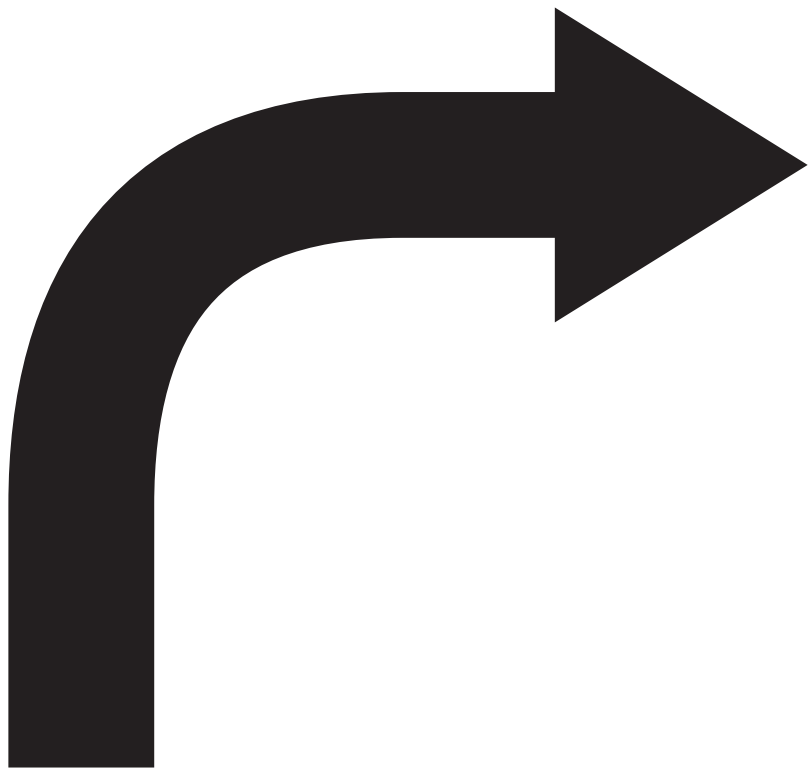
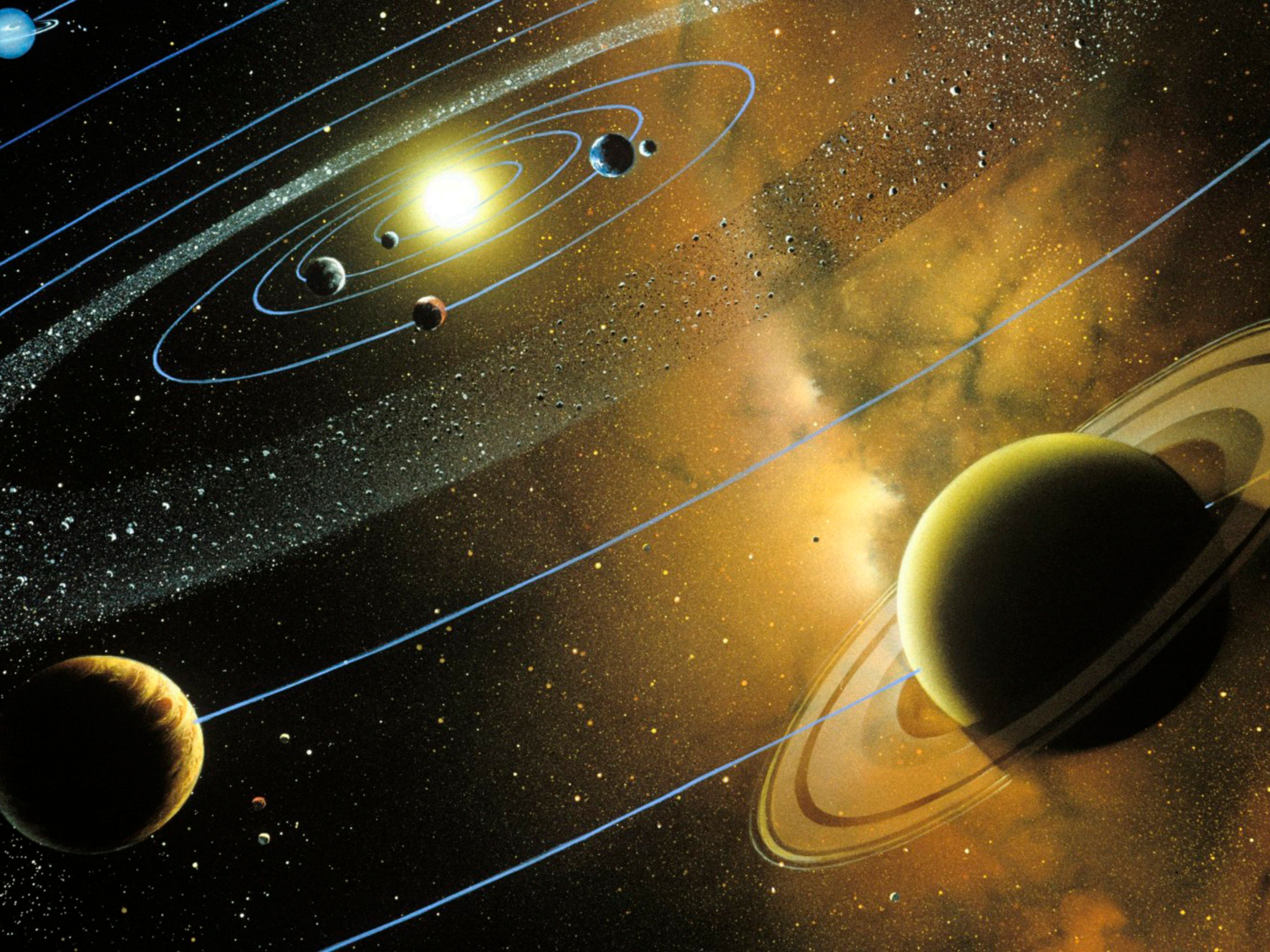
GOAL

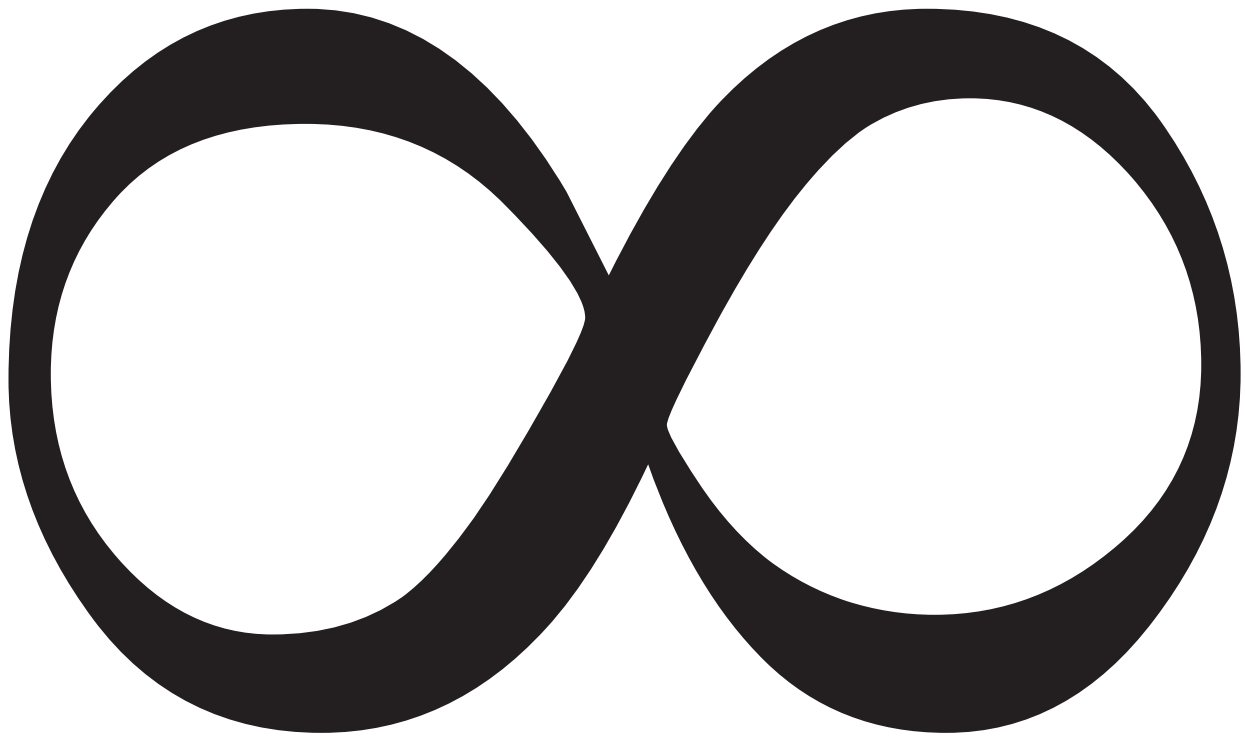
GOAL



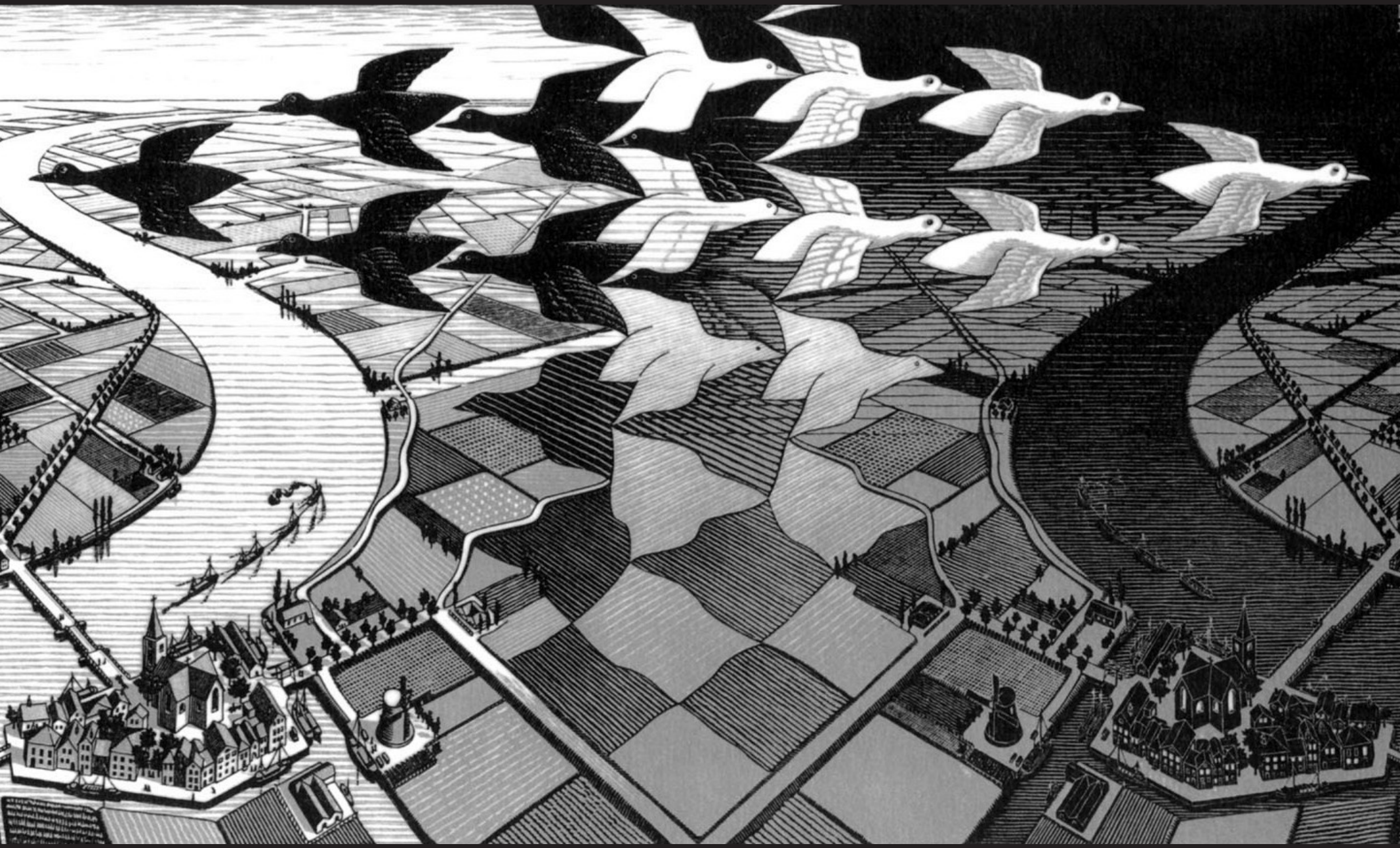


KODAK SAFETY FILM

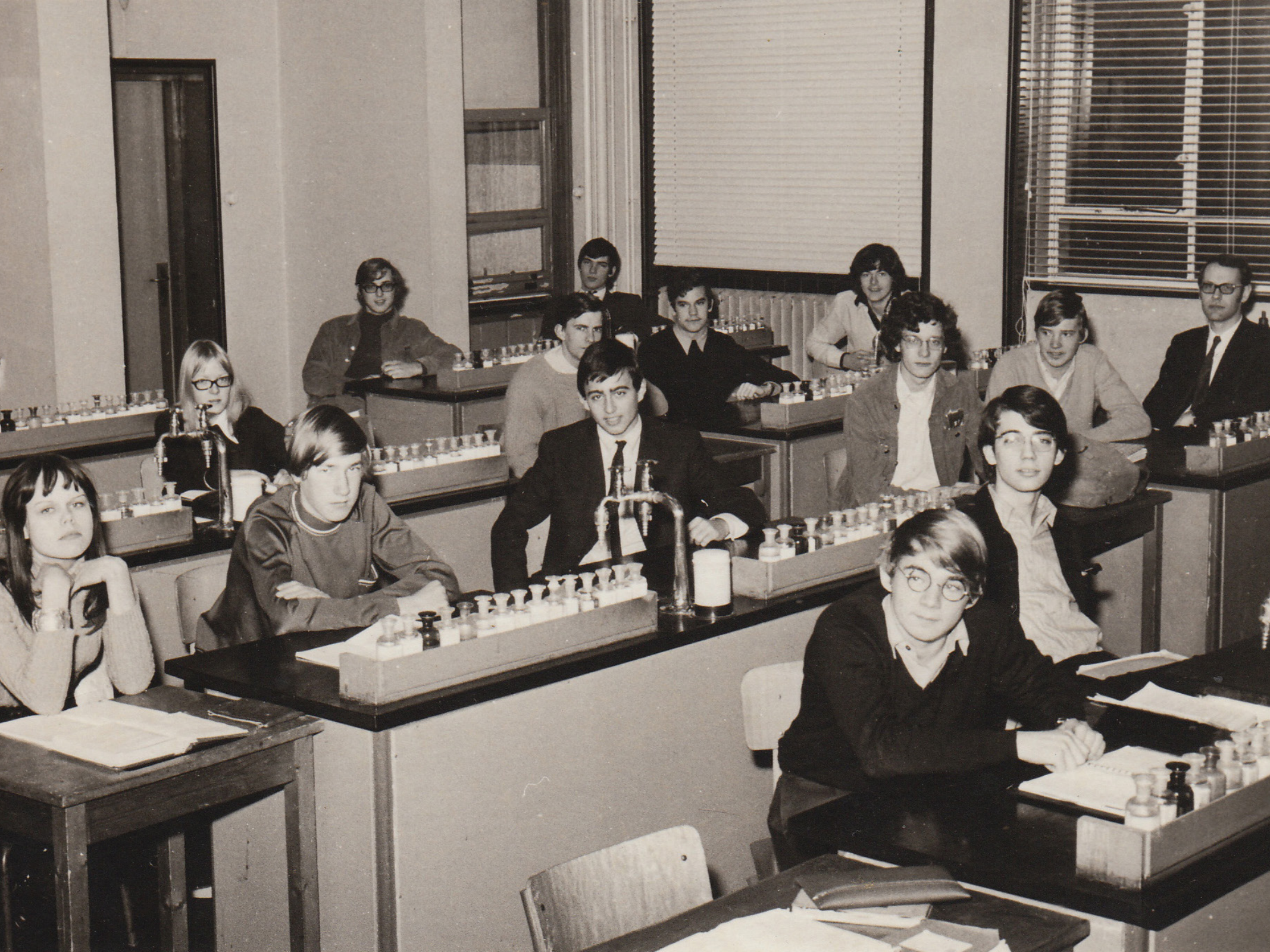
12A → 13 → 13A

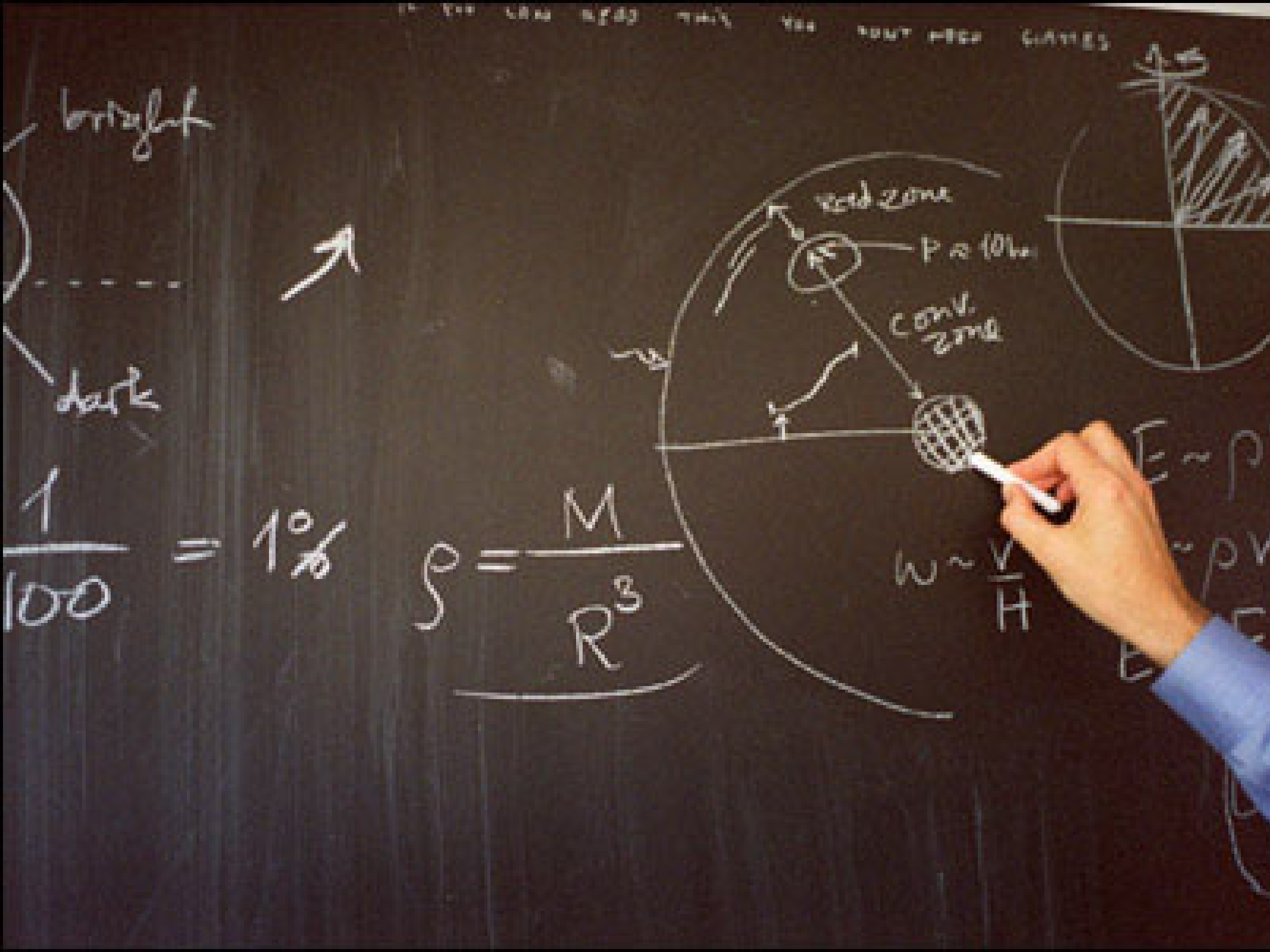


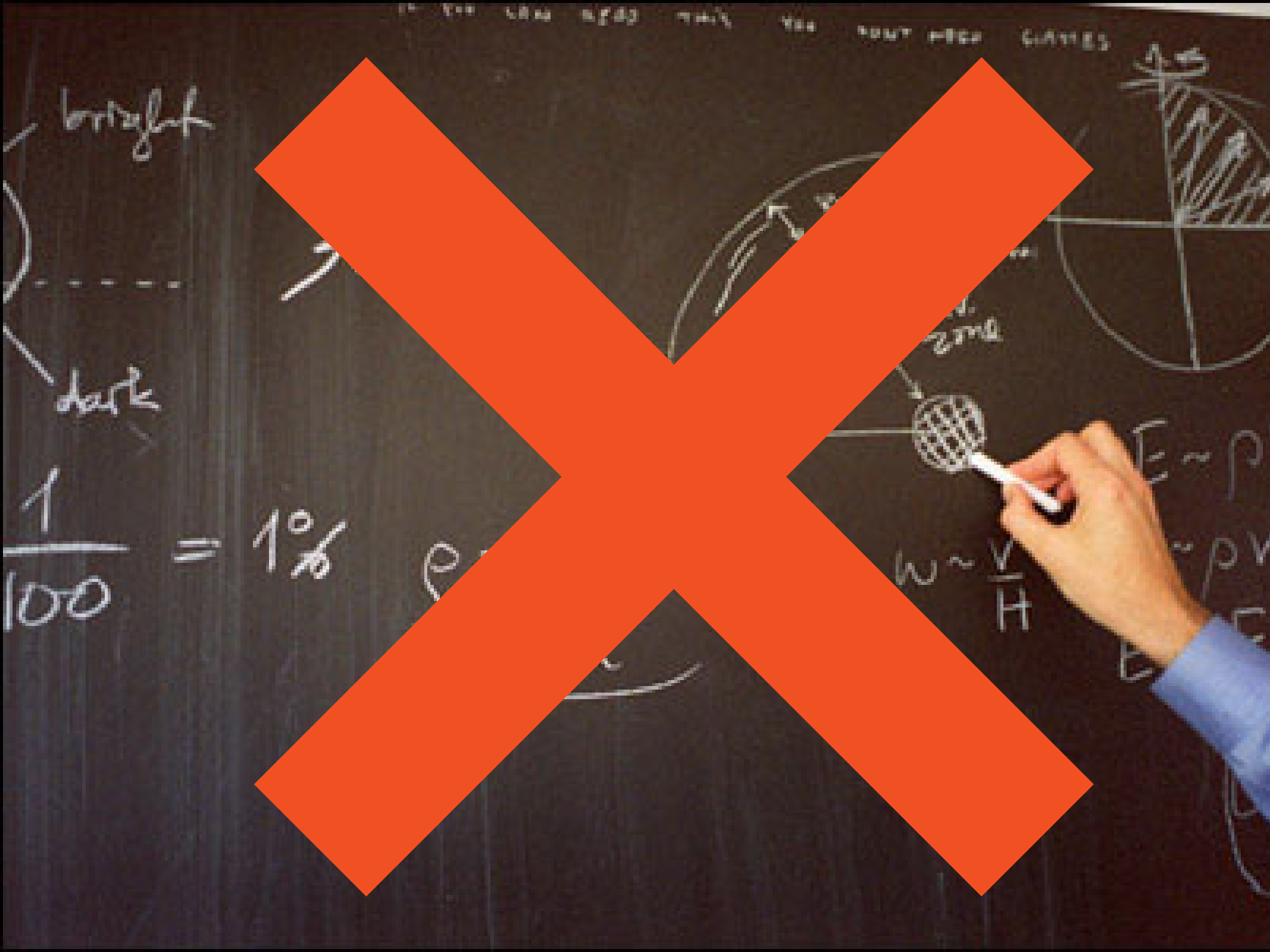
Why am I I?




KODAK TRI X P
→13
→13A




bright
dark
$\frac{1}{100} = 1\%$
$\rho = \frac{M}{R^3}$
$w \sim \frac{V}{H}$


bright
dark
1/100 = 1%

$x(t) = x_m e^{\frac{-b}{2m}t} \cos(\omega' t + \phi)$ $\quad \omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$ $\quad E(t) \approx \frac{1}{2} k x_m^2 e^{\frac{-b}{m}t}$

$T = 2\pi\sqrt{\frac{L}{g}}$ simple pend

$T = 2\pi\sqrt{\frac{I}{mgh}}$ physical pend

$v(t) = -\omega x_m \sin(\omega t + \phi)$

$a(t) = -\omega^2 x(t)$

$x_m \cos(\omega t + \phi)$

critical damp $b^2 = 4km$

under damped $b^2 < 4km$

over damped $b^2 > 4km$

$\omega_d = \omega$ resonance

$y(x,t) = y_m \sin(kx - \omega t)$ wave in pos direction

$k = \frac{2\pi}{\lambda}$ $\quad v = \frac{\omega}{k} = \frac{\lambda}{T} = \lambda f$ $\quad v = \sqrt{\frac{T}{\mu}}$ $\quad \mu = \frac{\text{mass}}{\text{length}}$ $\quad P_{ave} = \frac{1}{2} V \rho \omega^2 y_m^2$

$E_{tot} = U + K$

$k(t) = \frac{1}{2} m v^2$

$PE = mgh$

$\lambda = \frac{2L}{n}$ $n = 1,2,3$

$f = \frac{nV}{2L}$ $n = 1,2,3$

$V = \sqrt{\frac{B}{\rho}}$ Bulk modulus

$\Delta P_m = V \rho \omega S_m$ displacement / pressure

$P_m = 2PVI$

$P_m = V \rho \omega S_m$

$I = \frac{\text{power}}{\text{area}} = \frac{P_s}{4\pi r^2}$

$I = \frac{1}{2} \rho V \omega^2 S_m^2$

$f_{beat} = |f_1 - f_2|$

Pipe 2 open ends

$f = \frac{V}{\lambda} = \frac{nV}{2L}$ $n = 1,2,3$ displacement antinode pressure node

Pipe 1 open end

$f = \frac{nV}{4L}(n = 1,2,3)$ displacement antinode at open, node at closed

$\sin\theta = \frac{V}{V_s}$ $\quad \frac{V_s}{V}$ = mach #

$I_0 = 1 \times 10^{-12}$

$B = (10) \log \frac{I}{I_0}$

$\beta = 3\alpha$

$\Delta L = L \alpha \Delta T$

$\Delta V = V \beta \Delta T$

$Q = c \Delta T$ Heat capacity

$Q = cm\Delta T$ specific heat

$Q = Lm$ Heat of transformation

$f' = f \frac{V \pm V_d}{V \pm V_s}$

$W = \int_{V_i}^{V_f} P \, dV$

$\log \frac{x}{y} = \log x - \log y$

$\log_a x = y \iff a^y = x$

$P_{cond} = \frac{Q}{t} = k a \frac{T_H - T_C}{L}$

$R = \frac{L}{k}$

Multi Slab

$P_{cond} = \frac{A(T_H - T_C)}{\sum L/k}$

$P_{radiation} = \sigma \varepsilon A T^4$ emissivity

$5.67 \times 10^{-8} \frac{W}{m^2 K^4}$

$P_{net} = P_{abs} - P_{rad}$

$P_{abs} = \sigma \varepsilon A T_{env}^4$

$Q = 0$ $\quad \Delta E = -W$

$W = 0$ $\quad \Delta E = Q$

$\Delta E = 0$ $\quad Q = W$

$Q = W = 0$ $\quad \Delta E = 0$ $\quad \Delta T = 0$

$PV = nRT$

$R = 8.31 \frac{J}{\text{mol} \cdot K}$

$W = nRT \ln \frac{V_f}{V_i}$ (isothermal)

$K_{avg} = \frac{3}{2} kT$

$1.38 \times 10^{-23} \frac{J}{K}$

M = molar mass

$V_{rms} = \sqrt{\frac{3RT}{M}}$

$V_{avg} = \sqrt{\frac{8RT}{\pi M}}$

$V_{mp} = \sqrt{\frac{2RT}{M}}$

$\frac{3}{2} nRT$ change

$Q = nC_V \Delta T$ (constant Volume)

$C_V = C_P - R$

$\Delta E = \frac{3}{2} nR\Delta T$ changes

$Q = nC_P \Delta T$ (con press)

$W = P\Delta V = nR\Delta T$ (con press)

$\gamma = \frac{C_P}{C_V}$

$T_i V_i^{\gamma - 1} = T_f V_f^{\gamma - 1}$ $\quad P_i V_i^{\gamma} = P_f V_f^{\gamma}$ (adiabatic)

$nC_V \Delta T$

$P_i V_i = P_f V_f$

$\Delta S = \left| \frac{|Q_H|}{T_H} - \frac{|Q_L|}{T_L} \right|$

Dgs of freedom	Translation	rotation	Tot	C_V	C_P
monatomic	3	0	3	$\frac{3}{2}R$	$\frac{5}{2}R$
Diatomic	3	2	5	$\frac{5}{2}R$	$\frac{7}{2}R$
Polyatomic	3	3	6	$3R$	$4R$

$\Delta S = \int_i^f \frac{dQ}{T}$

$\Delta S = \frac{Q}{T}$ isothermal

$\Delta S = \frac{Q}{\text{small } \Delta T}$

refraction $\quad n_1 \sin\theta_1 = n_2 \sin\theta_2$

critical angle $\quad \theta_c = \sin^{-1} \frac{n_2}{n_1}$

Brewsters angle $\quad \theta_B = \tan^{-1} \frac{n_2}{n_1}$

$\frac{\lambda_1}{\lambda_2} = \frac{V_1}{V_2}$

$I = 4 I_0 \cos^2\left(\frac{1}{2}\right)$

thin film

$2L = \left(m + \frac{1}{2}\right)\frac{\lambda}{n_2}$

Single slit diffraction

$a \sin\theta = m\lambda$ $\quad (m = 1,2,3)$ minima

$I = I_m \left(\frac{\sin A}{A}\right)^2$ $\quad A = \frac{1}{2}\beta = \frac{\pi a}{\lambda} \sin\theta$

circular

$\sin$

Diffraction grating

$d \sin\theta = m\lambda$ $\quad (m = 0,1,2)$ maxima lines

Δ

bit separation

$D = \frac{m}{d \cos\theta}$ dispersion

$R = Nm$ resolving power

$\frac{1}{p} + \frac{1}{i} = \frac{1}{f}$ sp

$f = \frac{\text{radius of curvature}}{2}$

$|m| = \frac{h'}{h}$ $\quad m =$

concave real

virtual

pos

converg

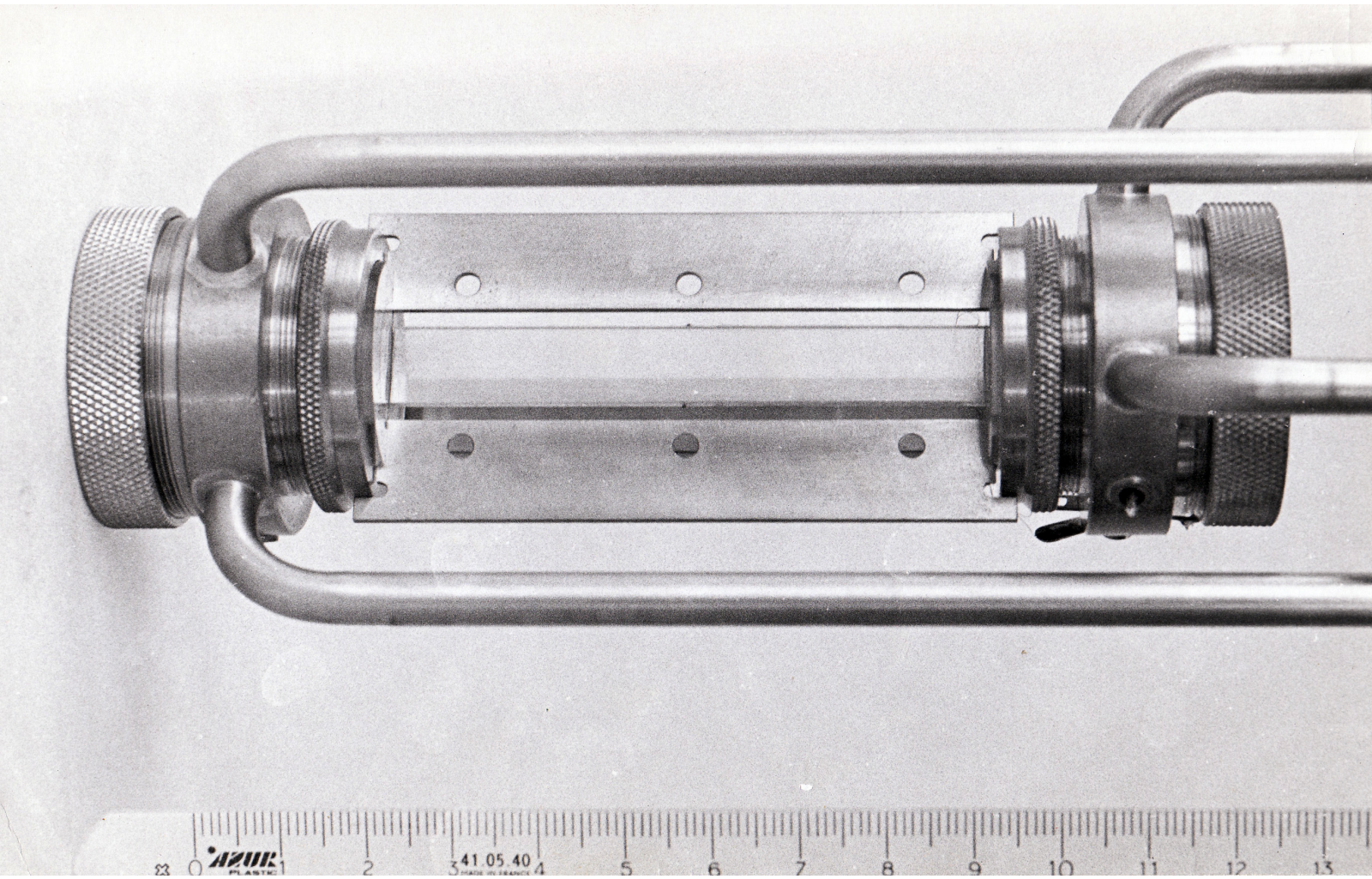
$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ $\quad r_1$ is near object

converging real

virtual

diverging virtual

$m_\theta = \frac{25\text{cm}}{f}$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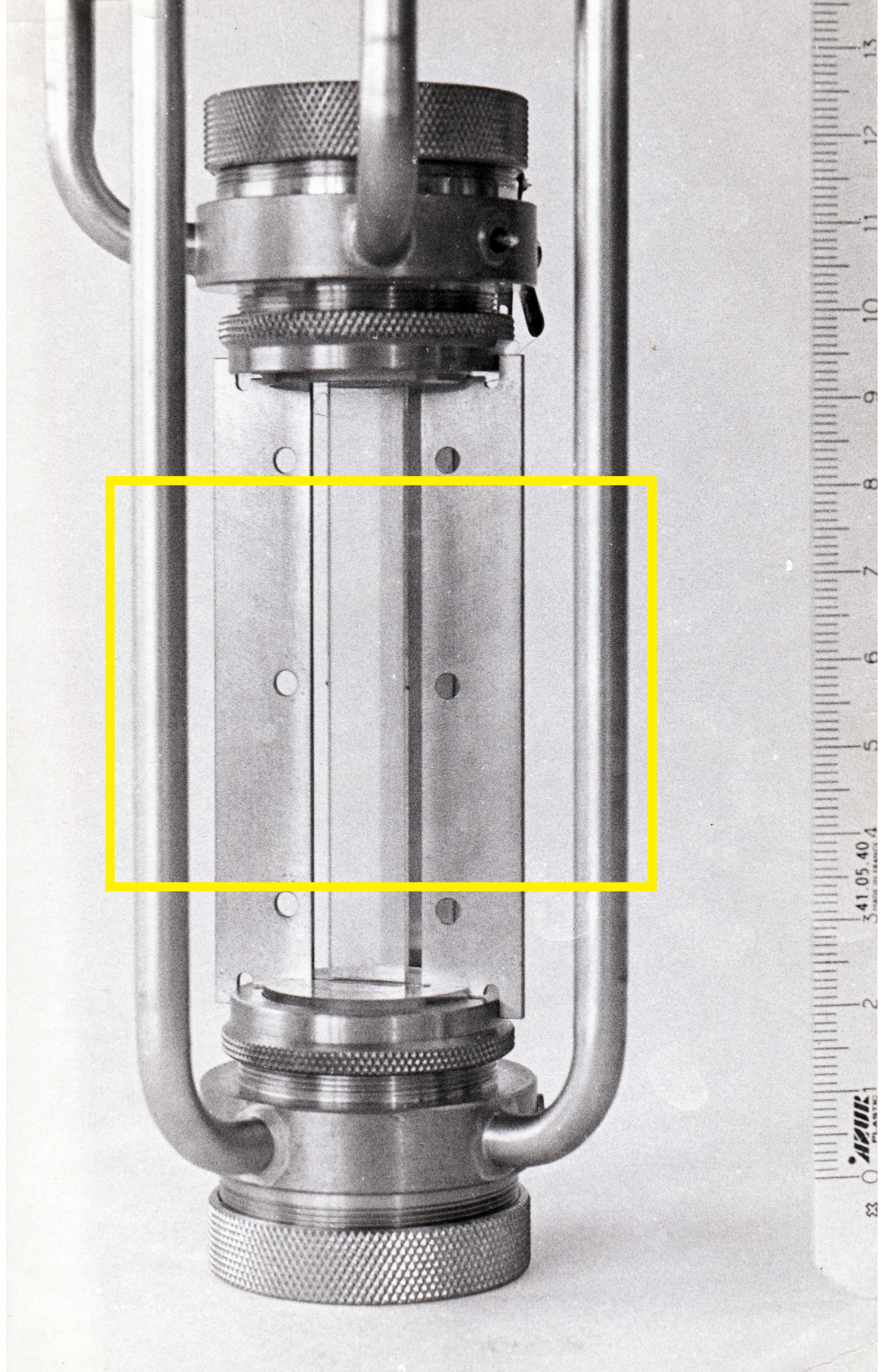
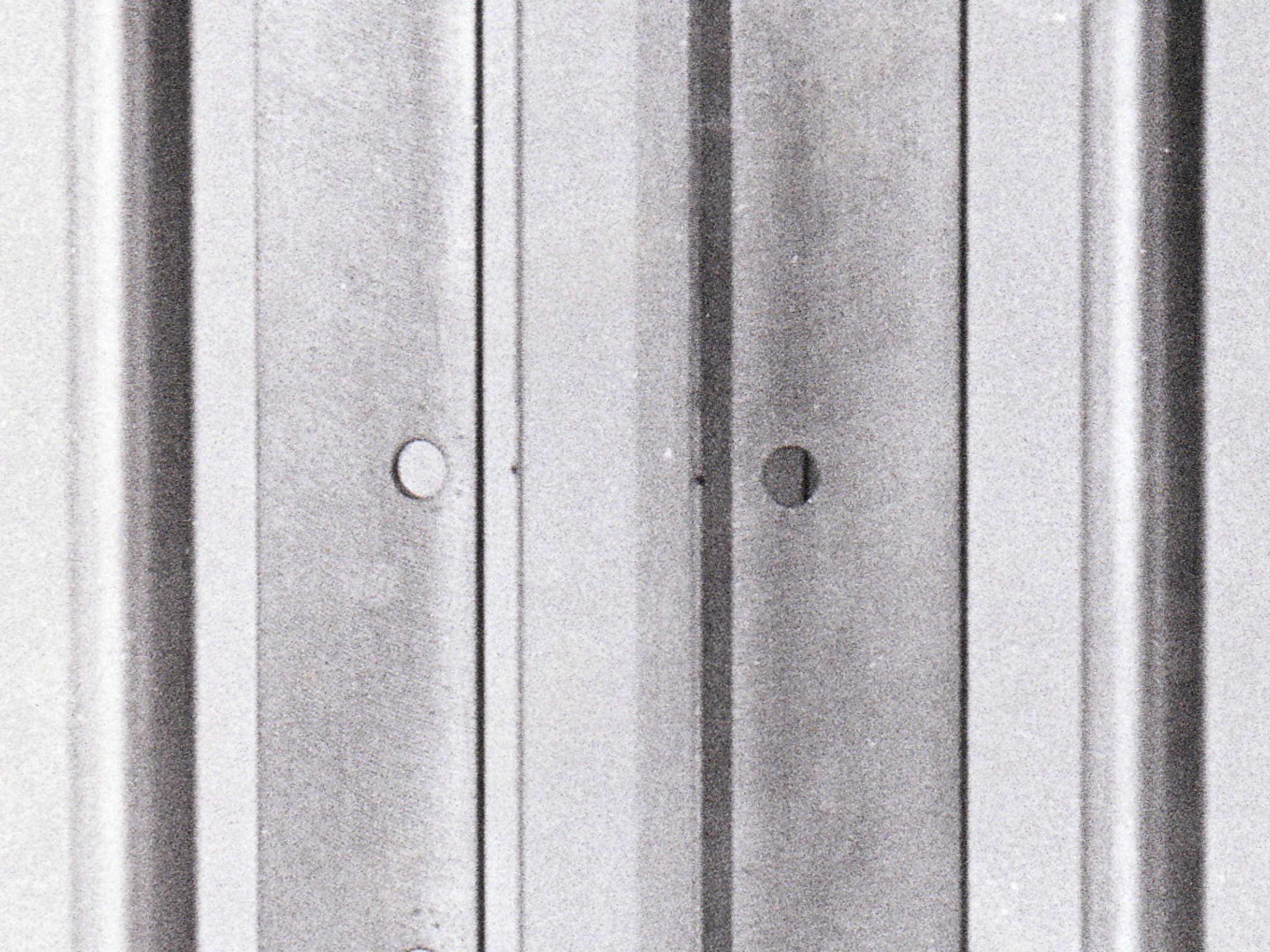
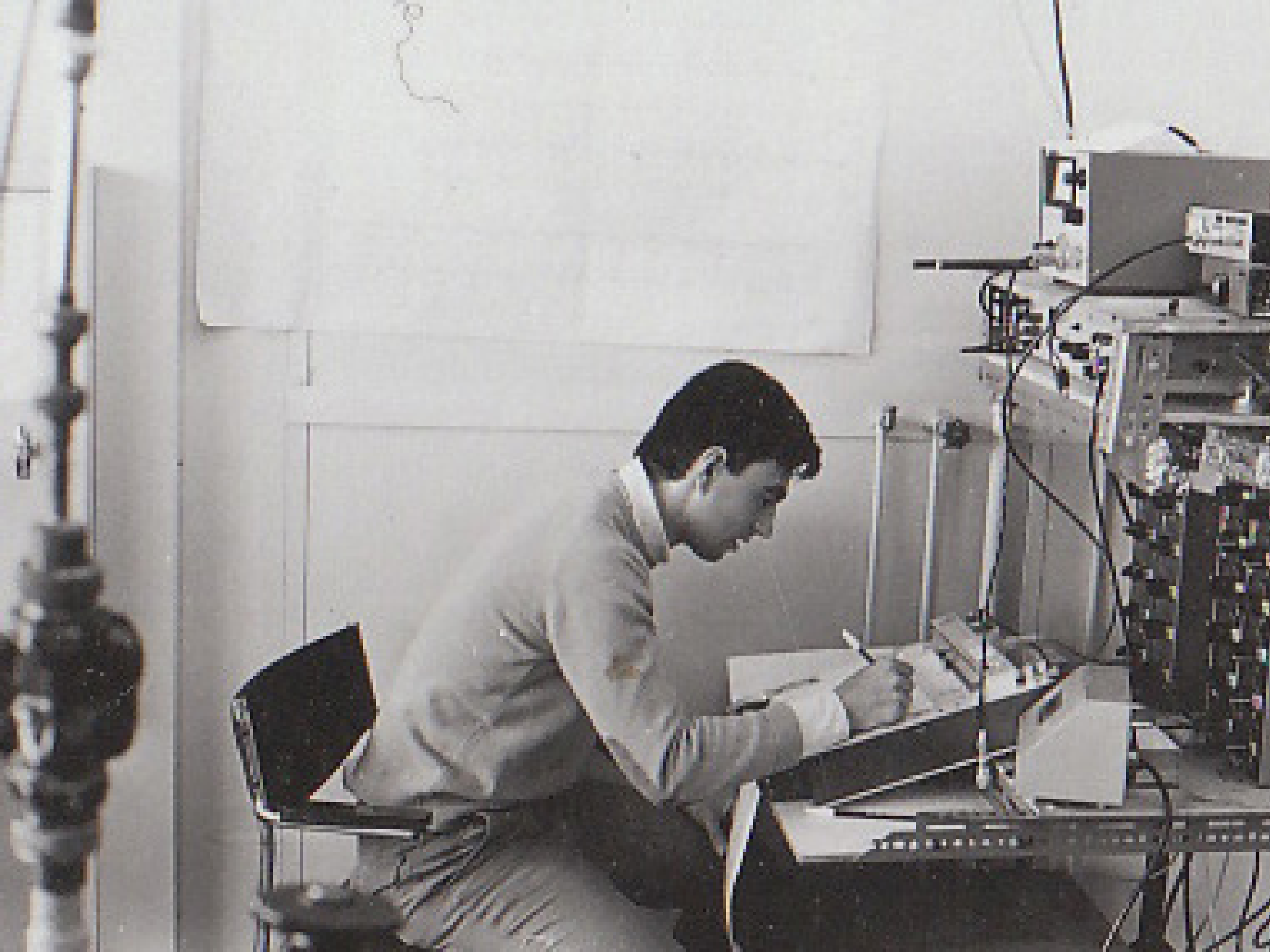
PLASTIC
41.05.40
MADE IN FRANCE







Volume 64A, number 1 PHYSICS LETTERS 28 November 1977

EXPERIMENTS ON THE INFLUENCE OF A MAGNETIC FIELD ON THE DUFOUR-EFFECT IN POLYATOMIC GASES: CONFIRMATION OF AN ONSAGER RELATION

E. MAZUR, G.W. 't HOOFT and L.J.F. HERMANS
Huygens Laboratorium der Rijksuniversiteit, Leiden, The Netherlands

Received 21 September 1977

Experimental data are reported on the influence of a magnetic field on the Dufour-effect, the reciprocal phenomenon of thermal diffusion, in an equimolar N_2–Ar mixture at room temperature. An Onsager relation in the presence of a magnetic field is confirmed.

In the absence of a magnetic field the Onsager relation between the Dufour and the thermal diffusion coefficient has been experimentally confirmed by Waldmann thirty years ago [1]. For transport phenomena occurring in polyatomic gases under the influence of an external field (Senftleben–Beenakker effects) [2], such a relation has not been verified to date. Recently [3], experiments were performed on the influence of a magnetic field on thermal diffusion: transverse thermal diffusion was measured and preliminary results for the system N_2–Ar were reported. The present paper experiments will be described on [illegible], viz. the transverse heat flux [illegible] mixture under the

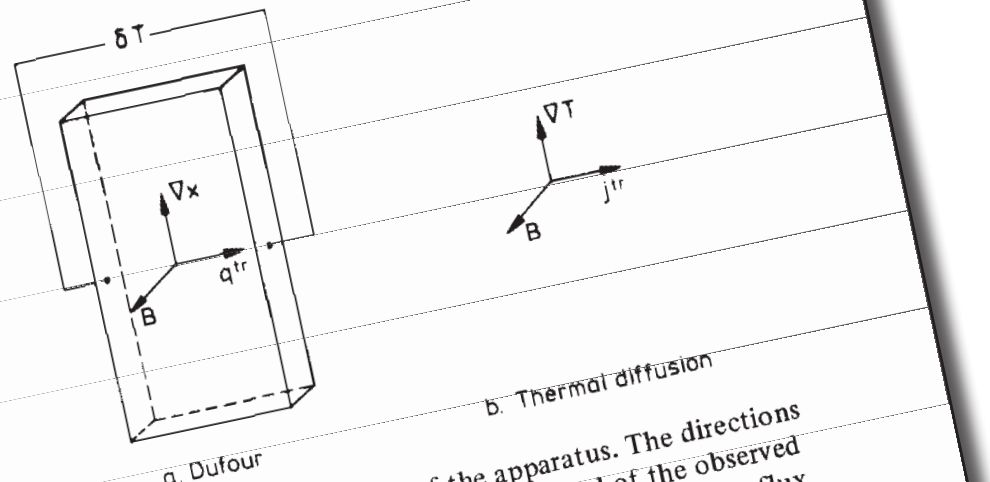
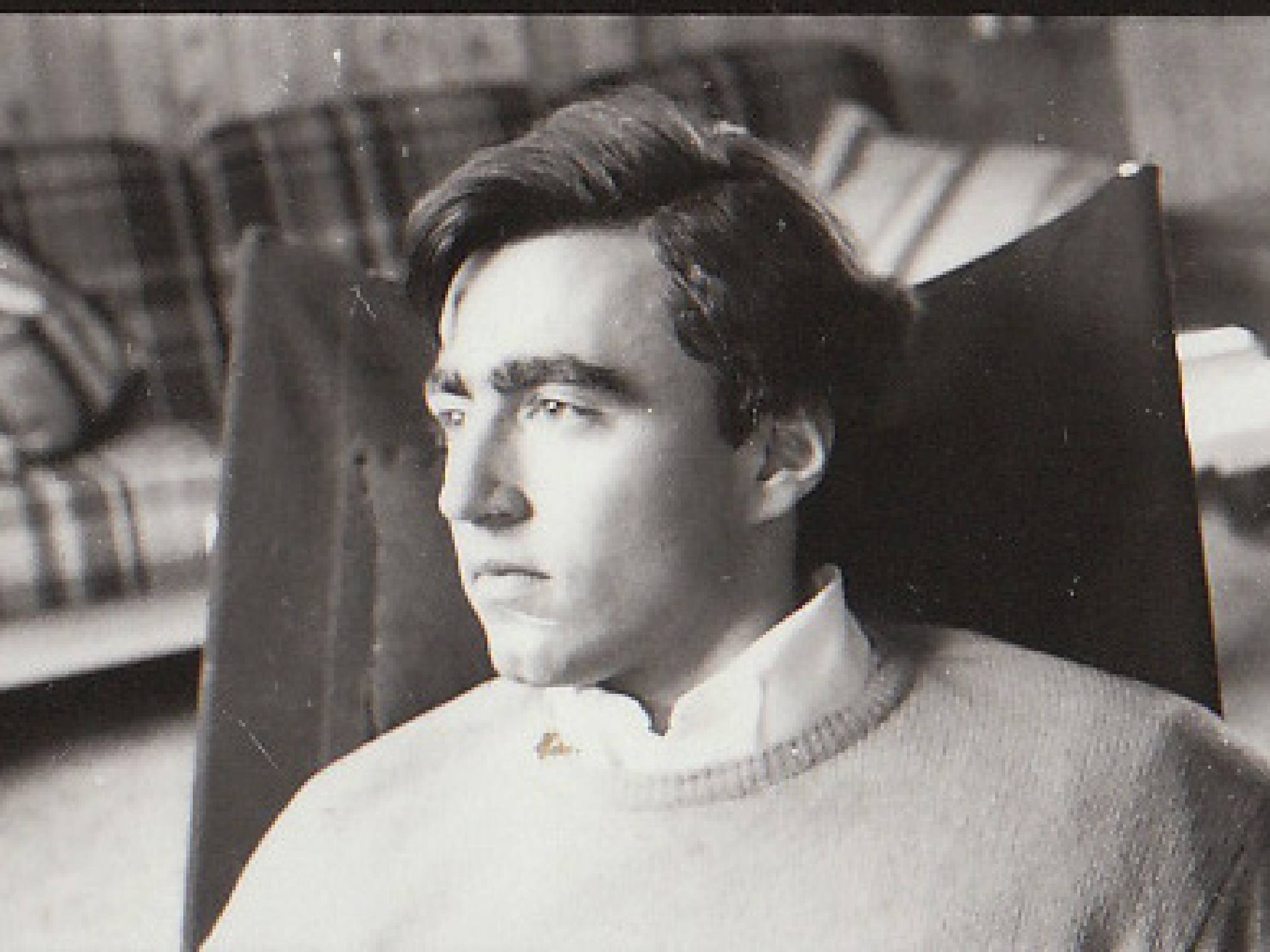


Fig. 1. (a) Schematic diagram of the apparatus. The directions of the applied N_2 concentration gradient and of the observed heat flux are indicated. (b) Direction of the observed N_2 flux in the thermal diffusion experiment (ref. [6]).

[illegible] the narrow walls of the [illegible] in ∇x and odd



N.V. Philips' Gloeilampenfabrieken

Eindhoven
Nederland

PHILIPS

De heer E. Mazur
Voordorp 90
2352 BW Leiderdorp

afd. dept. abt./ref. zeichen
personeelzaken
TT/MR

doorkiesnummer in-dialling
accès intern dir. durchwahl
(040) 7 55850

datum, date
24 november 1981

onderw. re.
conc. betr.

Geachte heer Mazur,

Van Prof. Knaap vernamen wij dat u mogelijkerwijs geïnteresseerd bent in een bezoek aan het natuurkundig laboratorium.

In verband hiermede nodigen wij u uit op 15 januari 1981 om 9.00 uur bij de afdeling personeelzaken, Willemstraat [illegible] Eindhoven. Wilt u bij de portier vragen naar onder-

[illegible] wij een plattegrondje bijgesloten naar de Willemstraat is

[illegible] door ons wor-

HARVARD UNIVERSITY

PIERCE HALL, CAMBRIDGE, MASSACHUSETTS 02138

DIVISION OF APPLIED SCIENCES

12 March 1981

Mr. Eric Mazur
Huygens Laboratorium
Wassenaarseweg 78
2300 RA LEIDEN
The Netherlands

Dear Mr. Mazur:

Referring to our correspondence in the fall of 1980, I am now pleased to inform you that we could offer you a postdoctoral position as Research Fellow, with an annual stipend of $18,600. The appointment could start any time in the fall of 1981, preferably September 15 or October 1, 1981, for the period of one year. Usually the appointment is renewable for a second year, as a two or three-year stay is preferable for the completion of an experimental project.

The expectation is that you would participate in our research on infrared excitation of molecules with short CO_2 laser pulses, and in our work on collisional effects in four-wave light mixing with dye lasers. I am sending you some preprints of our most recent work in this area, under separate cover. Please let me know whether you are interested in the position, for which your doctor's degree from Leiden University is a prerequisite. If your answer is positive, I should like to get an indication when you will defend your thesis, and when you could start here.

HARVARD UNIVERSITY
DIVISION OF APPLIED SCIENCES

Pierce Hall,
Cambridge, MA 02138

18 Aug '81

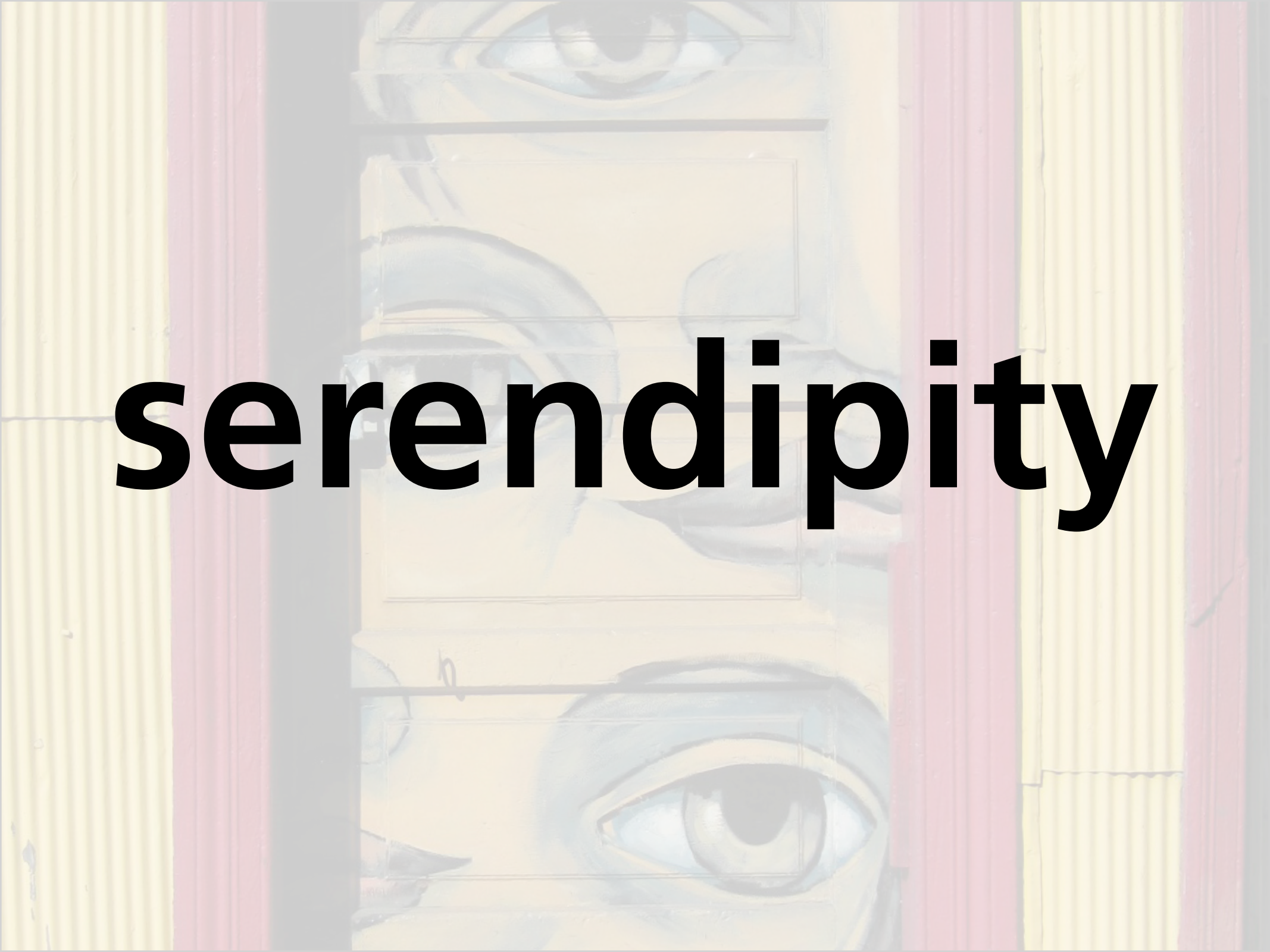
Den Heer E. Mazur
Leiden.

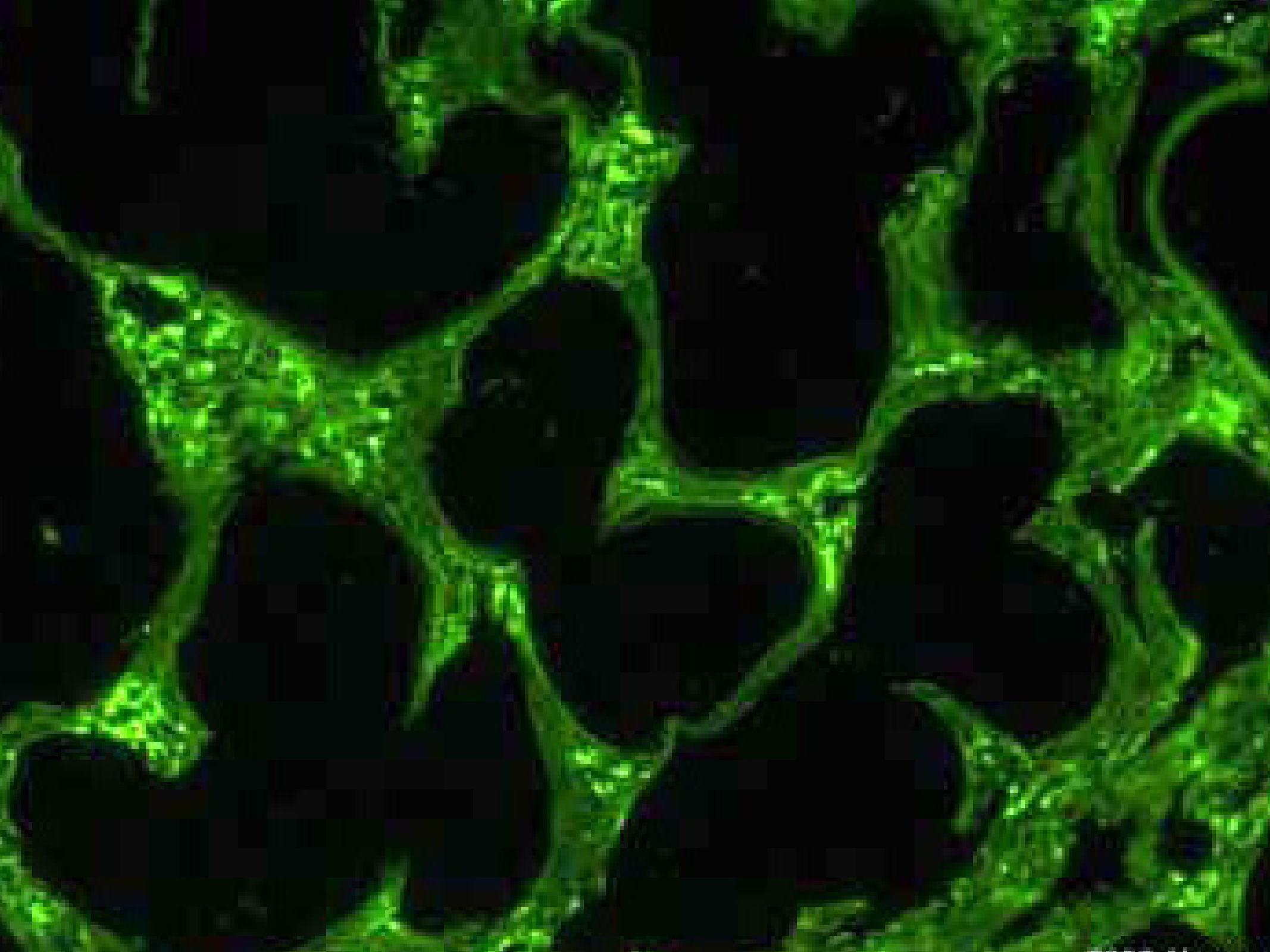
Waarde Mazur,

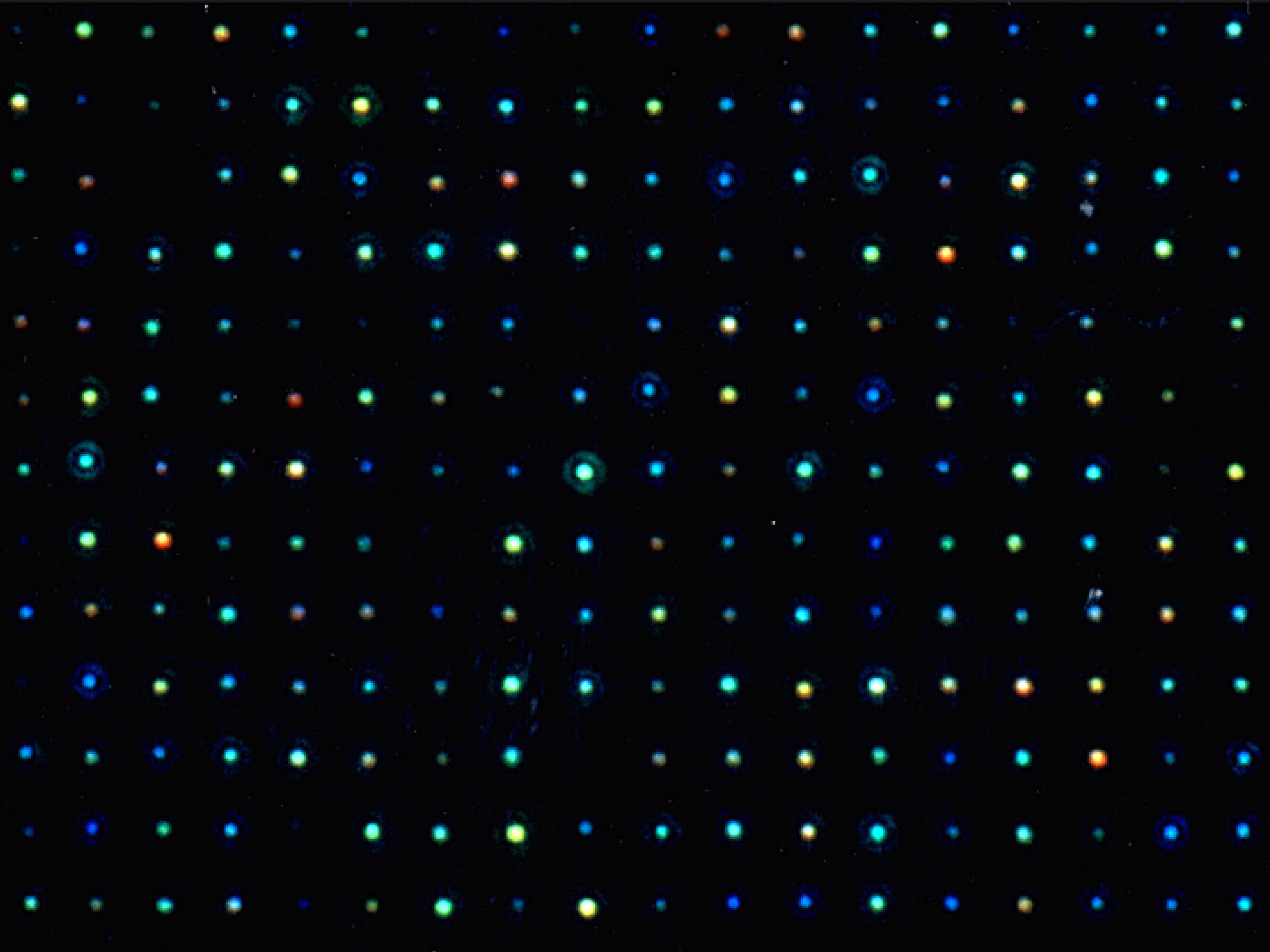
Van 5-11 September ben ik, vnl. voor
familiebezoek, in Nederland.
Graag zou ik op 8 of 9 September
met je willen praten over je a.s. bezoek.
Er is geen tijd om terug te schrijven.
Ik bel wel (7 of 8 Sept.) voor definitieve
afspraak. Zou je ook je ouders
willen inlichten over mijn komst?

Met vriendelijke groeten

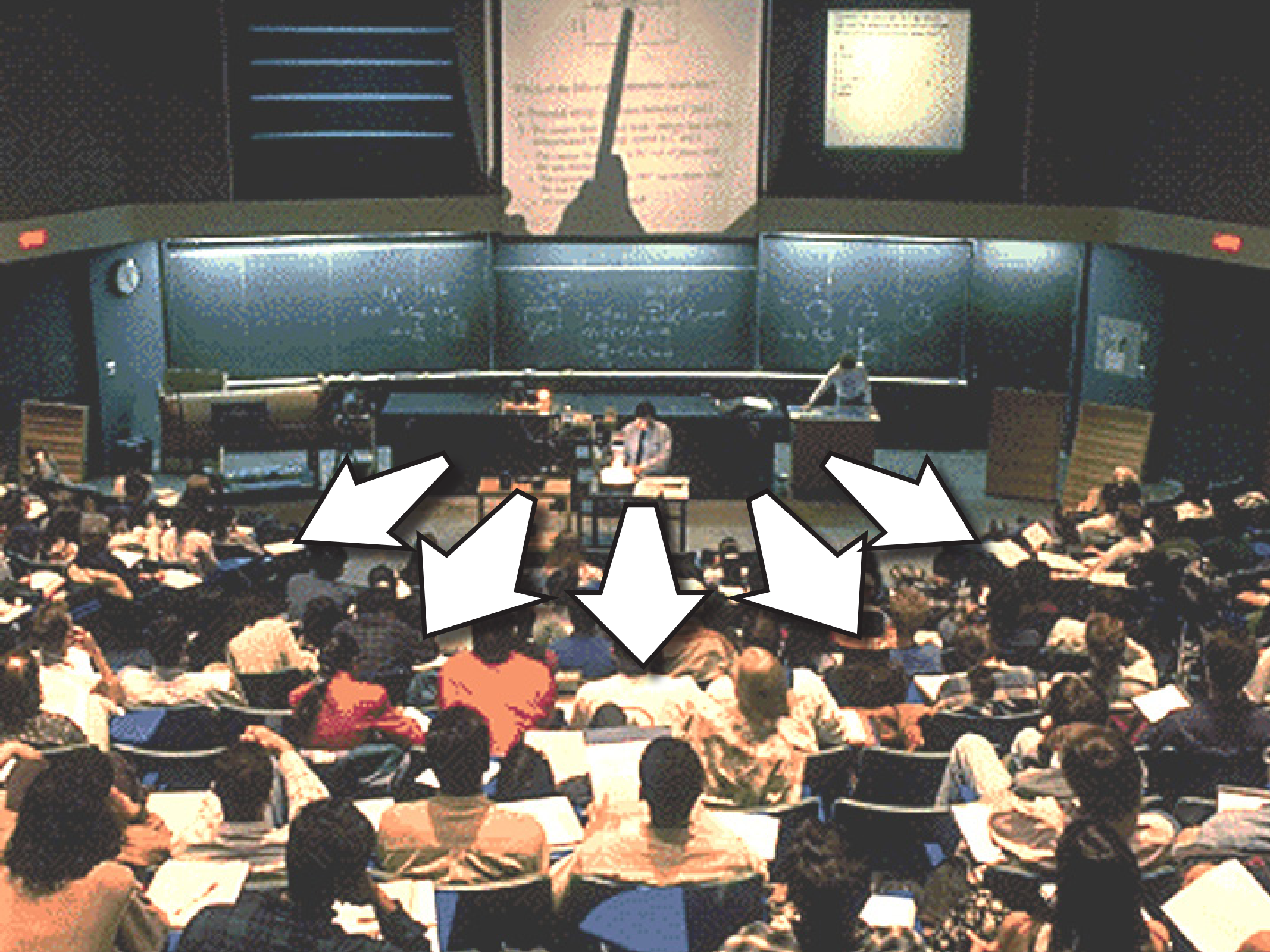
N. Bloembergen


serendipity






IN GOD WE TRUST
TER DOLLAR




an illusion. . .

1. transfer of information

1. transfer of information

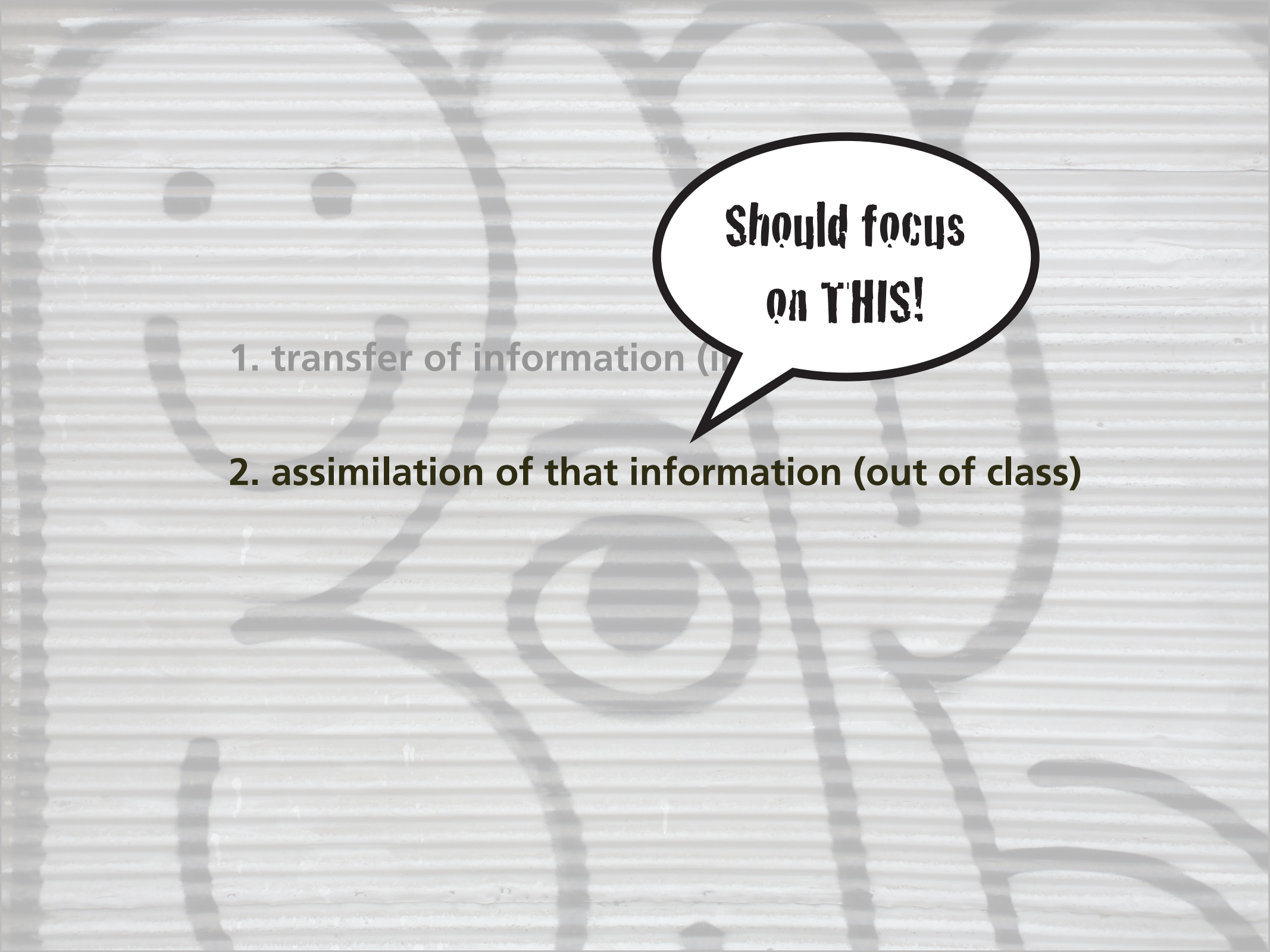
2. assimilation of that information

1. transfer of information (in class)

2. assimilation of that information

1. transfer of information (in class)

2. assimilation of that information (out of class)

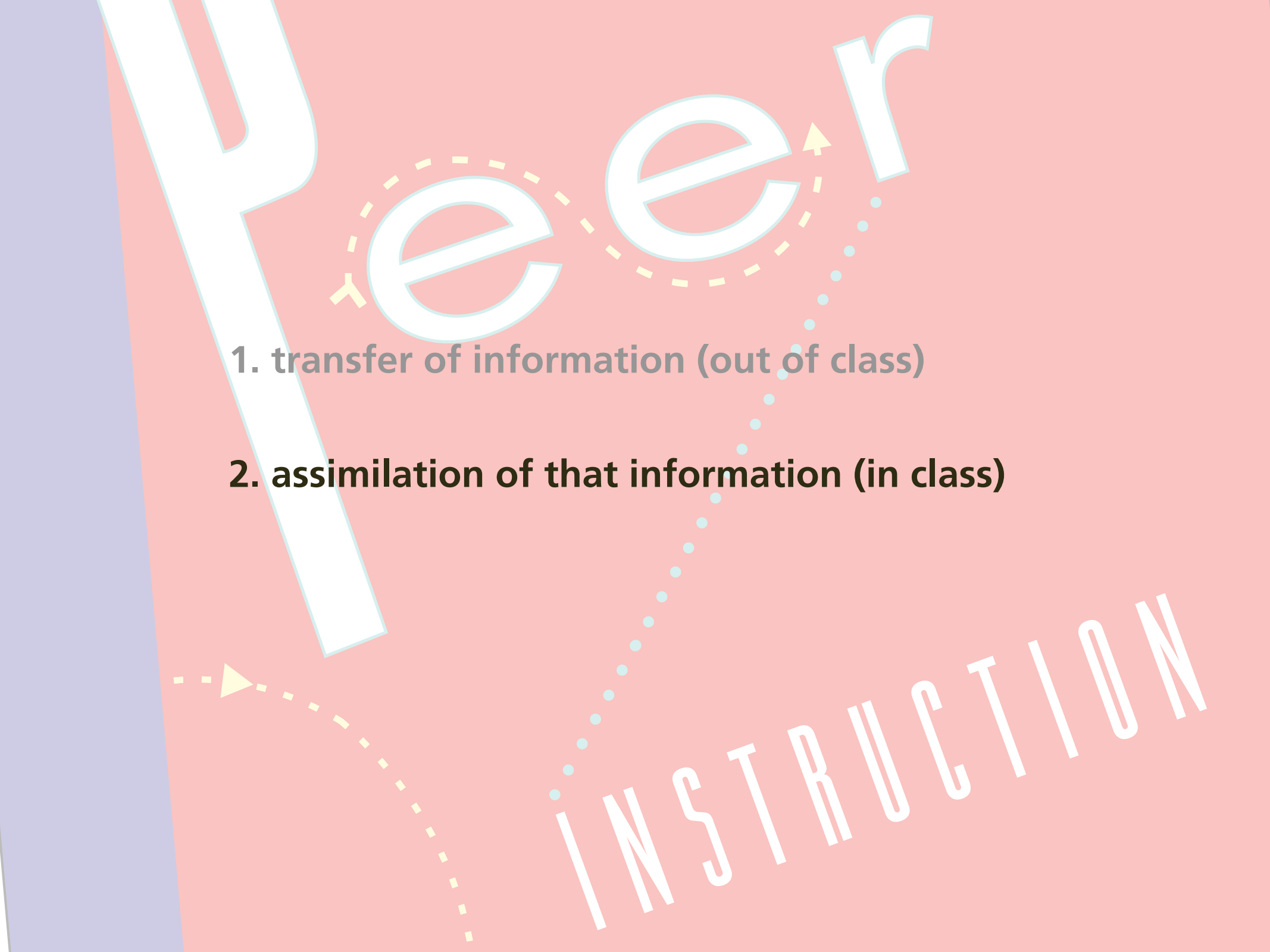

Should focus
on THIS!
1. transfer of information (i
2. assimilation of that information (out of class)

1. transfer of information (in class)

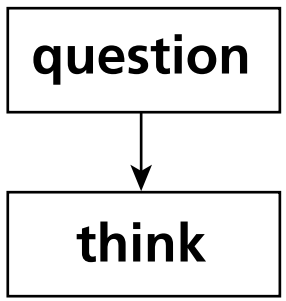
2. assimilation of that information (out of class)

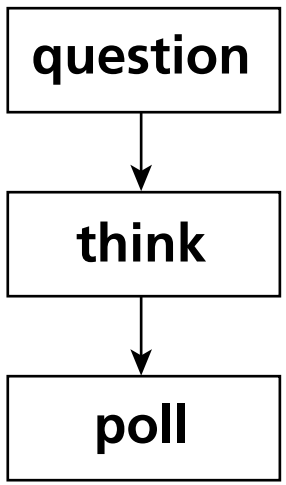
1. transfer of information (out of class)

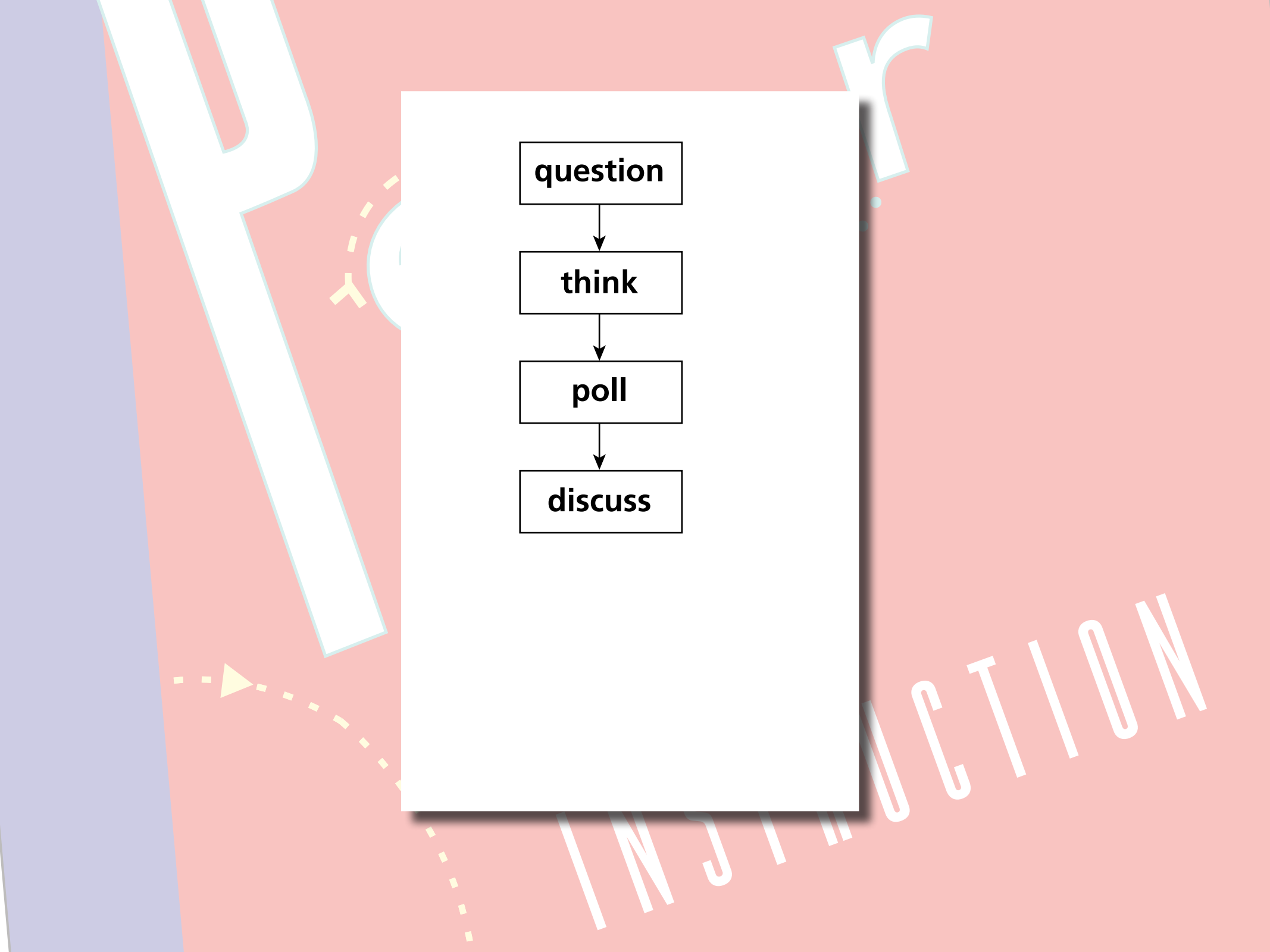
2. assimilation of that information (in class)

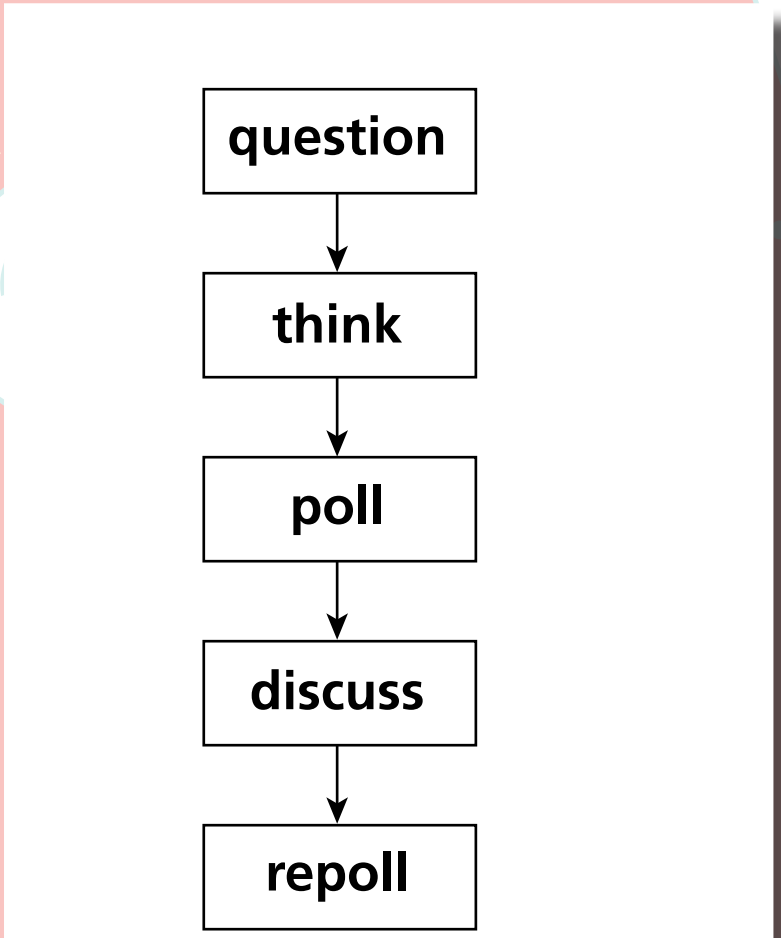

peer
1. transfer of information (out of class)
2. assimilation of that information (in class)
INSTRUCTION

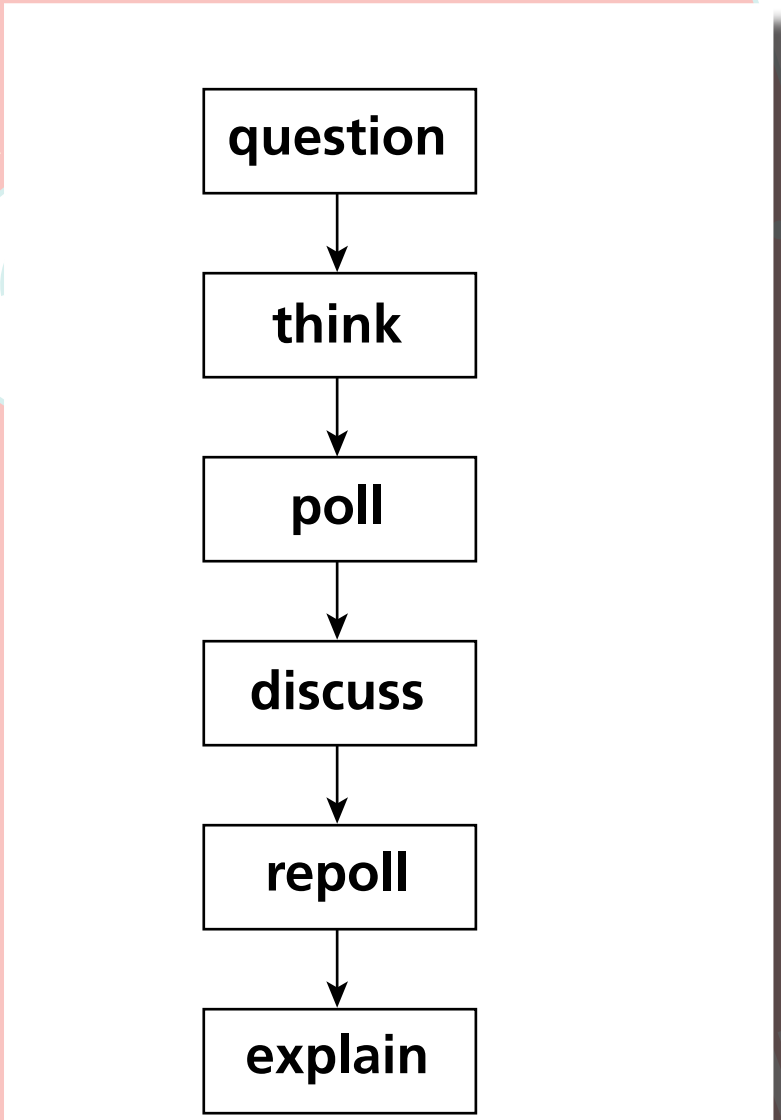
question

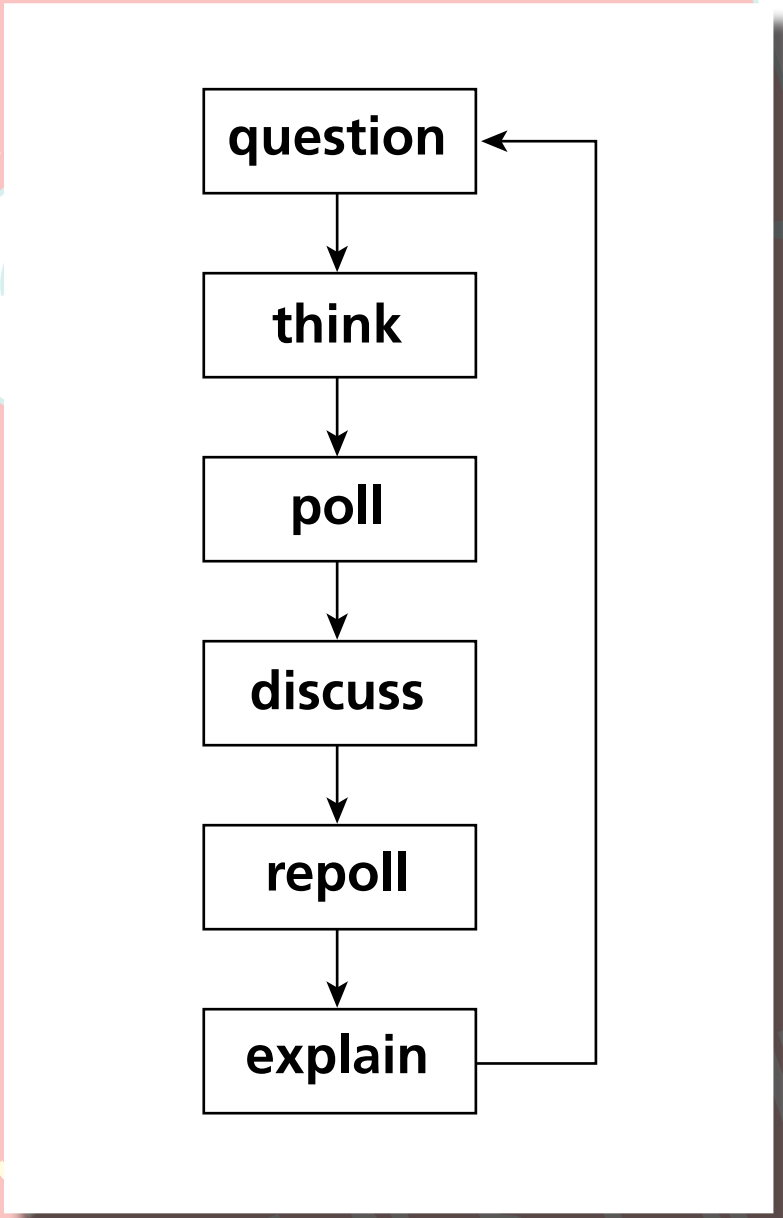

question
think


question
think
poll


question
think
poll
discuss


question
think
poll
discuss
repoll


question
think
poll
discuss
repoll
explain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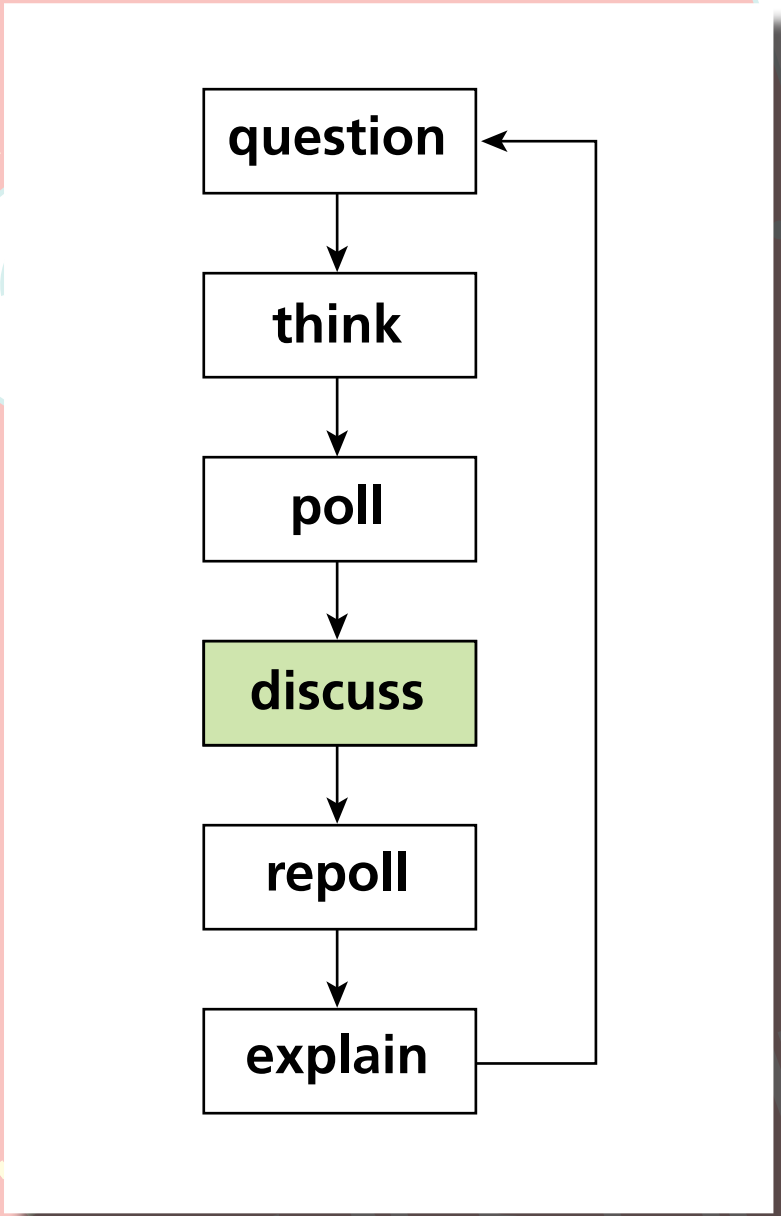
question
think
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repoll
explain

Archimedes Principle

An object submerged either fully or partially in a fluid experiences an upward buoyant force the magnitude of which is equal to the magnitude of the force of gravity exerted on the fluid displaced by the object.

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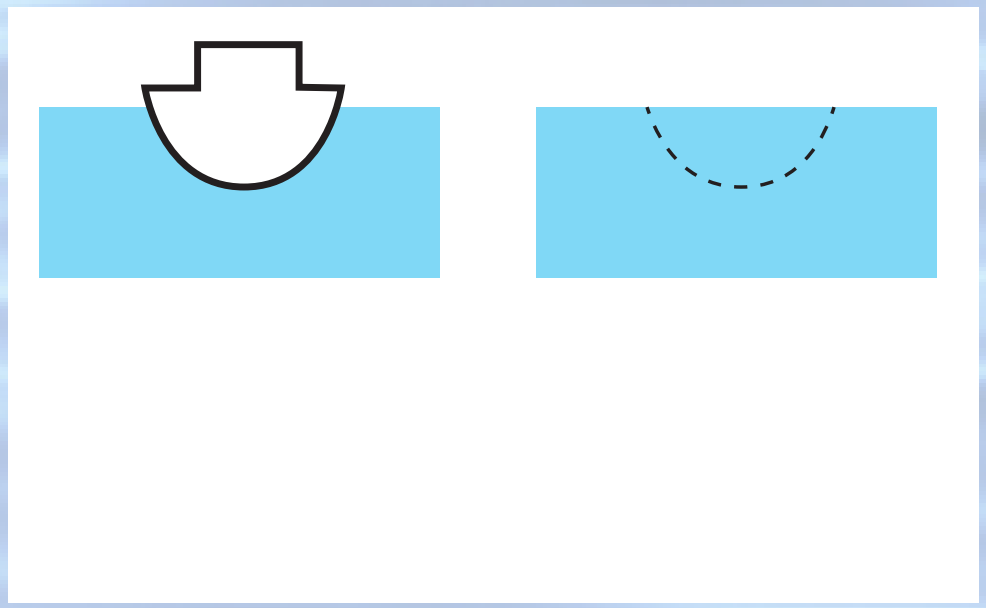

The volume of displaced fluid is equal to the volume of the submerged portion of the object.

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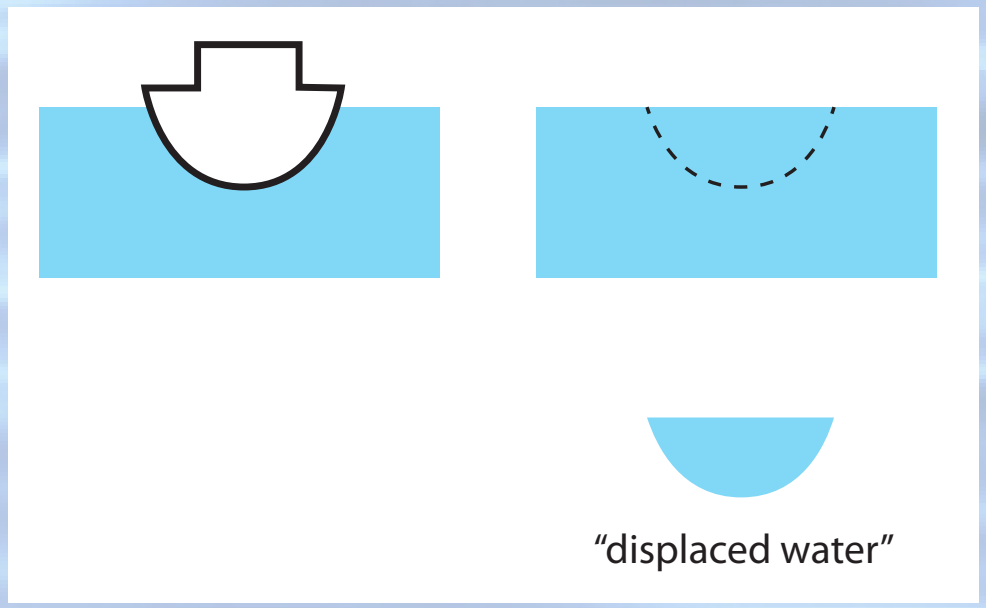

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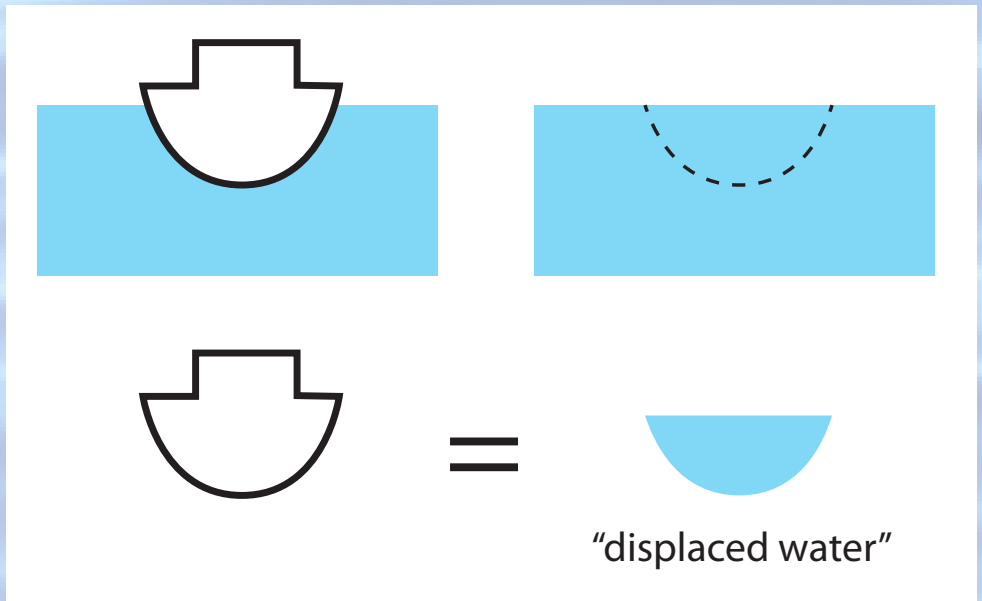
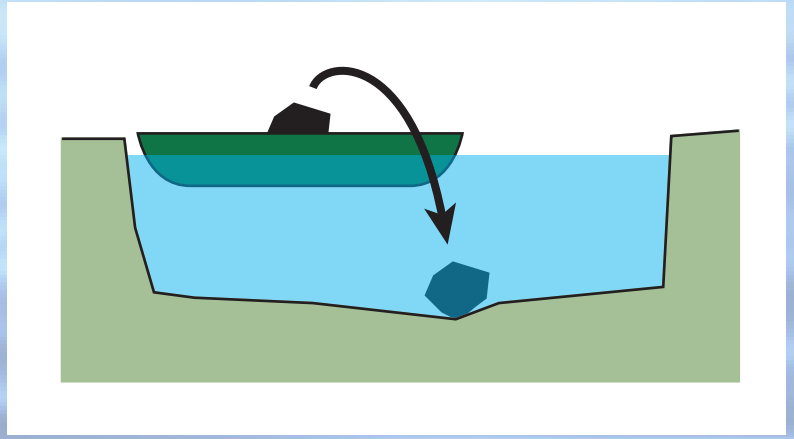


The volume of displaced fluid is equal to the volume of the submerged portion of the object.

A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.



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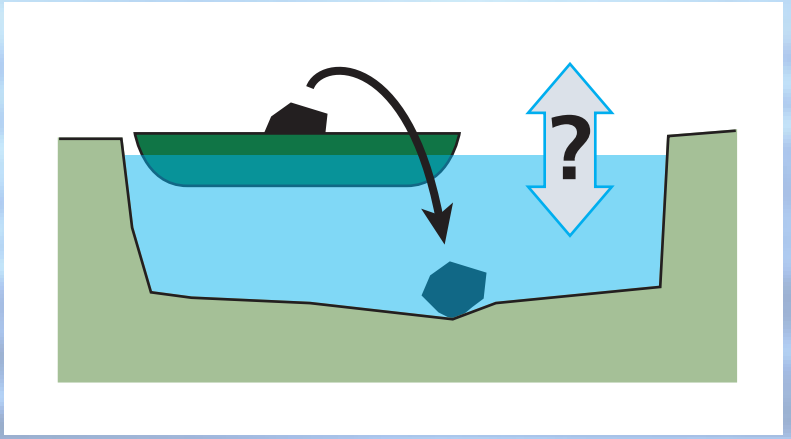

After the boulder sinks to the bottom of the pond, the level of the water in the pond is

1. higher than
2. the same as
3. lower than

it was when the boulder was in the boat.

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2. the same as
3. lower than

it was when the boulder was in the boat.

you got all fired up!

A boat carrying a large boulder is fl
de
to

Before I tell you the answer, let's analyze what happened.

A
th

1.
2.
3.

it was when the boulder was in the boat.

A boat carrying a large boulder is

fl

de

to

Before I tell you the answer, let's analyze what happened. You…

A

th

1.

2.

3.

it was when the boulder was in the boat.

A boat carrying a large boulder is

fl

de

to

Before I tell you the answer, let's analyze what happened. You…

1. made a commitment

A

th

1.

2.

3.

it was when the boulder was in the boat.

A boat carrying a large boulder is

fl

de

to

A

th

1.

2.

3.

it was when the boulder was in the boat.

Before I tell you the answer, let's analyze what happened. You…

1. made a commitment
2. externalized your answer

A boat carrying a large boulder is

fl

de

to

A

th

1.

2.

3.

it was when the boulder was in the boat.

Before I tell you the answer, let's analyze what happened. You…

1. made a commitment
2. externalized your answer
3. moved from the answer/fact to reasoning

A boat carrying a large boulder is

fl

de

to

A

th

1.

2.

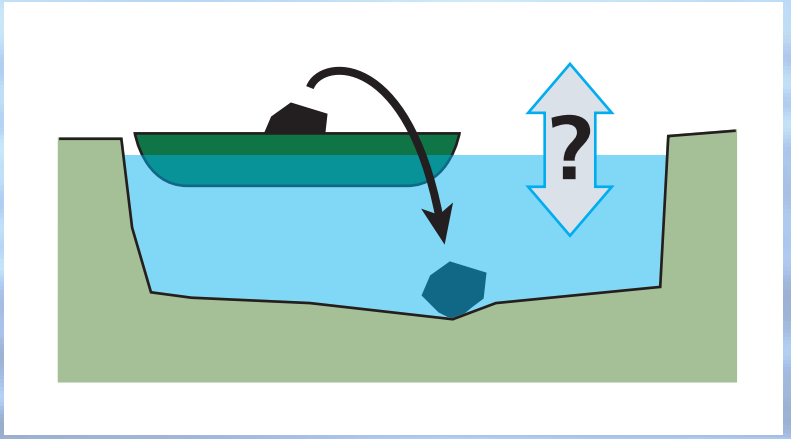
3.

it was when the boulder was in the boat.

Before I tell you the answer, let's analyze what happened. You…

1. made a commitment
2. externalized your answer
3. moved from the answer/fact to reasoning
4. became emotionally invested in the learning process

A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.

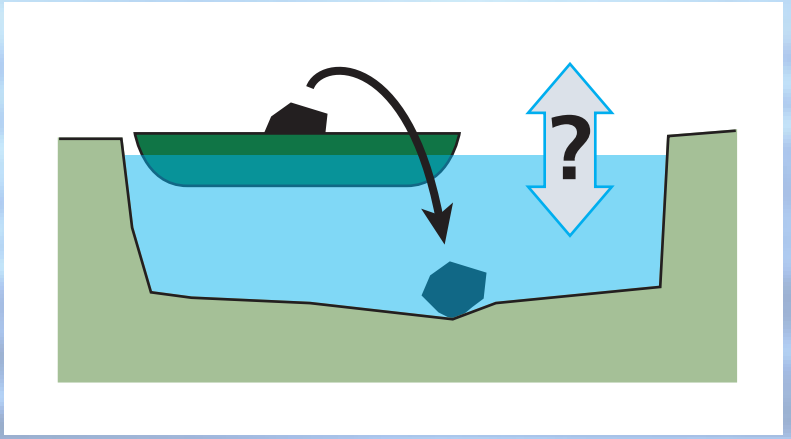


After the boulder sinks to the bottom of the pond, the level of the water in the pond is

1. higher than
2. the same as
3. lower than

it was when the boulder was in the boat.

A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.

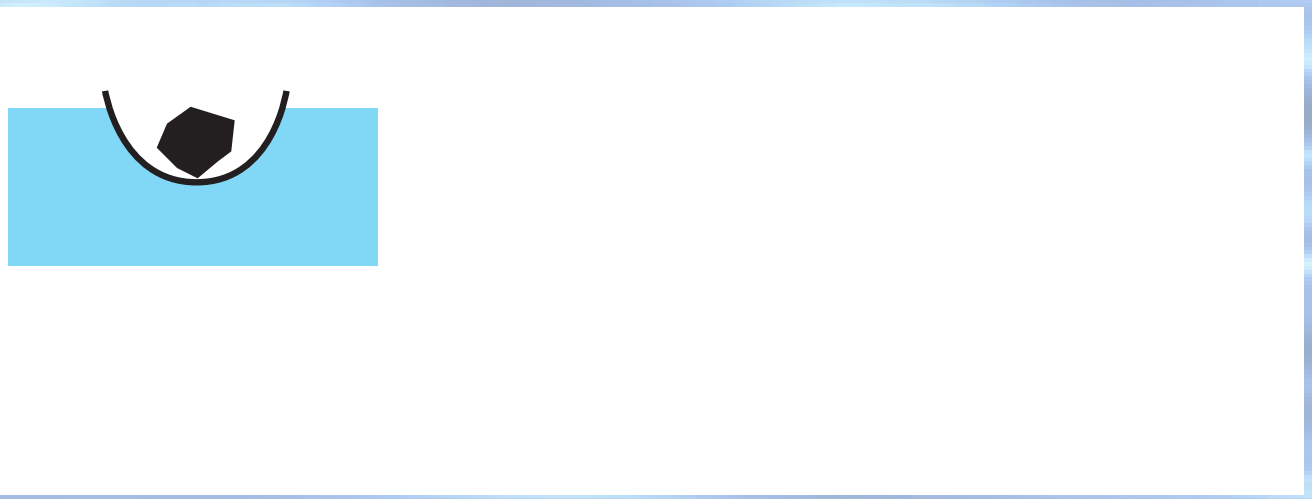


After the boulder sinks to the bottom of the pond, the level of the water in the pond is

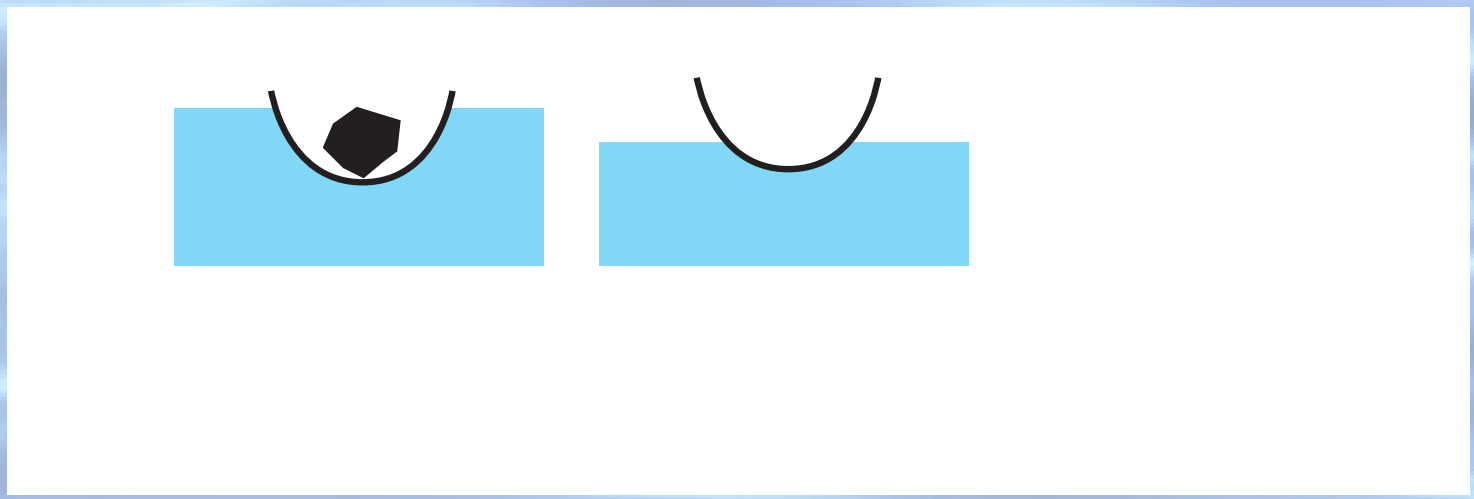
1. higher than
2. the same as
3. lower than ✔

it was when the boulder was in the boat.

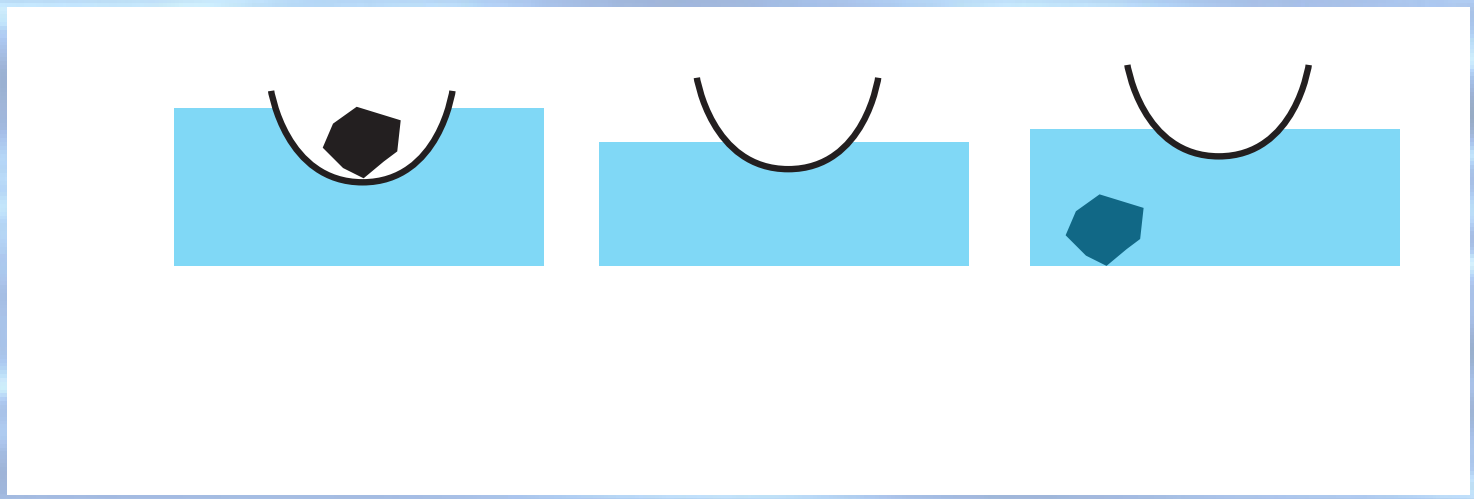
remember: amount of displaced water



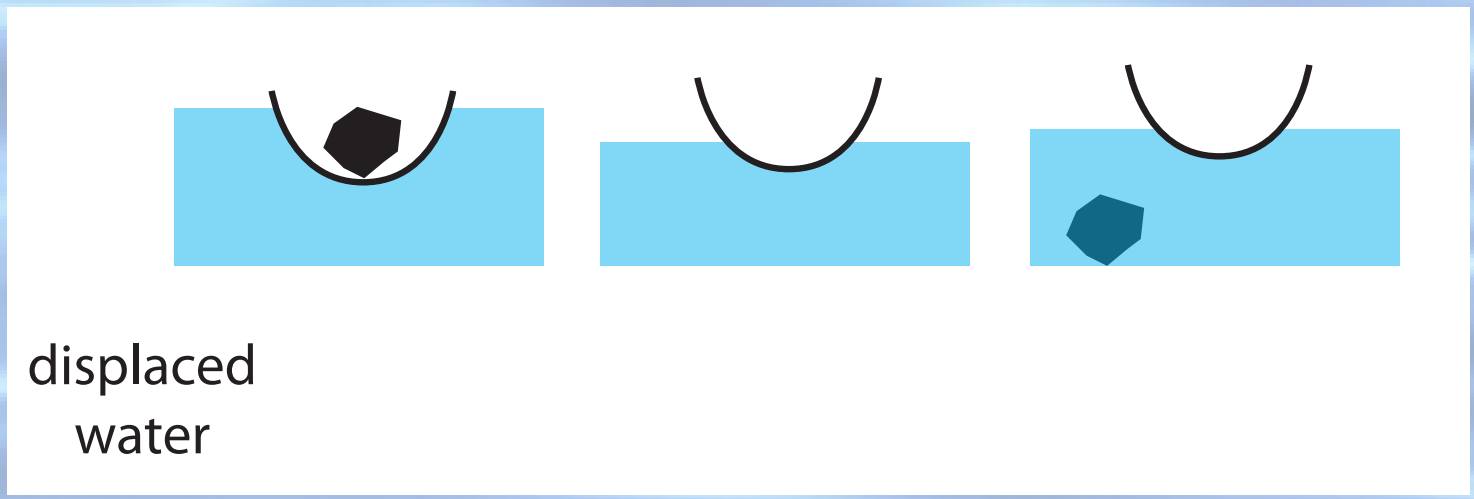
remember: amount of displaced water



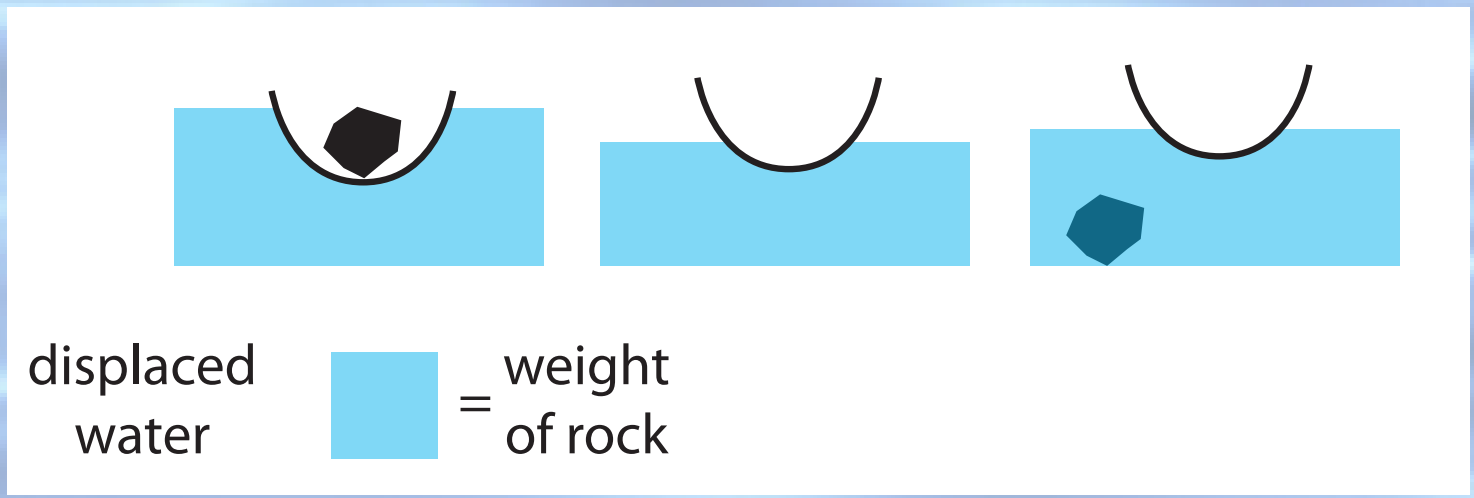
remember: amount of displaced water



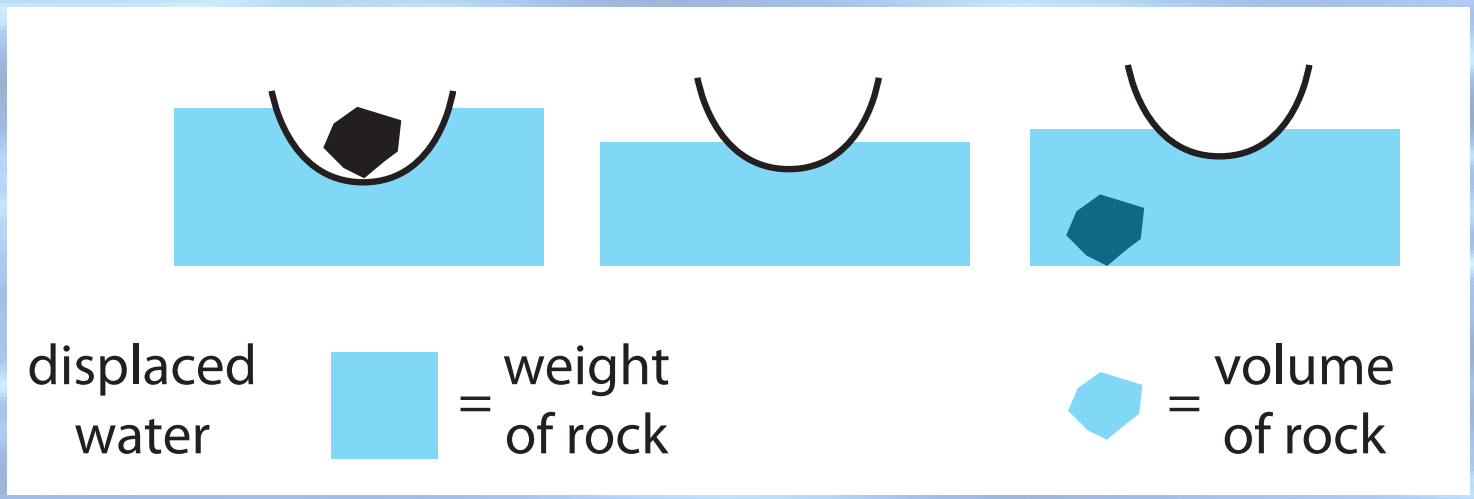
remember: amount of displaced water



remember: amount of displaced water



remember: amount of displaced water



remember: amount of displaced water

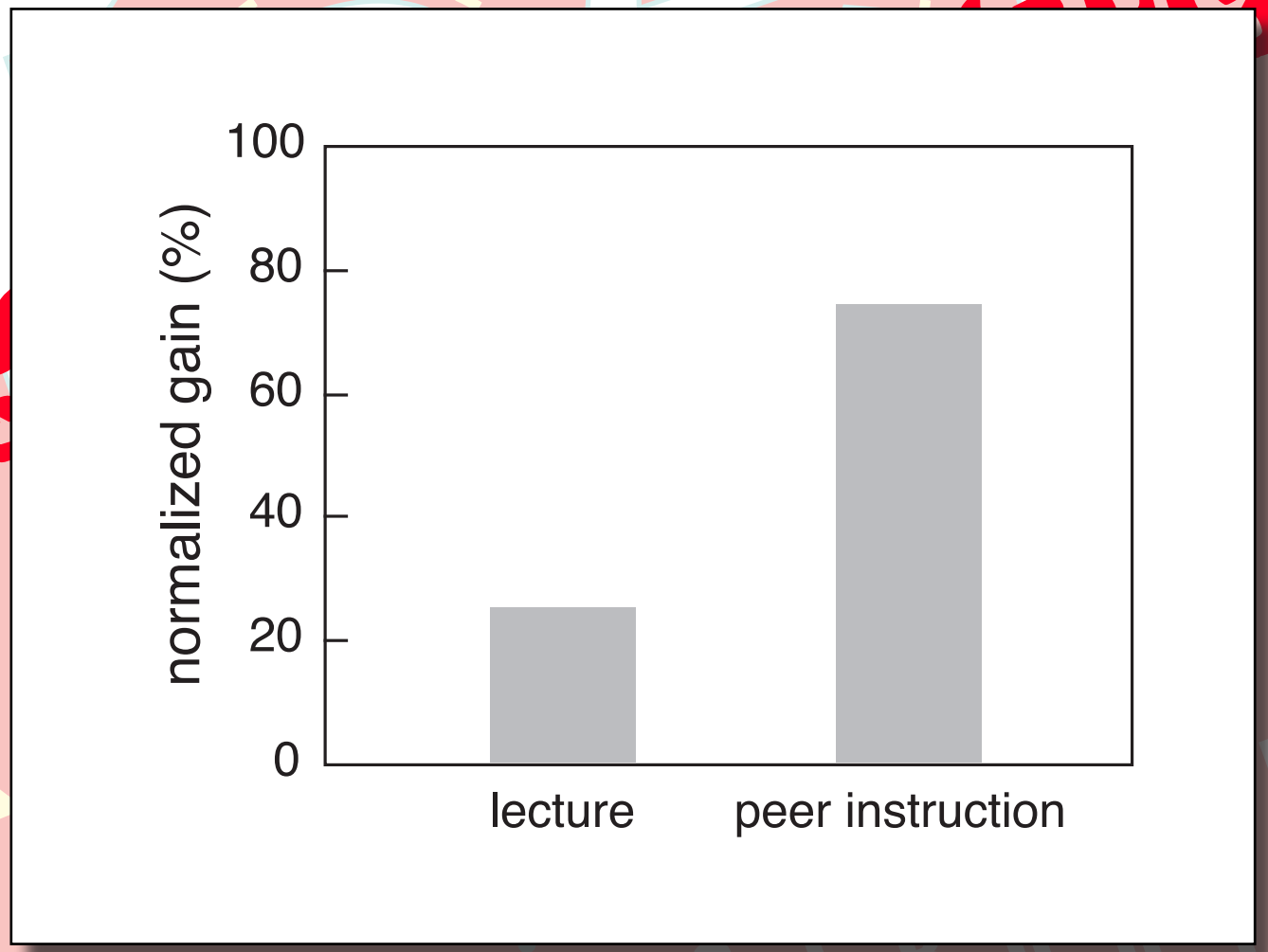
you won't forget this

Peer

back to PI

INSTRUCTION


Peer
Higher learning gains
INSTRUCTION


100
80
60
40
20
0
normalized gain (%)
lecture
peer instruction


Peer
Higher learning gains
Better retention
INSTRUCTION

Reflecting a Century of Innovation

Thank you!

Reflecting a Century of Innovation

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