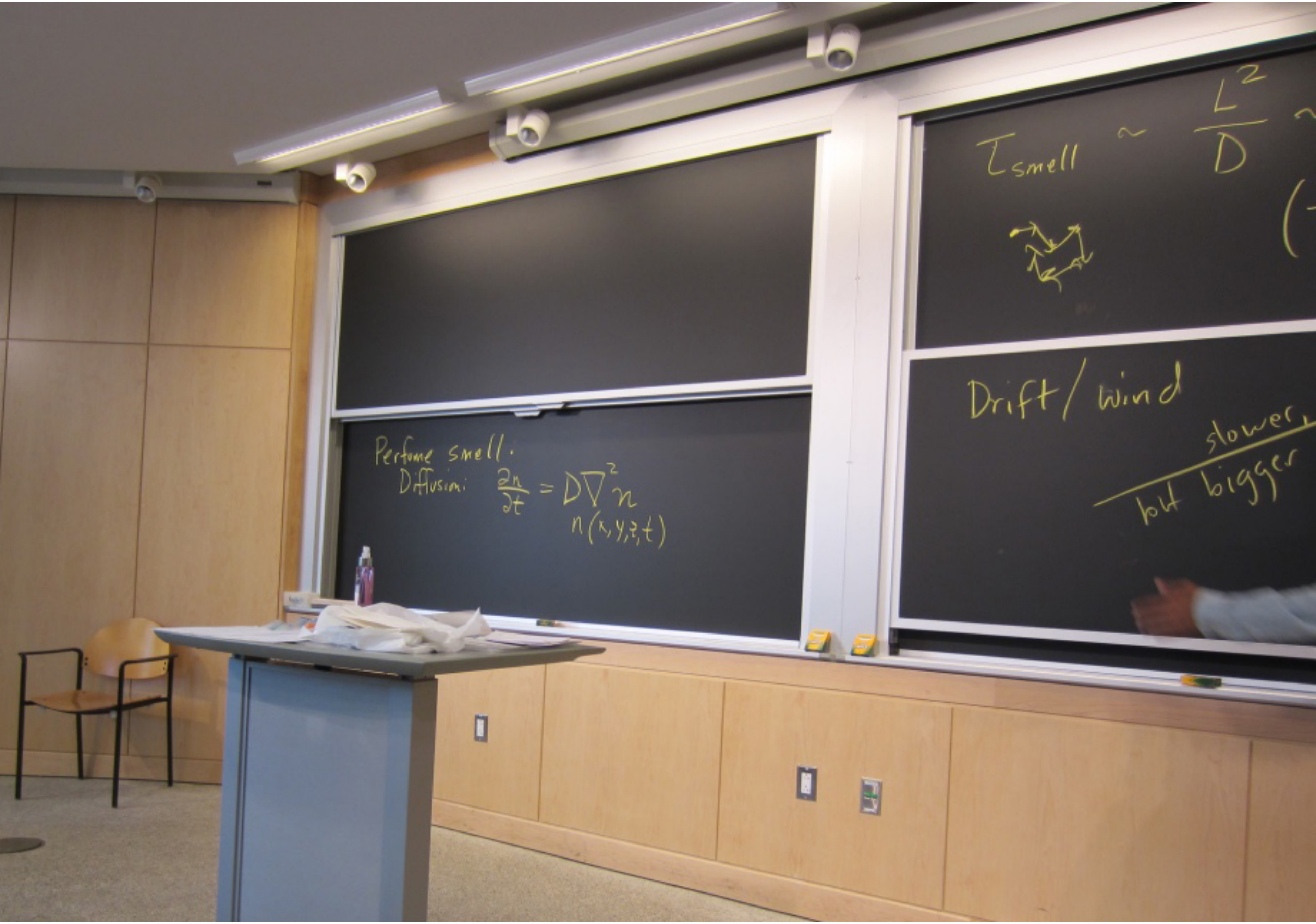
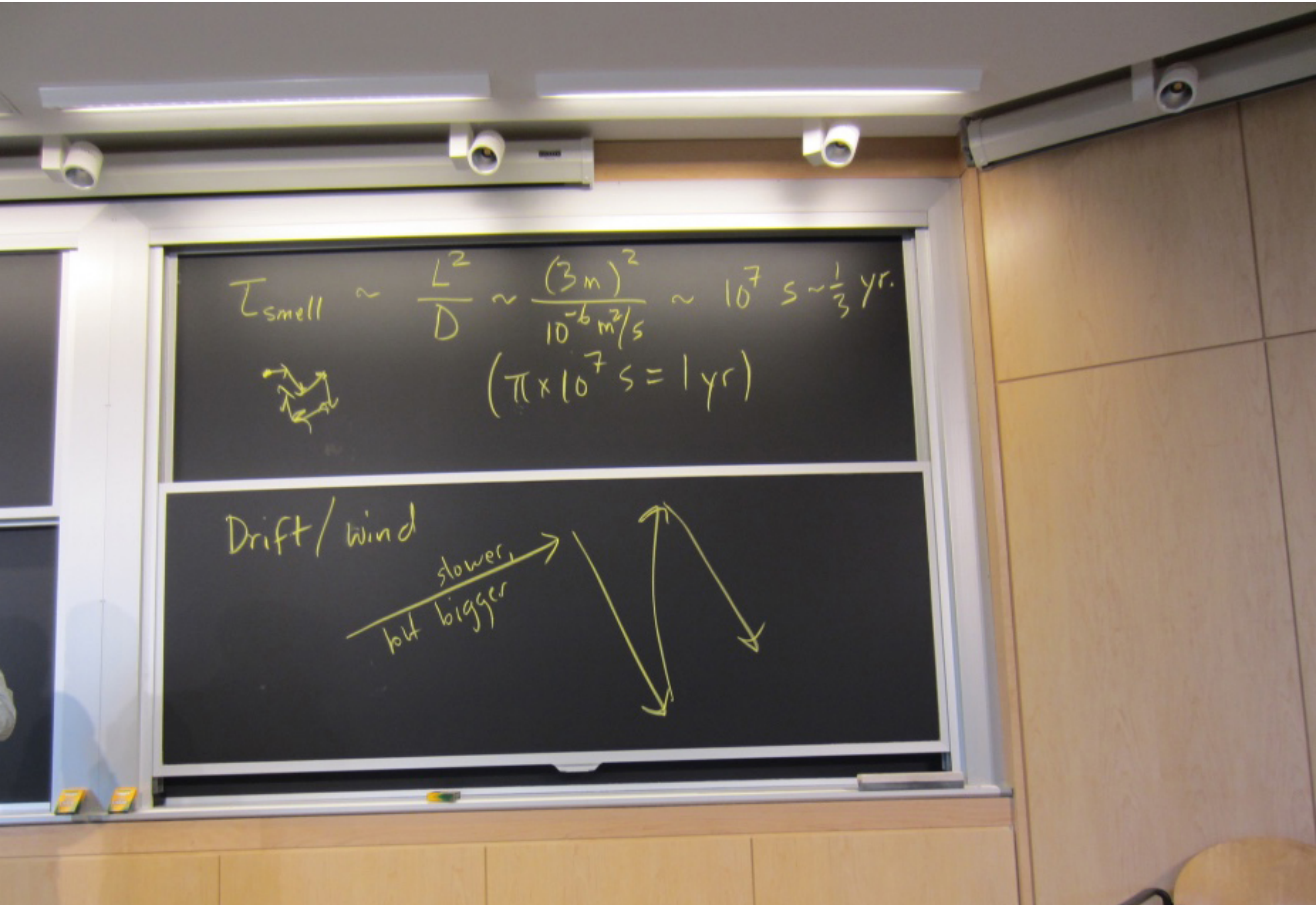
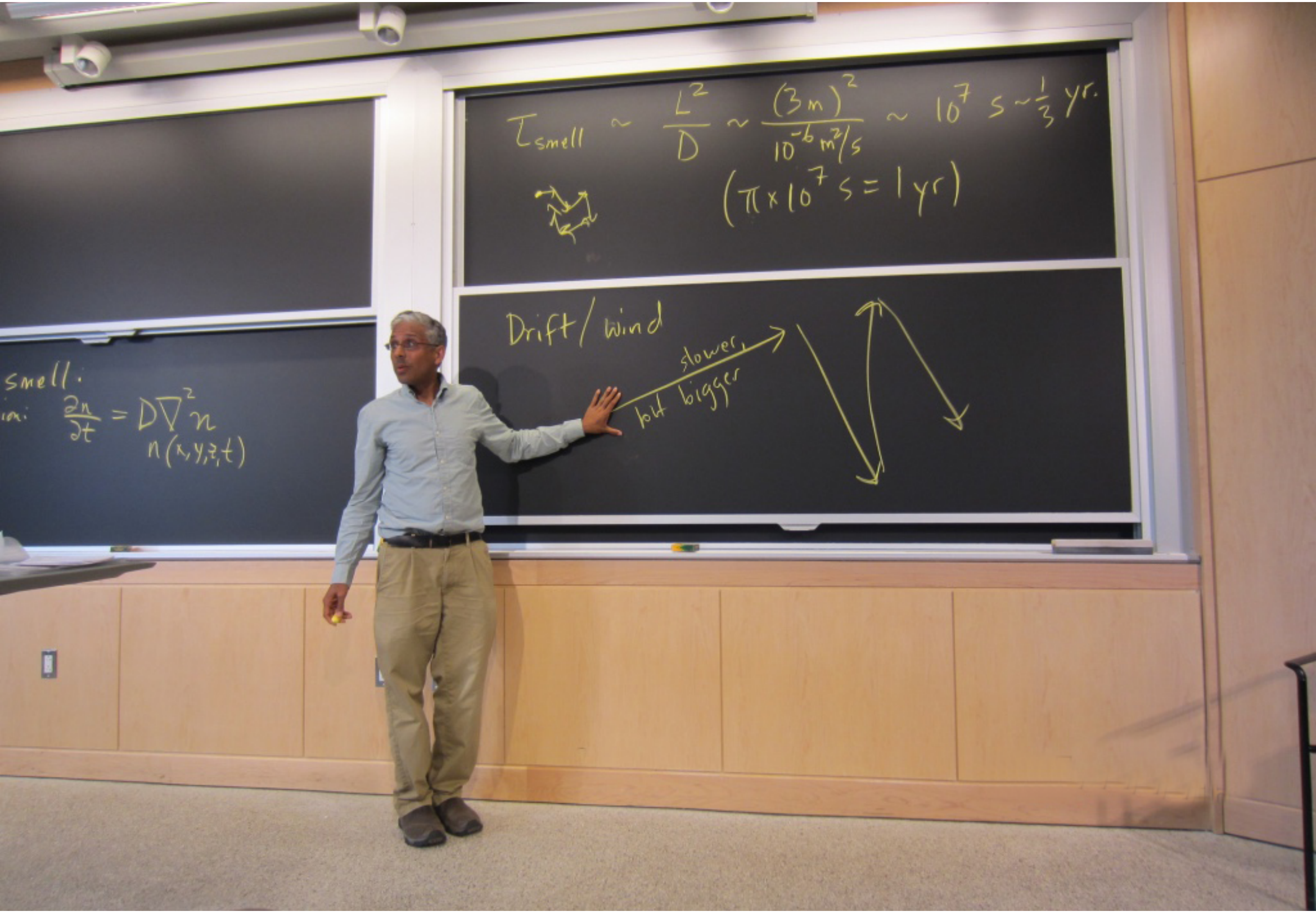
Sanjoy Mahajan

Art of Insights:

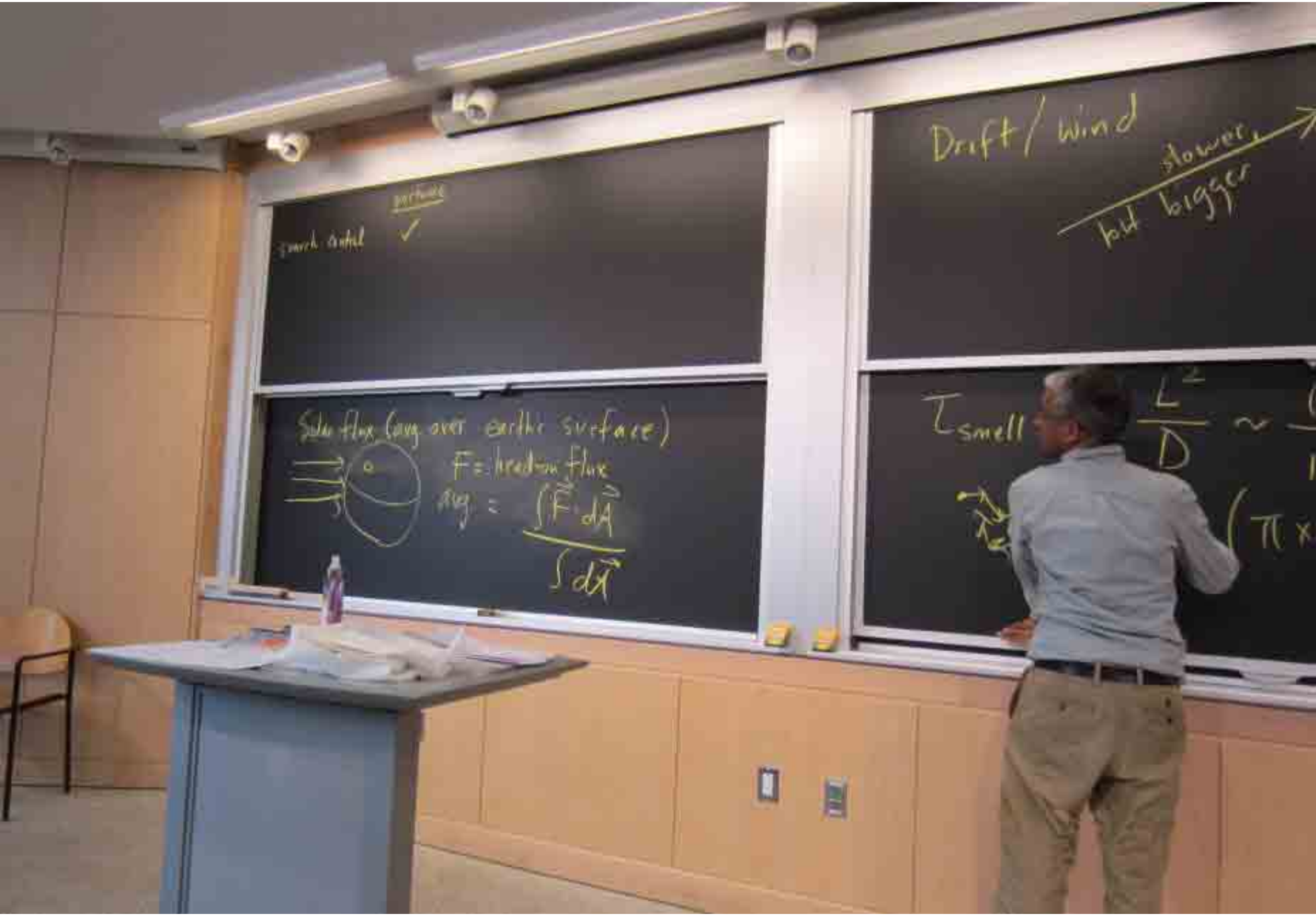
"Never Calculate Without Already Knowing the Answer!"

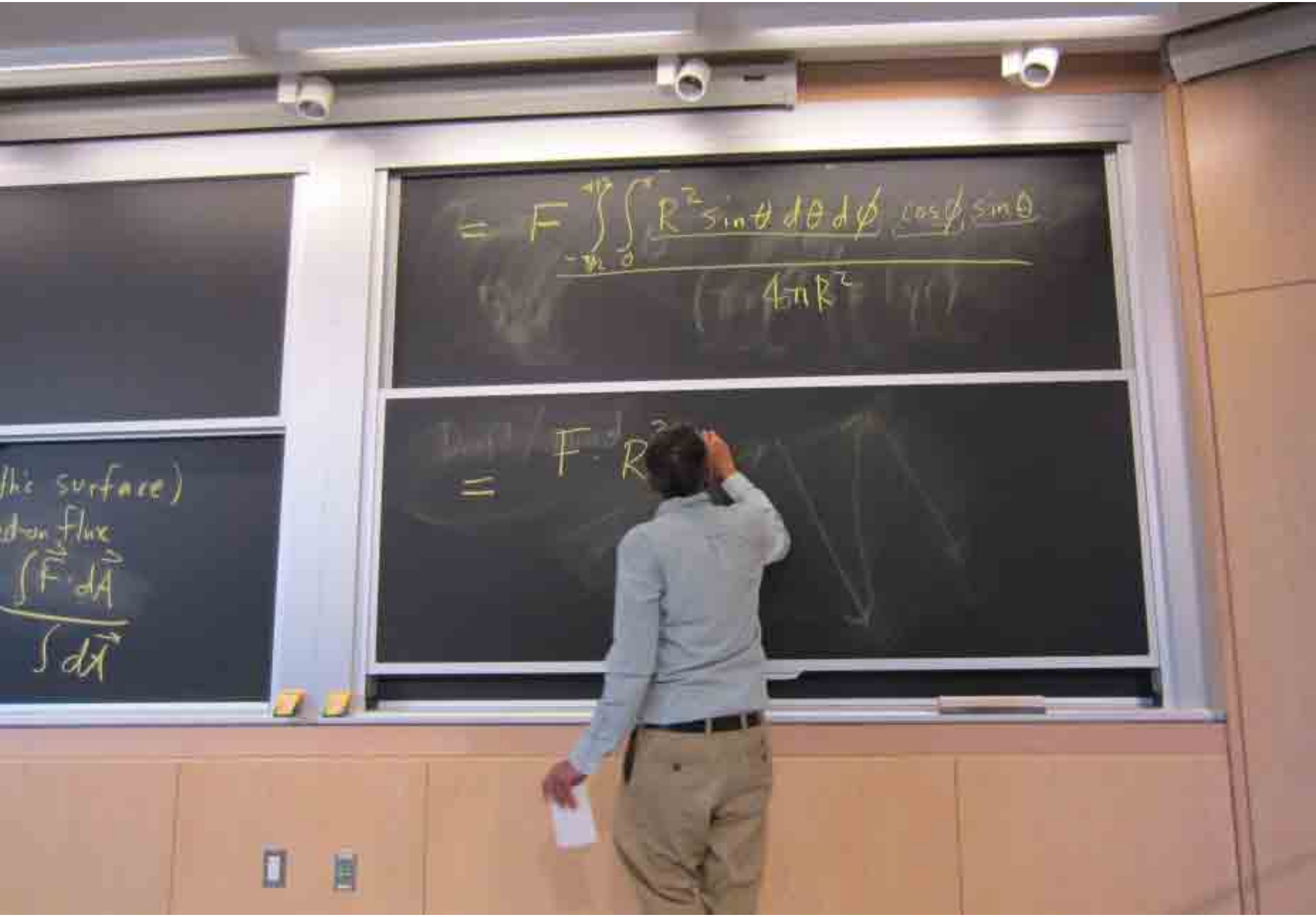

Perfume smell.
Diffusion: ∂n/∂t = D∇²n
n(x,y,z,t)
τsmell ~ L²/D ~
Drift / wind
slower,
but bigger

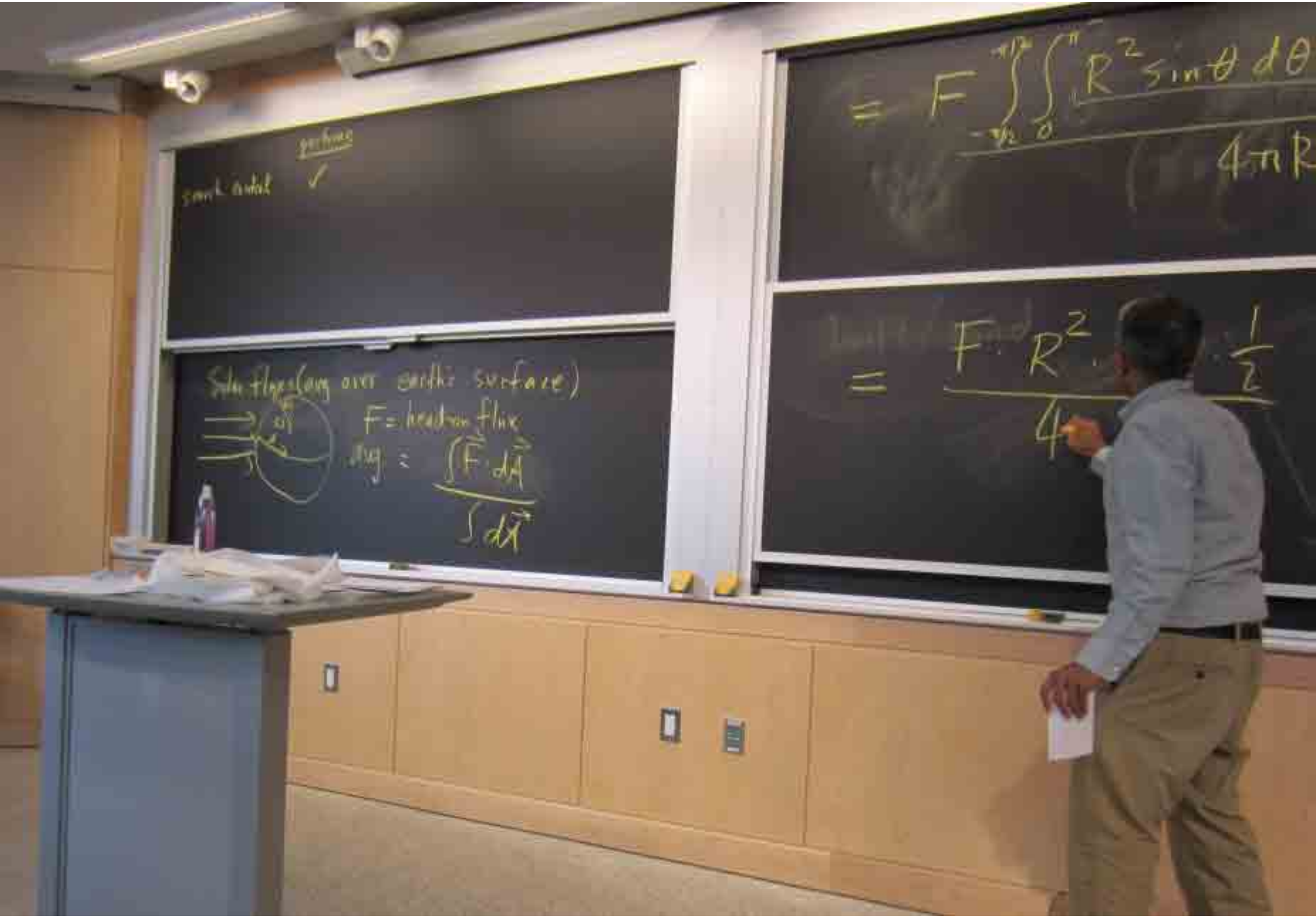

$\tau_{smell} \sim \frac{L^2}{D} \sim \frac{(3m)^2}{10^{-6} m^2/s} \sim 10^7 s \sim \frac{1}{3} yr.$
$(\pi \times 10^7 s = 1 yr)$
Drift/wind
slower,
but bigger

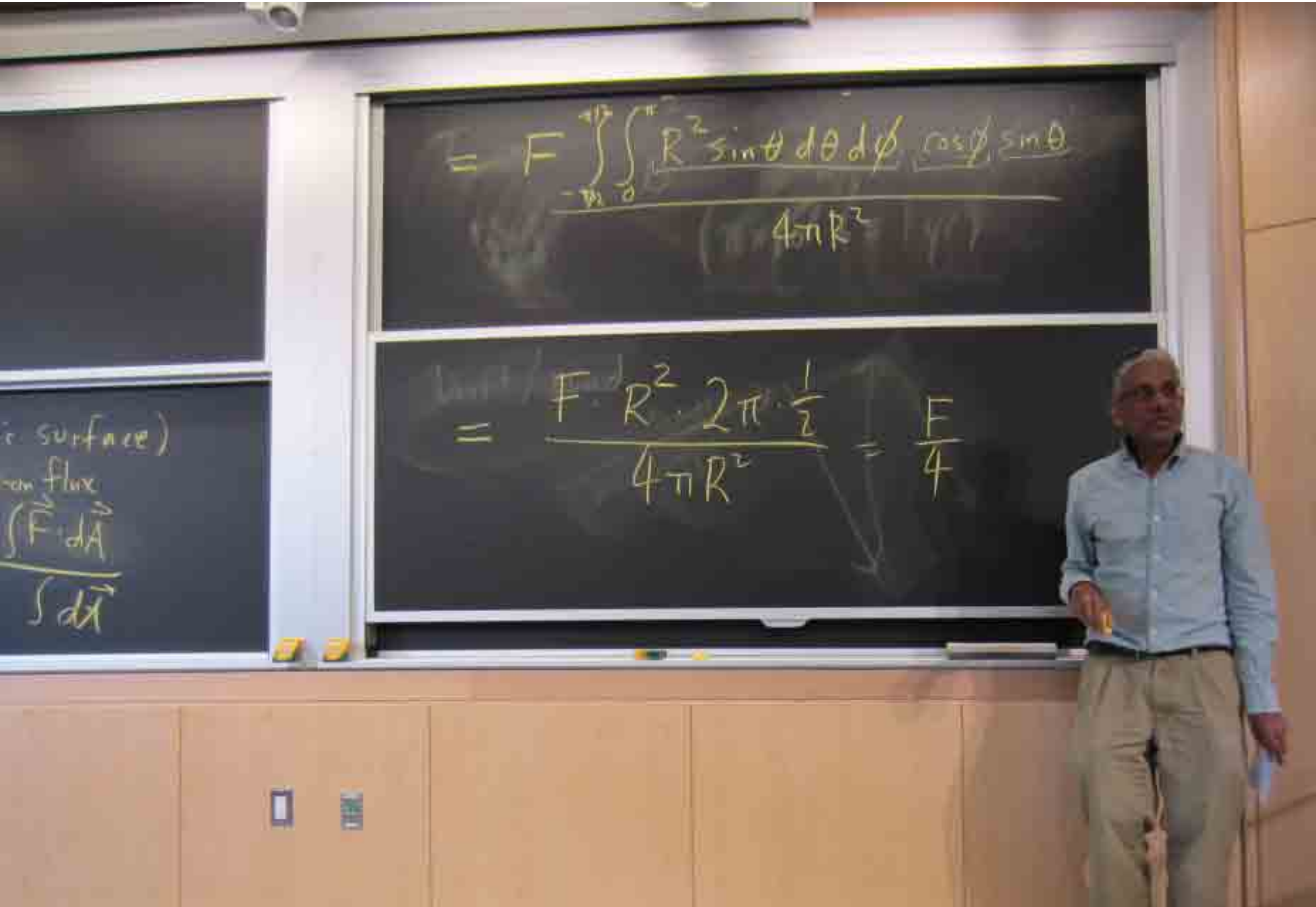


τ_smell ~ L²/D ~ (3m)²/10⁻⁶ m²/s ~ 10⁷ s ~ 1/3 yr.
(π × 10⁷ s = 1 yr)
Drift / wind
slower,
bit bigger
smell.
∂n/∂t = D∇²n
n(x,y,z,t)


Drift / wind
slower,
bit bigger
Solar flux (avg. over earth's surface)
F = head-on flux
avg. = ∫F⃗·dA⃗ / ∫dA⃗
τ smell ~ L²/D

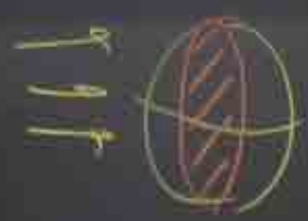

= F ∫∫ R² sinθ dθ dφ cosφ sinθ
4πR²
= F · R
surface)
flux
∫F · dA
∫dA


Solar flux (avg over earth's surface)
F = head-on flux

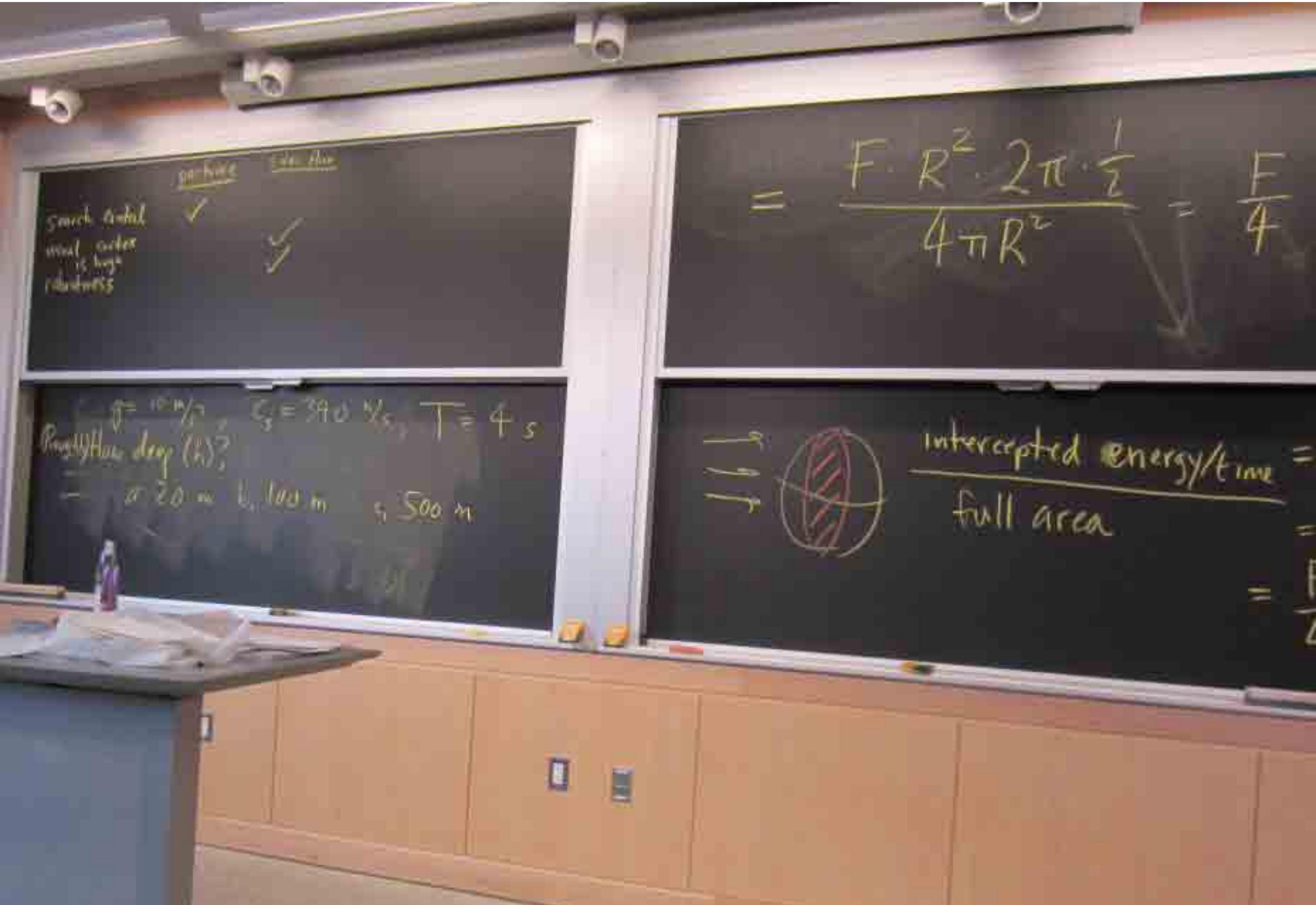


$= F \int_{-\pi/2}^{\pi/2} \int_{0}^{\pi} \frac{R^2 \sin\theta \, d\theta \, d\phi \, \cos\phi \, \sin\theta}{4\pi R^2}$
$= \frac{F \cdot R^2 \cdot 2\pi \cdot \frac{1}{2}}{4\pi R^2} = \frac{F}{4}$
surface)
flux
$\frac{\int \vec{F} \cdot d\vec{A}}{\int d\vec{A}}$

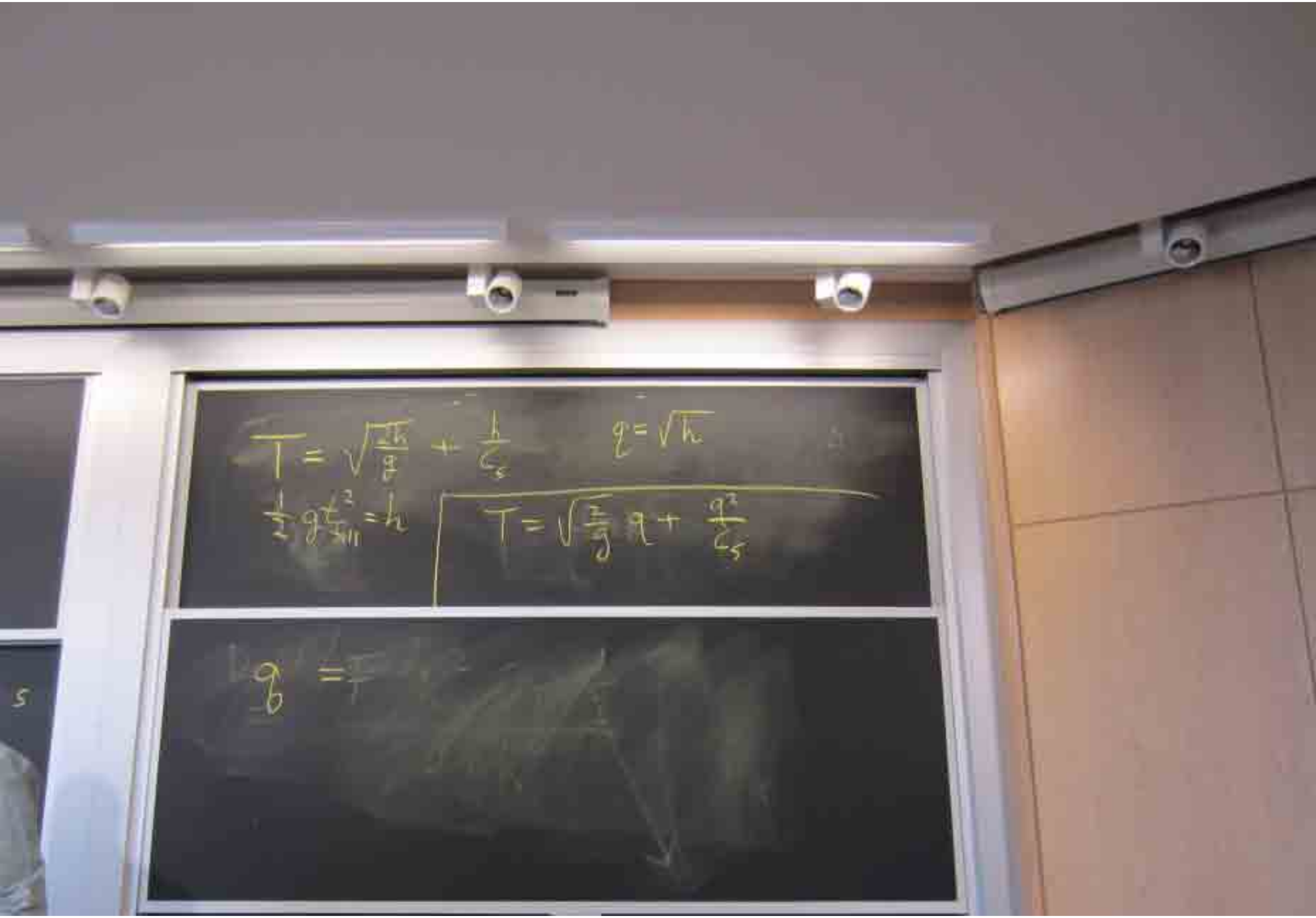
$$= \frac{F \cdot R^2 \cdot 2\pi \cdot \frac{1}{2}}{4\pi R^2} = \frac{F}{4}$$

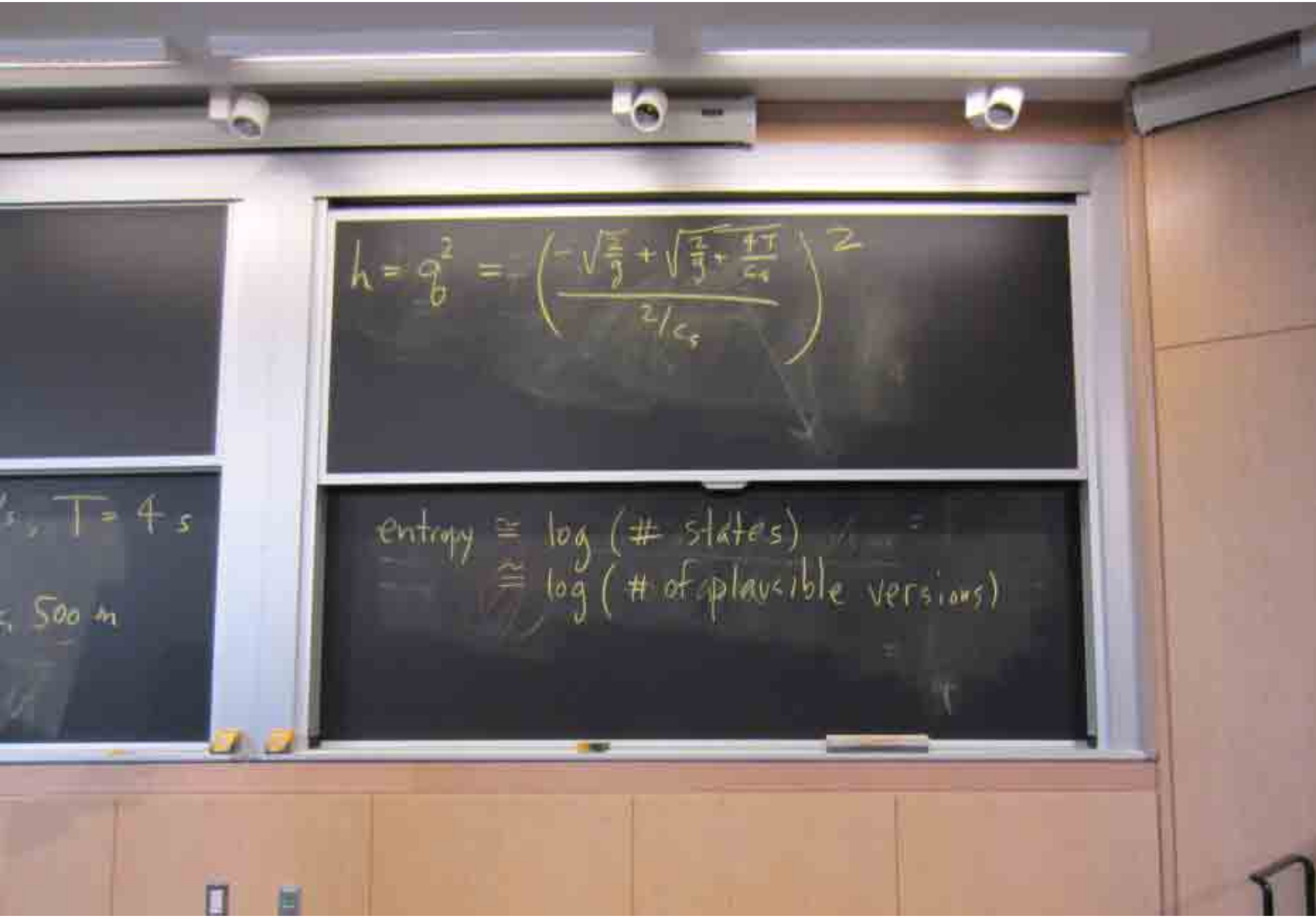


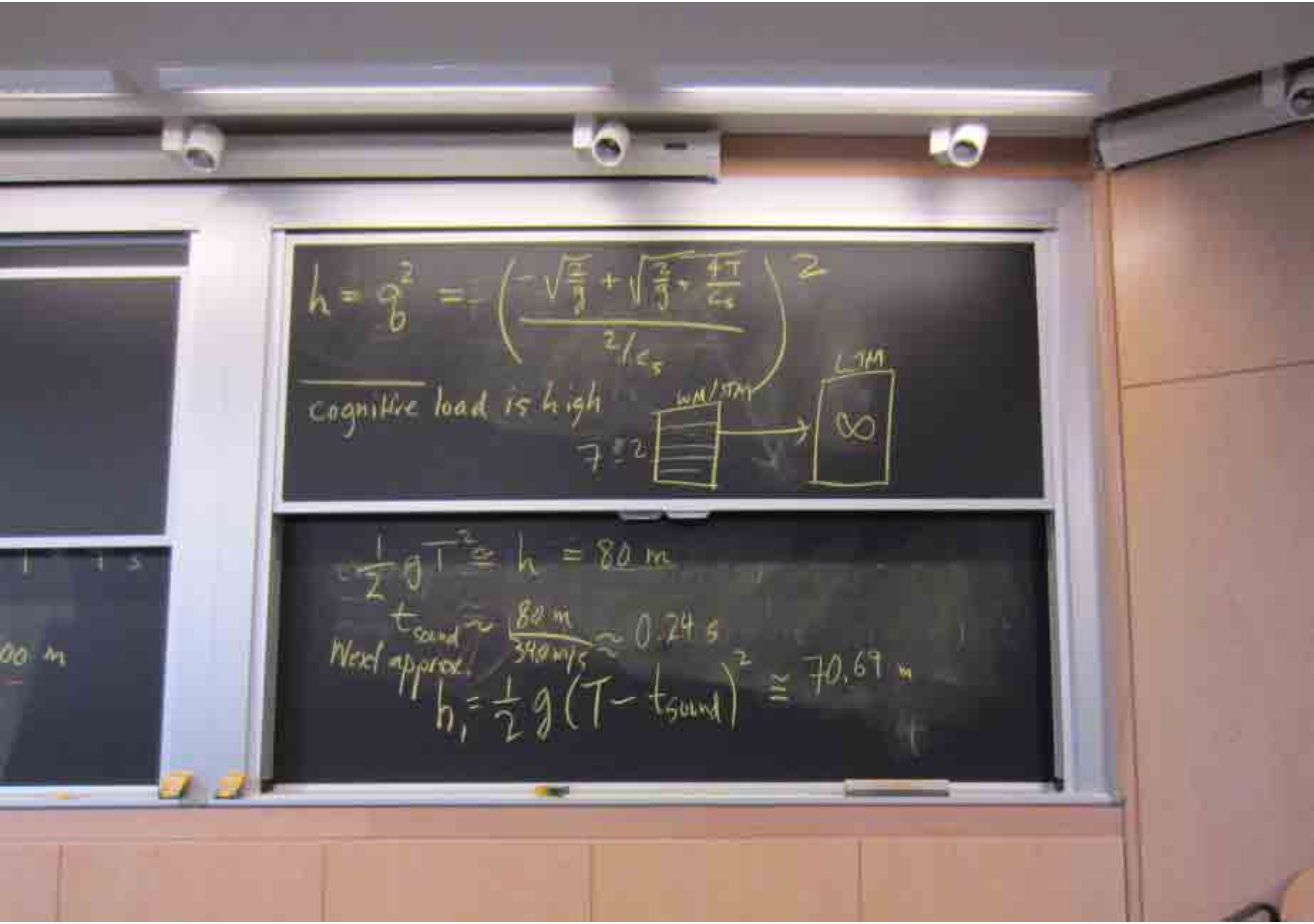
$$\frac{\text{intercepted energy/time}}{\text{full area}} = \frac{F \cdot \pi R^2}{4\pi R^2} = \frac{F}{4}$$

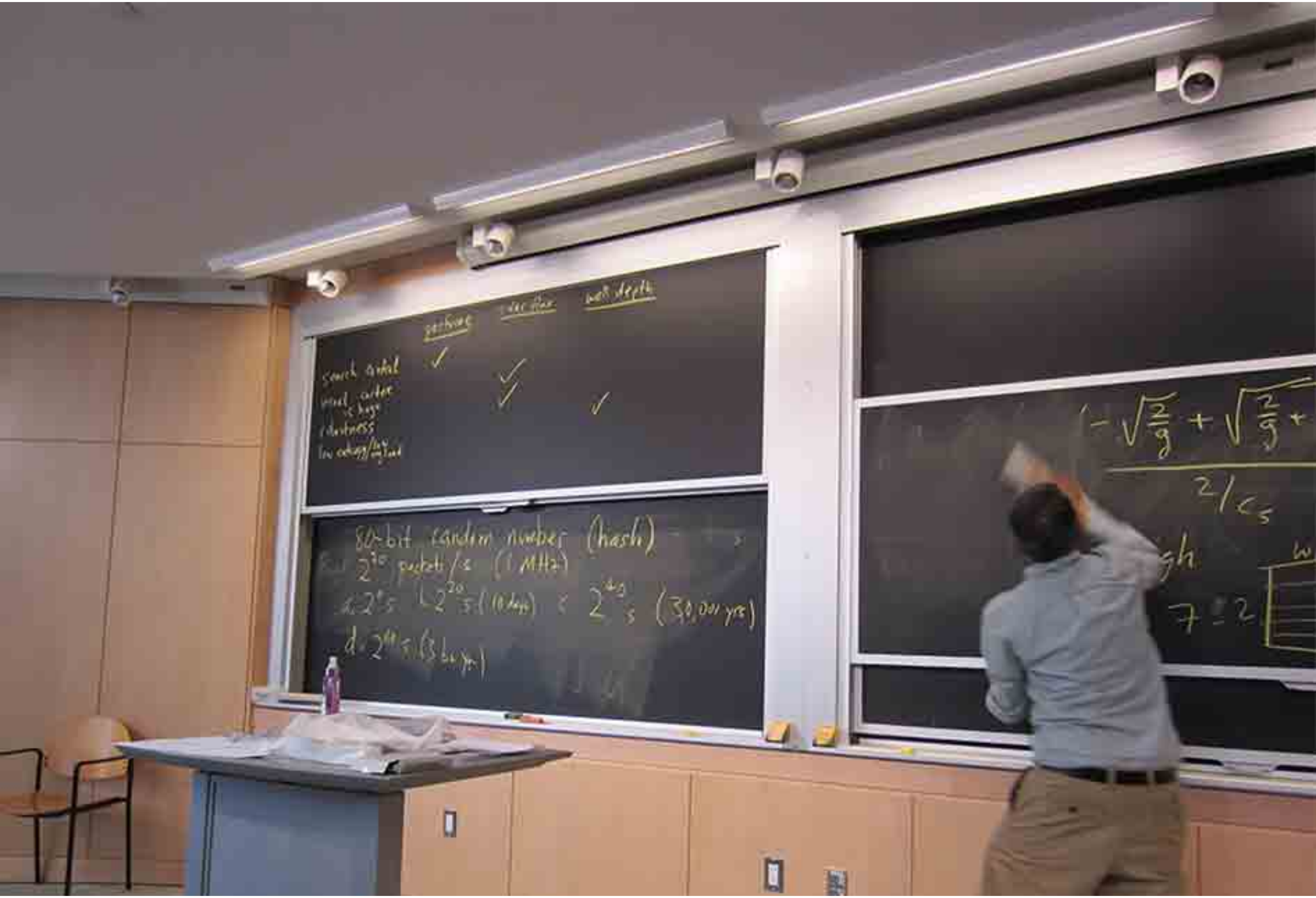


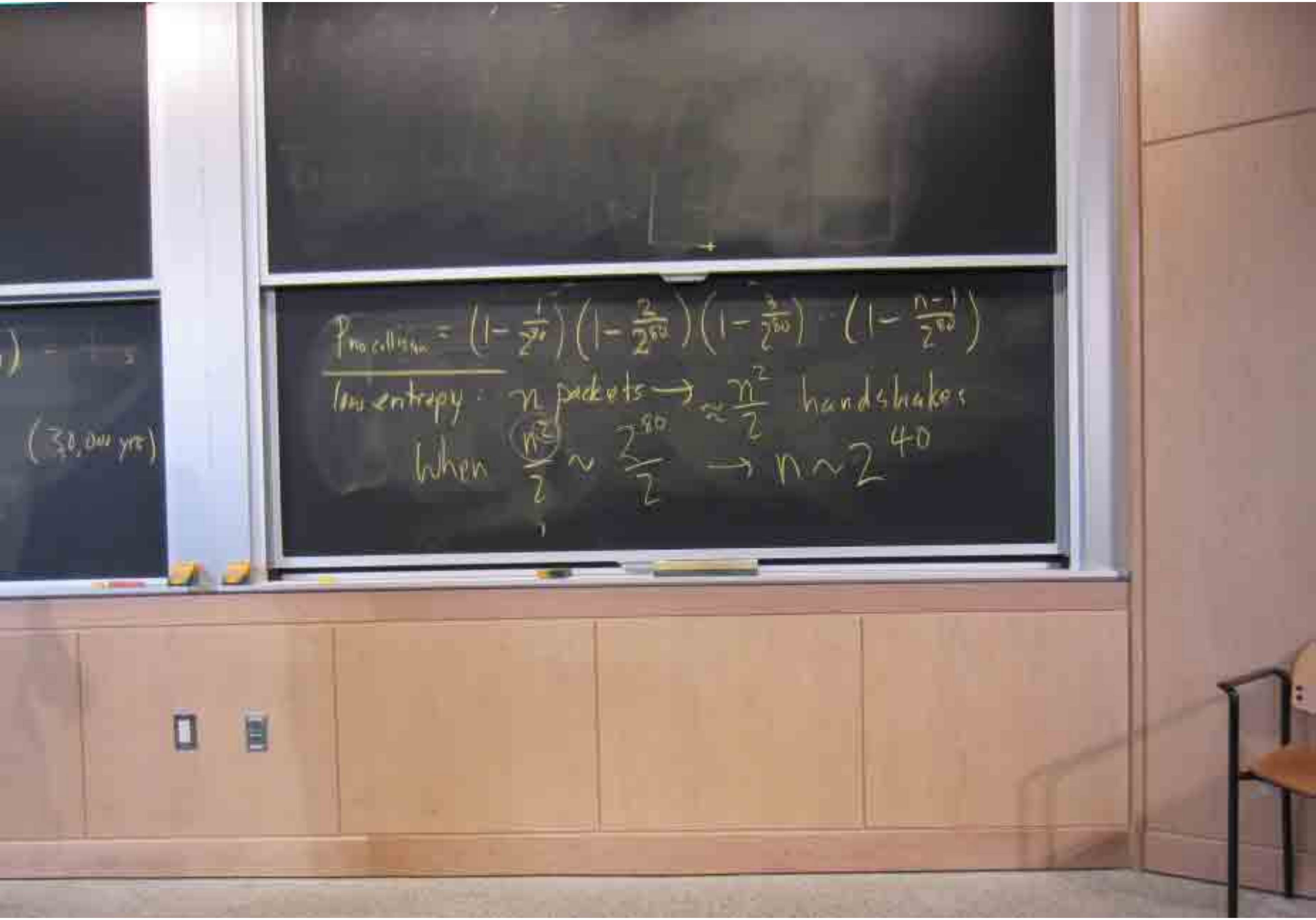
robustness
g = 10 m/s², c_s = 340 m/s, T = 4 s
How deep (h)?
a) 20 m b) 100 m c) 500 m
= F · R² · 2π · 1/2 / 4πR² = F/4
intercepted energy/time
full area

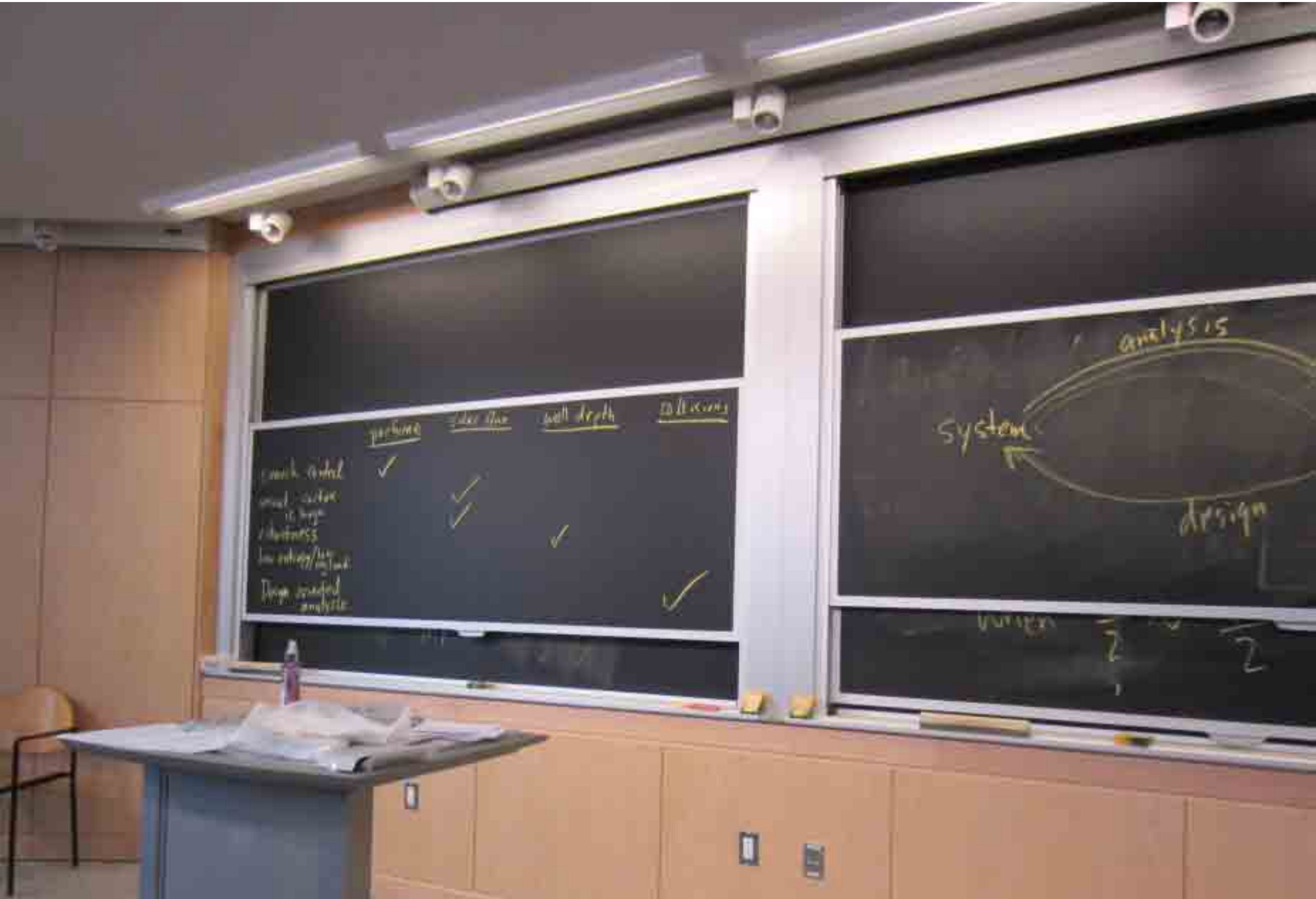

$T = \sqrt{\frac{2h}{g}} + \frac{h}{c_s}$
$q = \sqrt{h}$
$\frac{1}{2} g t_{fall}^2 = h$
$T = \sqrt{\frac{2}{g}}\, q + \frac{q^2}{c_s}$


T = 4 s
500 m
entropy ≅ log (# states)
≅ log (# of plausible versions)


cognitive load is high
WM/STM
LTM
7±2
∞
1/2 g T^2 ≅ h = 80 m
t sound ≈ 80 m / 340 m/s ≈ 0.24 s
Next approx.
h1 = 1/2 g (T − t sound)^2 ≅ 70.69 m


well depth
80-bit random number (hash)
(1 MHz)


(30,000 yrs)
$P_{no\ collision} = \left(1-\frac{1}{2^{80}}\right)\left(1-\frac{2}{2^{80}}\right)\left(1-\frac{3}{2^{80}}\right)\cdots\left(1-\frac{n-1}{2^{80}}\right)$
low entropy: n packets $\rightarrow \approx \frac{n^2}{2}$ handshakes
When $\frac{n^2}{2} \sim \frac{2^{80}}{2} \rightarrow n \sim 2^{40}$


well depth
analysis
system
design

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End of slides