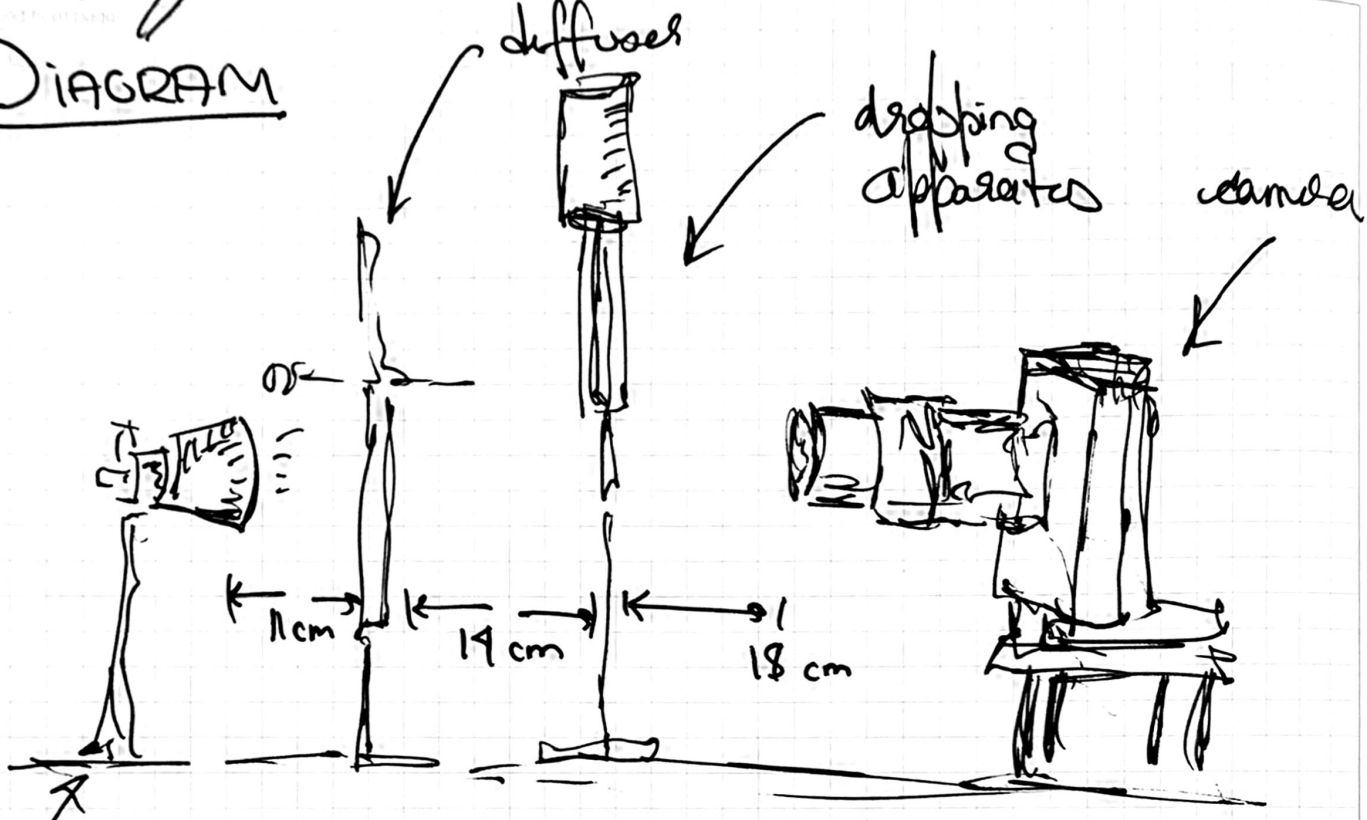
DIAGRAM



EXPERIMENTAL SETUP

PROCEDURE

[SETUP 1] 336×240 px
15941.3 fps
Exp 57.77 µs (100%)

} need to increase
② more light

filenames:
dpo_1
dpo_2
dpo_3
dpo_4

} not great views as too far out

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Signature Date 22.10.21

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Science vol.265 A cascade of structure in a drop falling from a faucet S. Nagel

[SETUP 2] 192 × 96 px ← drop high
39565 fps
25.93 us (100%)

filenames ← reduced & exported

dpo-6
dpo-7 , dpo-7-regime1
dpo-8
dpo-9 , dpo-9-regime2
dpo-10 ← reduced dpf again.
dpo-11 ← best shoot 3 should use for analyses.
dpo-11-r ← the ruler measurement.

end data collection for day 1.

DIMENSIONAL ANALYSIS

$L = \frac{LT}{M} \cdot \frac{M}{T^2} \cdot T$

$1 = \frac{\gamma T}{\eta}$ ← regime2

$L = \frac{L^4T^4}{M^4} \cdot \frac{M}{L^3} \cdot \frac{M^3}{T^6} \cdot T^2$

$= \frac{\rho \gamma^3 T^2}{\eta^4}$

$L = \frac{L^3}{M} \cdot \frac{M^2}{L^2 \cdot T^2} \cdot \frac{T^2}{M}$

$= \frac{\eta^2}{\rho \gamma}$

$\text{regime1} = \frac{\gamma^{1/3}}{\rho^{1/3}} T^{2/3}$

Fit this parameter. //

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BACKGROUND

Surface Tension: Tendency of liquids surfaces at rest to shrink to the minimum surface area as possible.

We can define it generally as

$$\gamma = \frac{1}{2} \cdot \frac{F}{L}$$

← force
← length of moving side

Viscosity : Resistance of a fluid to deformation at a given rate. We often work in Kinematic Viscosity

$$\nu = \frac{\mu}{\rho}$$

← dynamic viscosity what we call η in lab.

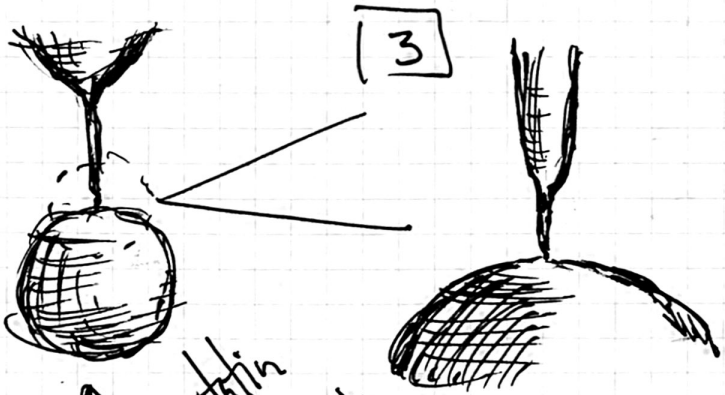
So, how can we determine what the dominant forces are at play in different regimes? Below are some possibilities:

1

SURFACE TENSION

2

3



VISCOSITY

gravity is not important

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More Terms :

hydrostatic pressure : The condition of equilibrium of a floating body and submerged body.

Basically, we can say

$$p(z) - p(z_0) = \int_{z_0}^{z} dz' \, \rho(z') g(z').$$

$$\approx \rho g h = \rho g (z - z_0)$$

on earth.

Bernoulli pressure : Increase in speed of fluid occurs simultaneously w/a decrease in static pressur OR fluid potential energy

This can be formalized by

$$\frac{v^2}{2} = \text{CONSTANT} - \underbrace{gz}_{\text{potential on earth}} - \underbrace{\frac{p}{\rho}}_{\text{static pressure}}$$

$$= \text{CONSTANT} - \Psi - \frac{p}{\rho}$$

↑ generalized potential.

→ Combining these two, we can get

$$\underbrace{\frac{1}{2}\rho v^2}_{\text{dynamic pressure}} + \underbrace{\rho g h}_{\text{potential on earth}} + \underbrace{p}_{\text{static pressure}} = \text{constant}$$

Finally, $\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho v) = 0$ is COM $\because \frac{M}{V} = \rho$

=> related to volume change

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REGIME 1:

gravitational potential } g, ρ
Surface tension } γ

$[R] \sim \left(\frac{\gamma^{\alpha}}{\rho^{\delta}}\right)[T]^{\delta}$

REGIME 2

Viscosity } η
Density } ρ
Surface Tension } γ

CRITICAL PHENOMENA

$[R] \sim [T]^{\delta}$ Power = 2/3

We want to find δ.

Regime 3

{ Viscosity η
Density ρ } power = 1/2

DATA COLLECTION

Res: 192 × 96
FPS: 38,565
MinPeriod: 25.93 μs

EXPOSURE: 20.98 sec
GAIN: 0 dB

Filenames

dpo-12
dpo-13
→ dpo-14* ← best one and used in analyses
dpo-15
dpo-15R ← rulers measurements.

$\frac{L^3}{\mu}$ $\frac{M}{LT}$ $\frac{\nu}{\nu/k}$

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ImageJ ← all analysis done in ImageJ.

	time (s)	dt (s)	r (px)	dr (px)
1)	0.92	0.08	28.88	3.00
2)	1.15	0.08	27.75	3.00
3)	1.38	0.08	26.63	3.00
4)	1.62	0.08	25.00	3.00
5)	1.85	0.08	23.63	3.00
6)	2.08	0.08	22.13	3.00
7)	2.31	0.08	20.13	3.00
8)	2.54	0.08	18.88	3.00
9)	2.77	0.08	17.88	3.00
10)	3.00	0.08	16.13	3.00
11)	3.23	0.08	14.16	3.00
12)	3.46	0.08	14.05	3.00
13)	3.69	0.08	11.72	3.00
14)	3.92	0.08	9.76	3.00
15)	4.15	0.08	7.55	3.00
16)	4.38	0.08	5.93	3.00
17)	4.62	0.08	3.95	3.00
18)	4.69	0.08	3.02	3.00
19)	4.77	0.08	1.87	3.00
20)	~~5.23~~	0.08	0.73	3.00

Filename:
- dpo_14.avi
- dpo_15R.avi

To calc dt:
- 5.23 s : final
- 0.92 s : initial

We want 20 data points, so

$$\frac{T_f - T_i}{\#(dp)} = \frac{5.23 - 0.92}{20}$$

$$= 0.2155$$

So, $\Delta t = 0.2$

=> about 3 frames

$t_{pinch} = 5.23$ s

px2m = 164090 ± 29360 px/m

PINCH OFF TIME

based off image, ± 3 px

precision of camera resolution

maybe too large.

precision of frame rate

measured center to center

164.09 mm ± 29.36

line matching