PHYSICS is FUN

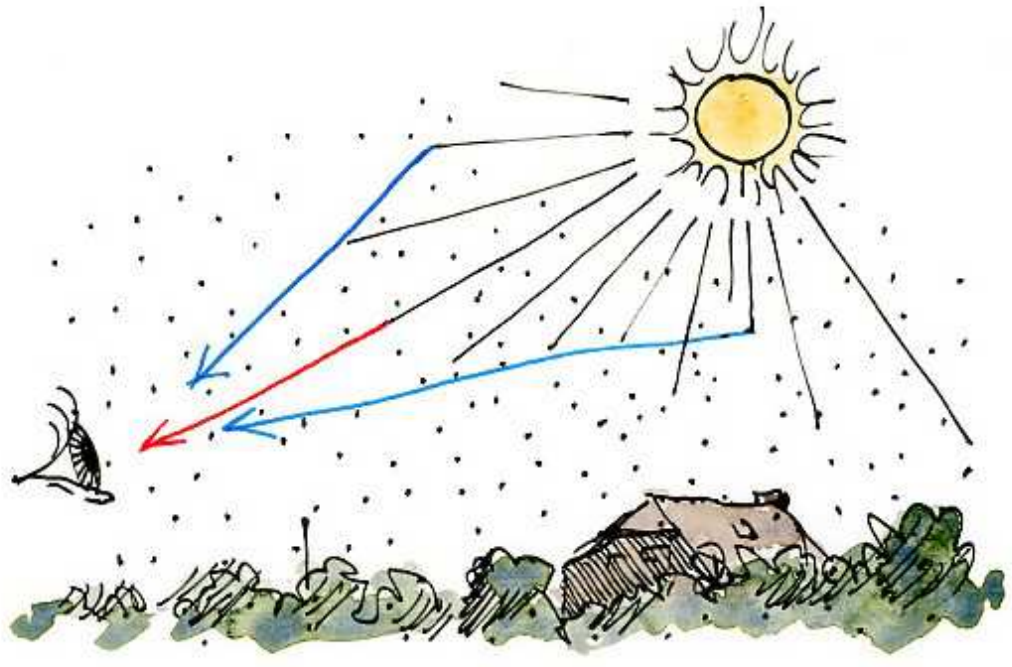
Daily-life examples with demonstrations

Jo Hermans

Young Minds Leadership Meeting, EPS, June 2013

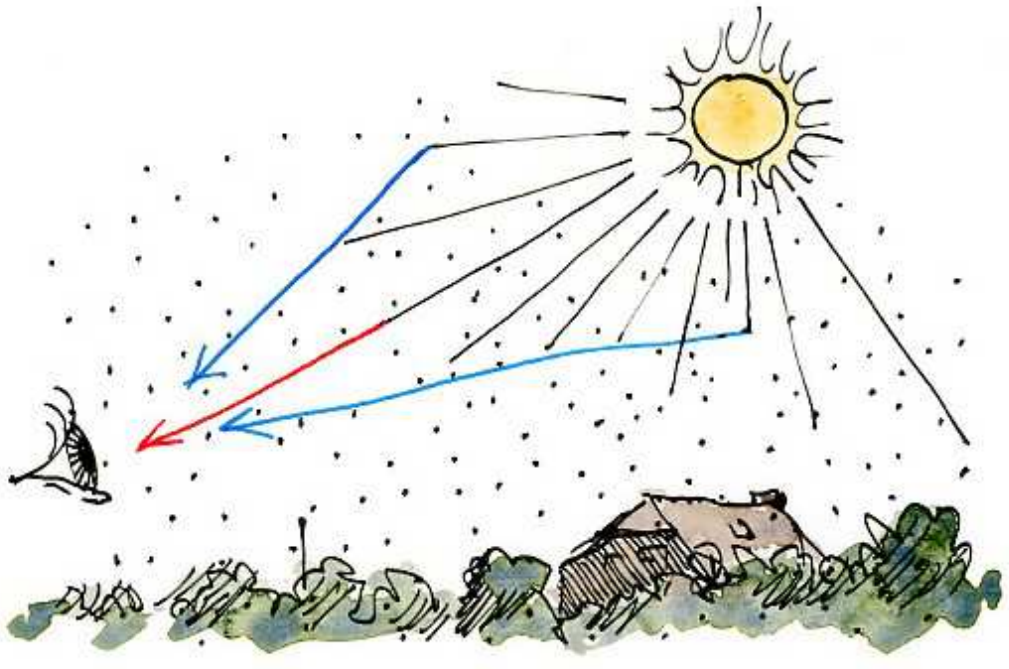
Why is the sky blue?

Why is the sky blue?



Beside the sun: indirect light by scattering

Why is the sky blue?



Blue light is scattered most

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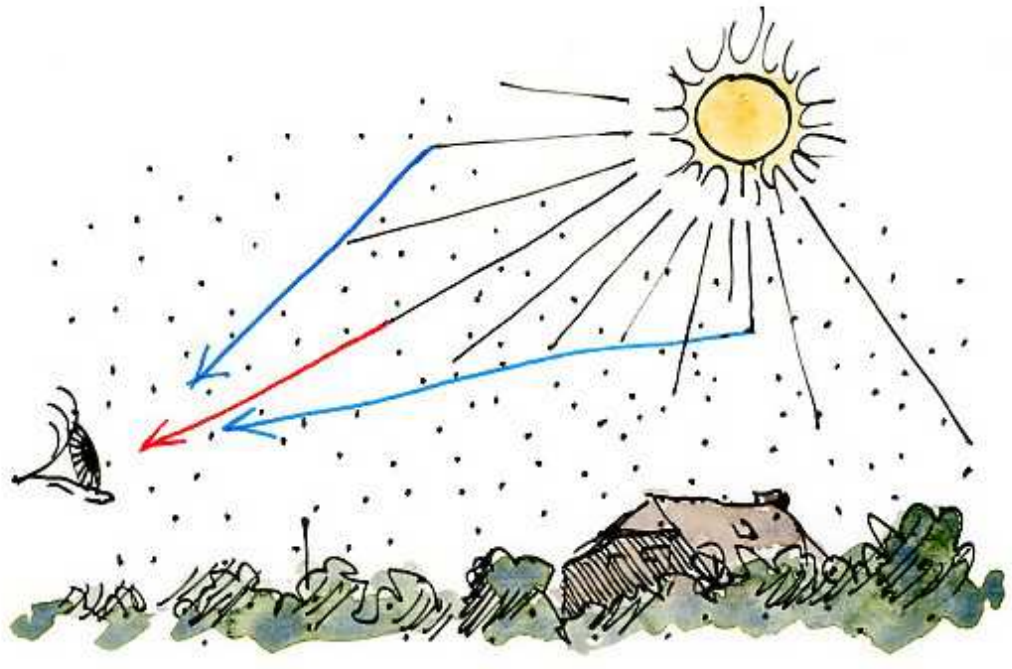


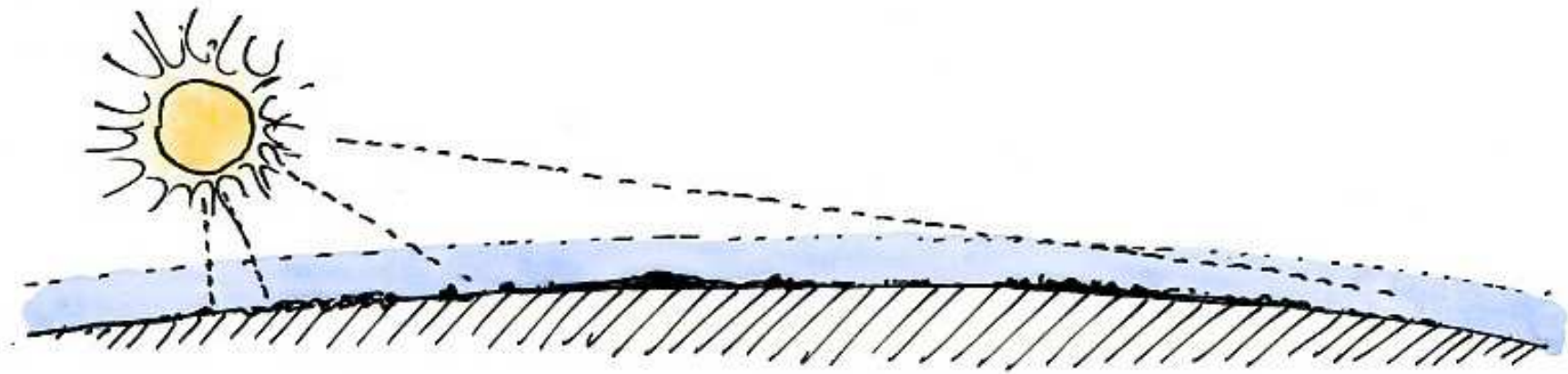
Blue light is scattered most because:
Rayleigh scattering ~ $1/\lambda^4$

Why is the setting sun ***red***?

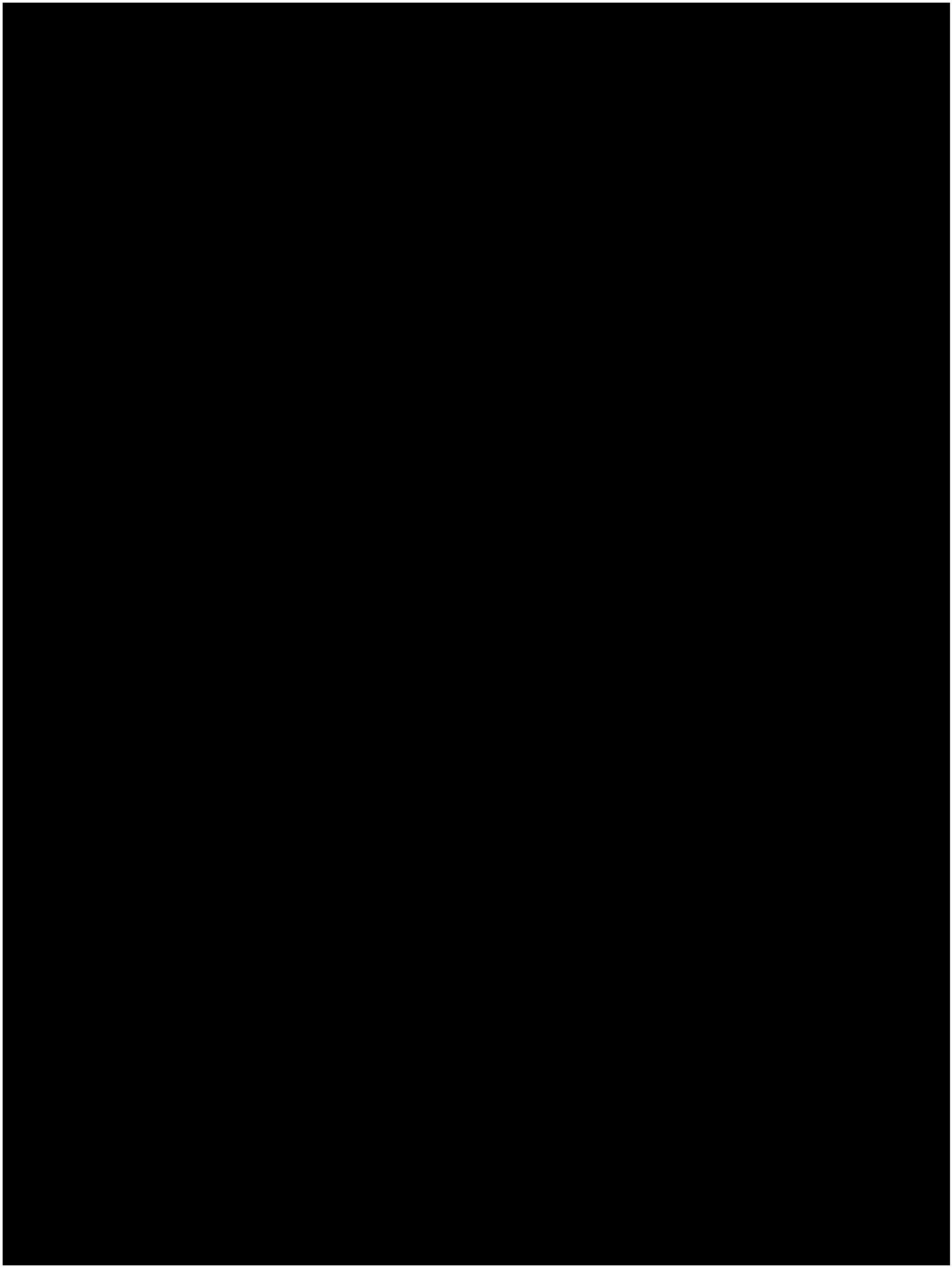
Why is the setting sun ***red***?

- Bluish light is scattered out → reddish light dominates
- Low sun: Extra long path through atmosphere →

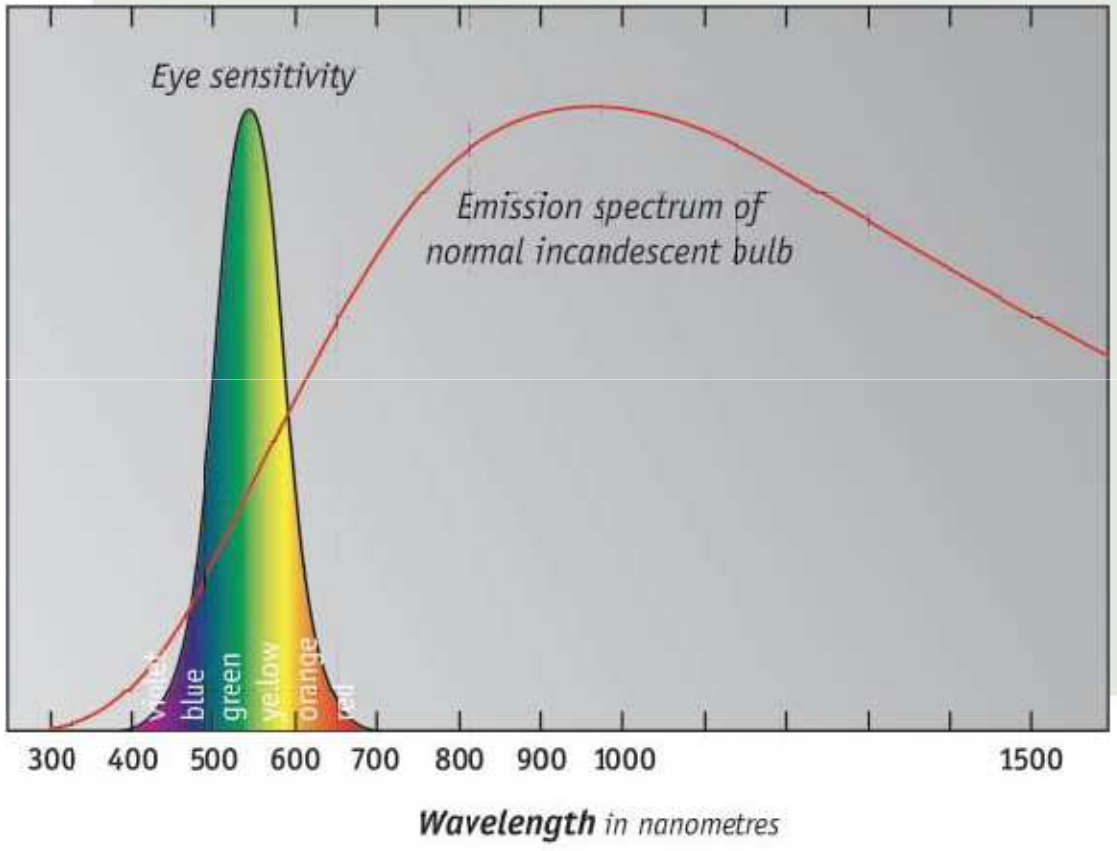
  Extra red sun



Home demo….



Why is an incandescent bulb so inefficient?



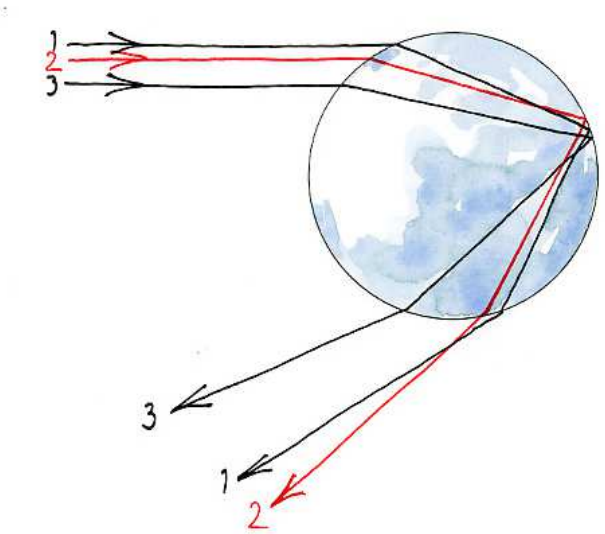
- It emits most of its radiation in the IR! (*cf*. Wien's law)

  Note also: blue vs. red!

The wonders of a rainbow

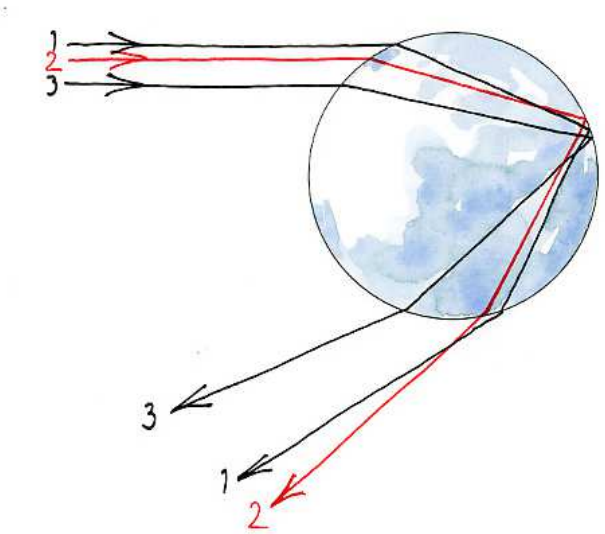
Rainbow (1)

- Sunrays reflected by raindrops
- Reflected light has maximum angle (‘rainbow angle’)
- Extra bright reflection at rainbow angle



Rainbow (2)

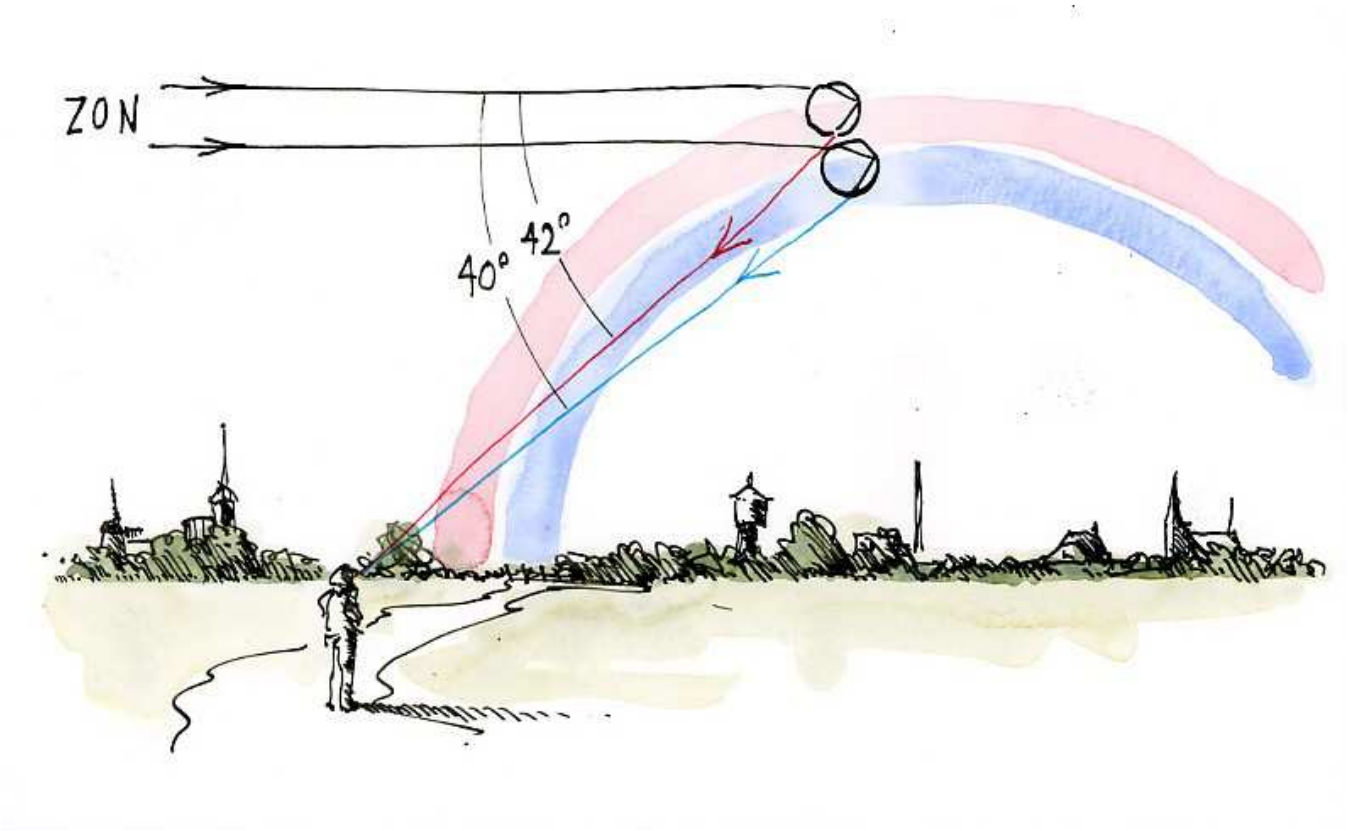
- Sunrays reflected by raindrops
- Reflected light has maximum angle (‘rainbow angle’)
- Extra bright reflection at rainbow angle



- Dipersion → RAINBOW

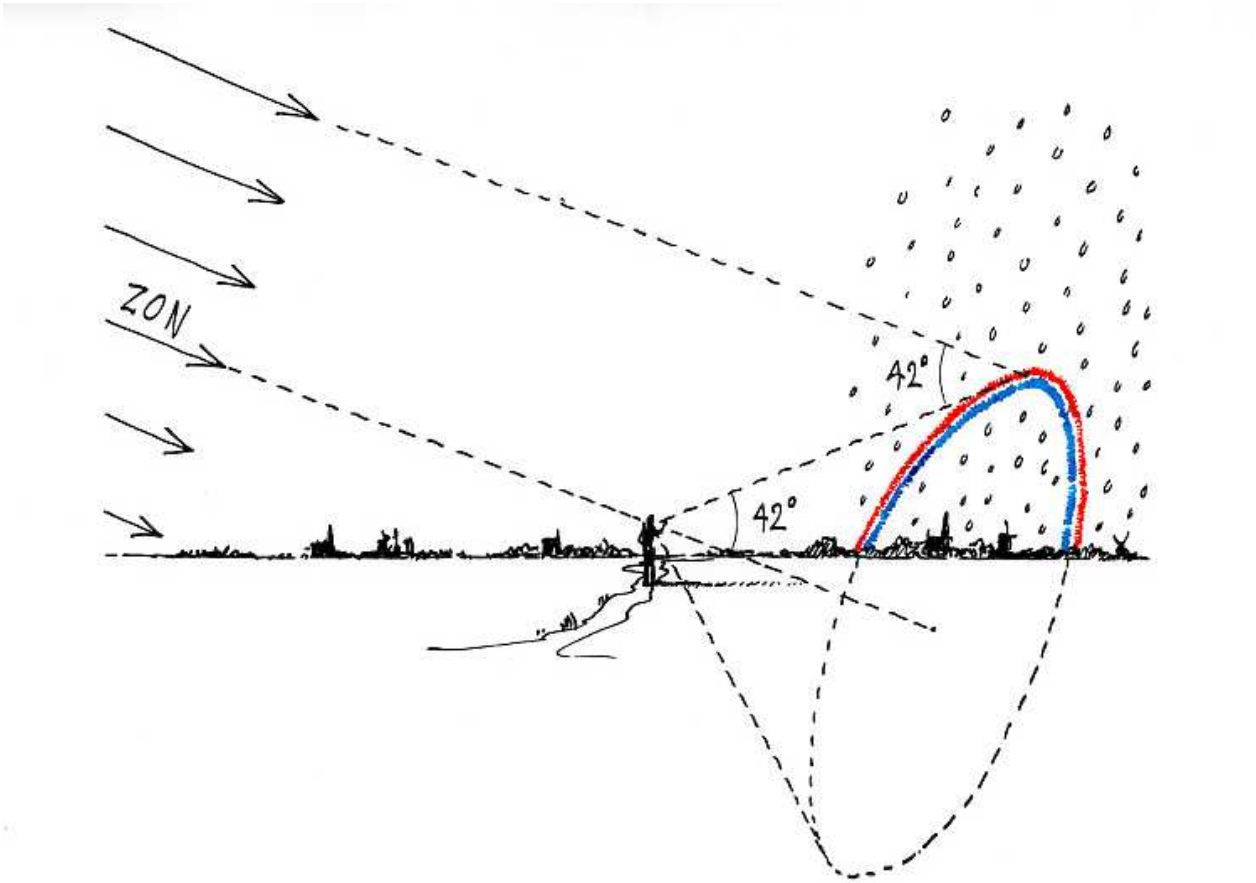
Rainbow (3)

- Each color originates from its ‘own’ droplets



Rainbow (4)

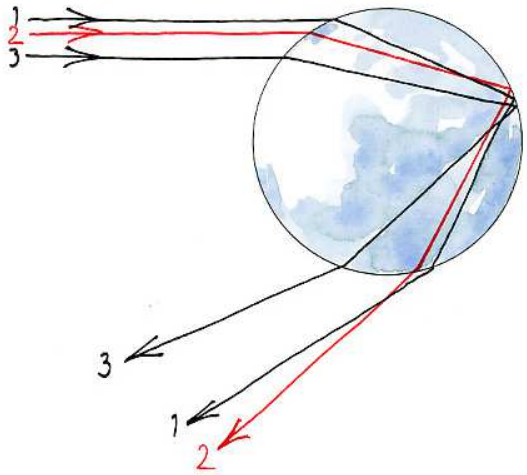
- The higher the sun, the less of a rainbow



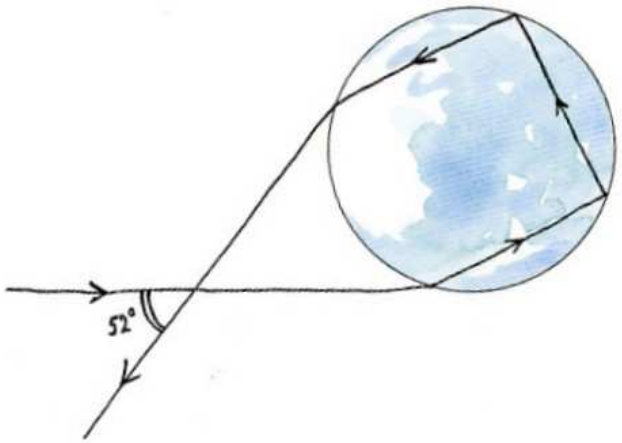
Rainbow (5)

- The secondary bow by extra reflection (weaker and reverse colors)

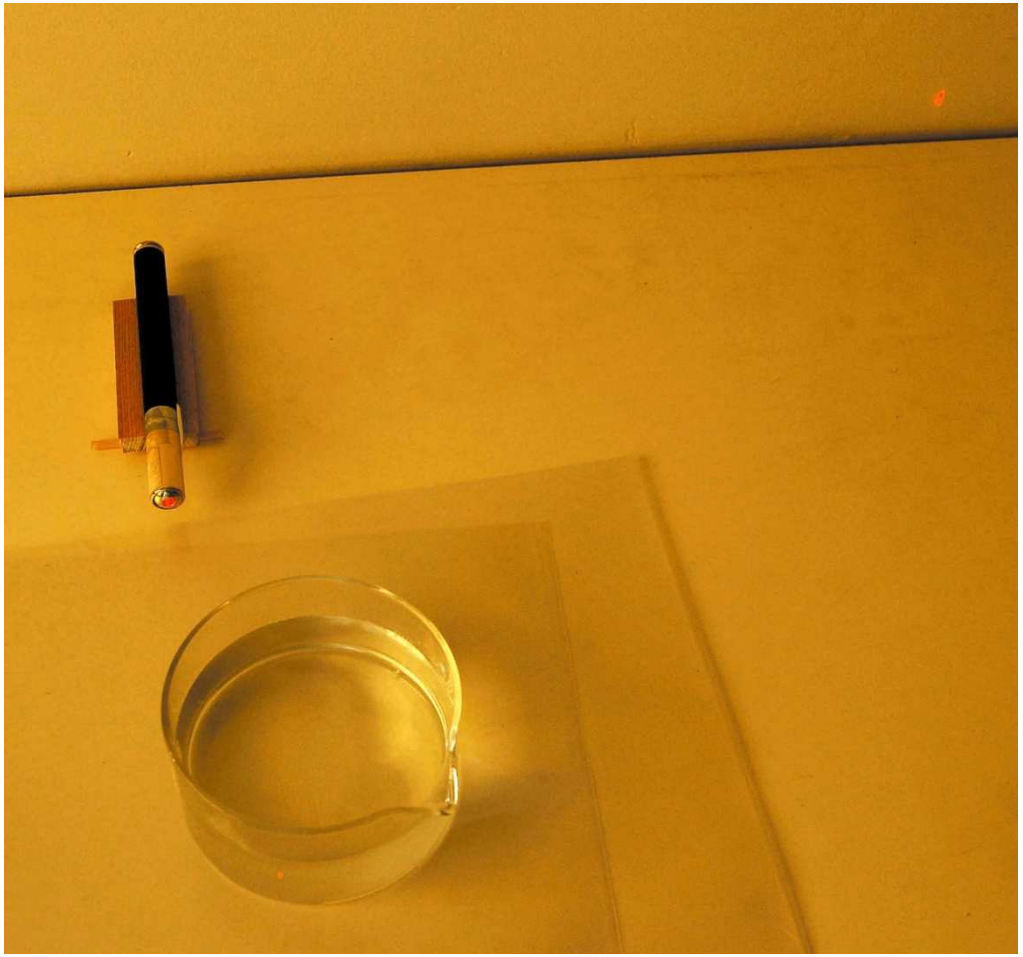
Primary bow:



Secondary bow*:*



DEMO rainbow angle



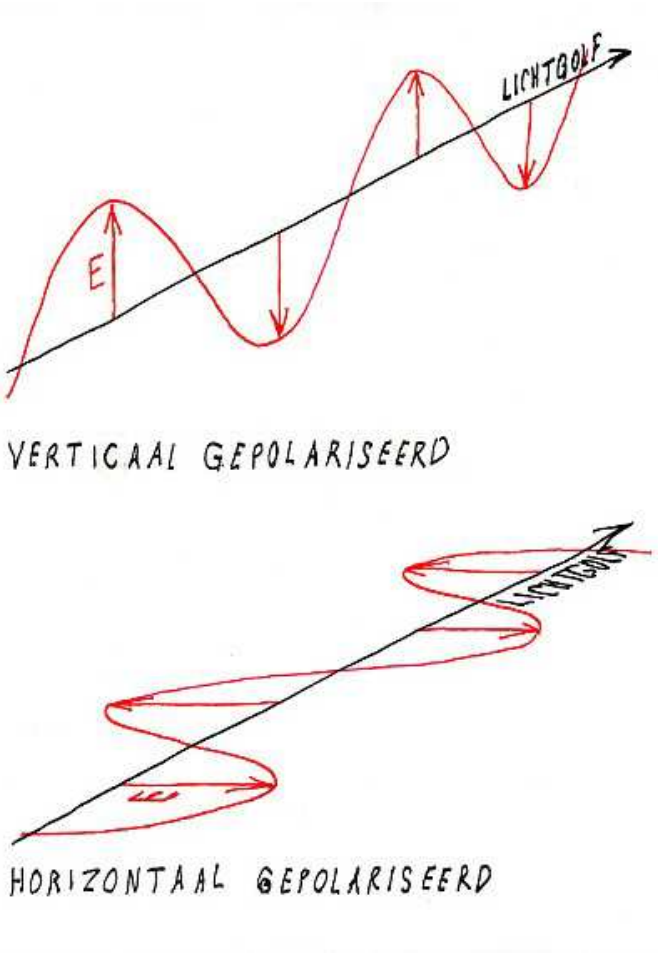
Two plastic sheets……..

They are polaroid filters!

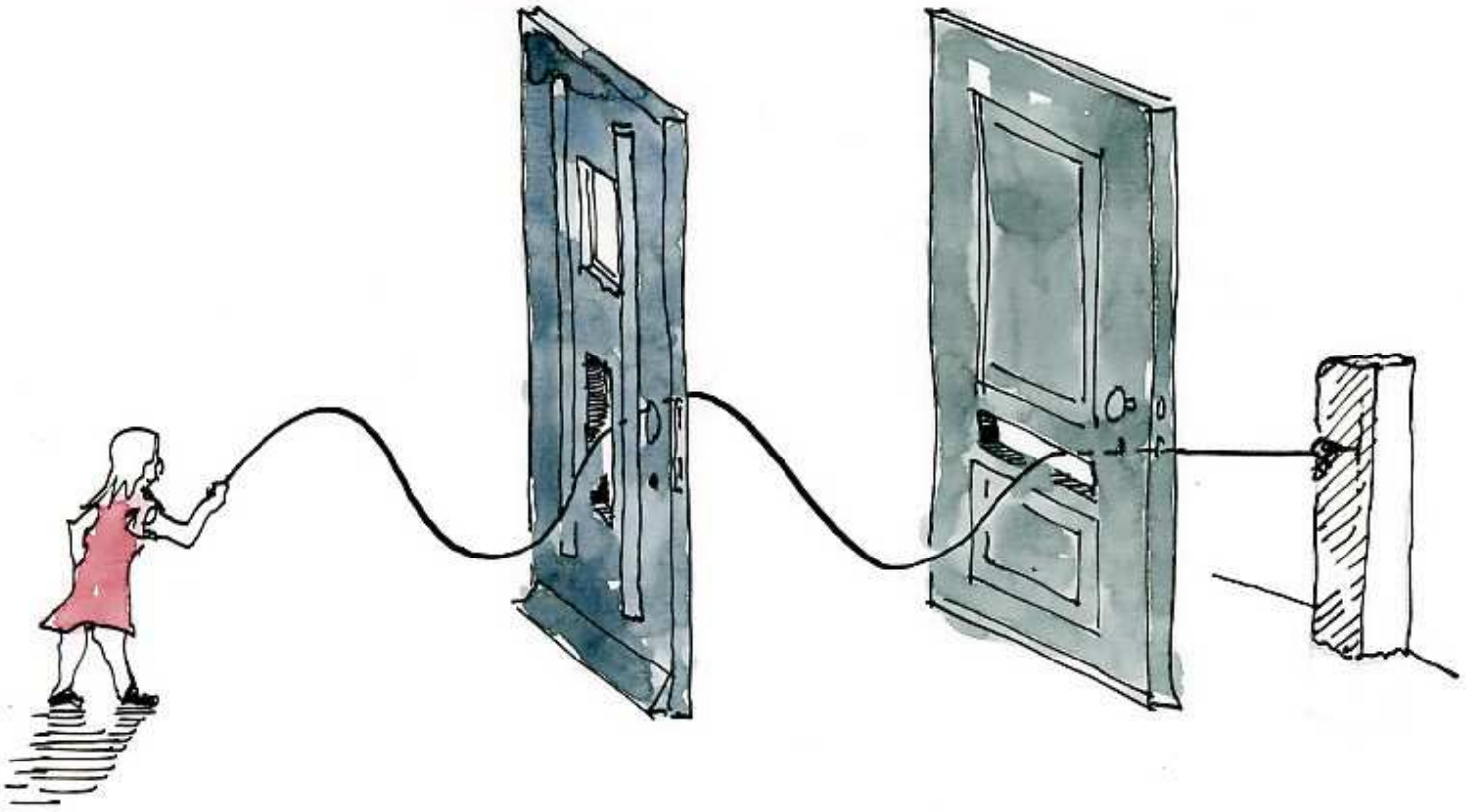
And how does that work?

Light…….

- Light consists of Electromagnetic waves
- The waves can be in any plane, for example:

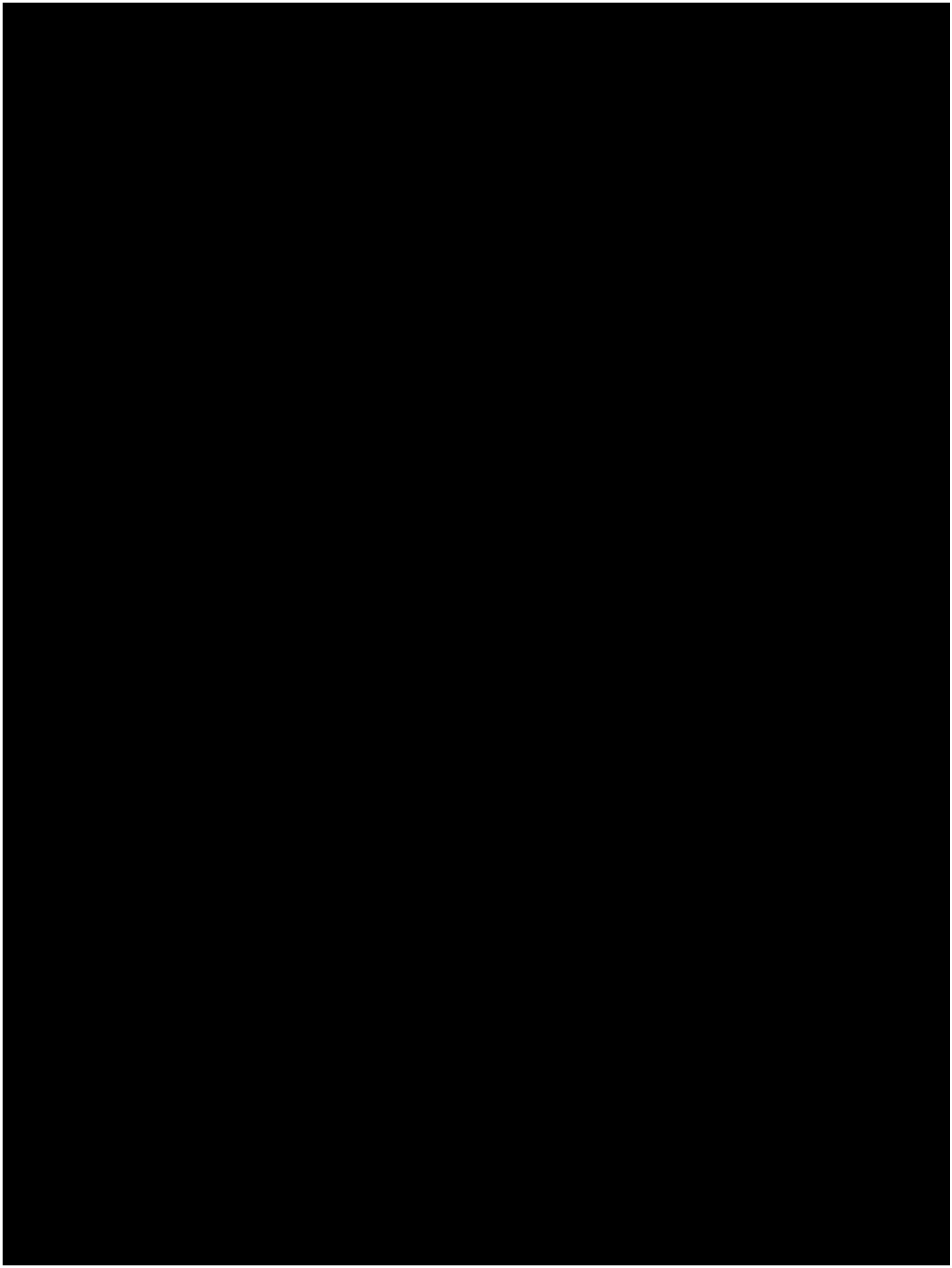


A Polaroid filter is like a mail box…..



Another demo…….

Two crossed polaroid filters as diagnostic tool……..



What good are Polaroid glasses?

They remove annoying reflections!

Because….

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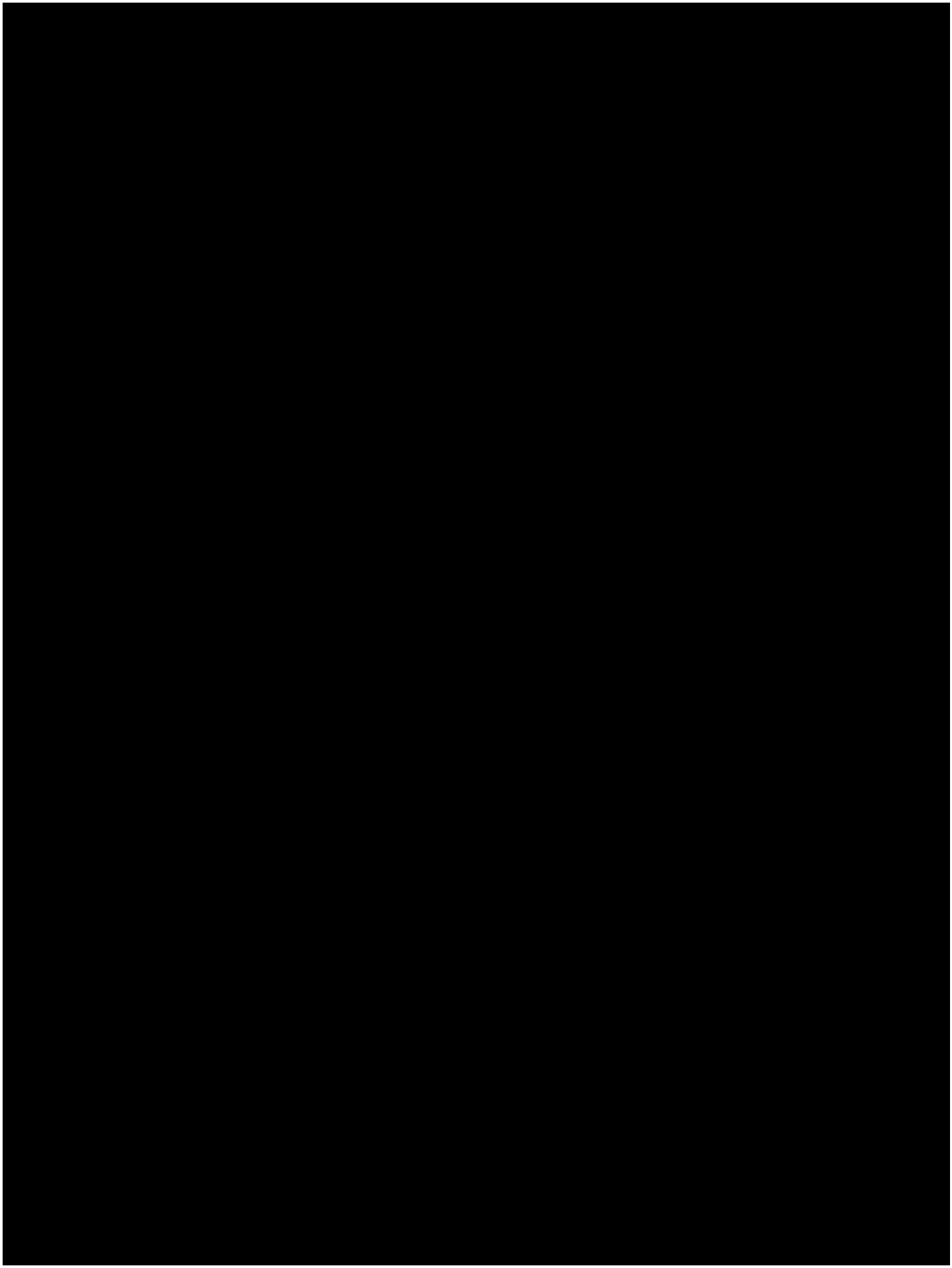
Because….

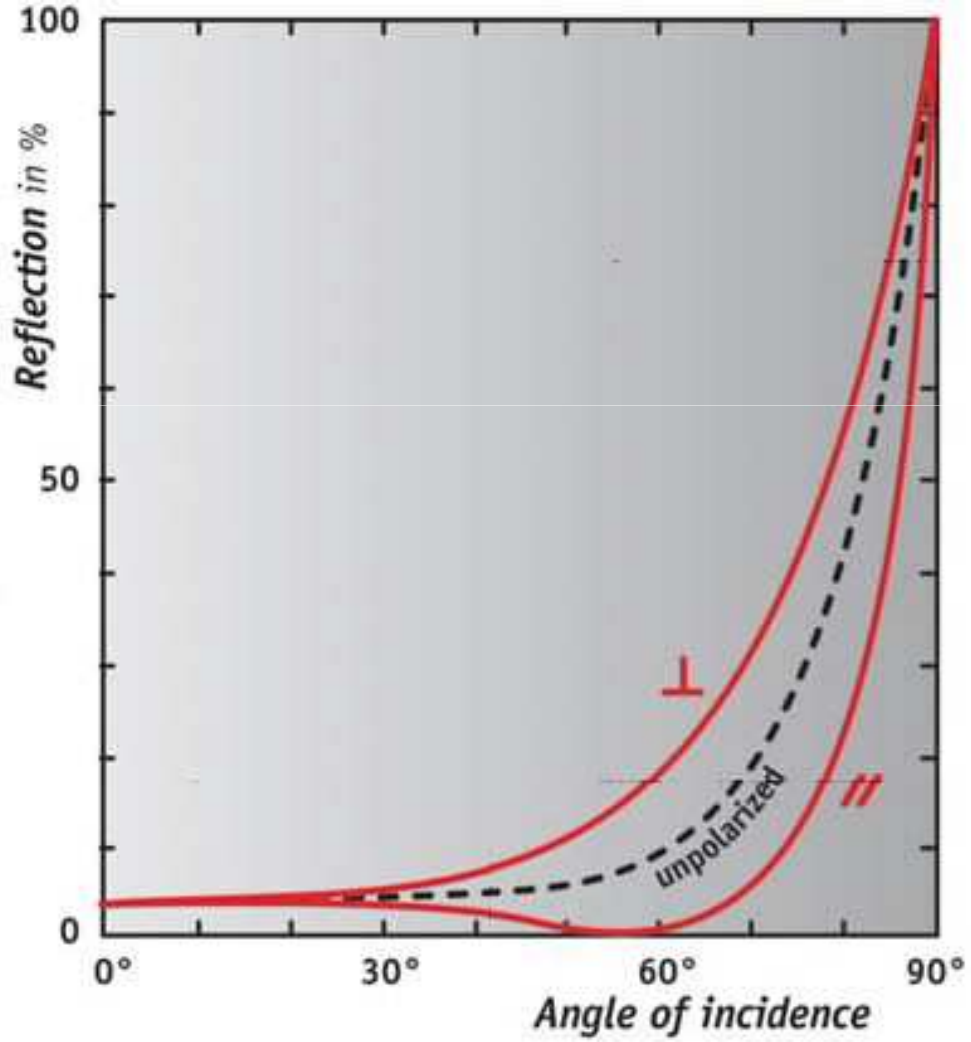
Reflected light is polarized!

Demo…..

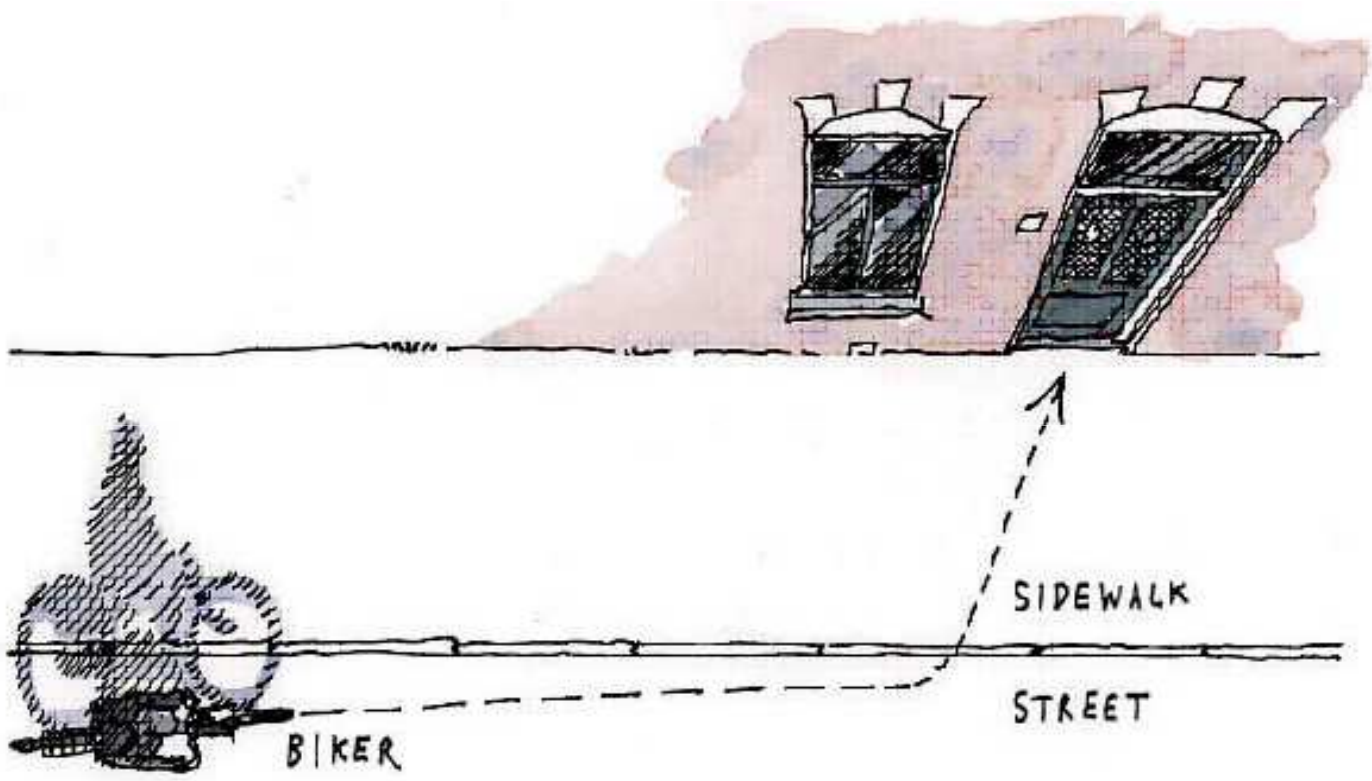


Reflected light is polarized

at water- or glass surface BECAUSE:



Where to get off your bicycle when in a hurry?



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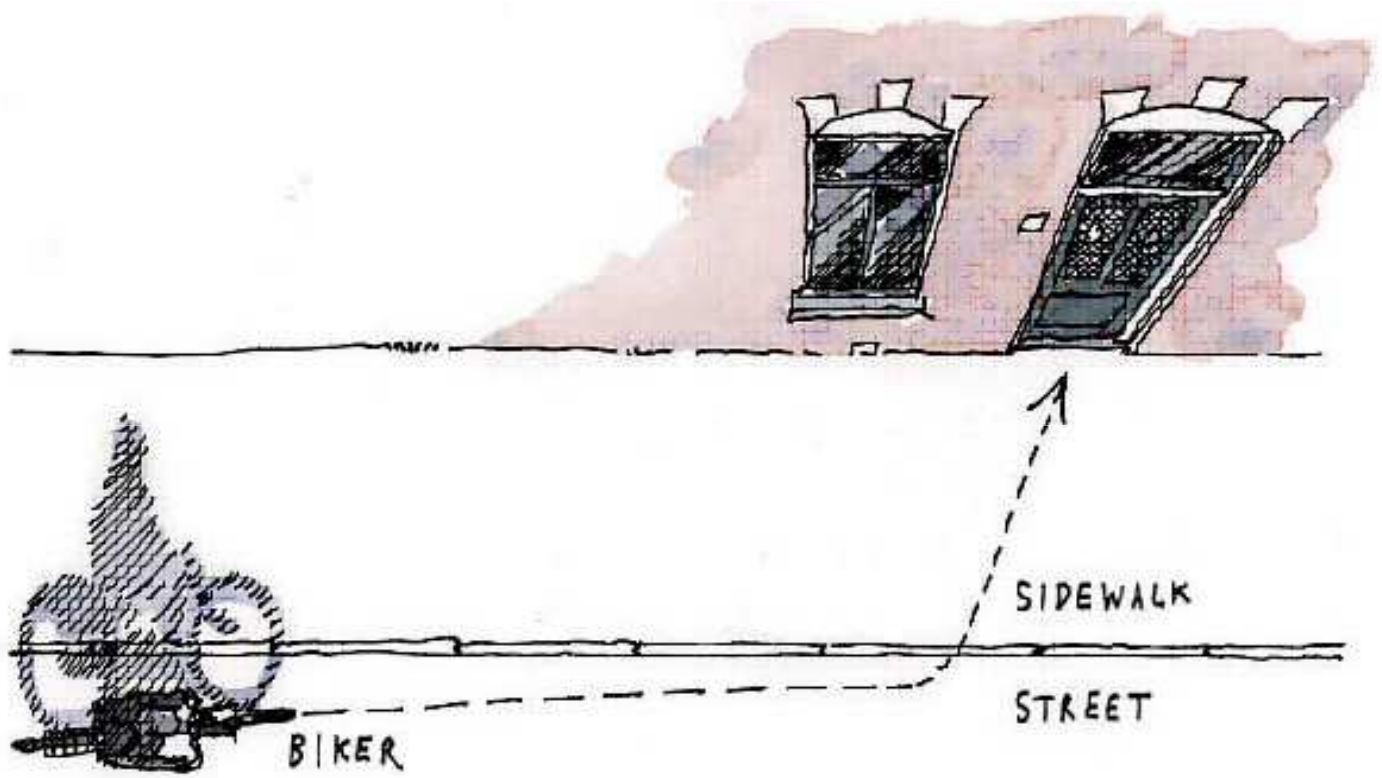
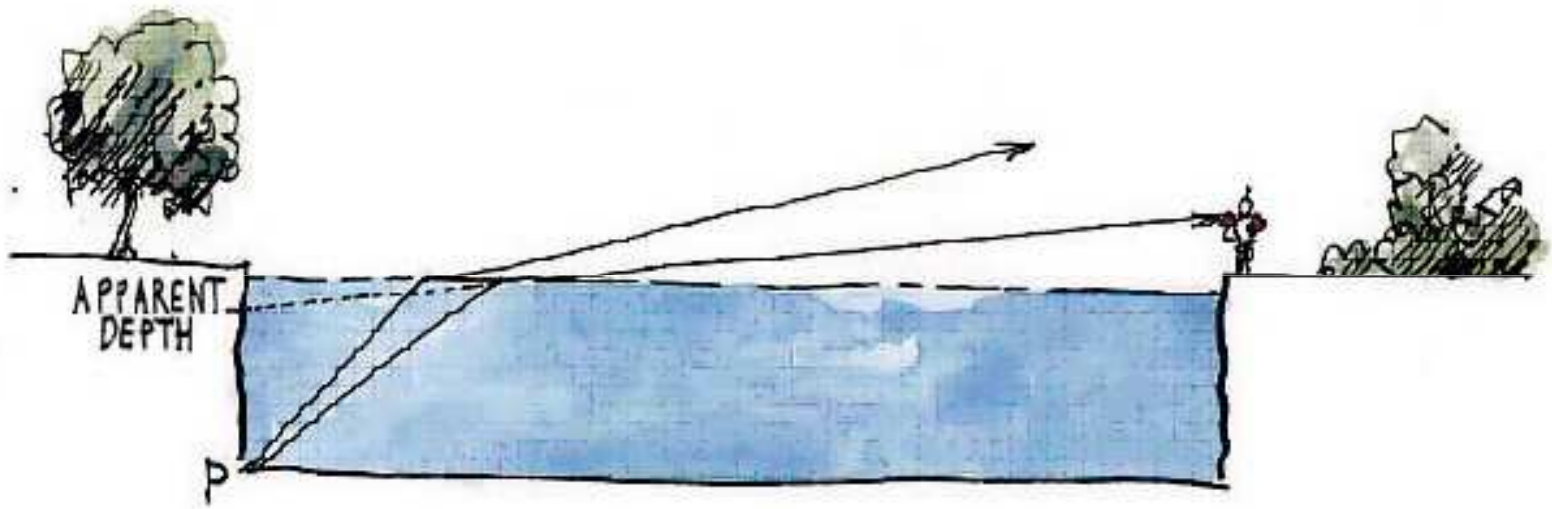


Follow the refraction law of light! (Snell's law)

Why does the pool look so shallow?



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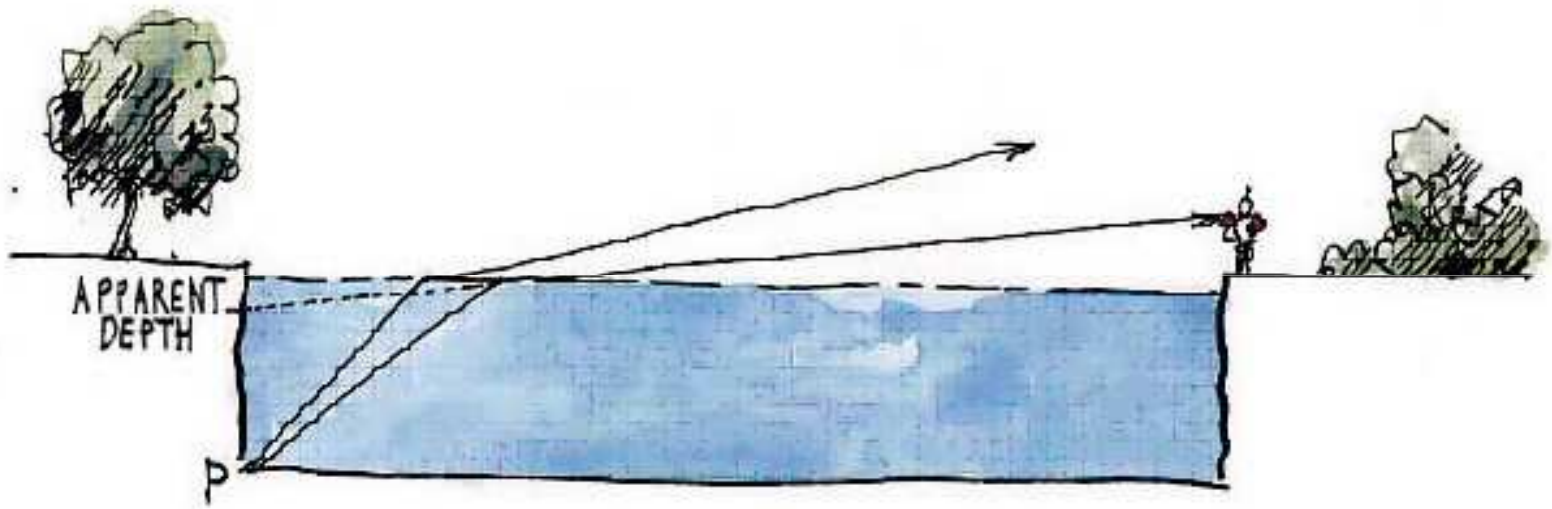
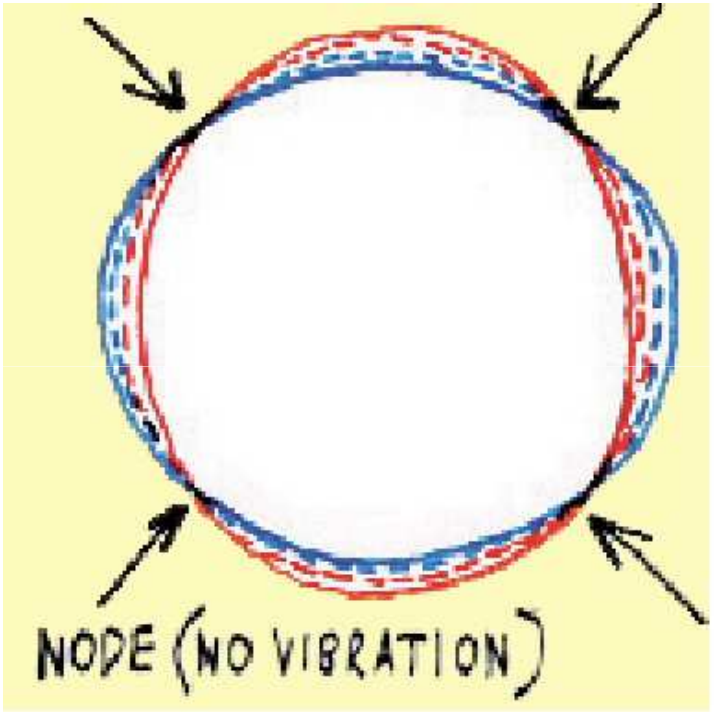


Light behaves like a hurried cyclist!

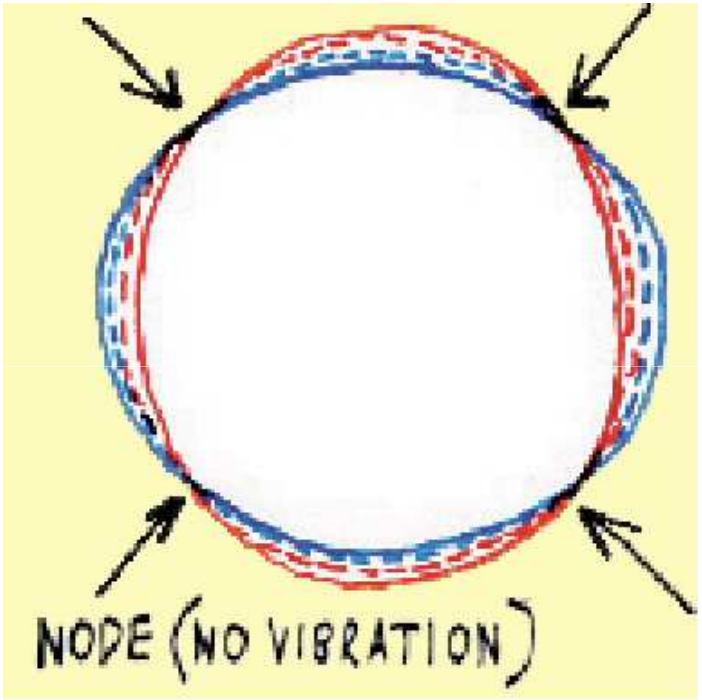
Why does a mug have TWO tones?

- Demo…..

Fundamental vibrational mode of mug ***without*** handle



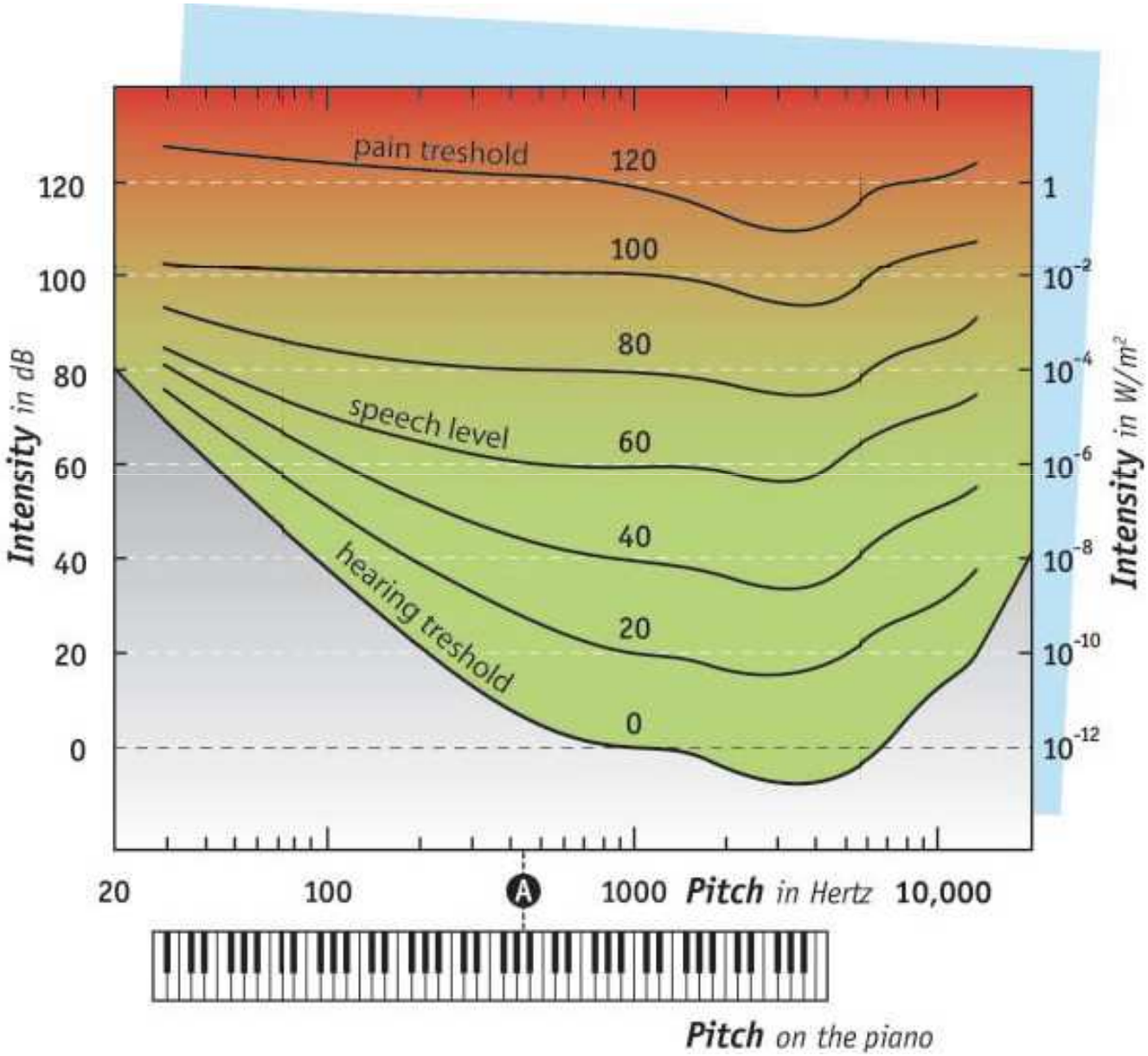
So: Why does a mug have TWO tones?



The frequency is lower if the handle vibrates along!

Remember: $\omega = \sqrt{(k/\mathbf{m})}$

How sensitive are our ears?



Note: Three surprises:

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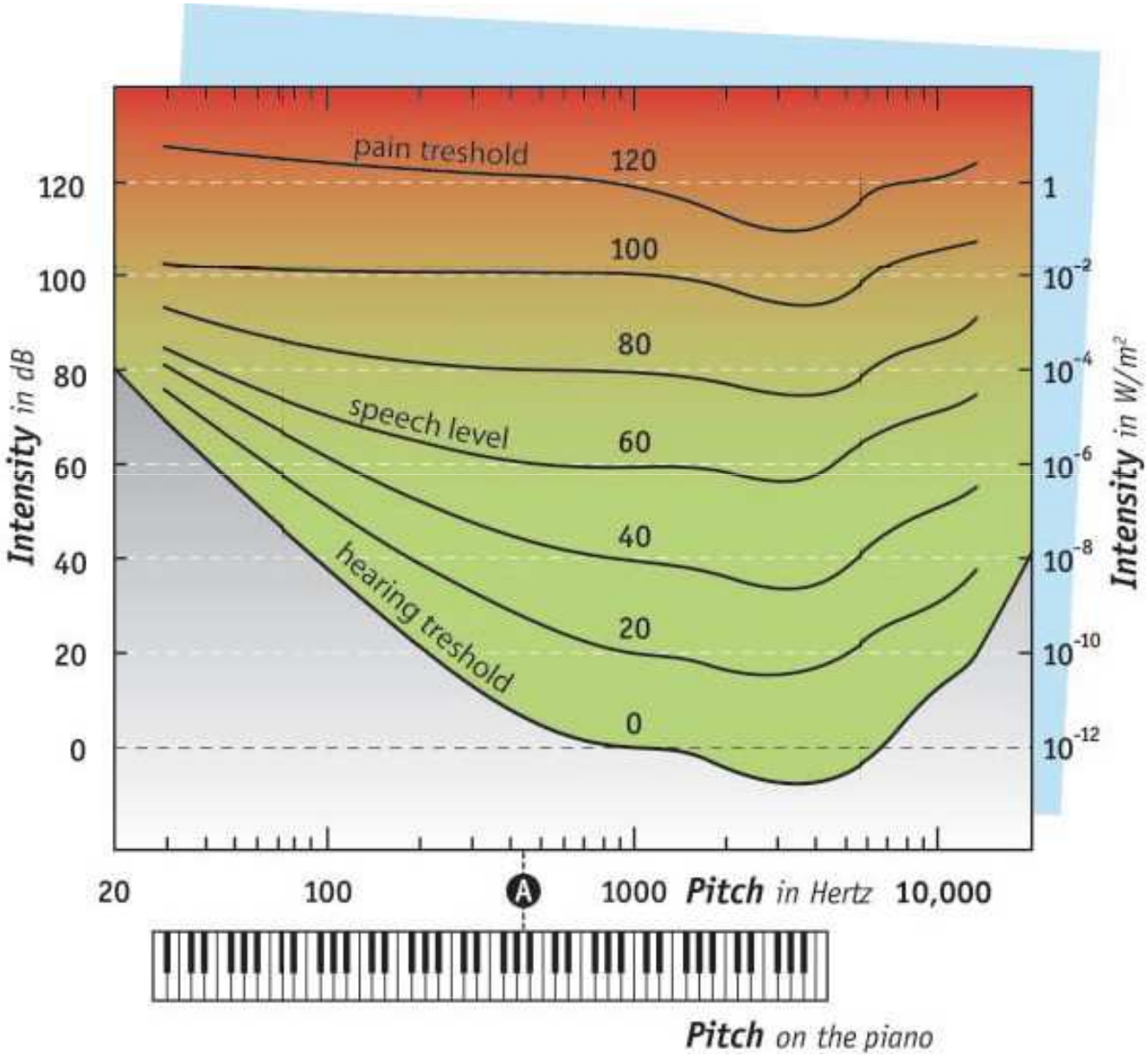
3. When turning down volume: ‘Loudness’ controll!


pain treshold
120
100
80
speech level
60
40
20
hearing treshold
0
120
100
80
60
40
20
0
Intensity in dB
1
10-2
10-4
10-6
10-8
10-10
10-12
Intensity in W/m2
20
100
A
1000
Pitch in Hertz
10,000
Pitch on the piano

The ‘Cocktail Party Effect’

- How to select one conversation in background noise?

- *Sound localization* is important tool!

Remember: Frequency and wavelength

- *Sound waves in air:*

Frequency: 20 Hz……20 000 Hz

Wavelength: 15 m……15 mm

↑

Head

How do we localize sound?

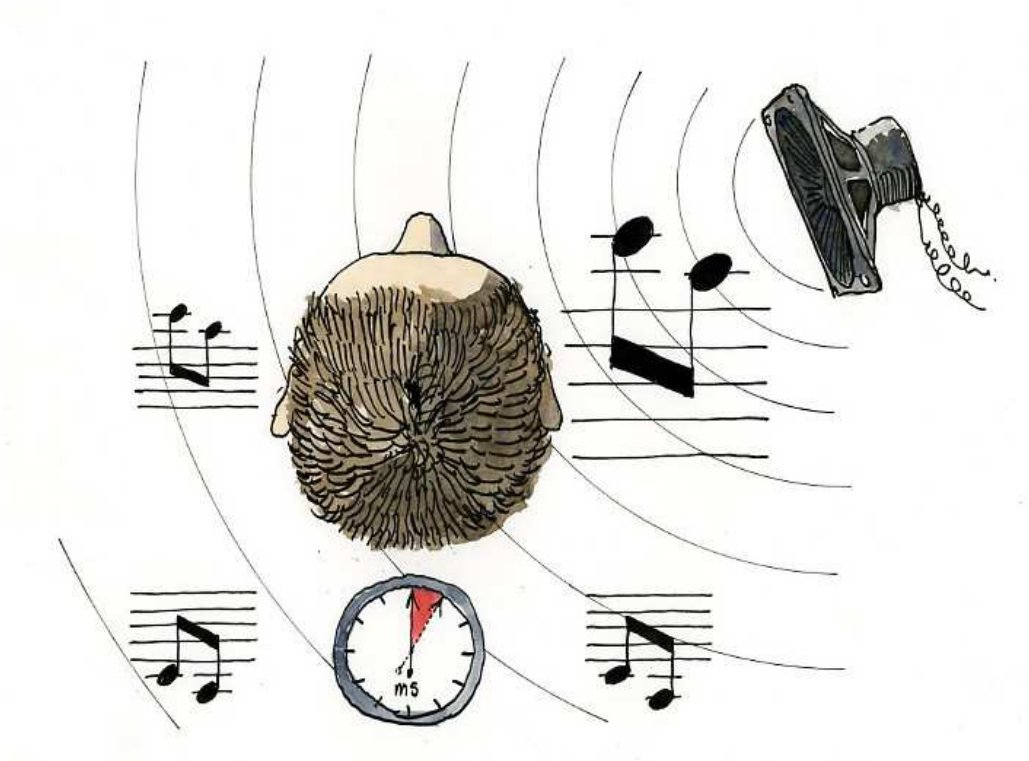
TWO mechanisms:

- For high frequencies:

  intensity difference

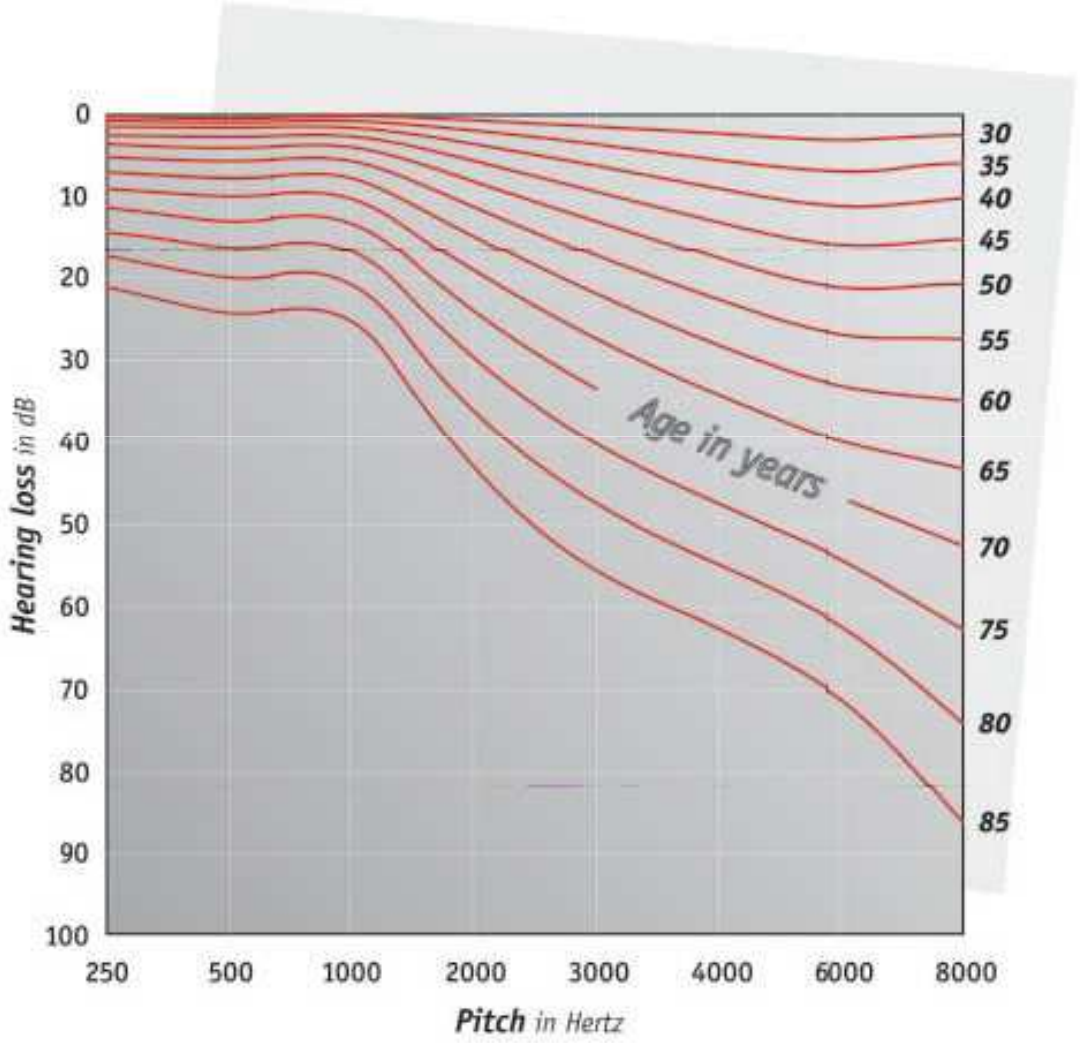
- For low frequencies:

  time difference



Hearing loss when getting older…..

- We loose primarily high frequencies!
- So we loose sense of localization



Why do tea leaves end up in the center?

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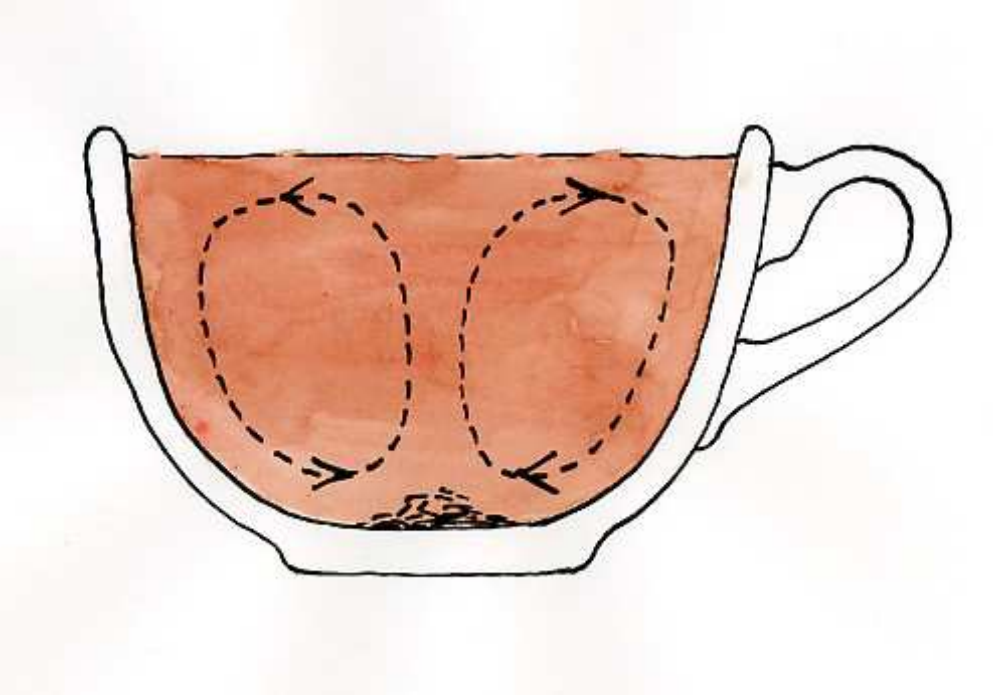


The centrifugal force is smaller near the bottom!

(due to friction)

Crazy pipe

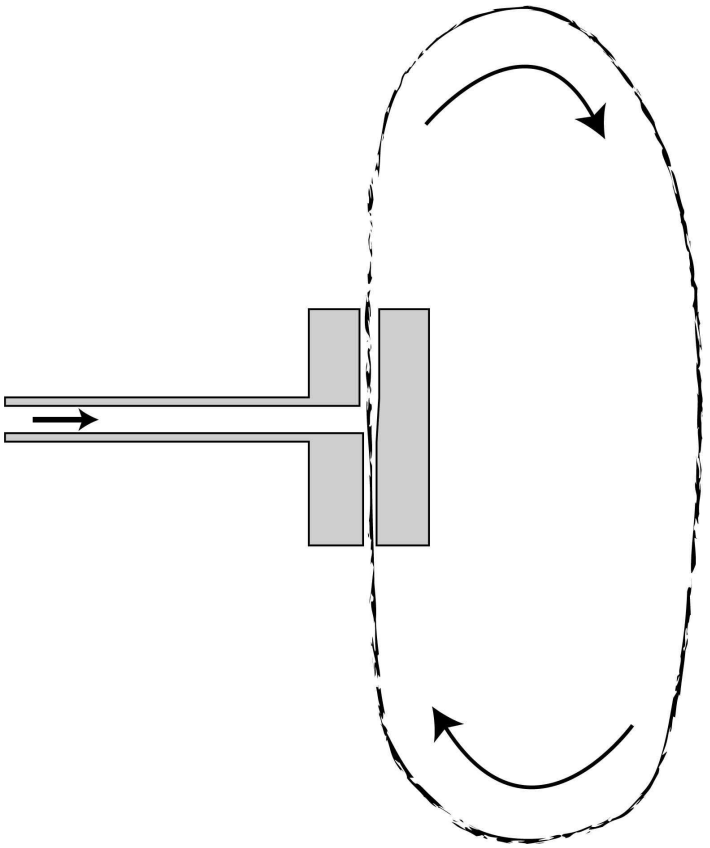
- DEMO…….

Crazy pipe explained

- Poiseuille flow profile:

  $v = (1/4\eta)(r^2 - R^2)\ \text{grad}\ p$

- Speed in center ~ R^2



Crazy pipe: Implication for our health

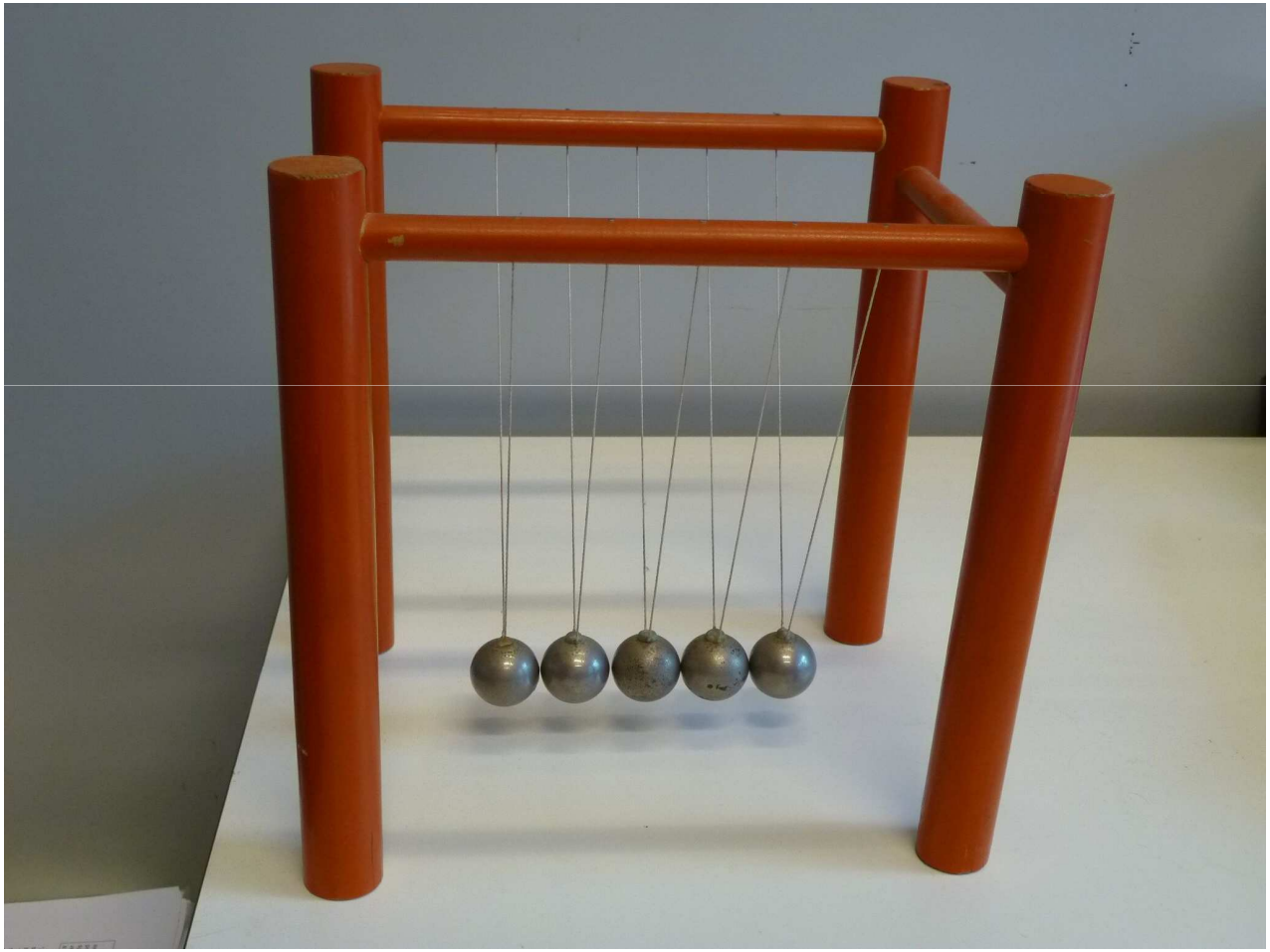
- Average flow velocity ~ R^2
- Cross section ~ R^2

→ *Volume* per second ~ R^4

($= \pi R^4 \Delta p / 8 \eta L$)

Now think of hardening arteries!!

Newton’s cradle



Newton's cradle: 1 *vs*. 2 balls

Suppose:	*IN*		*OUT*
	m, v		2m, ½v
• Momentum:	mv	=	mv
• E_{kin}:	$\frac{1}{2}mv^2$	≠	$\frac{1}{2}(2m)(\frac{1}{2}v)^2$

Why does flowing air behave so funny?

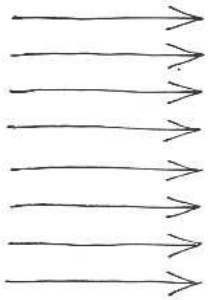
DEMO’s….

Why does flowing air behave so funny?

- Where speed is *high*, pressure is *low*

  (Bernoulli: $p + \frac{1}{2}\rho v^2 = constant$)

1. *Ping pong ball*
2. *Air flow between two discs*
3. *Ball having spin*



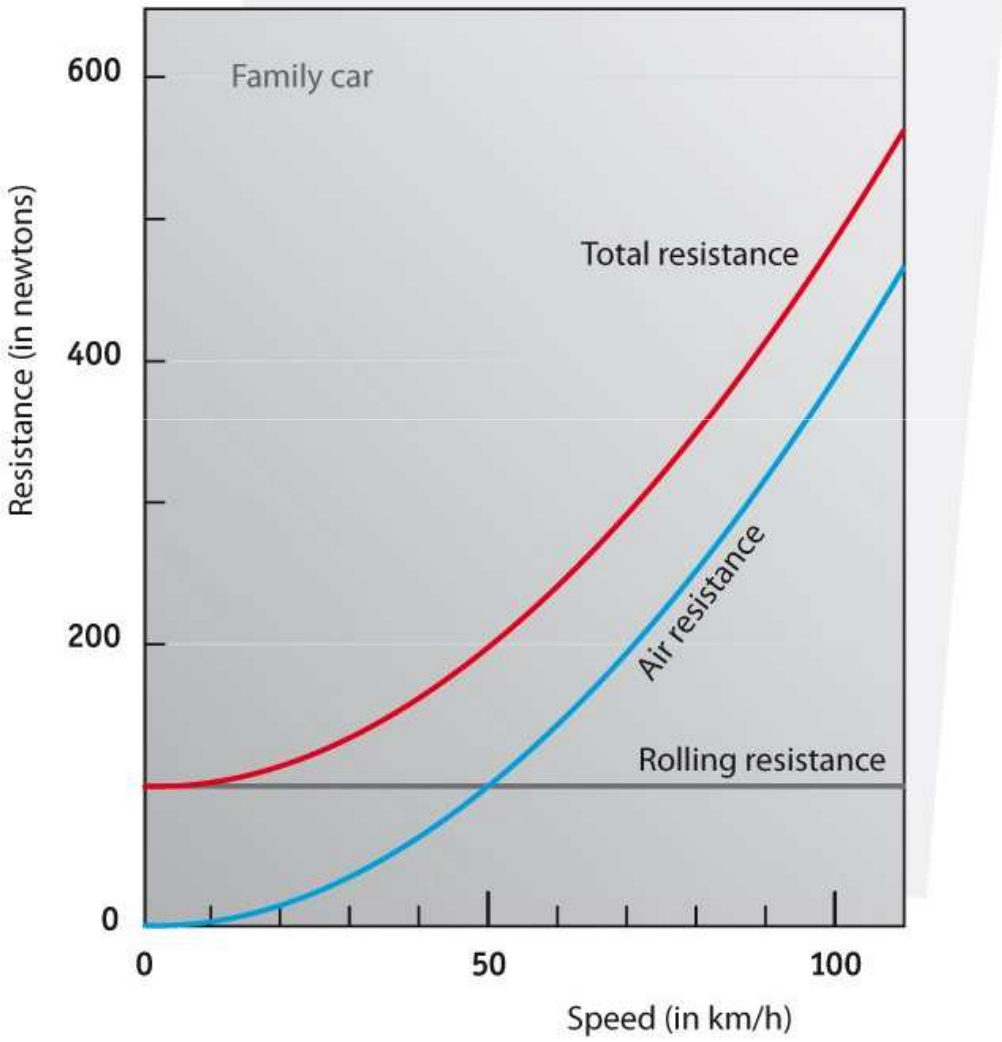
Topspin case*:*

Why driving fast costs more energy

- **Resistance** is the key for energy use

Rolling resistance = $C_r mg$

Air resistance = $AC_d \times \frac{1}{2}\rho v^2$



Why driving fast costs more energy

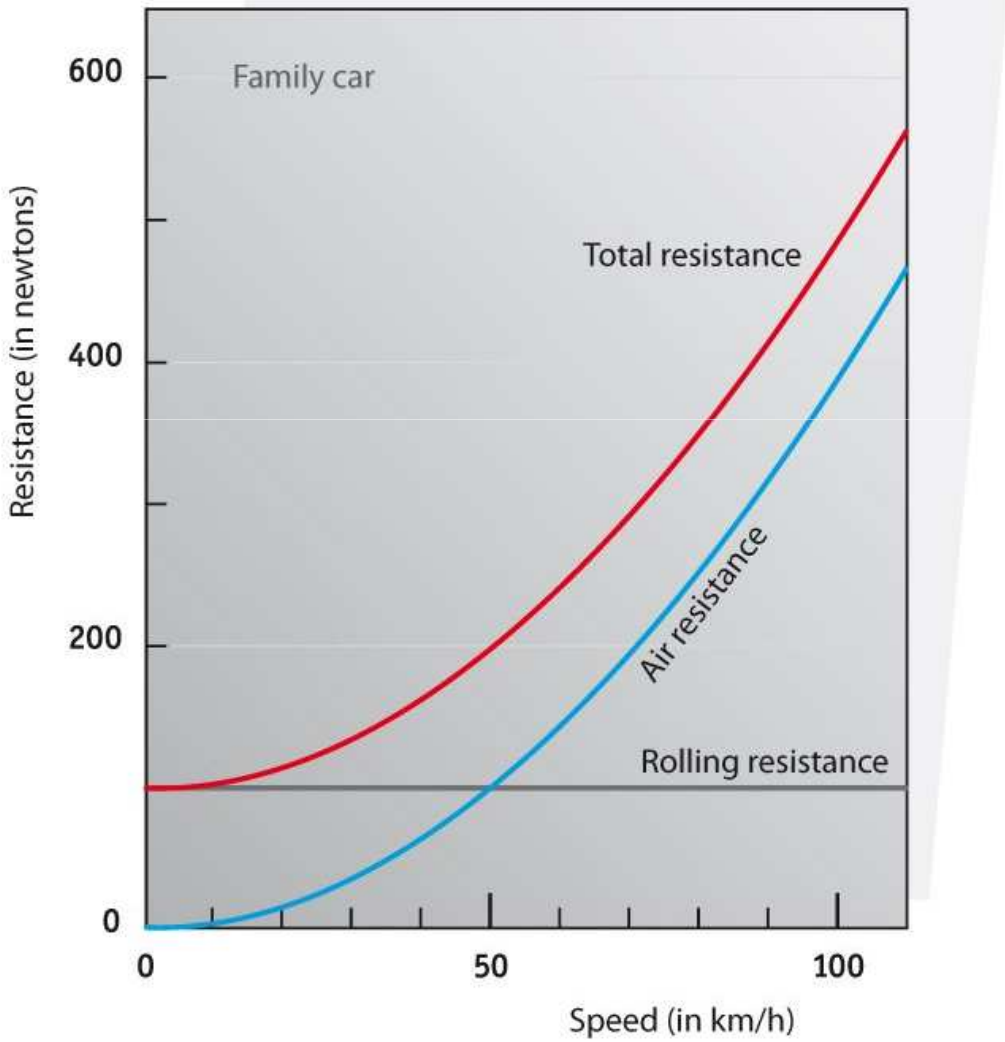
- **Resistance** is the key for energy use:

Work = Force × distance

→ Force = Work / distance

(1 N = 1 J / m

= 1 kJ/km)



Why is the air so dry in winter?

Why is the air so dry in winter?

- Outside, water vapor condenses,

  so humidity is low

- Inside at higher temperature the relative humidity is low

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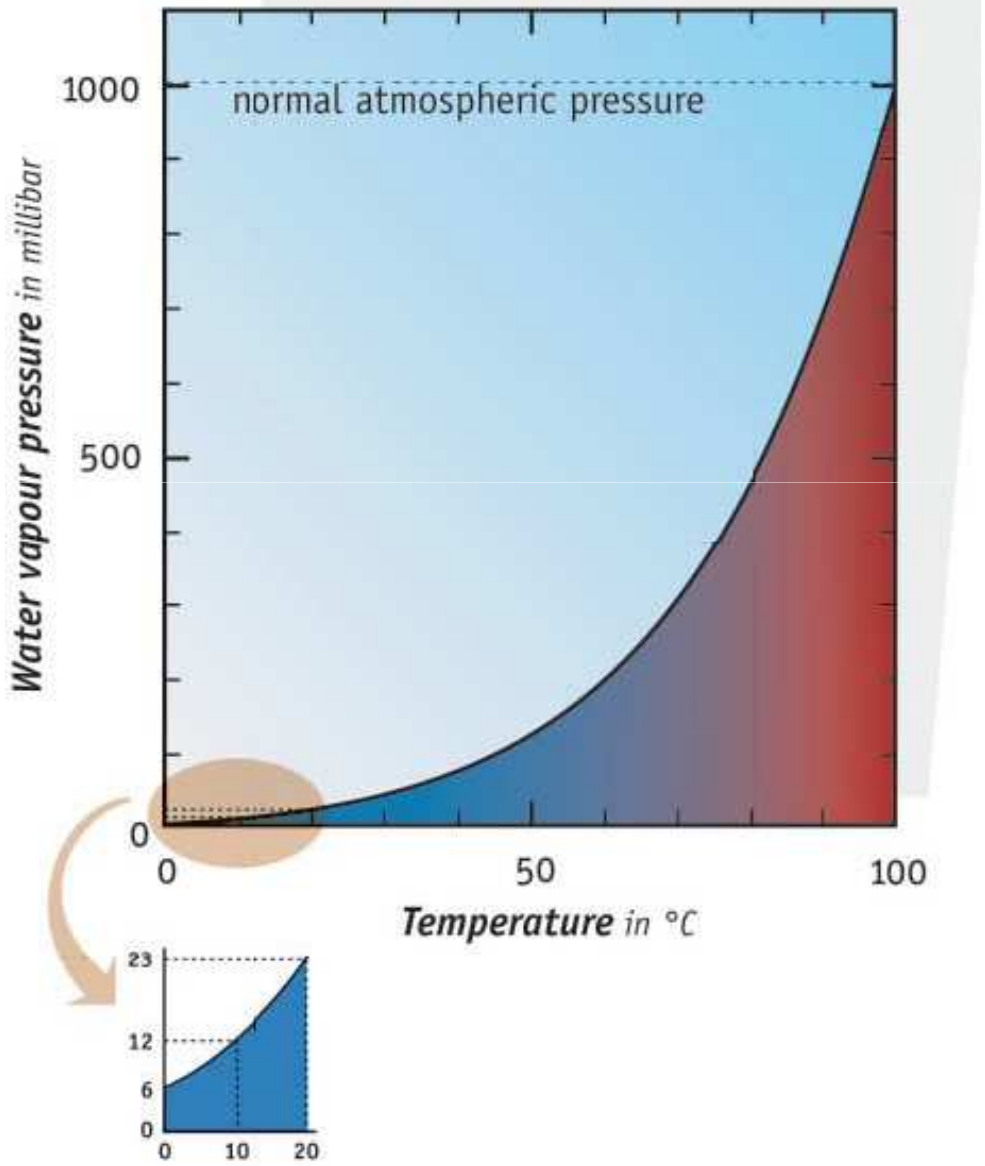
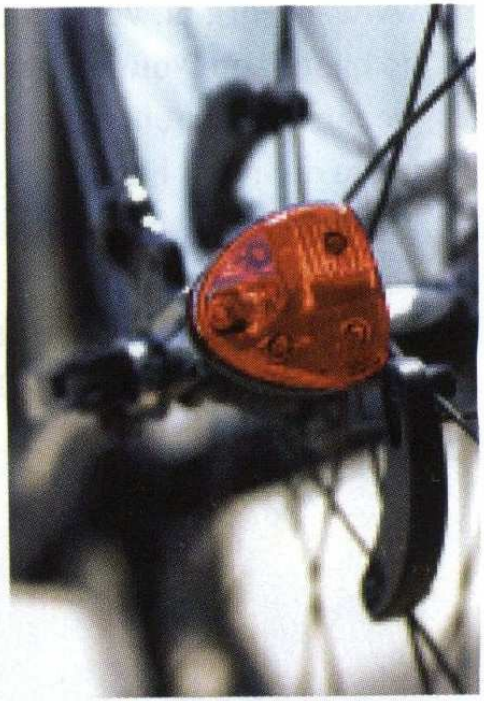


Free energy? (stupid Dutch *bicycle light* advertisement)

ALTIJD LICHT OP DE FIETS

Nu het weer vroeger donker wordt, is goede verlichting op de fiets een vereiste. Een geweldige en energiebesparende oplossing zijn deze fietslampjes zónder batterij. Want Reelight is een setje ledfietslampen dat zijn eigen energiebron is. Magneten aan het wiel wekken via inductie, dus zonder extra weerstand bij het trappen, de benodigde energie op. En doordat de verlichting altijd brandt, ook overdag of wanneer u stilstaat voor het stoplicht, verkleint Reelight de kans op ongelukken met veertig procent. De lampjes kosten € 33,- per set. Meer weten? Kijk op www.reelight.com. De lampjes zijn verkrijgbaar via www.pointbike.nl.

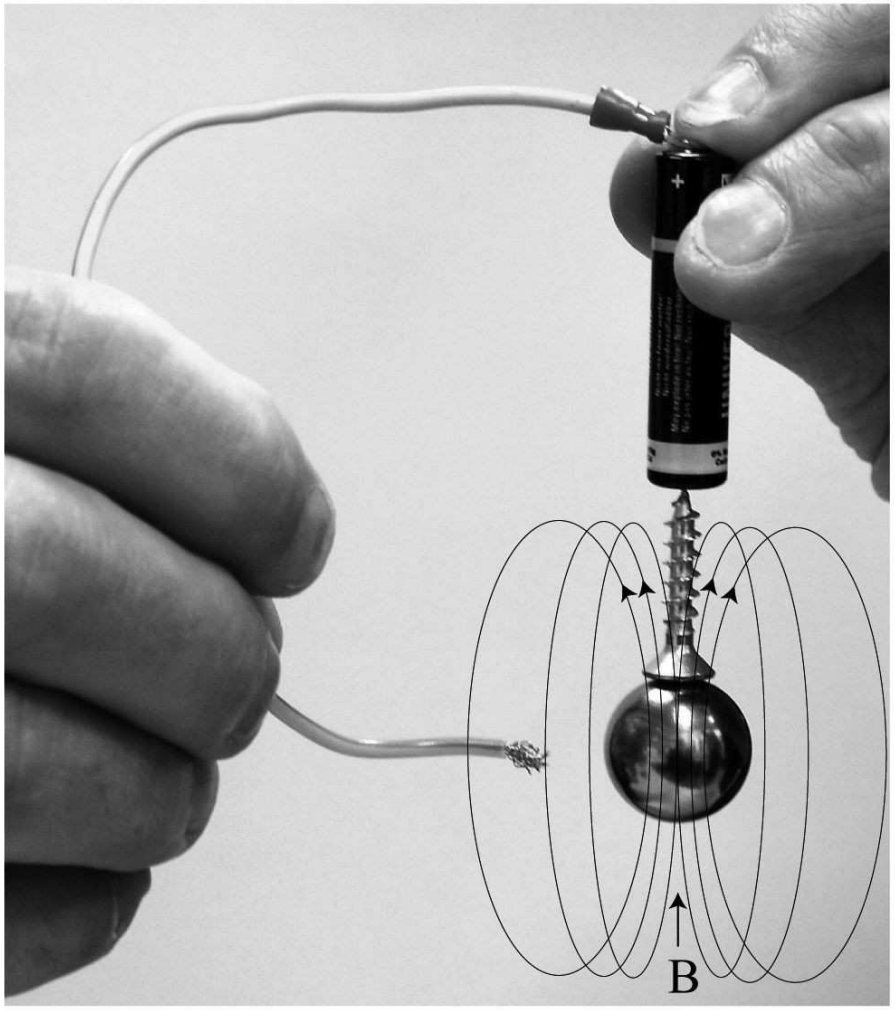


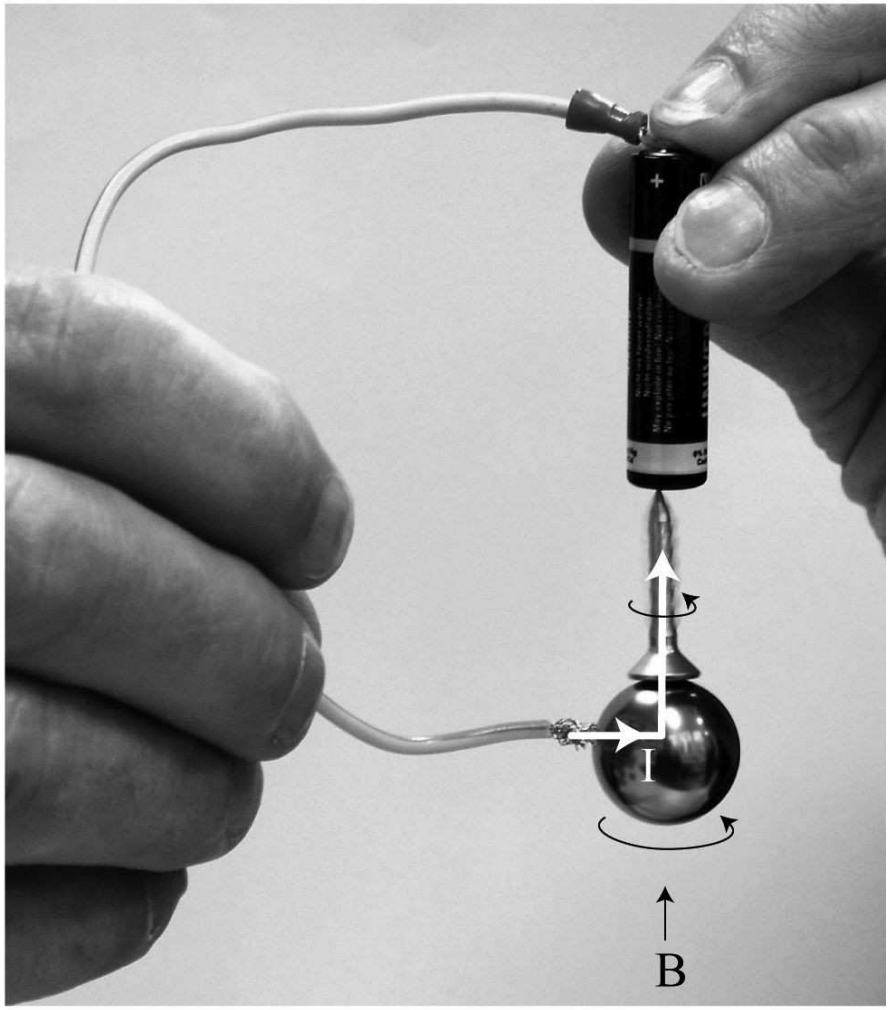
Nonsense, of course!

DEMO……

The simplest motor in the world….

The simplest motor in the world….





Finally:

- The reckless wine glass……