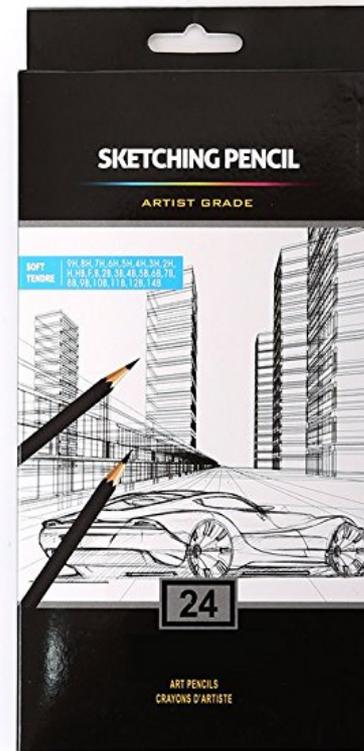


# paper & pencil electronics



**Andreas Bernhard Wagner & graphene  
@lowfatcomputing**

# resistors

softer

→ more conductive

harder

→ more resistive



Roll over image to zoom in

dainayw  
24 Drawing Pencils Set, Art Sketching Pencils 14B, 12B, 10B, 9B, 8B, 7B, 6B, 5B, 4B, 3B, 2B, B, HB, F, H - 9H, Graphite Pencils for Adults & Kid Artists  
★★★★★ 29 customer reviews | 3 answered questions  
Amazon's Choice for "shading pencils for sketching"

Price: **\$10.59** ✓prime  
FREE Shipping on orders over \$25—or get FREE Two-Day Shipping with Amazon Prime

Coupon  Save an extra 15% when you apply this coupon. Details

- 24 Graphite drawing pencils for artists kit include every color you need: 14B, 12B, 11B, 10B, 9B, 8B, 7B, 6B, 5B, 4B, 3B, 2B, B, F, HB, H, 2H, 3H, 4H, 5H, 6H, 7H, 8H, 9H.
- Complete Archival Quality Artist Sketching Set, Perfect gift for the Beginning Artist and artists looking to take their Shading & Sketching to a PROFESSIONAL LEVEL.
- A smooth writing feeling, Top-quality graphite pencil for writing, a hexagonal shape that prevents rolling off the table, this multipurpose artists set will keep you crafting fine, detailed illustrations & textured shading like a pro.
- Crafted from the finest basswood, these artist pencils for sketching contain Evenly Distributed Graphite resulting in a Longer Lasting Point, A lightweight Balance that Feels Good in Your Hand, Enhances Your Control & creates Richly Pigmented, Ultra-Smooth & Even Color laydown every time.
- 100% SATISFACTION GUARANTEE: We set out to create the perfect art supplies for drawing, We guarantee you'll love how they layer down richly pigmented color that blends flawlessly & resist cracking, chipping & breaking - or we'll refund your money 100% - no questions asked! Best Art Supplies for Drawing

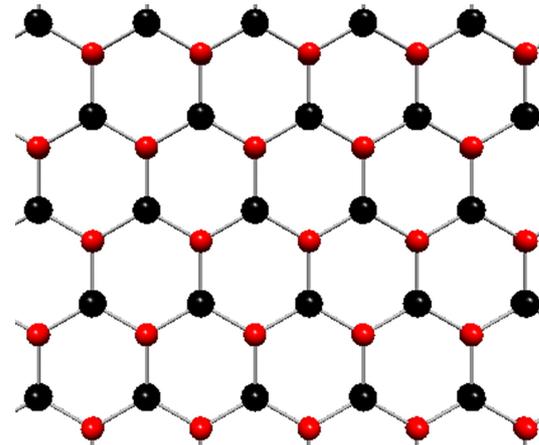
note: sometimes clays and oils are added to the softest pencils

# graphite vs graphene

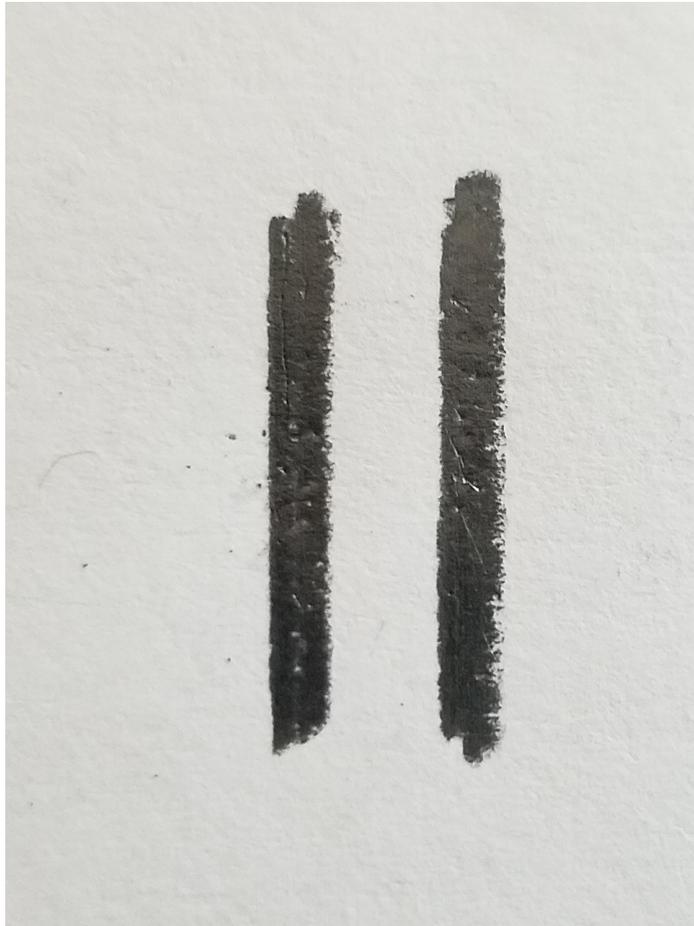
A single layer of **graphite**, is known as **graphene**

...and can be peeled off with scotch tape

graphene is more conductive than graphite



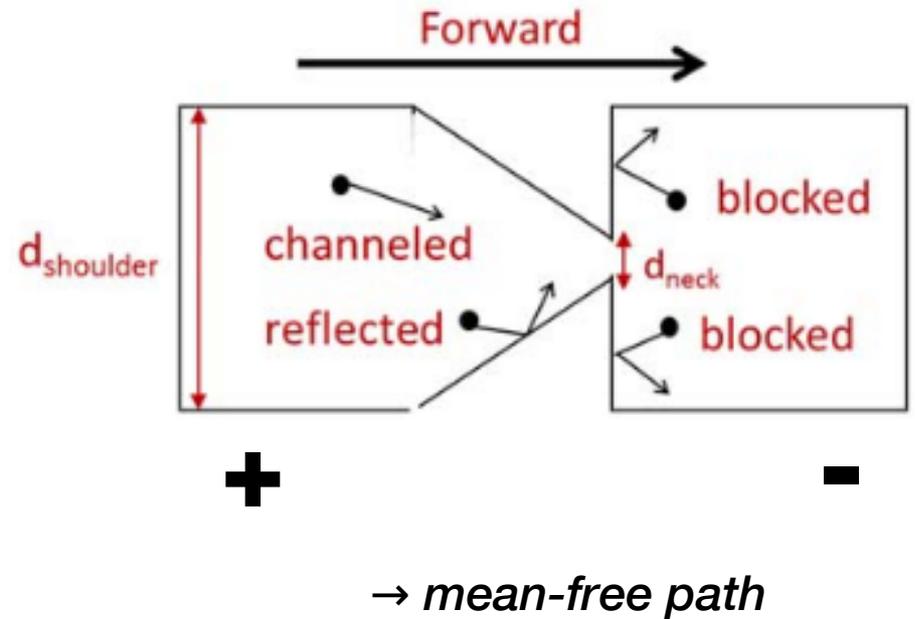
# capacitors



**40nF capacitor**

- paper dielectric
  - remember, the paper has two sides
- ...and you can stack sheets of paper too.

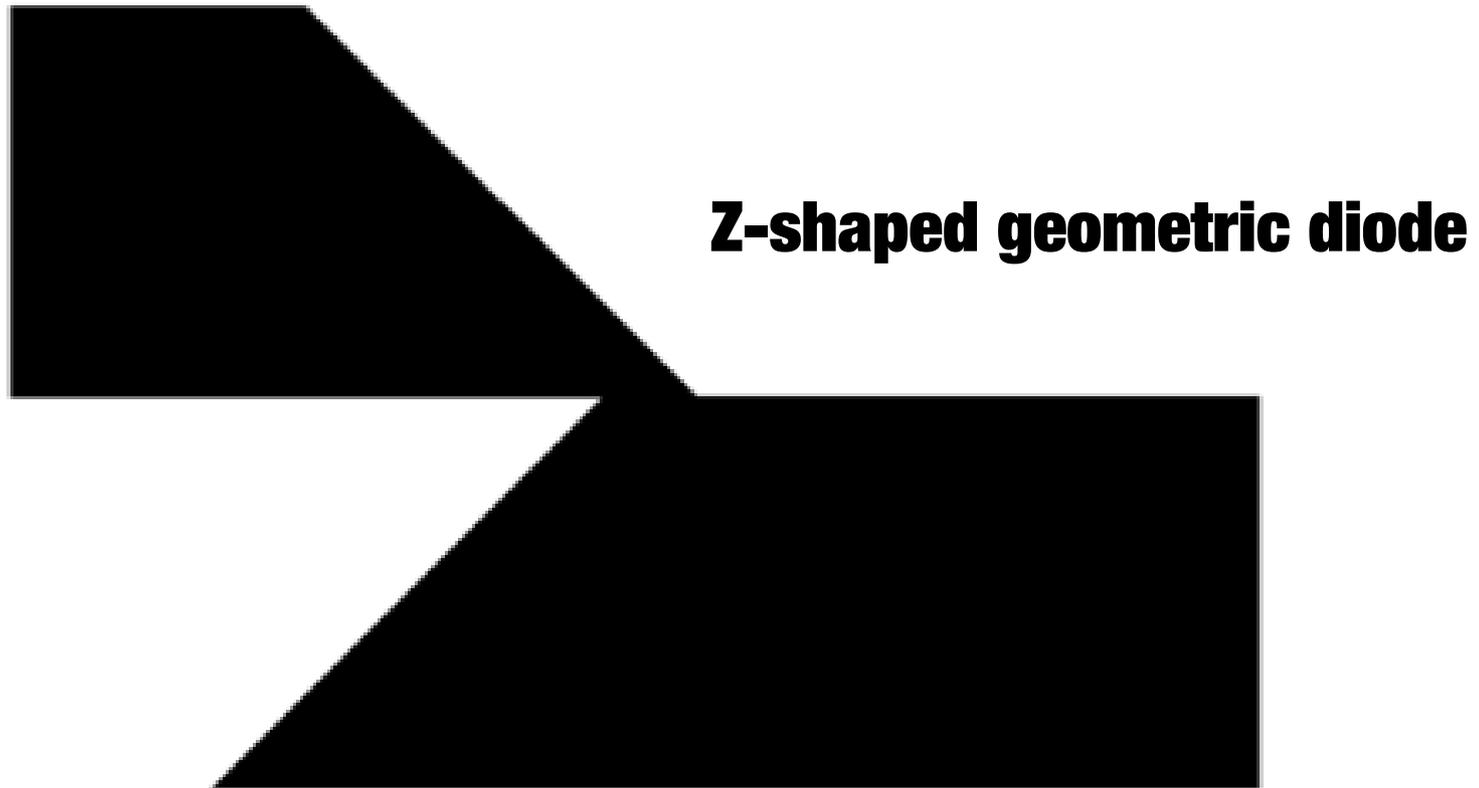
# diodes



I needed a tiny gap between the anode funnel and the cathode block.

**-V reverse bias**  
**+V forward bias on my multimeter**

# diodes



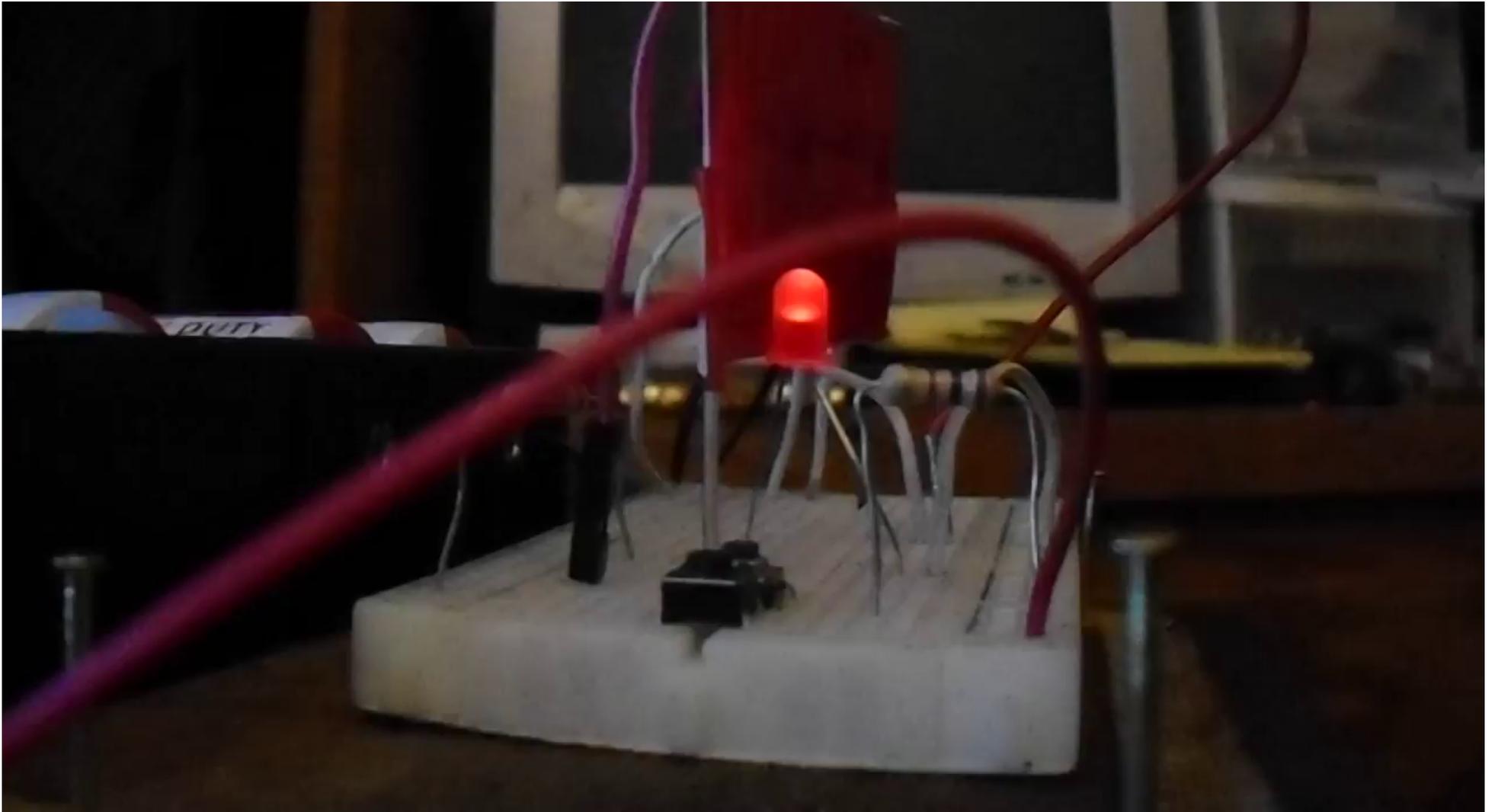
(another geometric diode with even higher asymmetry)

**PCB:** geometric figures you draw define the electrical connections between components

**Chip design:** geometric figures also create the components themselves

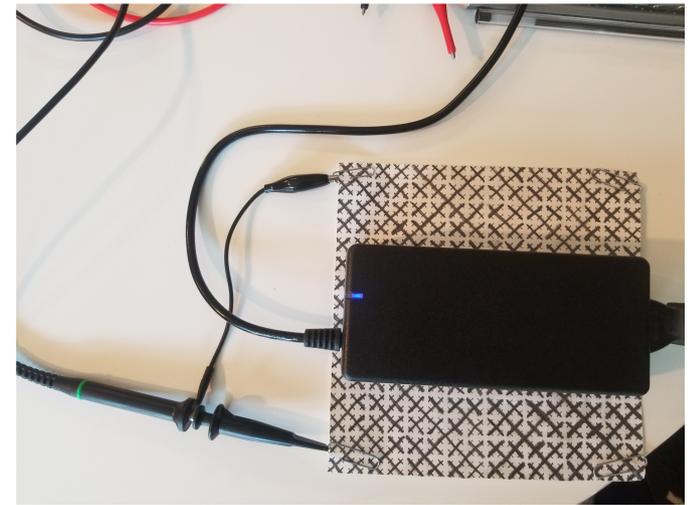
# transistors

**Scott's NPN transistor NOT Circuit:**



<https://hackaday.io/project/21622-graphite-circuitry-experiments>

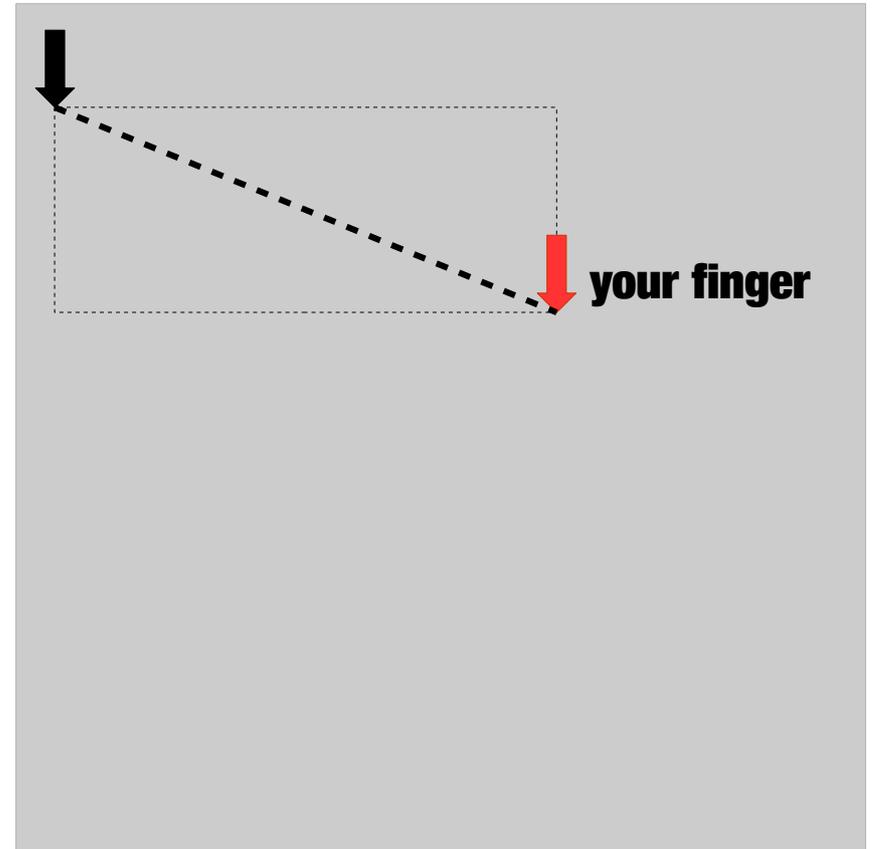
# antennas...



**60Hz**

# (capacitive) touch input

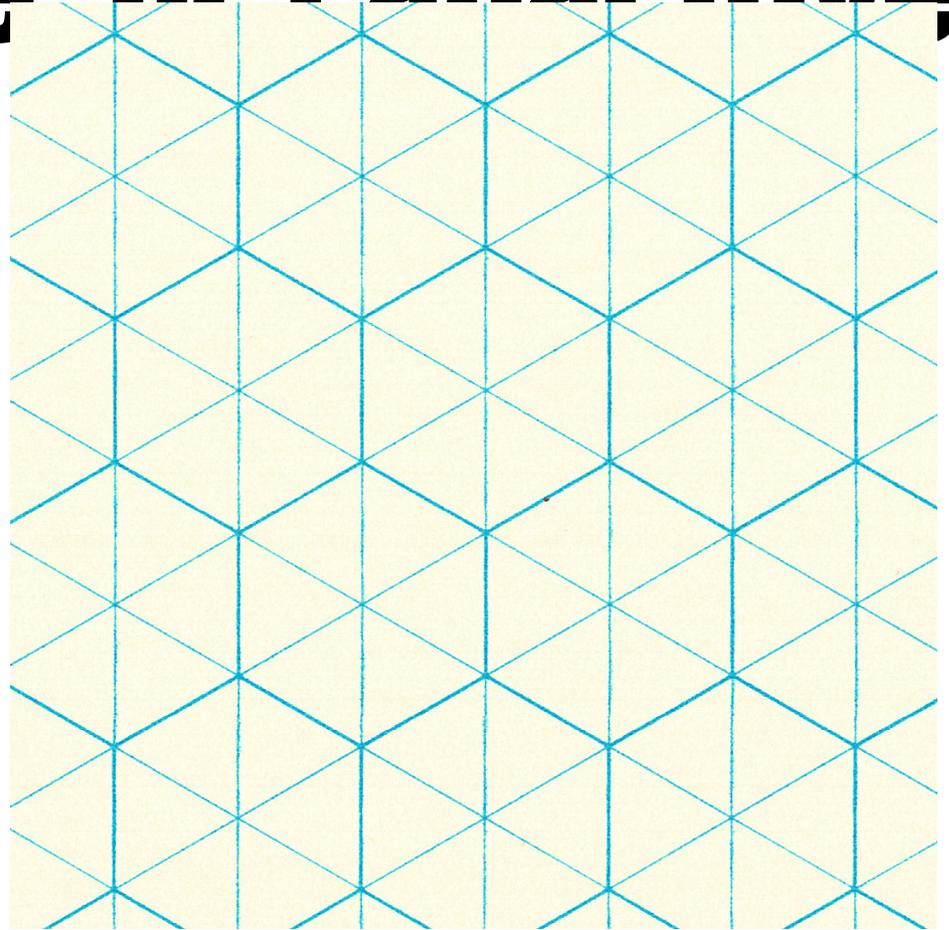
- Your body holds a lot of charge
- Touching a filled area is very noticeable
- Change distance:
  - variable resistance
- aperiodic pattern to distinguish x and y



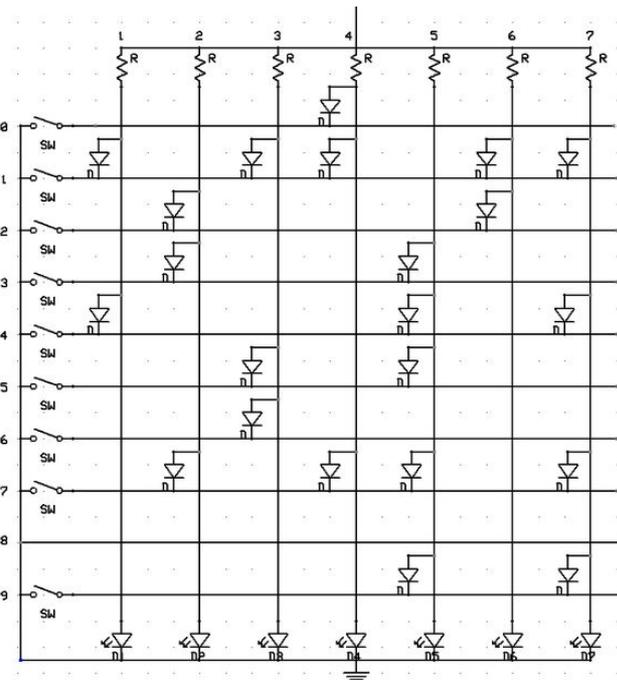
# matrix rom

( resistive, diode or capacitive )

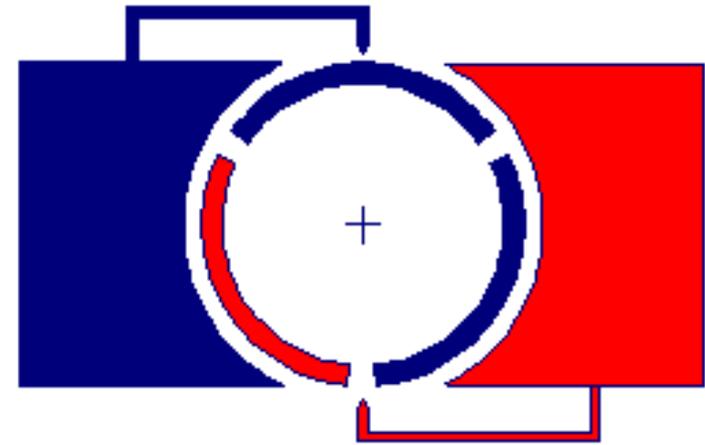
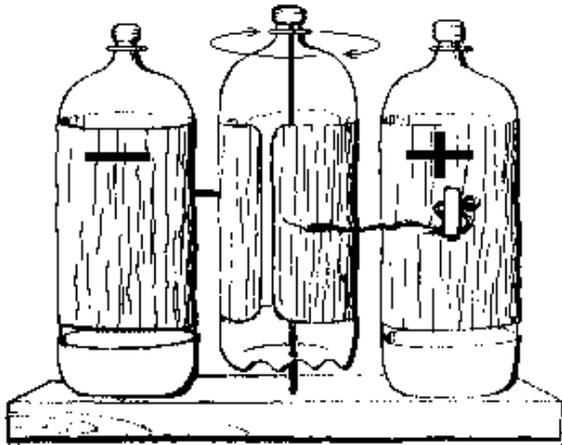
- data & code on sheets of graph paper?
- hexagon paper for easier access



**Hexagon graph paper:  
good for chemistry and for routing circuits**



# mechanical vane displays?



mechanical vane display

- electrostatic motor
- vane or moiré mechanical display

**but will my graph paper run Forth?...**

**Questions ? Comments .**