Electric Charge

Electron is negative
Proton is positive
(no smaller electric charges)

Benjamin Franklin:
- Silk rubbed glass is positive
- Fur rubbed rubber is negative

OOPS!

Charge is measured in Coulombs (C)

1 Coulomb = 6.28×10^{18} charges

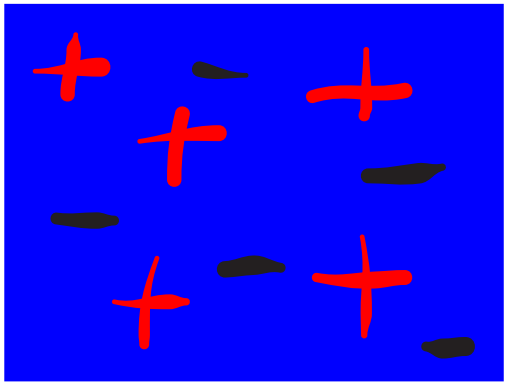
Dragging your feet on the carpet during winter adds -1×10^{-6} Coulombs of charge

Electric Charge II

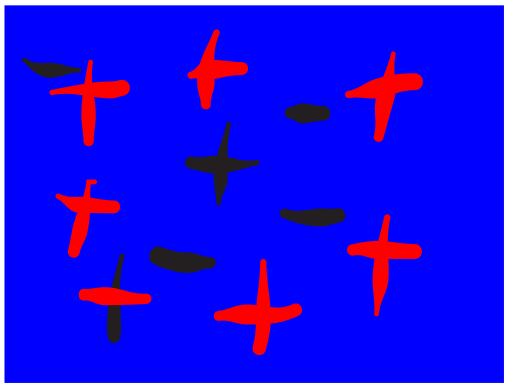
Neutral objects have both negative and positive charges (an equal number of both)

Something positively charged has more positive charges than negative

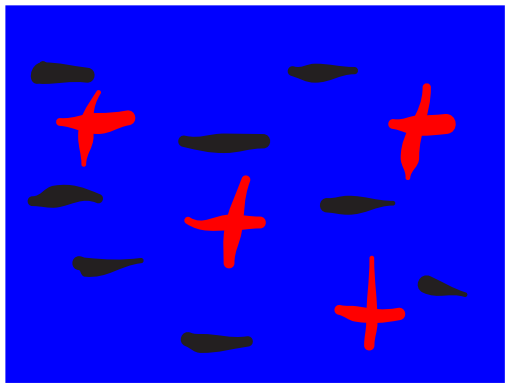
Something negatively charged has more negative than positive



neutral



positive

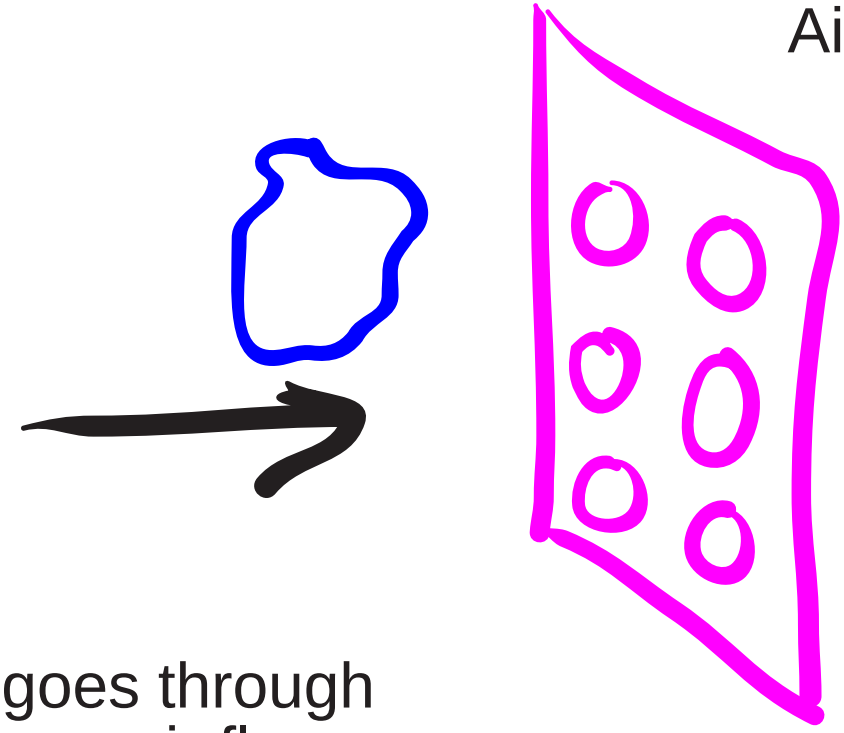


negative

Dust Filters

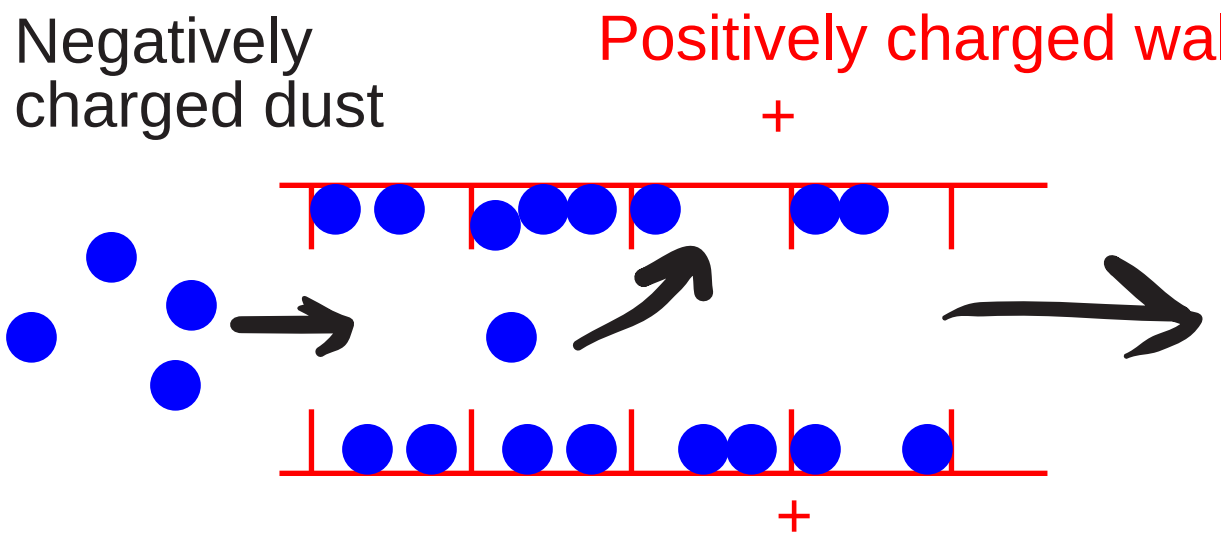
Can filter dust by passing air through small pores:
air goes through, large dust particles get trapped

Dust floats around
Gravity pulls down
Buoyancy keeps it up
Air resitance slows it
Air currents move it



Problem:
small dust goes through
clogging slows air flow

Electronic Air Cleaner



Blow air through electronic air cleaner, negatively charged dust sticks to positively charged walls

Electric Force

Like charges repel

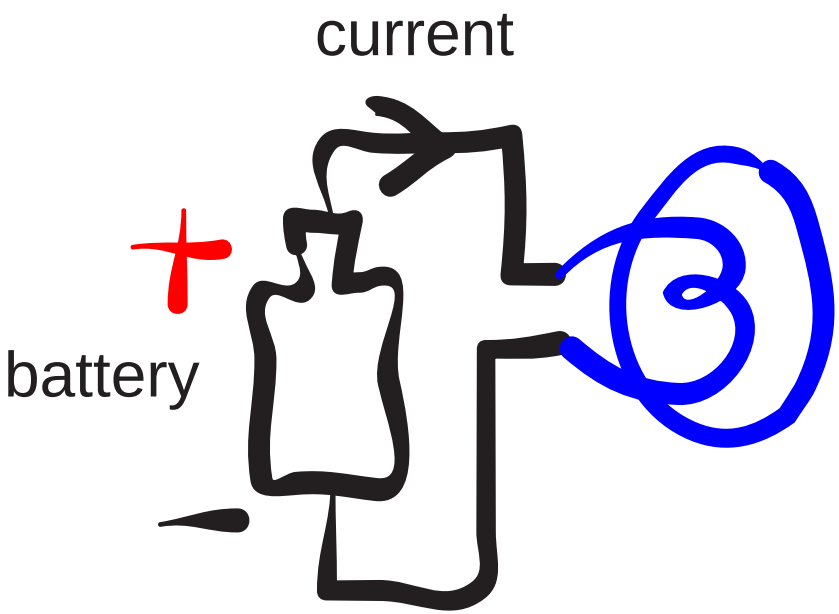
Unlike charges attract

The closer the charges, the stronger the force

Coulomb's Law $F = \frac{k\, q_1\, q_2}{R^2}$

Force is proportional to the product of the charges divided by the distance between them squared

Voltage



Power supply (battery) pushes current around the circuit

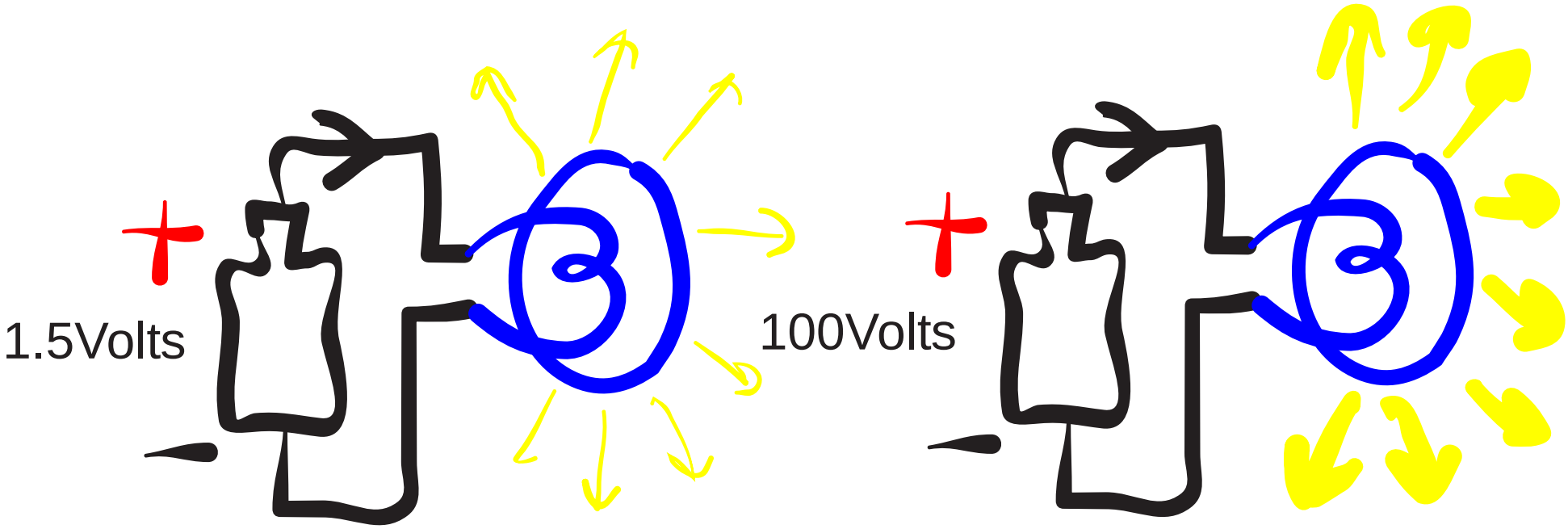
Battery keeps one side positive and other negative

Work is done in lighting the bulb

This work comes from the charges in the circuit which in turn comes from the battery

Voltage measures the potential energy of a unit of charge at a particular location

Voltage II



Positive charge has some potential energy (it wants to go to the negative terminal).
As it moves to the negative terminal, it releases energy in the bulb, lighting it.

Positive charge has much more potential energy and releases much more to the light bulb.
Light bulb glows better.

Dust

What is dust?

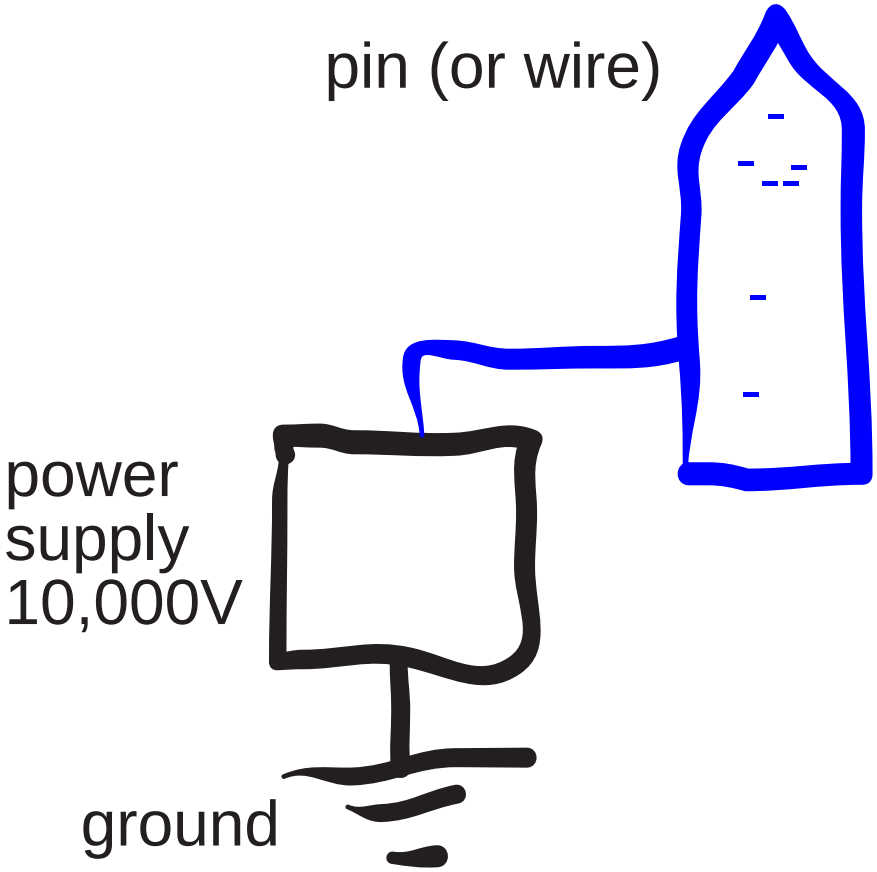
Dust: rock, dirt, organic matter in tiny pieces

Soot: carbon, organic material that has been burned imperfectly, oily, greasy, tar like

Ash: powdery non-combustible residue of a fire

basically neutral particles floating in the air

Charge the Dust



Power supply pushes negative charges onto the pin.

The charges repel each other but eventually end up on the tip where they are very close together.

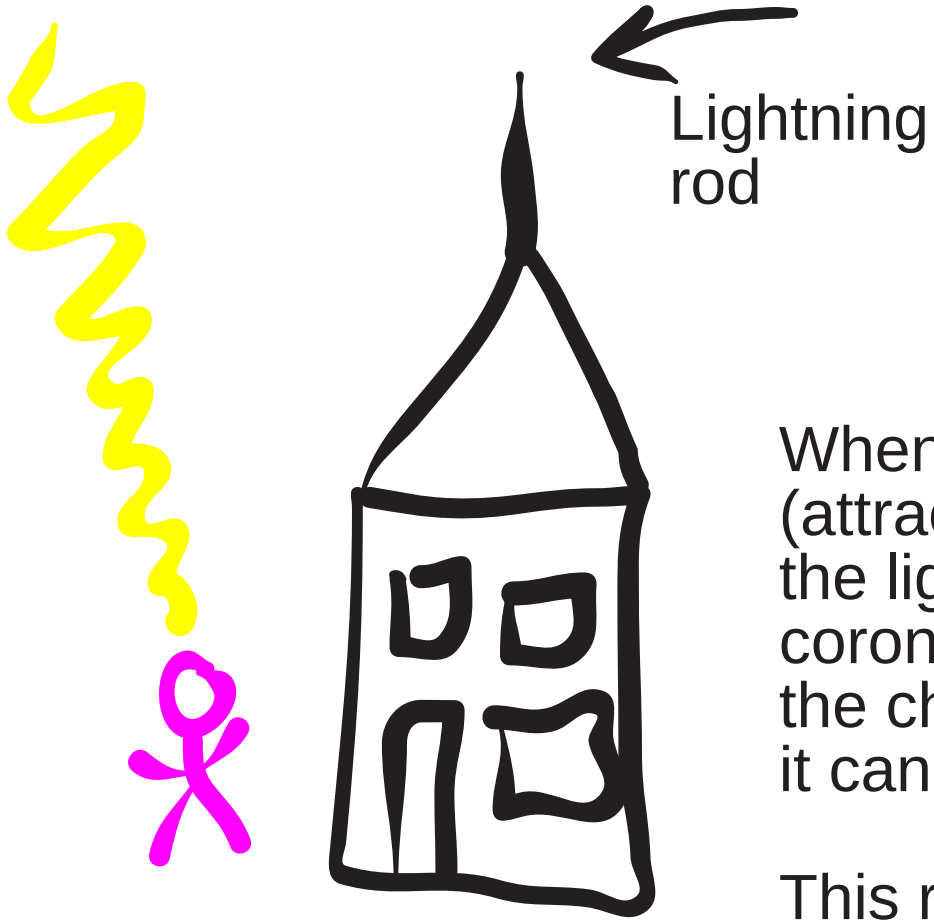
When the charge has built up to a large enough value, the electrons jump off the pin on their own.

Corona Discharge

Potential energy is released when the electrons fly off the pin: Light is emitted

Also works for wires

Lightning Rod



Lightning is a massive charge on the clouds that flows to the ground.

Lightning rod is not just an easy path to ground for the lightning.

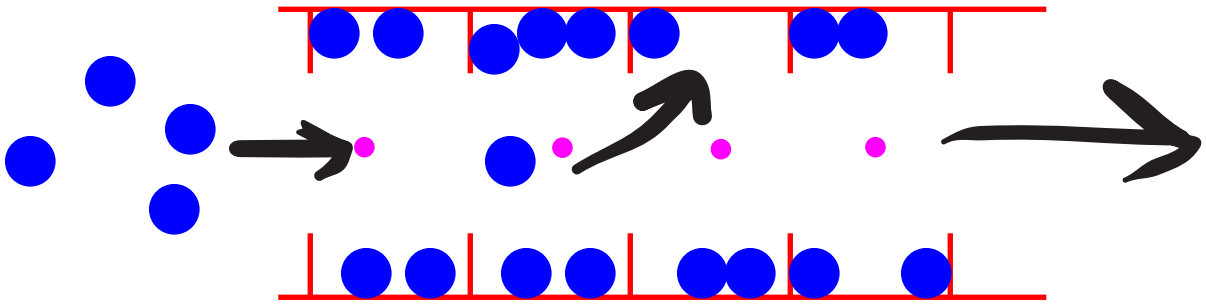
When house charges up (attracting the lightning), the lightning rod emits a corona discharge, releasing the charge into the air where it can move up into the clouds.

This release of charge makes the house less attractive to lightning.

Also on wing tips of airplanes

Electrostatic Precipitator

Power supply between walls and corona wires



- Negatively charged wires

Corona discharge from the negatively charged wires releases electrons into the air that then charge the dust particles, making them negatively charged.

This negatively charged dust is then attracted to the positive walls, trapping the dust.

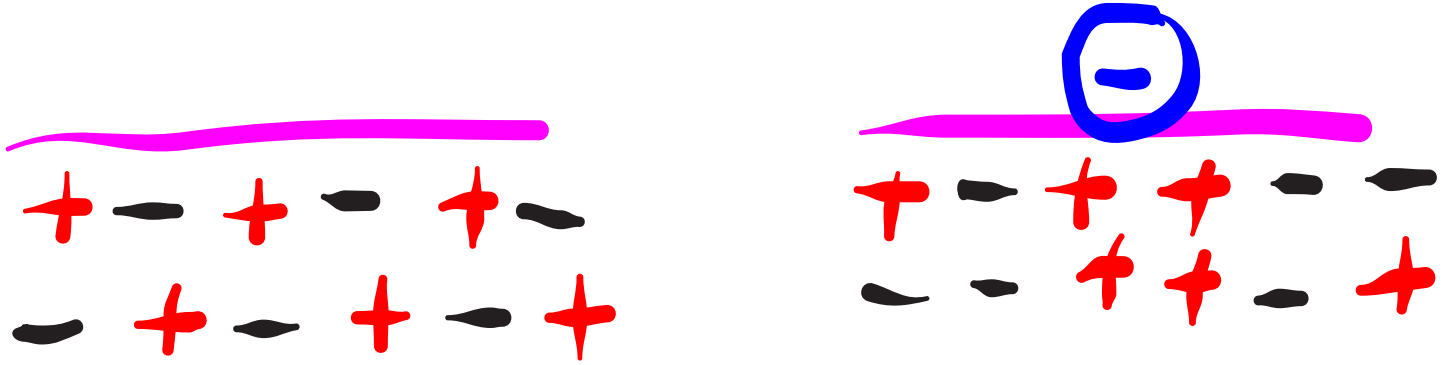
The electrostatic force is much stronger than gravity and any air currents.

Other Dust Cleaners

Ion Generator

Charges dust but does not trap it

Instead it sticks to the neutral walls of the room or the furniture



Charged dust particle polarizes the neutral surface so that they attract.

Xerox Machines

Copy an image onto paper using toner particles (plastic particles that are coloured)

Want to put toner on the paper where there is writing on the original

How does it work?

Electrostatics

Photoconductor

In darkness

insulator
(does not
conduct electricity)

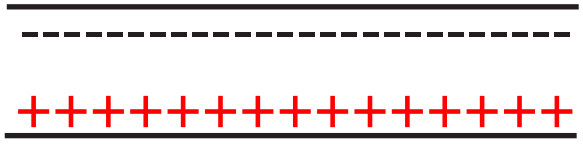
In light

conductor
(conducts electricity)

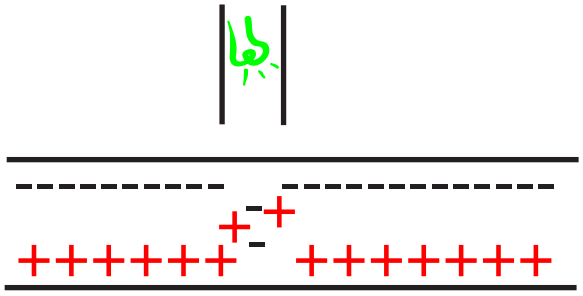
Lots of light, good conductor
Less light, less of a conductor (more resistance to charge flow)

Quantum Mechanics

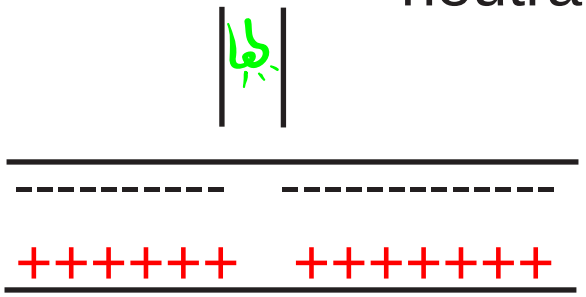
Charged Photoconductor



Place charge on both sides of the photoconductor



Illuminate one spot, turning that spot into a conductor, charge can move and gets neutralized



There is no isolated charge where the light shines

Xerox Machine

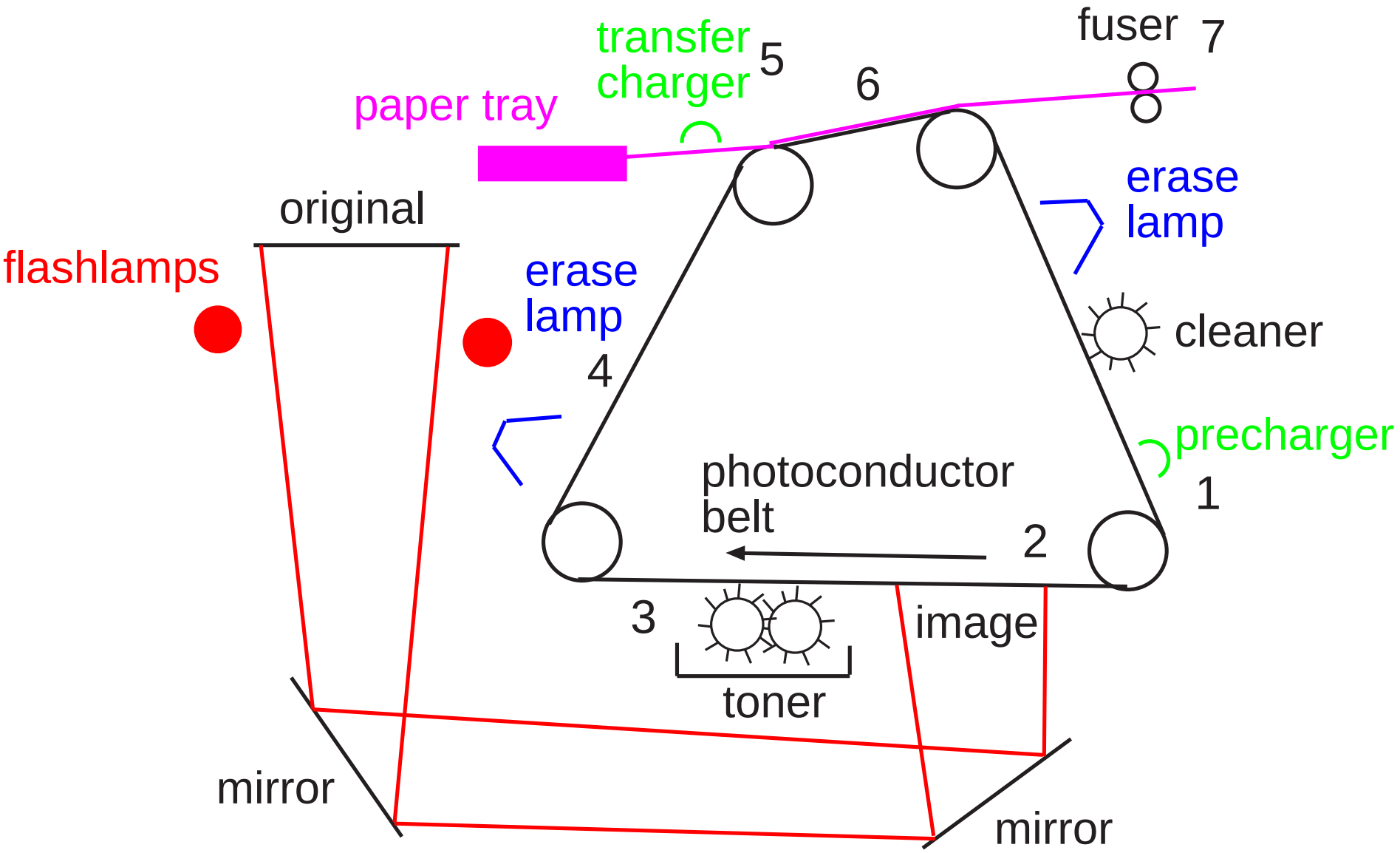


Image Transfer

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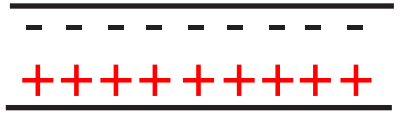

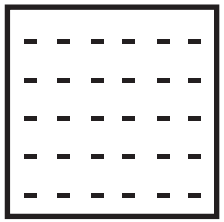

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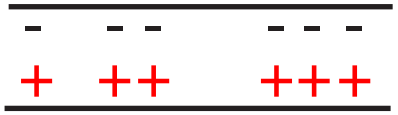

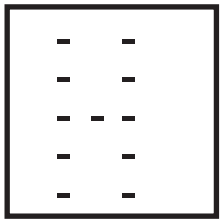

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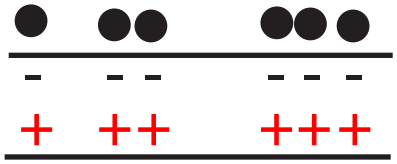

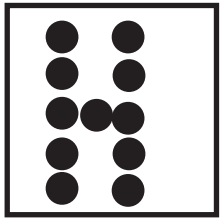

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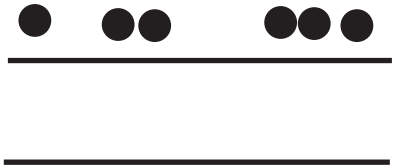

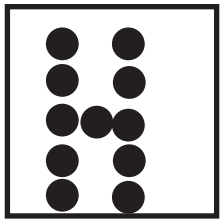

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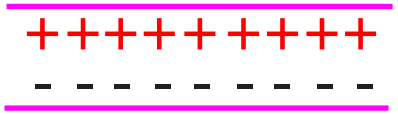

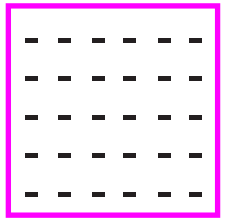

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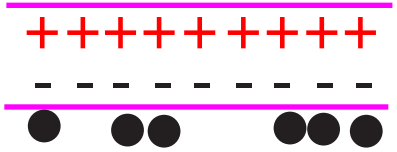

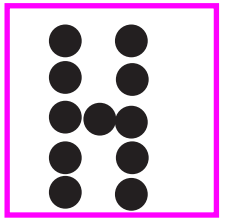

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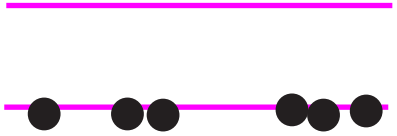

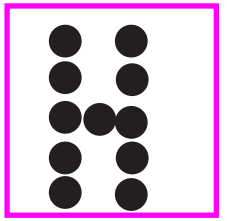

Laser Printer

Use laser to scan an image onto a photoconductive drum

This creates a charge image on the drum that can then be covered with toner

The toner is then transferred to the paper, creating the image