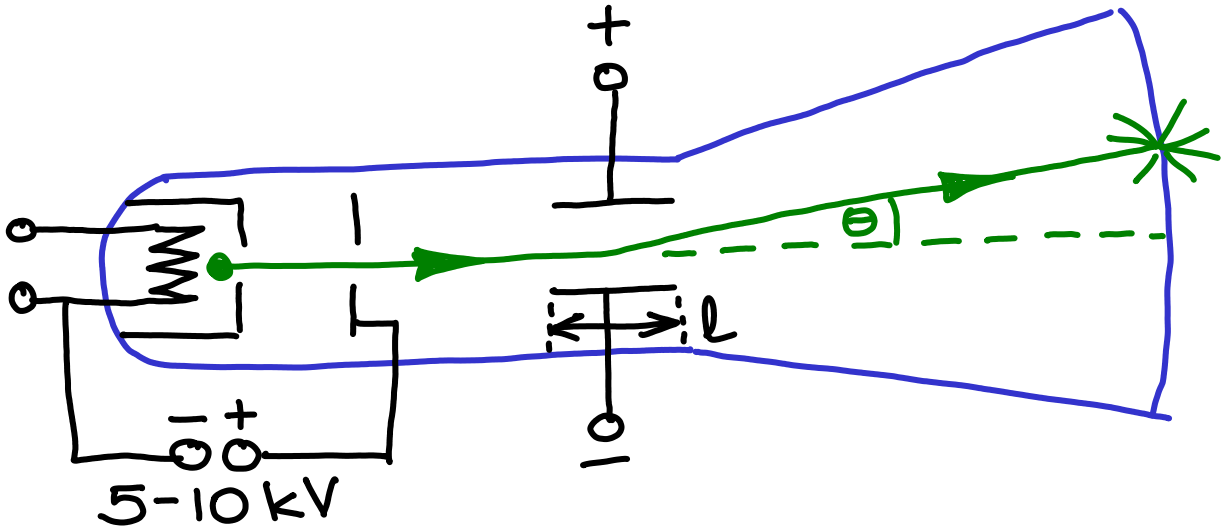
Electrons

(cathode rays)

Joseph John Thomson, 1897

(1906, Nobel)



$$\frac{q}{m} = \frac{E \tan\theta}{B^2 l}$$

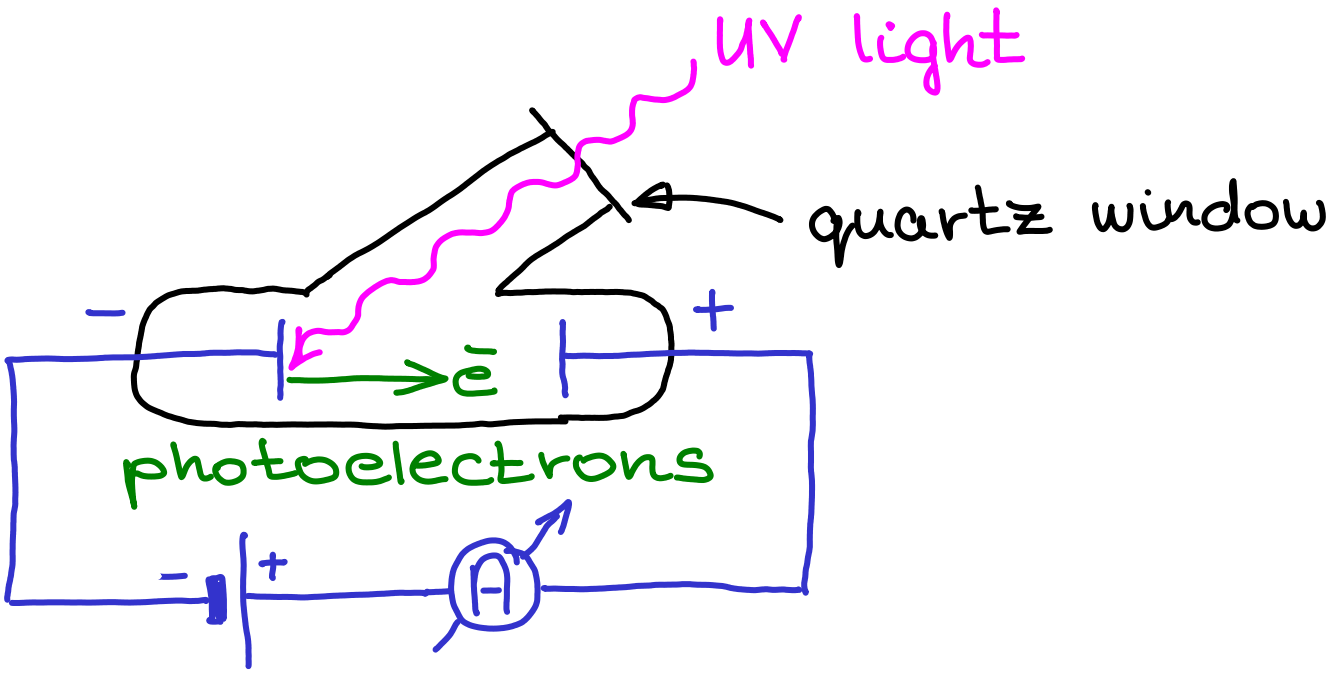
$$\underbrace{\frac{E}{B} = v_0}_{\text{velocity selector}}$$

$$\boxed{\frac{q}{m} = 1.76 \cdot 10^{11} \frac{C}{kg}}$$

charge to mass ratio of the electron, or electric charge density of the electron.

Photoelectric effect

When light shines on the surface of a metal, electrons are emitted by the metal.

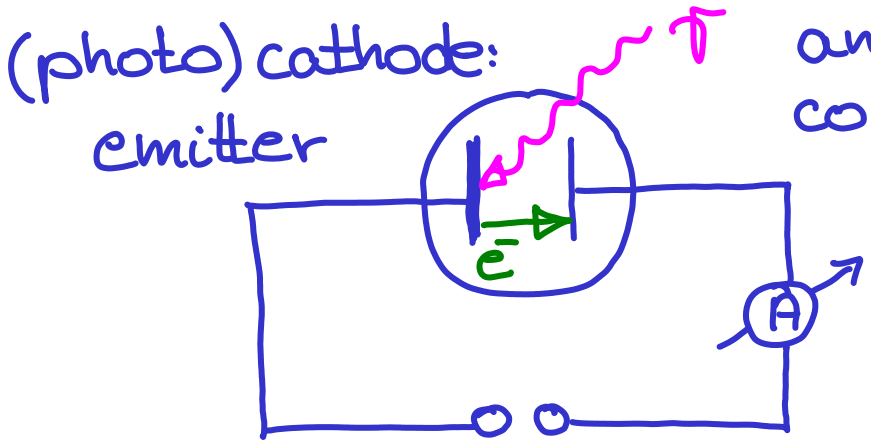


Heinrich Hertz, 1887

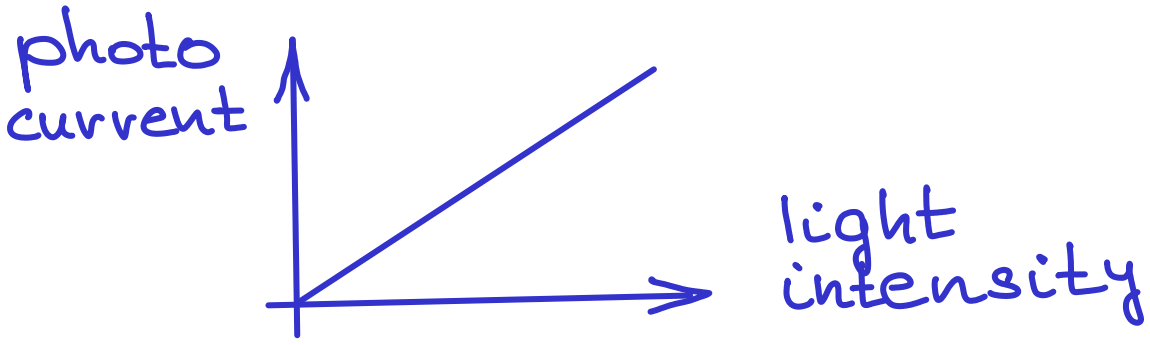
Philipp von Lenard (1905, Nobel)

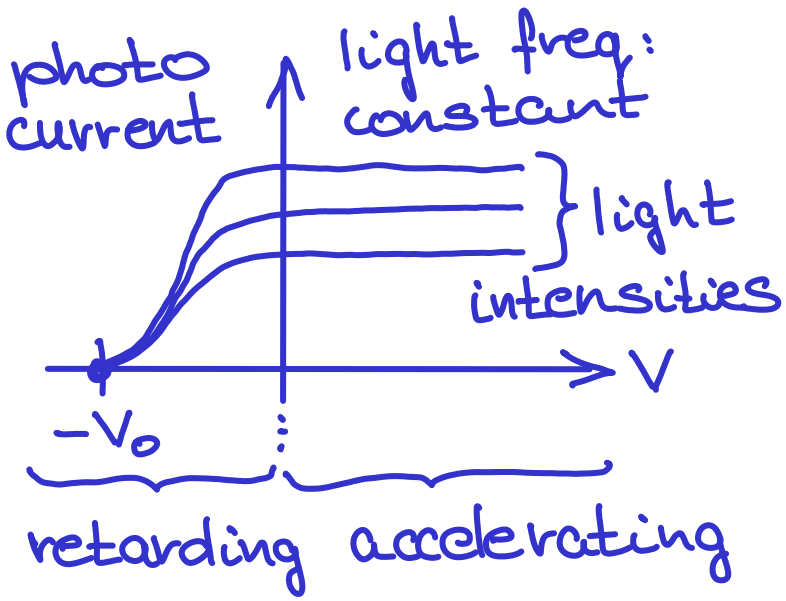
Albert Einstein (1921, Nobel)

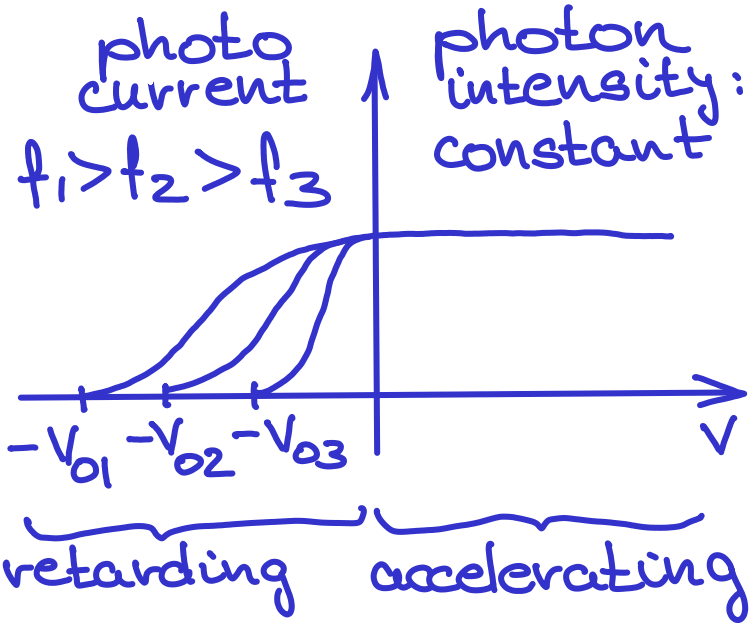
Photoelectric effect 2.



− + : accelerating
+ − : retarding
} potential





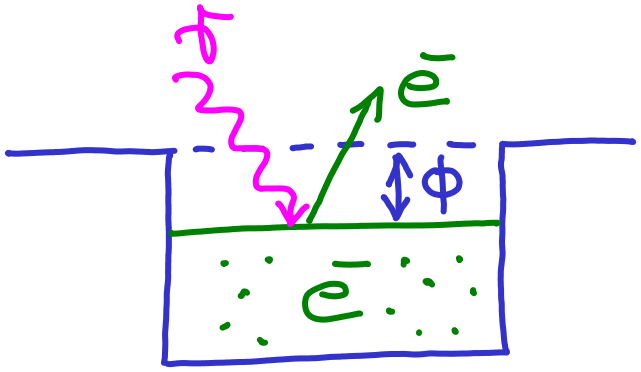


Even at very low light intensities, the photoelectrons appear quickly:

(Lenard: 0.1s, later experiments: ≈1ns.)

Einstein's explanation, 1905

(1921, Nobel Prize)



Light is quantized:

$$E_\gamma = hf$$

red : 1.8eV, blue: 3.1eV

$$E_\gamma = \boxed{\begin{aligned} hf &= \phi + \tfrac{1}{2} m_e v_e^2 \\ hf &= \phi + eV_0 \end{aligned}}$$

$KE = \frac{1}{2}mv^2$ is ok, b/c v is low!

The energy of ONE photon is taken by ONE electron.

ϕ : work function of the cathode

Na : 2.36eV	Al : 4.20eV	Cu : 4.48eV
K : 2.29eV	Zn : 4.33eV	Ag : 4.64eV

Millikan:

$$KE = eV_0 = hf - \phi$$