Let's review properties of light:

PLANCK'S CONSTANT

Moves with speed c, $c = \lambda f$

Is made up of photons (indivisible quanta of radiation) with energy E: $E = hf$

Photons are particles, and since they move with speed c, they must be **massless**

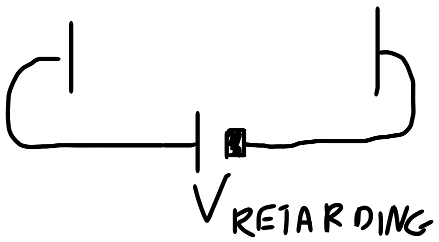
RECALL $E^2 = (pc)^2 + \underbrace{(mc^2)^2}_{0}$ => $E = |p|c$

A photon can have any energy (determined by frequency) and the momentum is then constrained to have amplitude E/c.

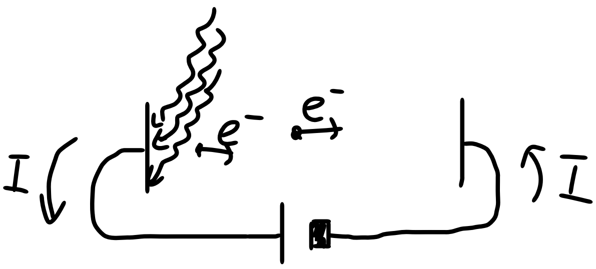
What about $\vec{p} = \gamma m \vec{u}$ ? Since we have u=c, $\gamma =$ infinity while m=0. (inifinity)(0) is undefined, or in other words can be anything. Photons can have any momentum at all, depending on the frequency of light.

Back to the photoelectric effect.

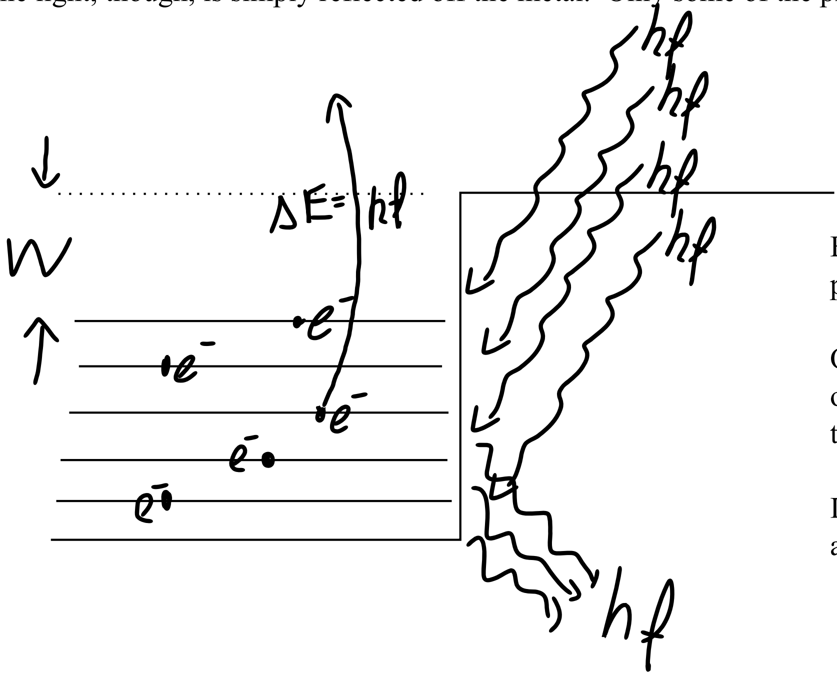
The set-up:




is an open circuit. You won't get current flowing in it, no matter what the voltage in a battery.
When light shines on one of the electrodes, it emits electrons, closing the circuit. Current flows in the direction indicated, unless the battery stops it from flowing. The battery does not determine the direction of light flow; the light does!




Most of the light, though, is simply reflected off the metal. Only some of the photons are absorbed to eject electrons.




Ejection from the metal is possible if hf > W

On the picture to the left, oneo out of 4 photons found an electron to eject, the others just reflected off.

In reality, the fraction of photons absorbed will be much much smaller.

-> clicker question

We know that if we keep intensity constant, and increase the frequency, the number of photons will go down (since each photon will carry more energy). What happens in the PE effect?

-> clicker question

Let's now discuss the detailed energetics of the PE effect.

After the electron is ejected from the metal, its kinetic (non-relativistic) energy is at most

$$E_K^{MAX} = hf - W$$

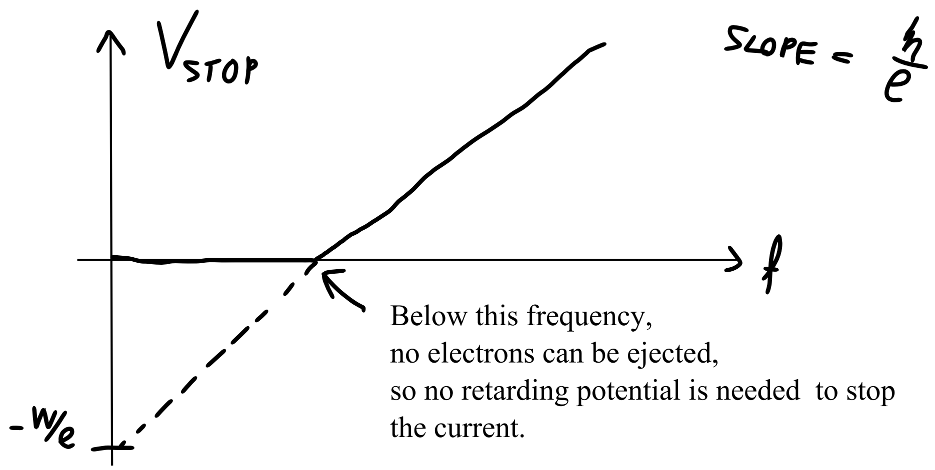
-> clicker question

- > clicker question

We can increase the retarding potential (making the electrons run up a hill between the electrodes) until some value at which the current will stop. This is called the stopping potential, $V_{stop}$

$$e\, V_{STOP} = E_K^{MAX} = hf - W$$

As a graph,




Einstein received the Nobel prize in 1921 for this explanation, after it was confirmed by Millik-an's experiment.

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