

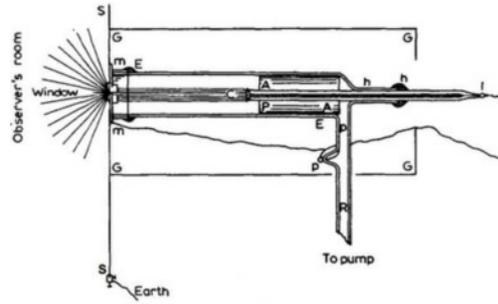
Higher Physic P&W The Photoelectric Effect

Waves and particles

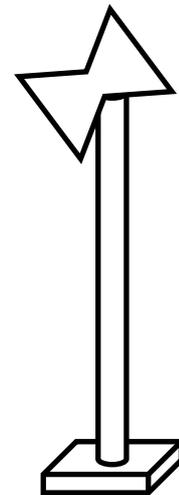
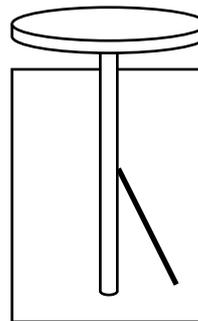
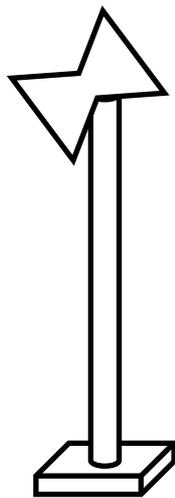
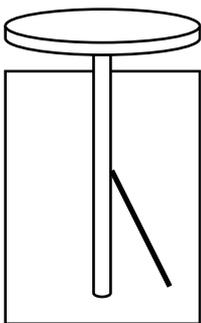
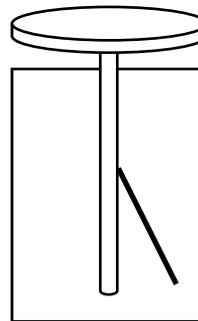
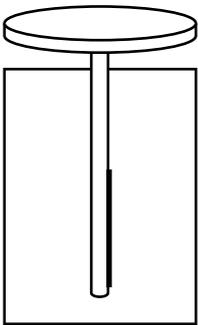
With light beams showing interference, diffraction and reflection it was concluded that light carried energy in the form of a wave.

Experiments carried out by Philipp Lenard and Heinrich Hertz dismissed the idea that light was a wave.

In these experiments light of certain colours (frequencies) knocked electrons off certain metal surfaces.



The Story of the charged electroscope

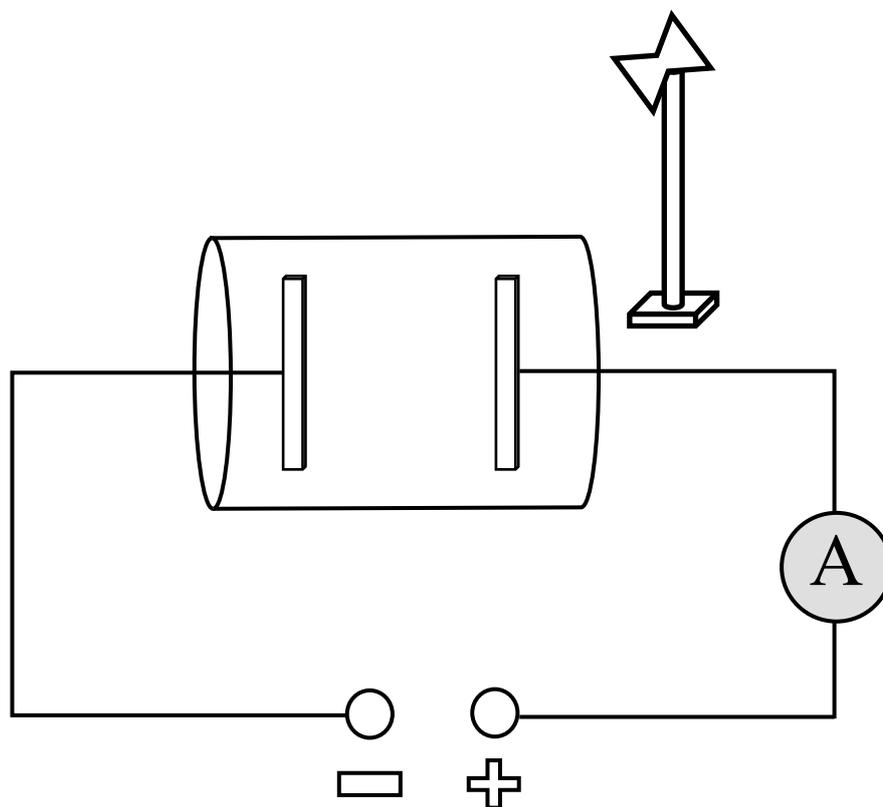


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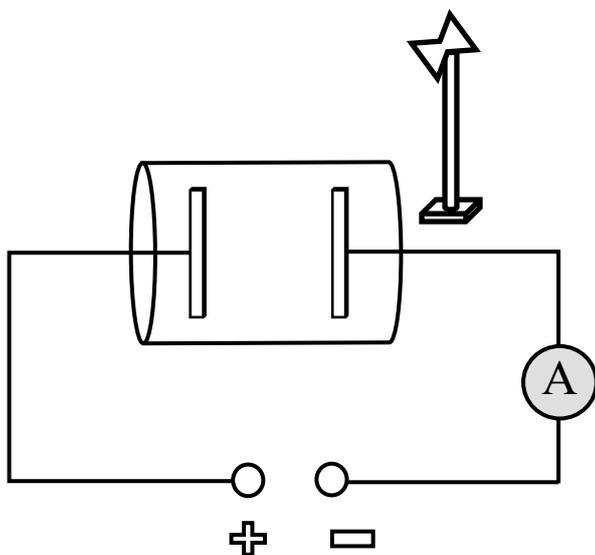
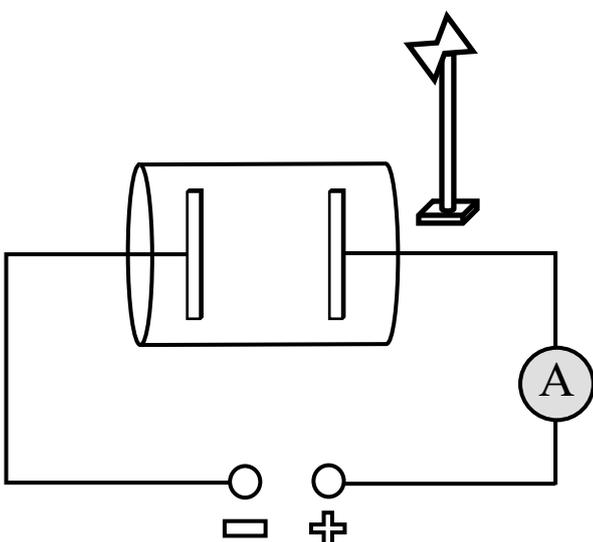
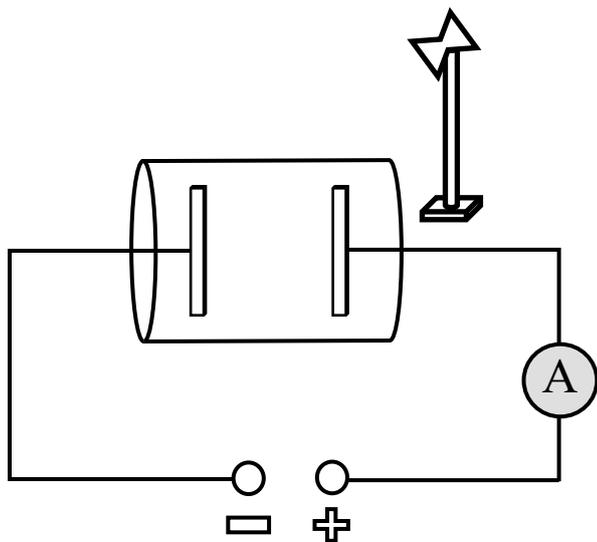


Philipp Lenard and Robert Millikan's Discovery

Philipp Lenard made an apparatus like the one below



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What the Experiments showed

Light can knock electrons off the surfaces of metals. Waves cannot do that !



No matter how bright the light is shone on some metals it doesn't budge any electrons at all.

Bright light means bigger amplitude of a wave which means more energy.

This is surely odd!

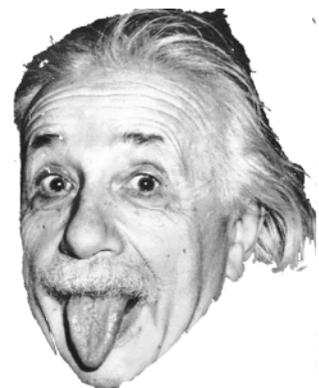
It seems that only light of a certain frequency ie colour can dislodge electrons from certain metals.

I have also noticed that there seems to be a certain **threshold** frequency of light that which below **NO** electrons will ever be knocked off from the metal.



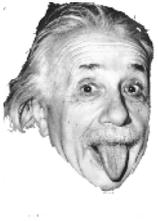
Yikes ! Help!

Need help guys!



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Photons of Light



Albert Einstein proposed a solution. He said that light could be thought of as tiny packets of energy almost particle like.

He called these tiny packets of light energy

Photons

He said that these photons carried energy that was linked to their colour or frequency by a simple relationship.

$$E = hf$$

In other words the energy of the photons were directly proportional to the frequency of the light.

The constant linking the energy and frequency is called Planck`s Constant and is equal to 6.63×10^{-34} Js

Red light has a wavelength of 700 nm.

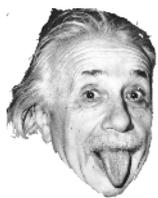
Determine the energy of a photon of red light

Blue light has a wavelength of 400 nm.

Determine the energy of a photon of blue light

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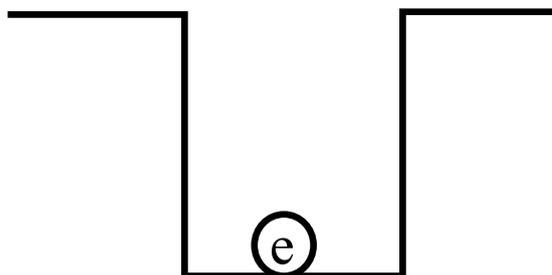
Einstein's Photoelectric Equation



Albert Einstein won a Nobel Prize for this amazing work. He solved the puzzle of electrons being ejected from metals as follows.

He imagined the electrons to be in deep wells in the metal. It would take different photon energies to knock the electrons out of the holes.

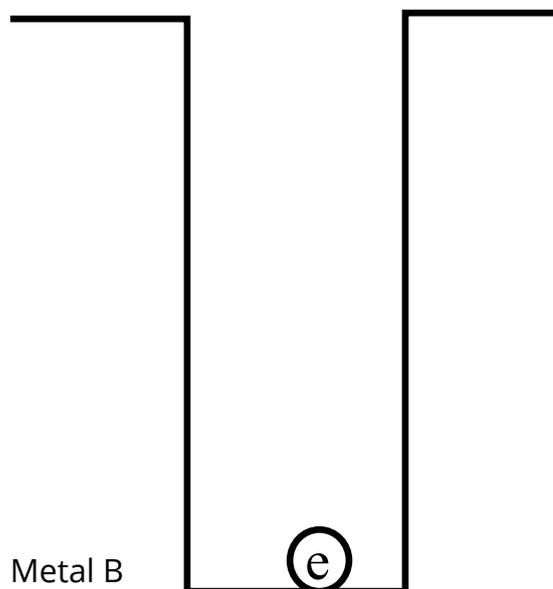
Any excess energy the electron has when it escapes the well appears as kinetic energy



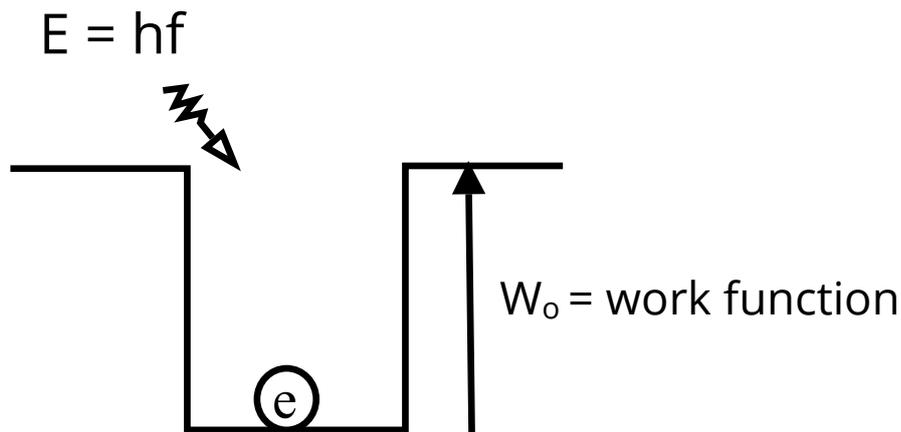
Metal A



Metal B



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Example

The work function of a metal is 1.5×10^{-29} J. Light with frequency 3.0×10^{13} Hz is shone onto its surface.

Calculate the energy of the photon :

Explain why an electron will be ejected from the metal`s surface

Calculate the maximum kinetic energy the ejected electron could have,