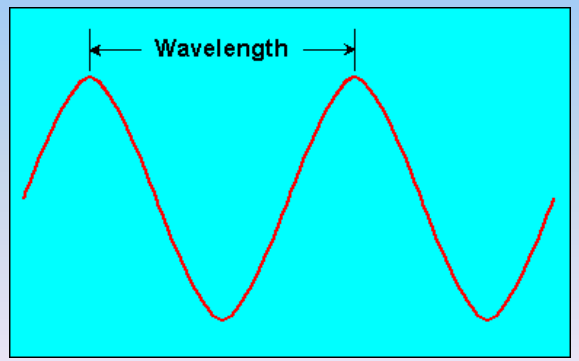
# Photoelectric effect

**Light is commonly described as a wave with the properties: wavelength, frequency, energy and speed**

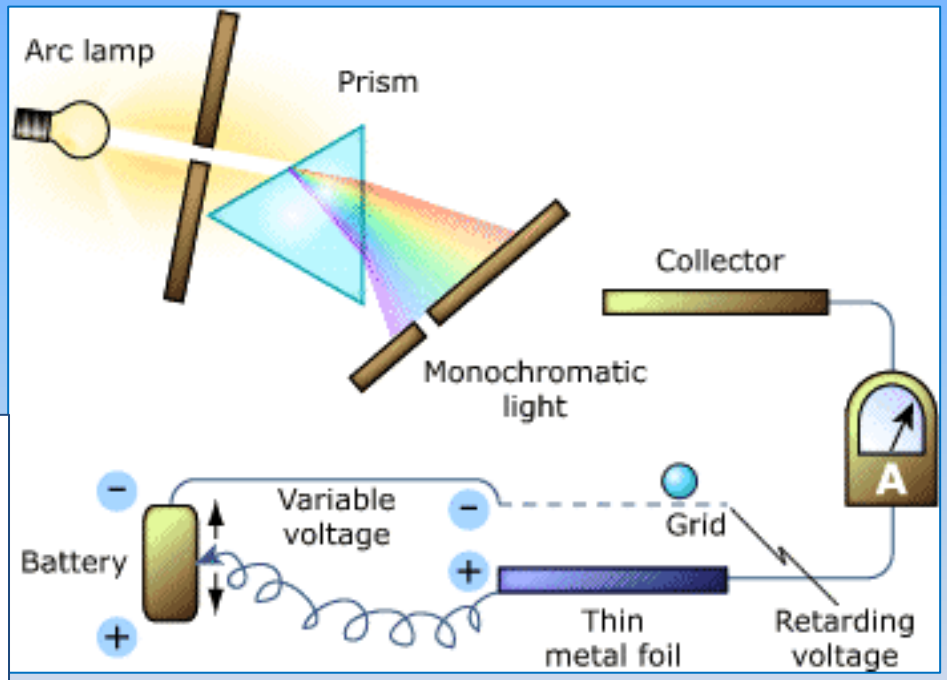
**For the waves experienced in daily life (sound and water waves) we also describe their amplitude.**

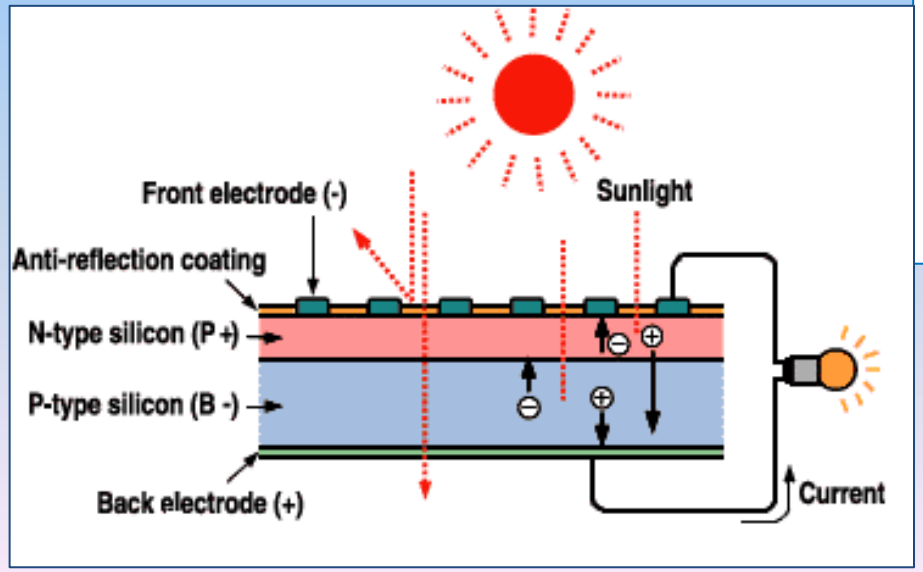
**We know that the speed of Light is independent of everything else (constant 300,000 km/sec), wavelength and frequency are seen by the eye as colour. However, it is not obvious what corresponds to brightness or energy.**




# The **Photoelectric Effect**

- occurs when light shines on certain metal surfaces, causing electrons to be ejected from the metal and hence an electric current flows
- is used in electronic circuits for automatic doors, solar cells and night vision goggles
- is the crucial phenomenon in the creation of electricity by photovoltaic (solar) cells



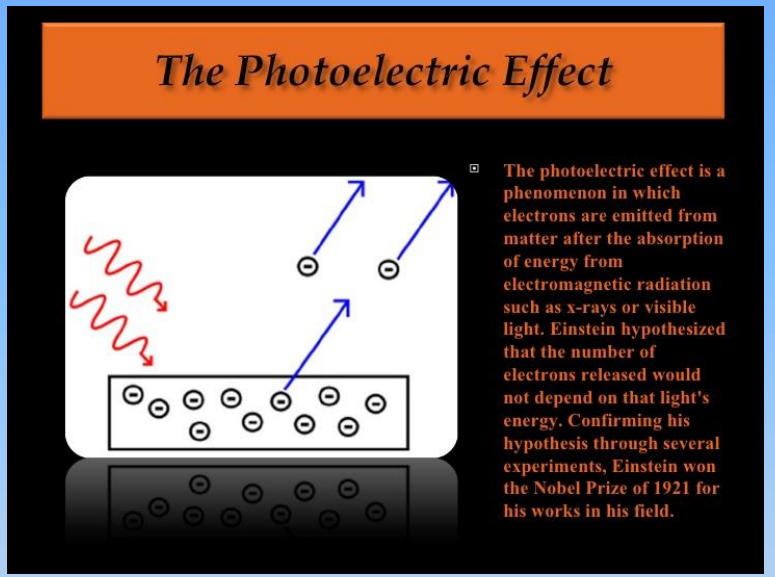



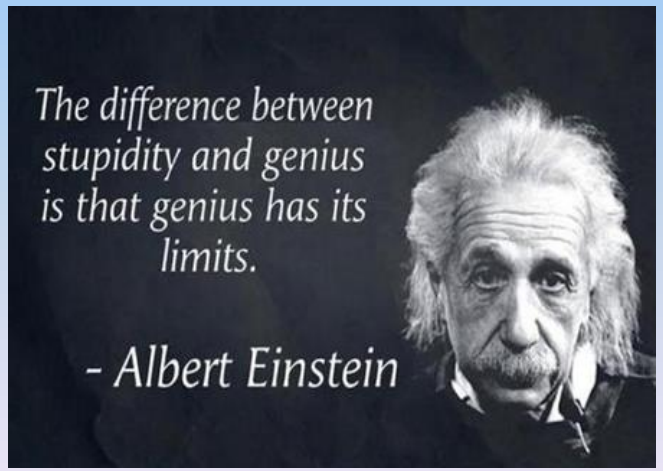
It was observed that during the **Photoelectric Effect** :

- Increasing the amount of light shining on a photoelectric cell increases the current produced but not the voltage
- Certain metals will not produce an electric current. Red light will not cause electrons to flow no matter how bright it is.
- Very dim blue light will still generate some electric current.

# Albert Einstein

**won a Nobel Prize for his explanation of the Photoelectric effect**

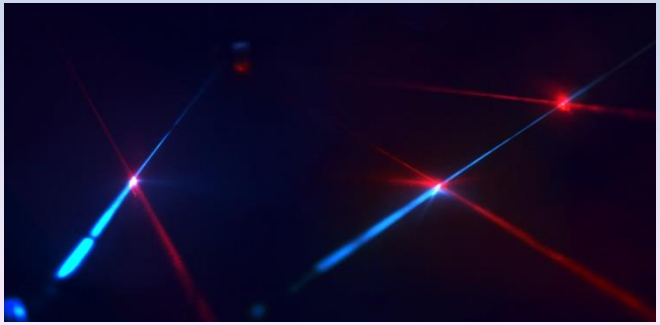


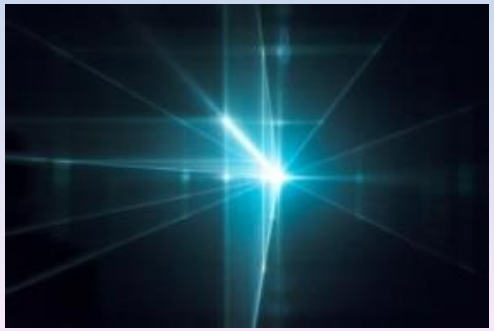




Einstein proposed that light travels in discrete packets called photons, each with discrete amounts of energy known as **quanta.**

# Einstein described the following observations about the Photoelectric Effect:

- light **photons** are received individually, with each photon emitting a photoelectron
- bright lights have more photons than dim lights
- **high frequency light** has **high energy photons** and **low frequency light** has **low energy photons**
- brightness (**intensity**) is a measure of how many photons are emitted
- **frequency** is a measure of the energy of the light





# Quantum Theory of the Photoelectric Effect

- Electrons can absorb or emit energy only in discrete amounts called **quanta.**
- Energy of each quanta (photon) is proportional to the frequency of radiation.
- $E=hf$ is a linear relationship. When graphing Energy (J) vs Frequency (Hz), the gradient of this relationship is equal to Planck's constant $h$ = 6.63 x 10 -34Js
- Since $c=f\lambda$ where $c$= speed of light = 3 x 10 8 m/s
- And $f = c/\lambda$ therefore E= $hc/\lambda$