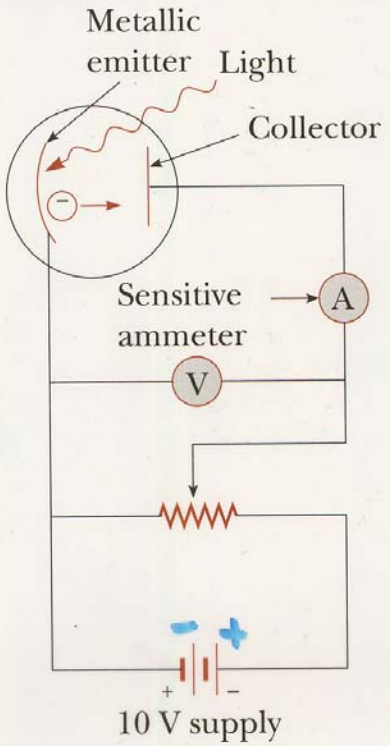
PHOTOELECTRIC EFFECT

Photo Electric Effect



$K_{max} = \frac{1}{2} m_e v_{max}^2 = e V_s$

Figure 2.15

V_s and thus k_{max} are independent of intensity of light source.

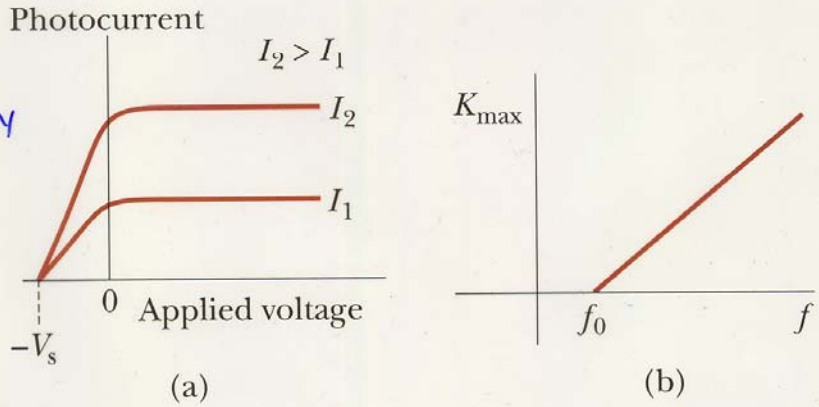


Figure 2.16

f_0 = threshold frequency

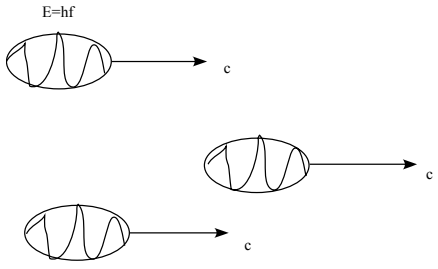
1. When the tube is kept in the dark I = 0.
2. When light strikes the metallic plate inside the tube you get a current.
3. This current arises from the electrons (photoelectrons) emitted with different kinetic energies by the metallic plate.
4. If the voltage between the plates is reversed, the photoelectrons will now be repelled by the negative collector plate.
5. If we gradually increase the potential until the highest energetic electrons are stopped, then I = 0:

$$K_{\max} = \frac{1}{2} m_e v_{\max}^2 = eV_s$$

6. From graph (a) we see that I increases with light intensity. This was expected classically since higher intensity corresponds to more power per unit area or more energy per unit time and thus more electrons per unit time and thus the higher the current.
7. From graph (a) we also see that V_s and thus K_{max} are independent of the intensity of the light source. That is, increasing the rate at which energy strikes the metallic (emitting) plate does not increase K_{max}. Classically, this completely unexpected.
8. K_{max} depends on the frequency of light source and increases as frequency increases. This was of course classically unexpected.
9. There's a threshold frequency f_o such that if $f < f_o$ no electrons are emitted. This was also classically unexpected because an electron should be able to eventually acquire sufficient energy from any light source of any frequency and thus be ejected.

EINSTEIN'S SOLUTION

1. Light is composed of discrete (quanta) bundles of energy called photons that move at the speed of light. Photons are massless!



2. The energy of photons are E=hf

3. K_{max} of a photoelectron occurs when a single photon gives all its energy E=hf to a single electron.

$$\boxed{K_{\max} = hf - \phi}$$ Photoelectric Effect Equation

Φ= work function of metal
(minimum energy required to remove an electron from the metal)

4. f_o = threshold frequency
(frequency required to remove an electron from the metal with zero KE.

$$0 = hf_o - \phi$$

$$\boxed{f_o = \frac{\phi}{h}}$$ Threshold Frequency

If $f < f_o$, no electrons will be emitted.