The photoelectric effect

BIOPHYSICS 1 — LECTURE


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The experiment

What was changed:
1. Color of light ($\lambda, f$)
2. Intensity of light ($I_{\text{light}}$)

What was studied:
1. Number of electrons
2. Speed/kinetic energy of $e^-$

Electronvolt

$E_K = eV_{\text{stop}}$ ($I = 0$)
## Results

<table>
<thead>
<tr>
<th>Predictions of classical theory</th>
<th>Experimental result</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_{\text{light}} \uparrow \rightarrow E_k \uparrow (v \uparrow) )</td>
<td>( I_{\text{light}} \uparrow \rightarrow N_e \uparrow ) ( E_k )-did not change</td>
</tr>
<tr>
<td>( f \uparrow \rightarrow \text{no effect} )</td>
<td>( f \uparrow \rightarrow E_k \uparrow )</td>
</tr>
<tr>
<td>at any ( f ) (color)</td>
<td>only if ( f &gt; f_0 ) (cutoff frequency)</td>
</tr>
<tr>
<td>delay</td>
<td>instantaneous ( \text{(same moment)} )</td>
</tr>
</tbody>
</table>

![Visible light diagram](image)
Einstein's theory

Light is made of photons (packets of energy, $E = hf$).

Photoelectric effect

1 photon is absorbed by 1 electron

energy = $hf = \phi + E_k$

(binding energy) (kinetic energy)

(escape)

1. Intensify $\uparrow$ $\rightarrow$ more photons ($N_{\text{photons}} \uparrow$) $\rightarrow$ $N_e \uparrow$
2. $f \uparrow$ $\rightarrow$ $E_{\text{photon}} = hf \uparrow$ $\rightarrow$ $E_k \uparrow$
3. $hf_0 = \phi + 0$, $f < f_0$ $\rightarrow$ $hf < \phi$
4. Photon = concentrated energy