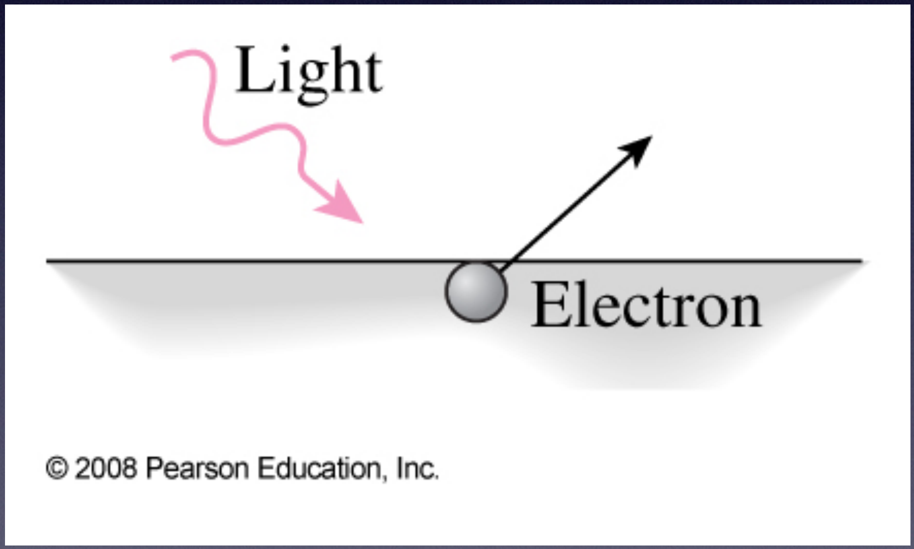
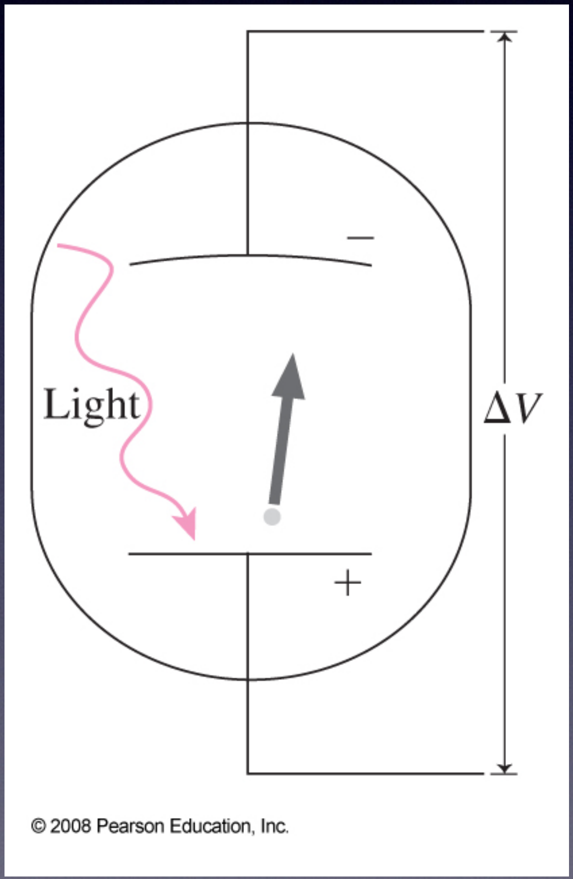
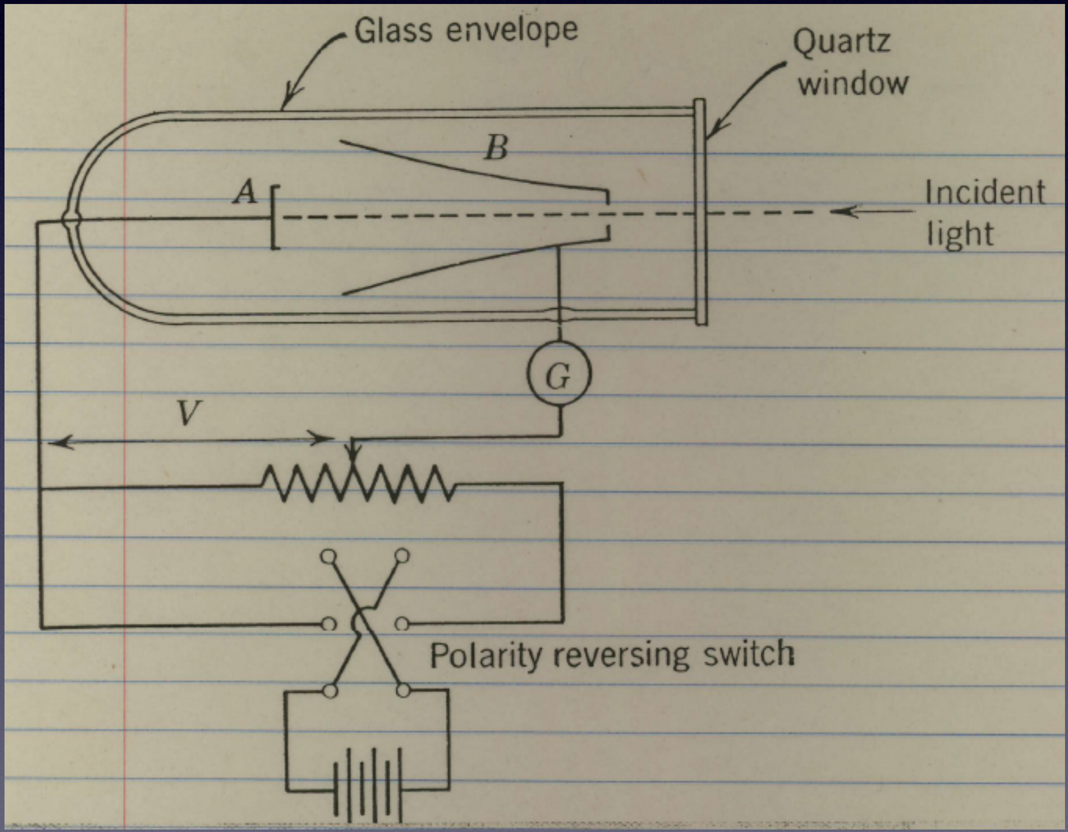
Pictures for Phys 217

- Photoelectric effect

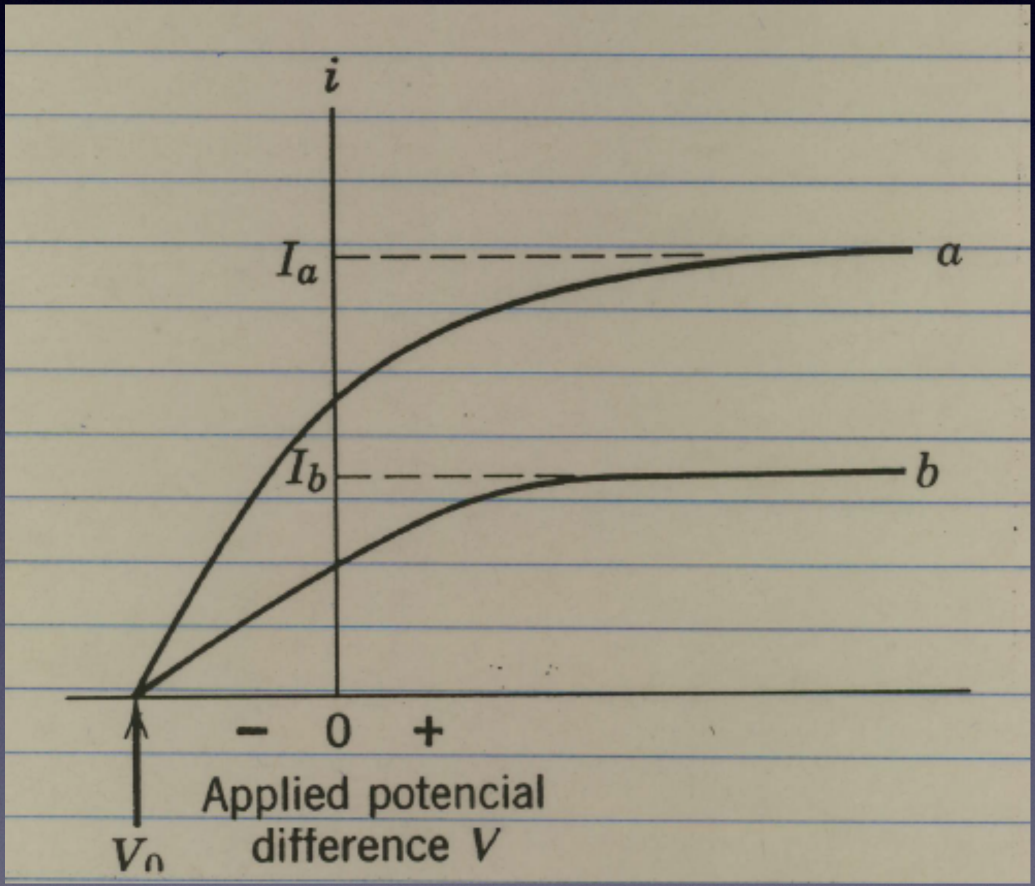


Studying the PE effect

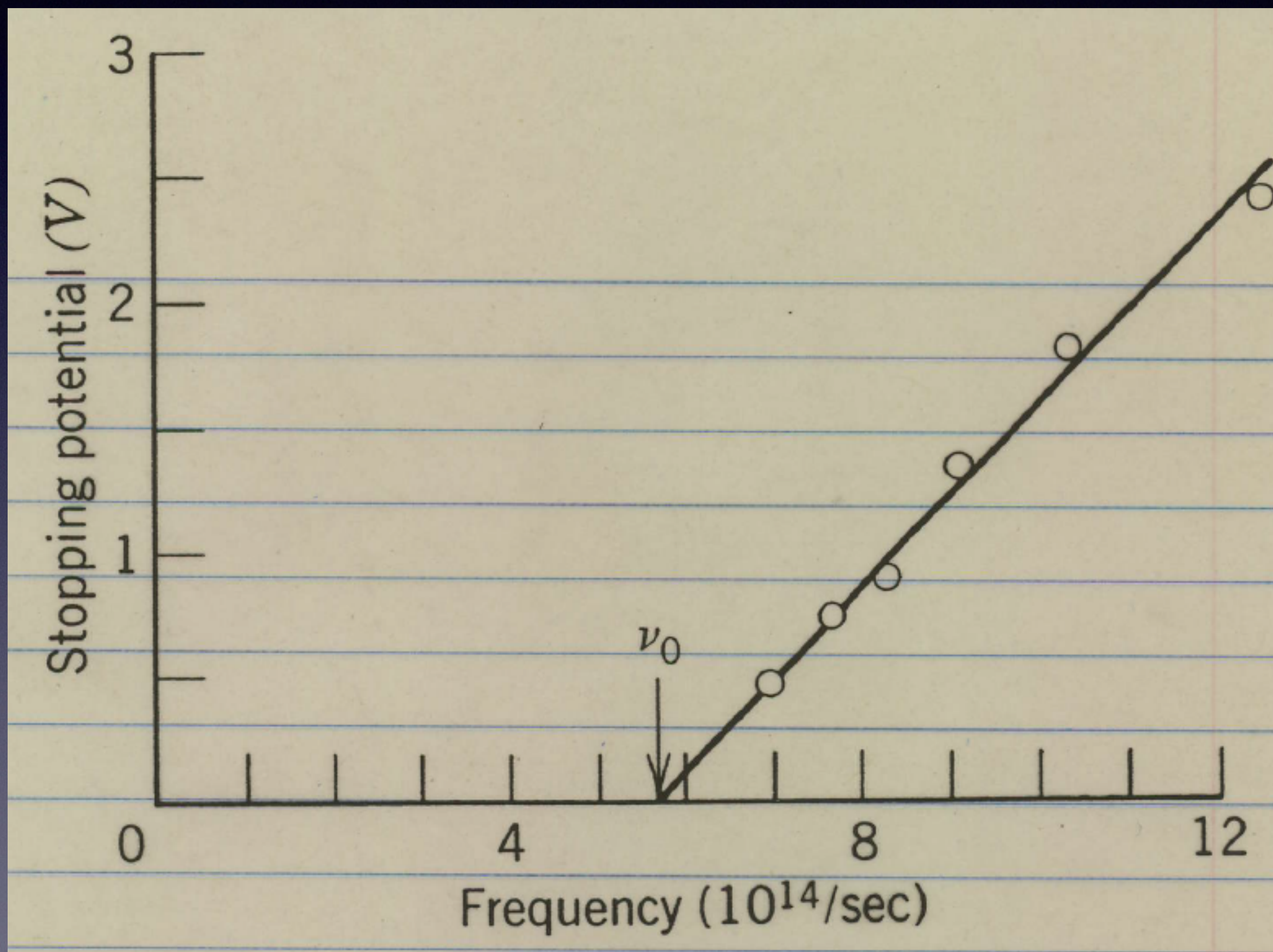




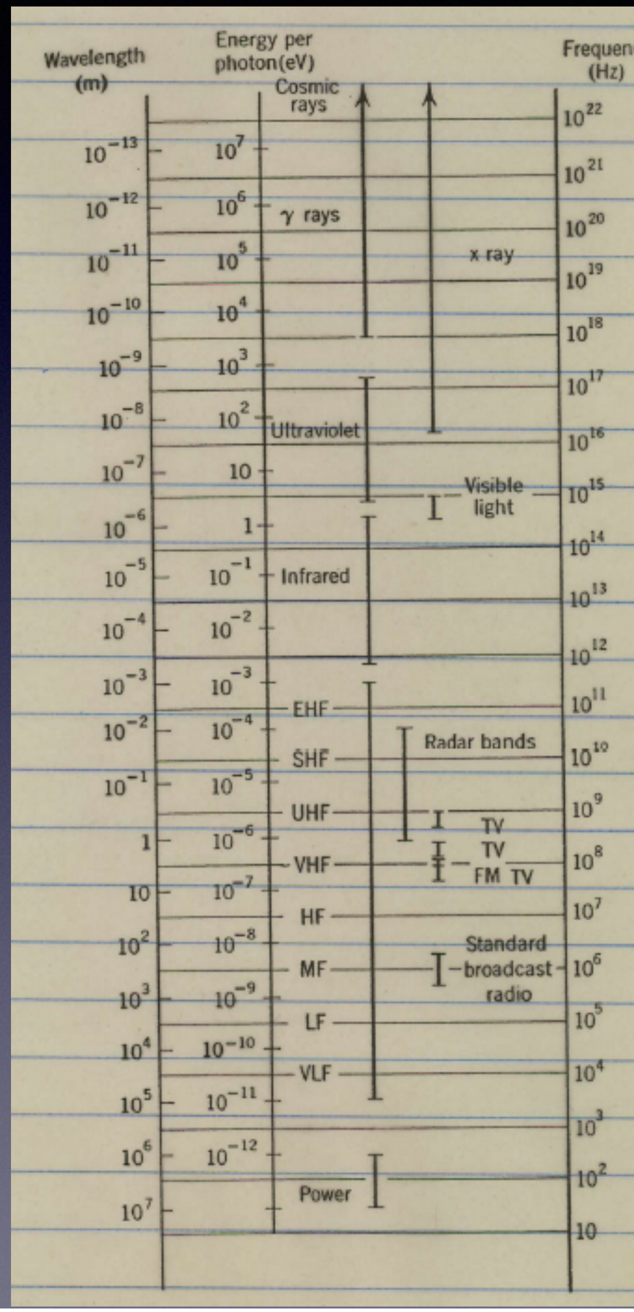
Some results



Actual data

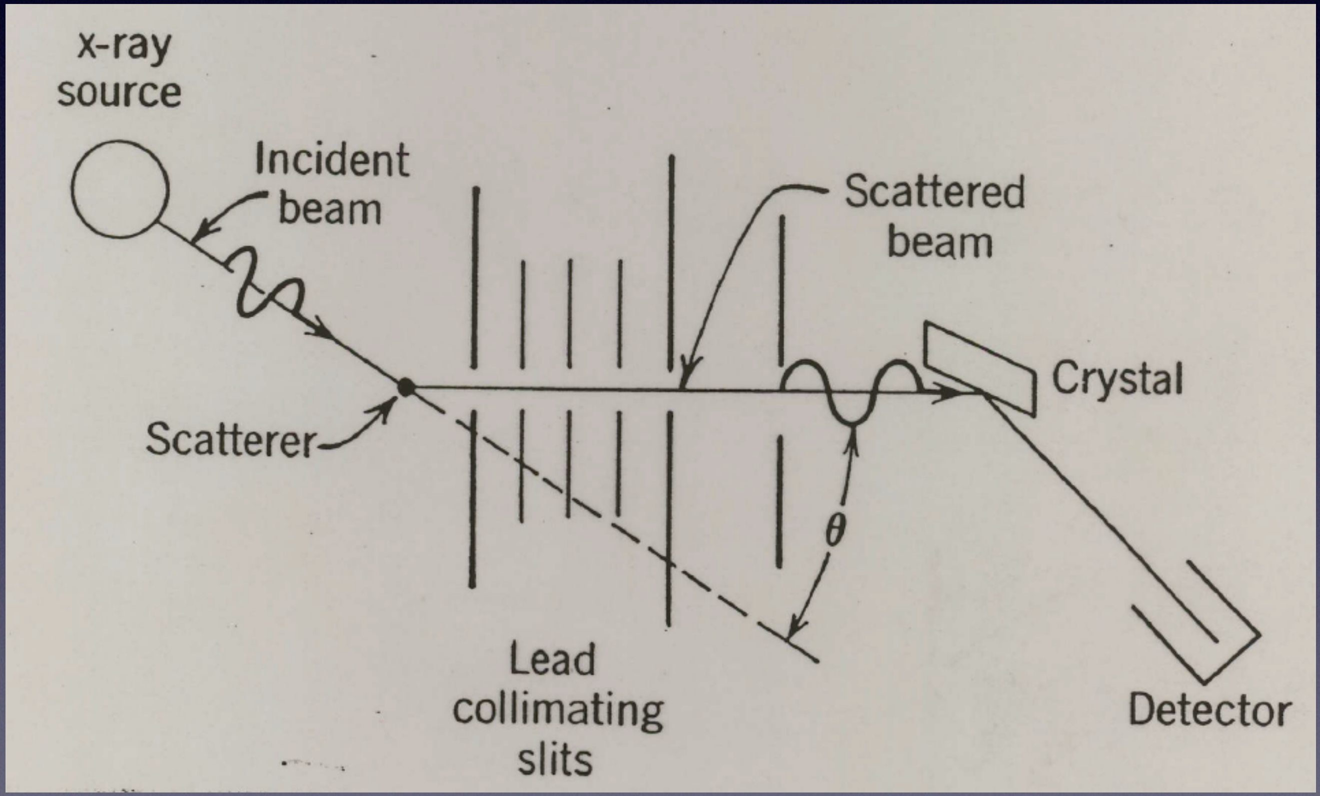


EM spectrum

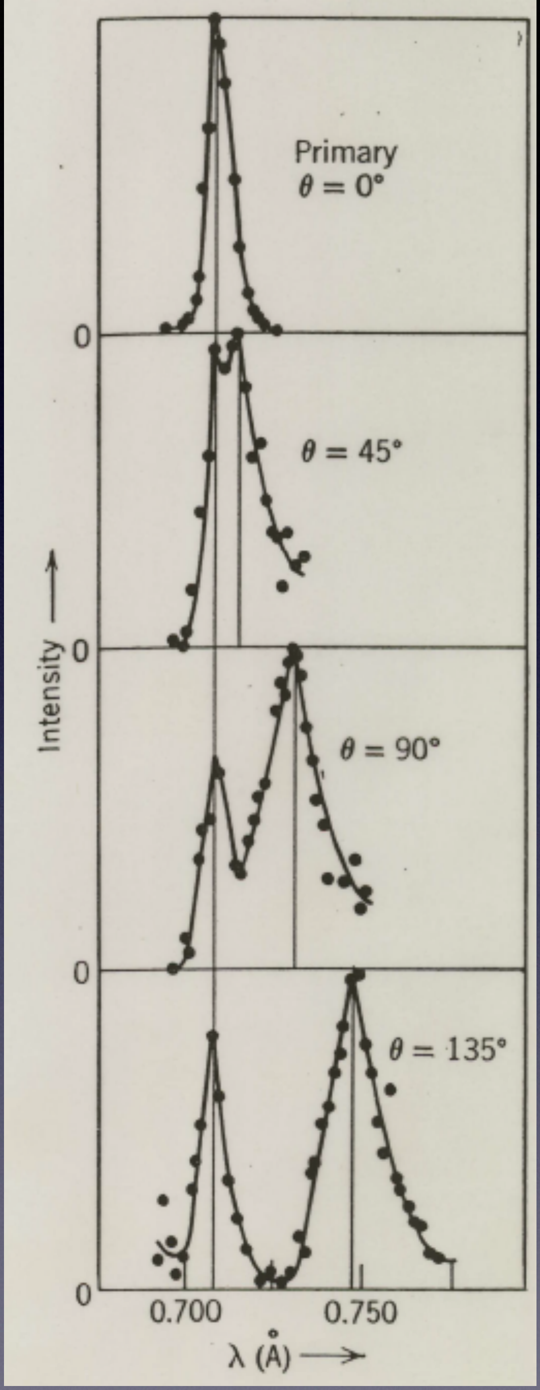


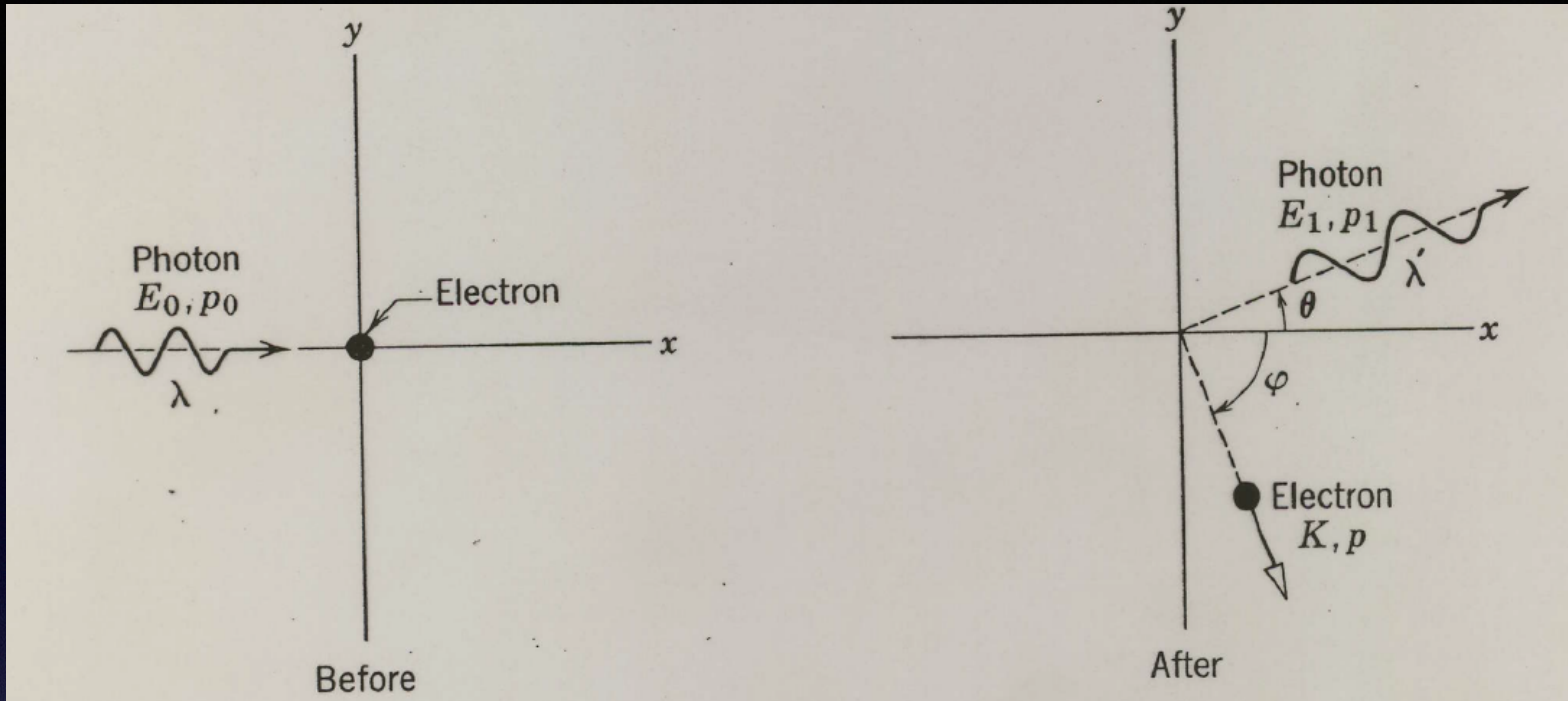
Wavelength (m)
Energy per photon(eV)
Frequenc (Hz)
Cosmic rays
γ rays
x ray
Ultraviolet
Visible light
Infrared
EHF
SHF
UHF
VHF
HF
MF
LF
VLF
Radar bands
TV
TV
FM TV
Standard broadcast radio
Power

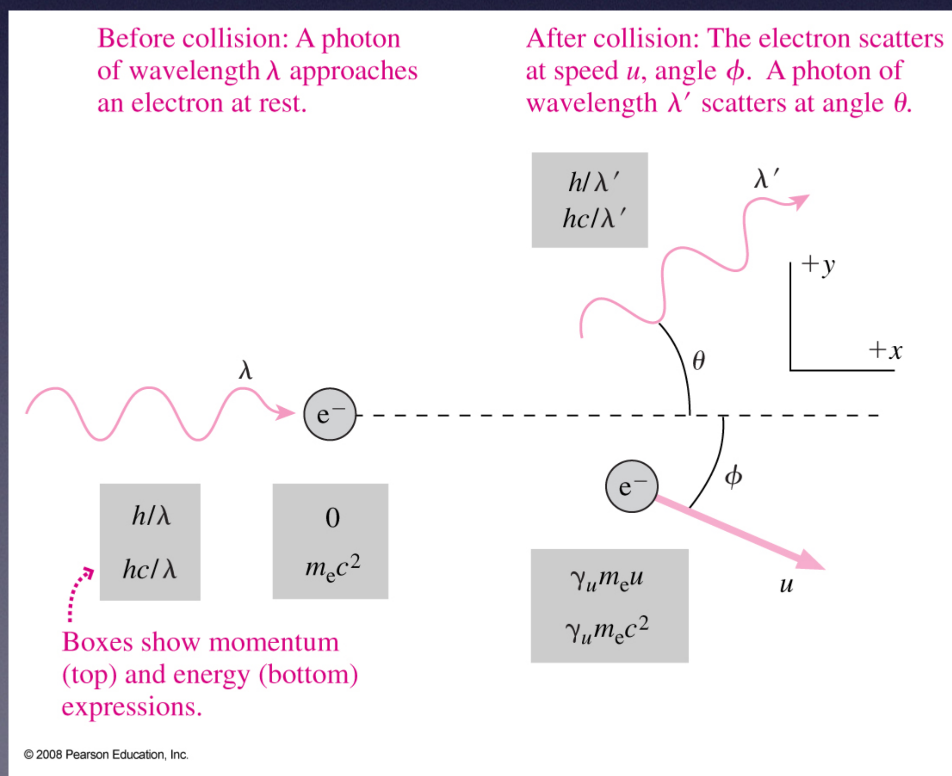
Compton effect



Compton results




Photon
E_0, p_0
λ
Electron
x
y
Before
Photon
E_1, p_1
λ'
θ
φ
Electron
K, p
After


Before collision: A photon of wavelength λ approaches an electron at rest.
After collision: The electron scatters at speed u, angle ϕ. A photon of wavelength λ' scatters at angle θ.
h/λ'
hc/λ'
λ'
$+y$
$+x$
θ
λ
e^-
ϕ
h/λ
hc/λ
0
$m_e c^2$
$\gamma_u m_e u$
$\gamma_u m_e c^2$
u
Boxes show momentum (top) and energy (bottom) expressions.
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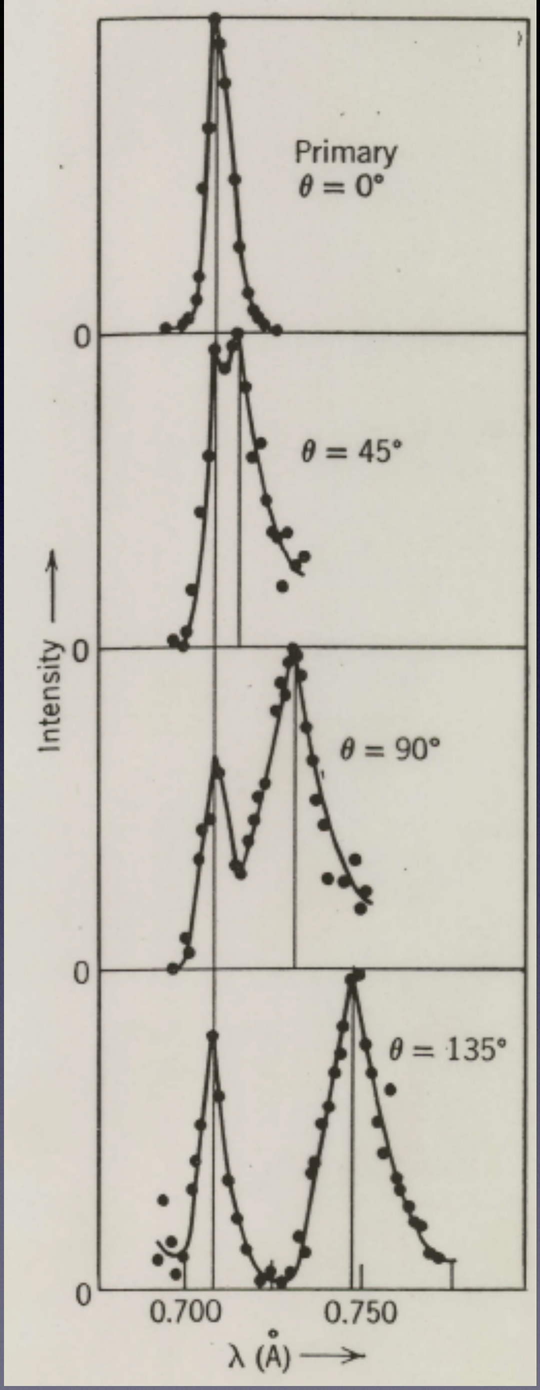
Compton results



Diffraction

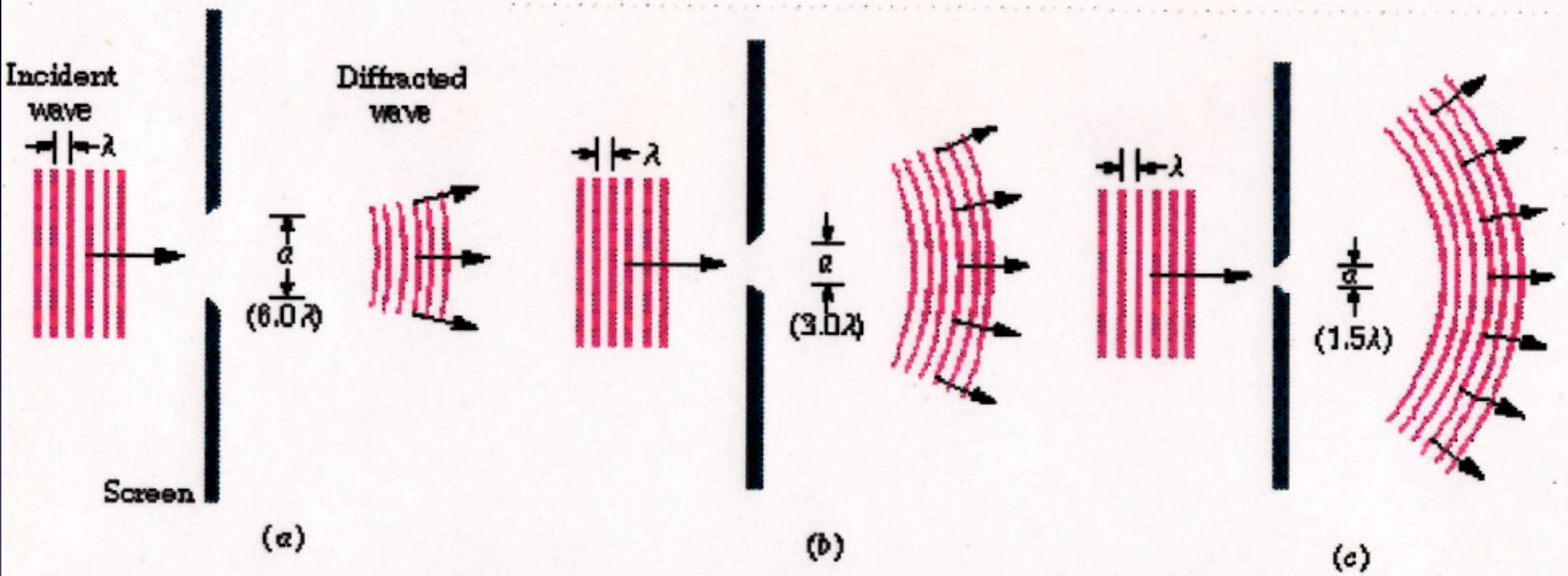
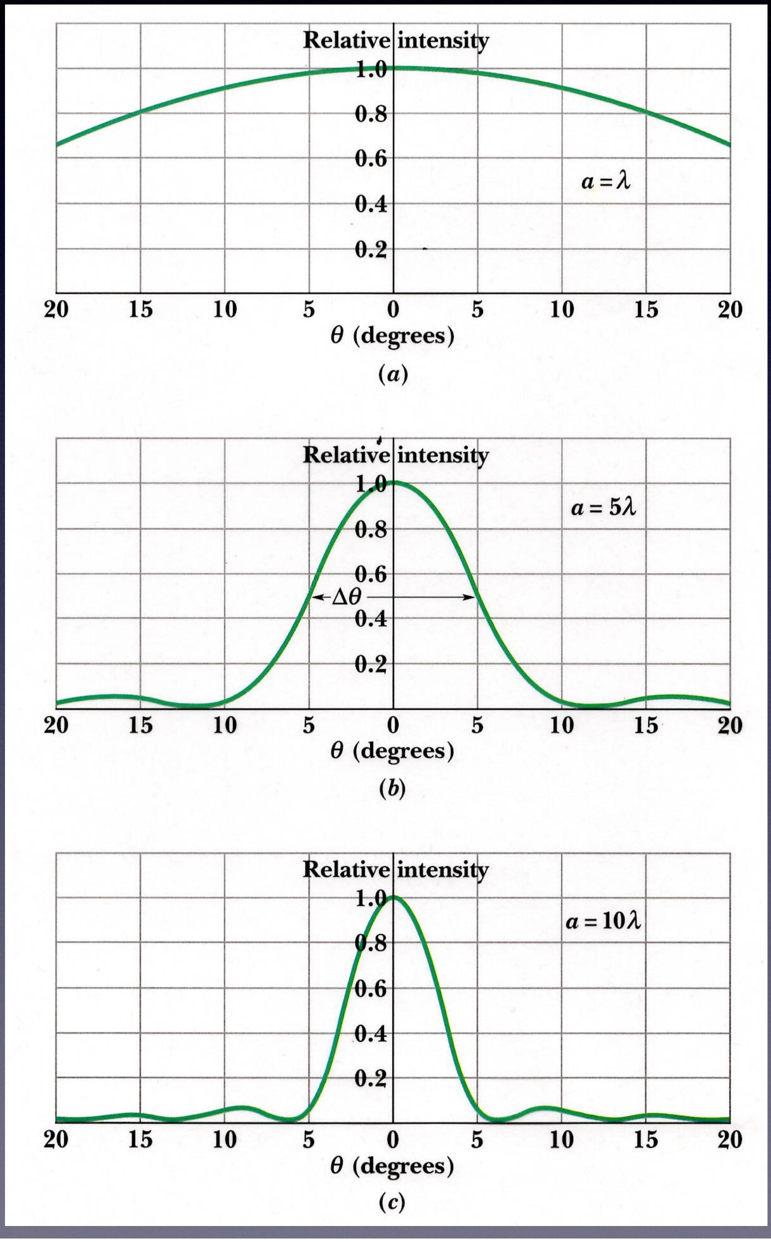
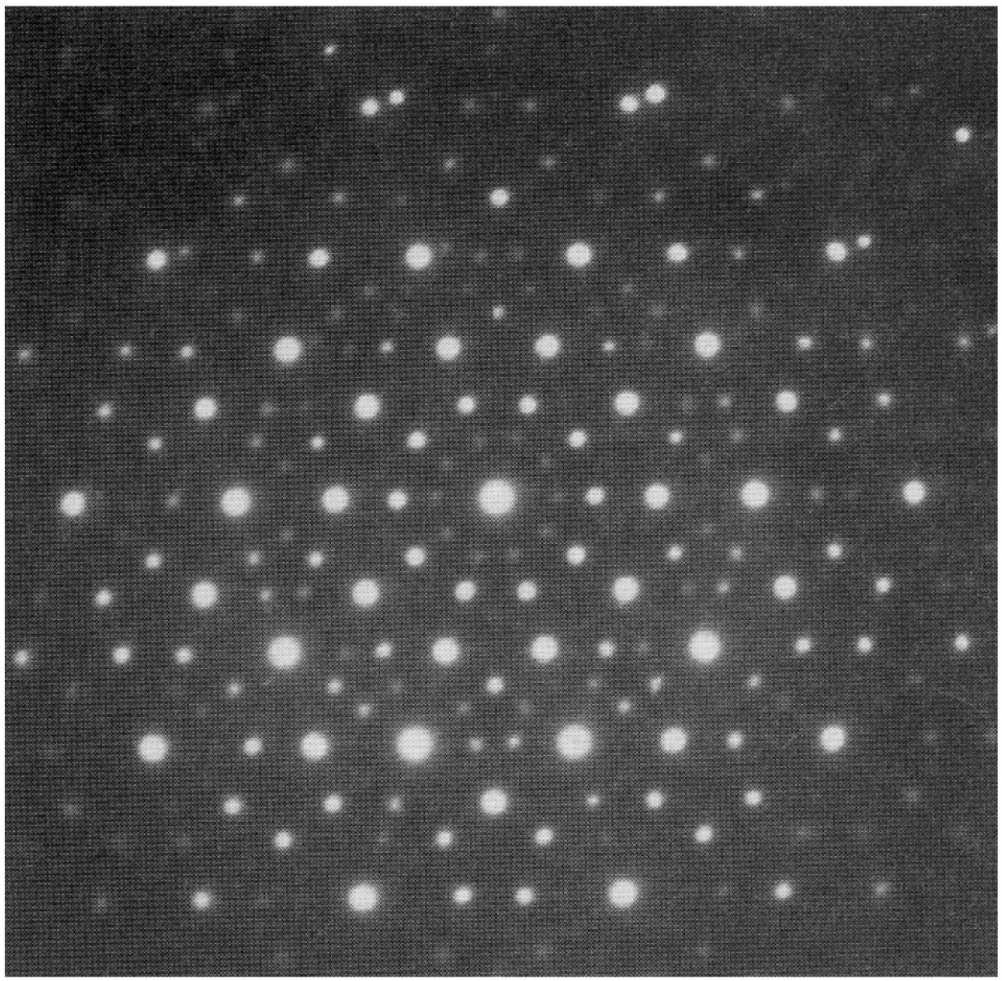


FIGURE 36-5 Diffraction represented schematically. For a given wavelength λ, the diffraction is more pronounced the smaller the slit width *a*. The figures show the cases for (*a*) slit width $a = 6.0\lambda$, (*b*) slit width $a = 3.0\lambda$, and (*c*) slit width $a = 1.5\lambda$. In all three cases, the screen and the length of the slit extend well into and out of the page, perpendicular to it.

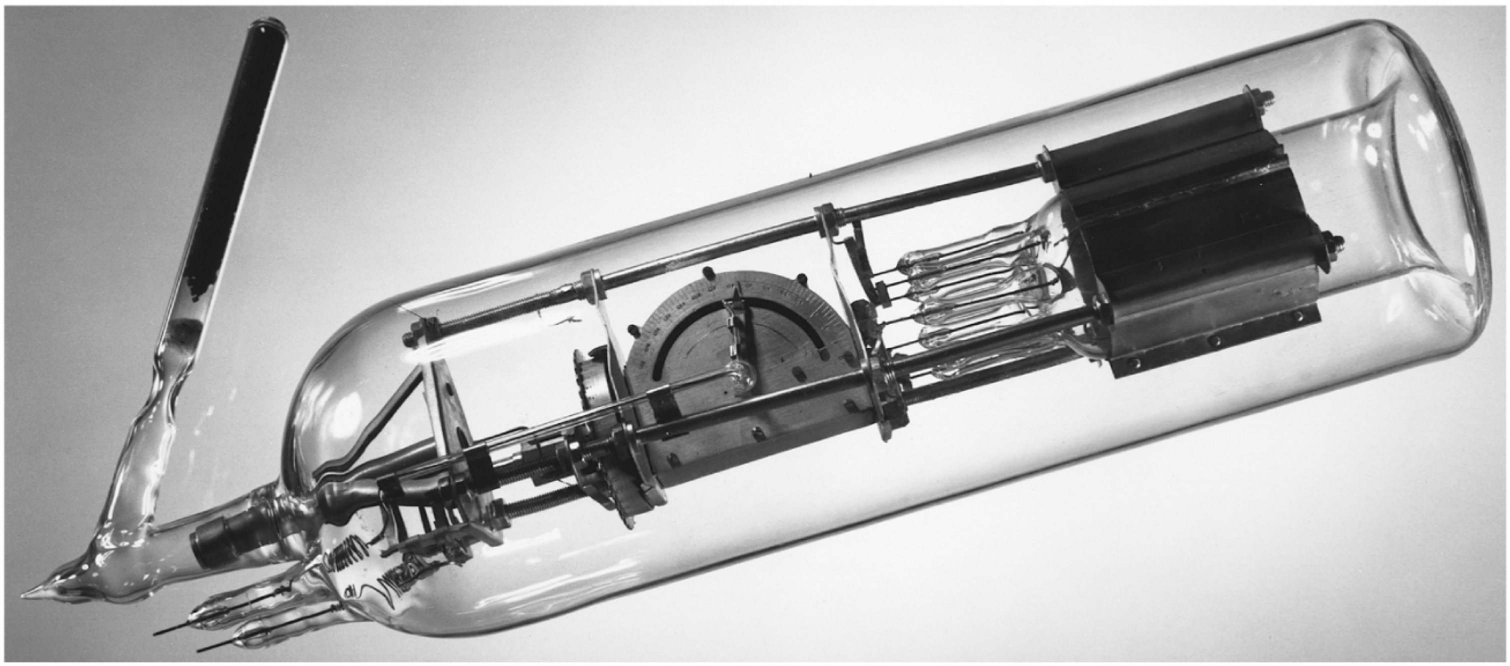
Illustration of intensity



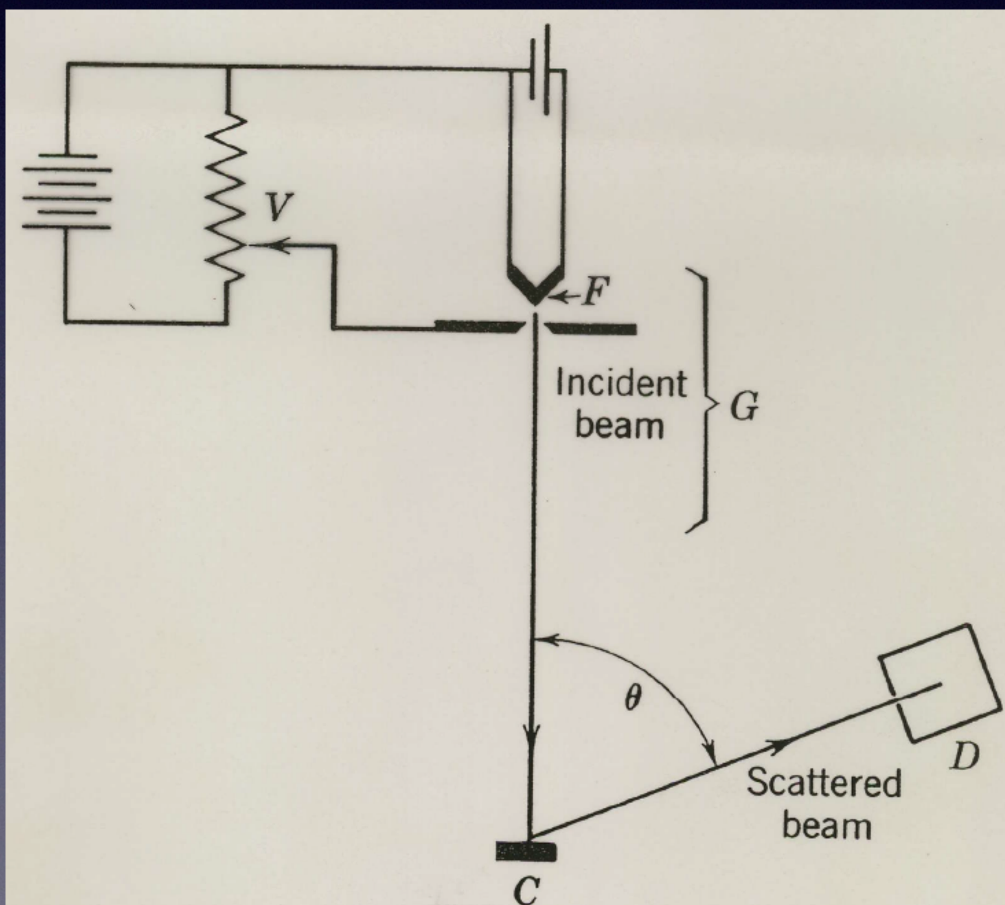
Electron diffraction

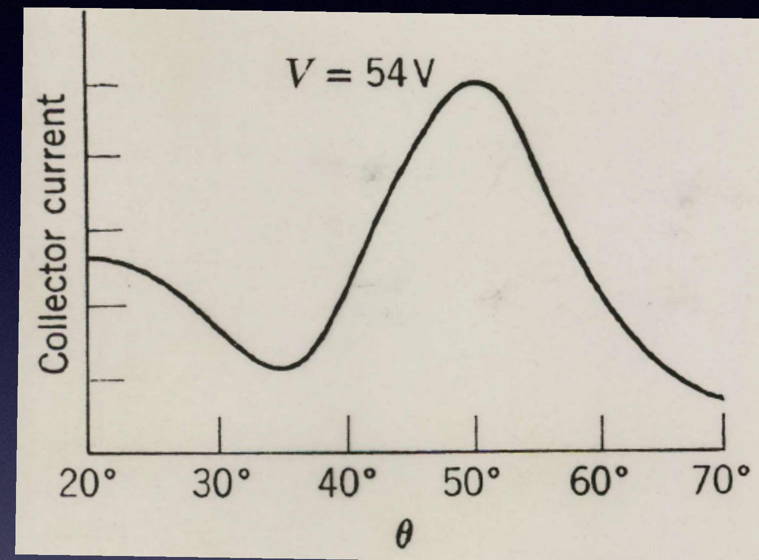


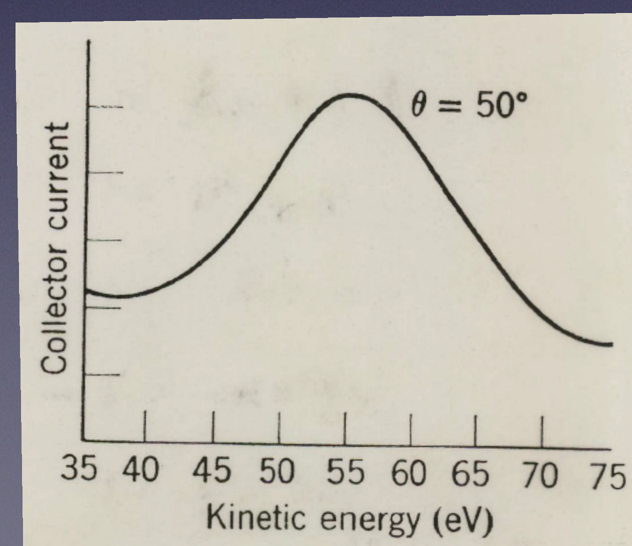
Equipment

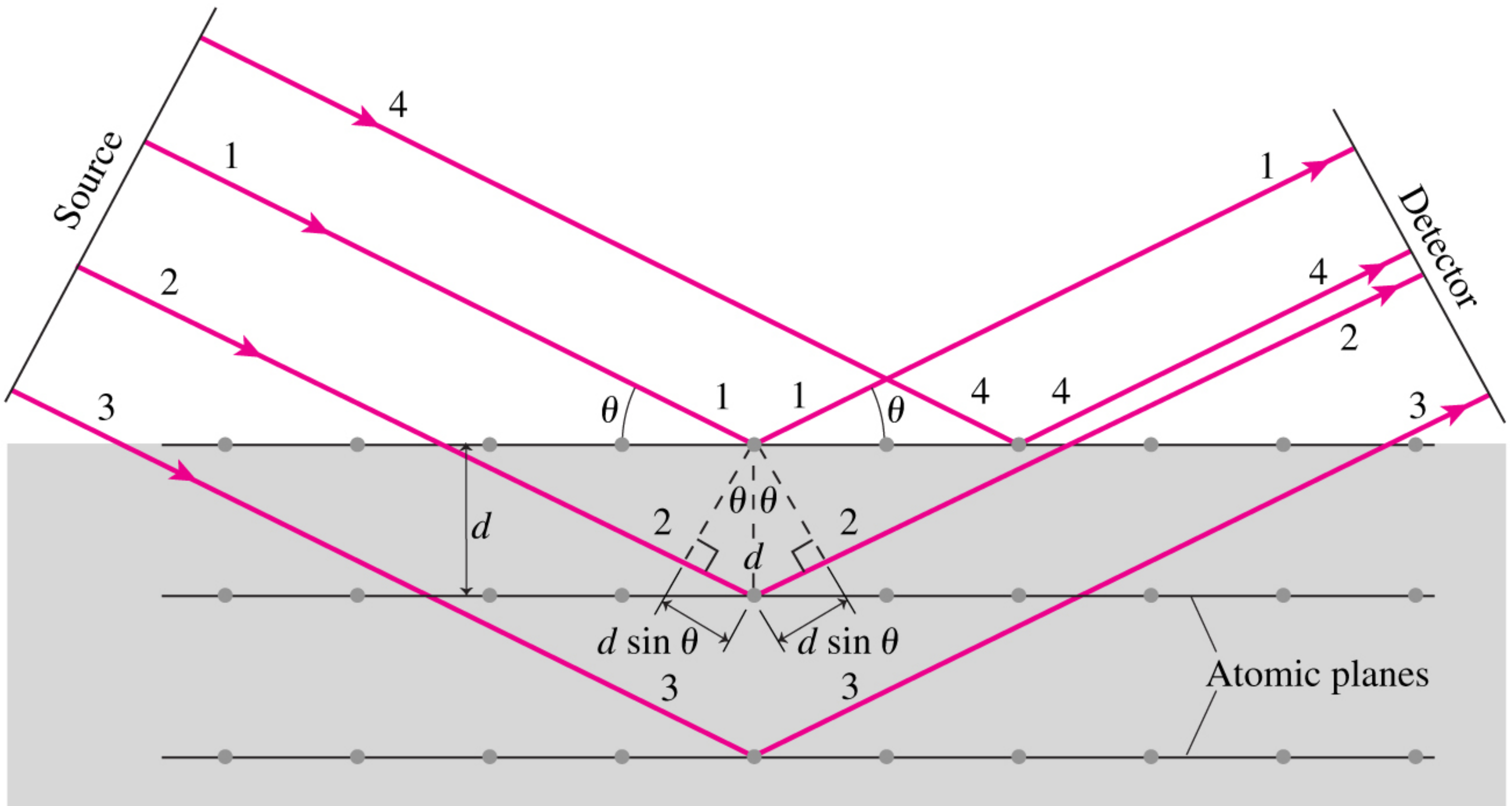


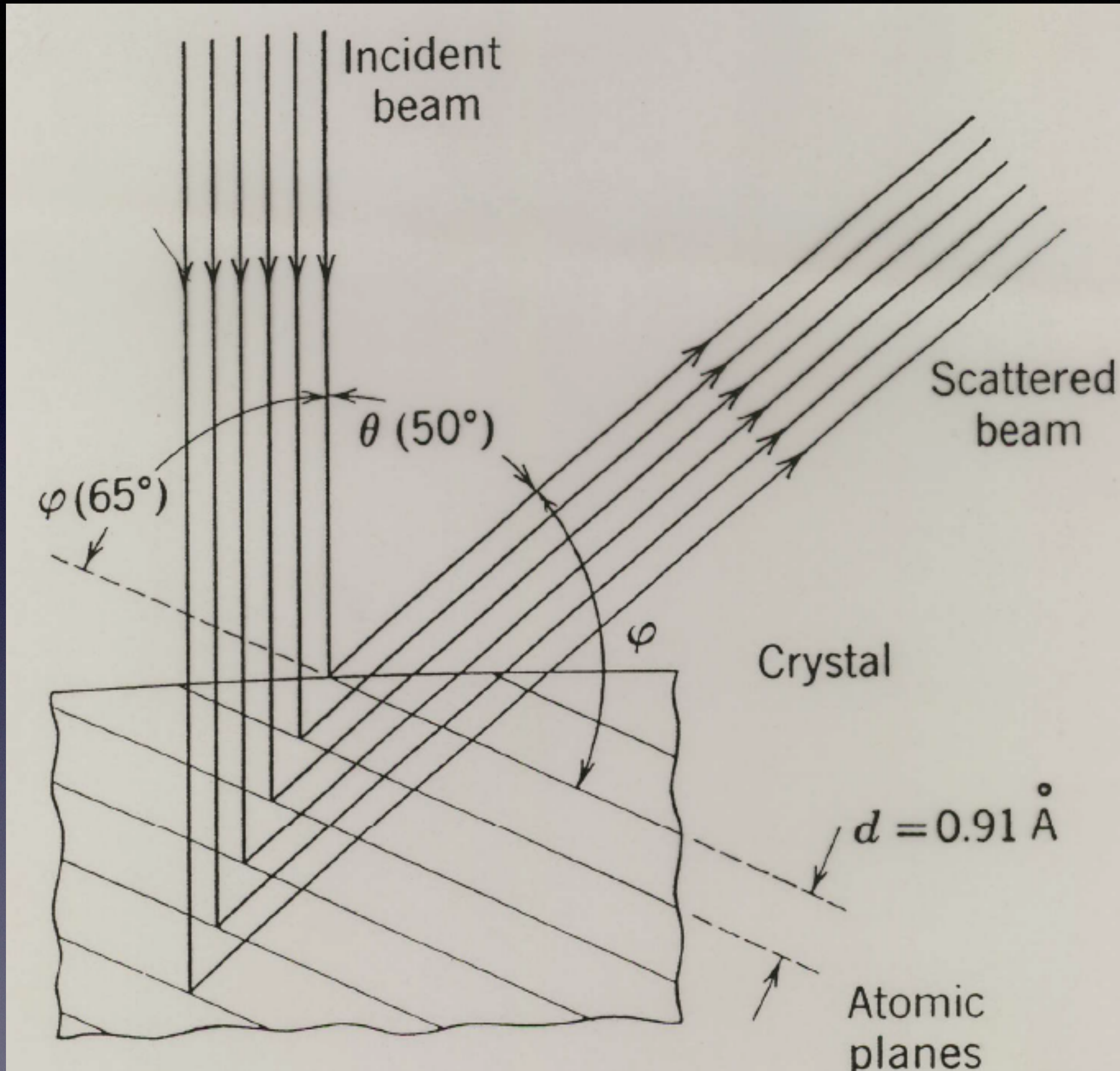
Matter waves

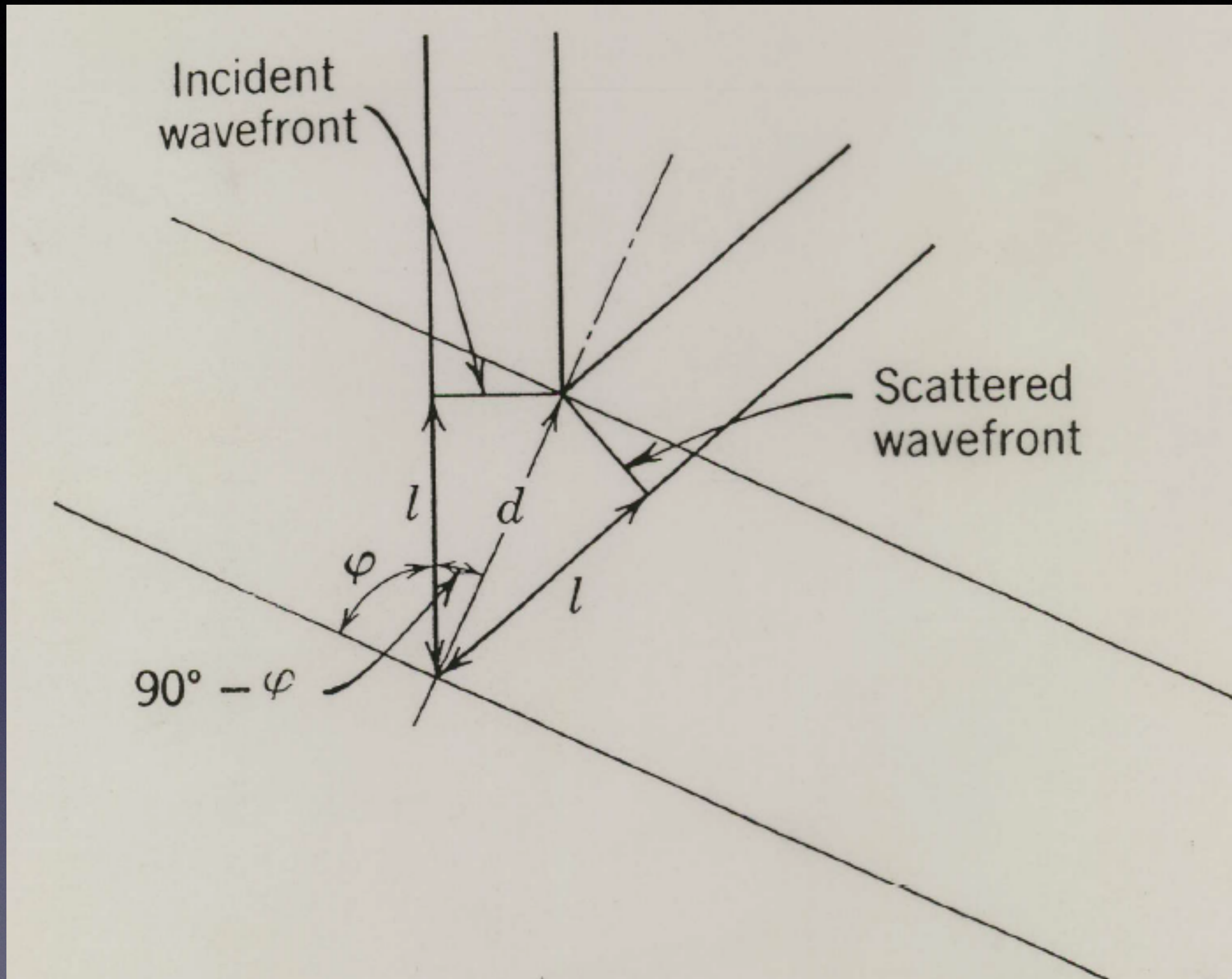




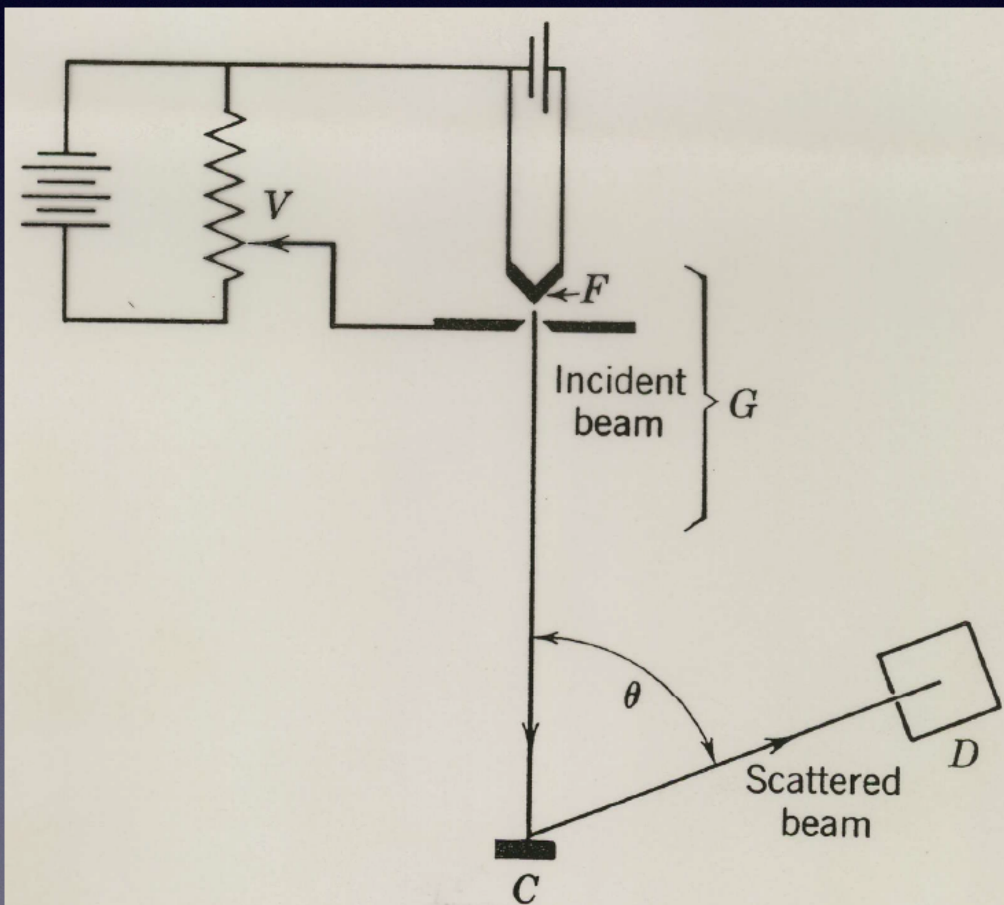


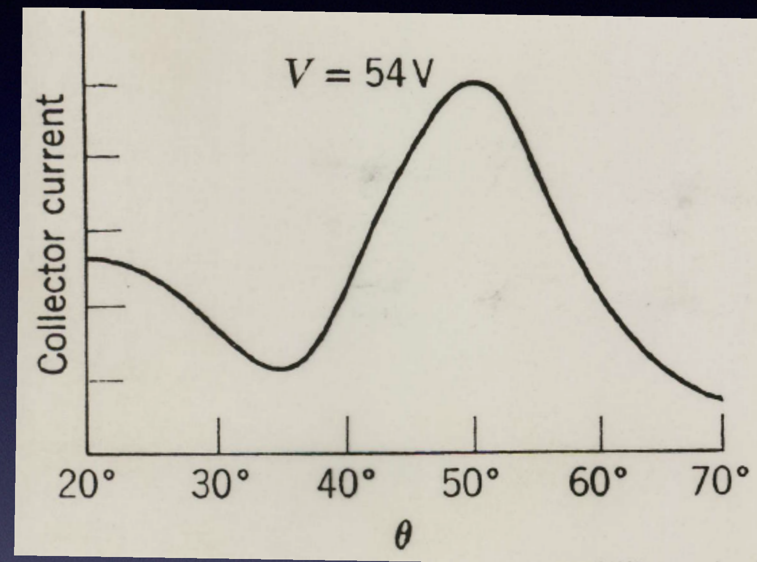

Source
4
1
2
3
θ
1
1
θ
4
4
1
4
2
3
Detector
d
2
θ θ
2
d
d sin θ
d sin θ
3
3
Atomic planes

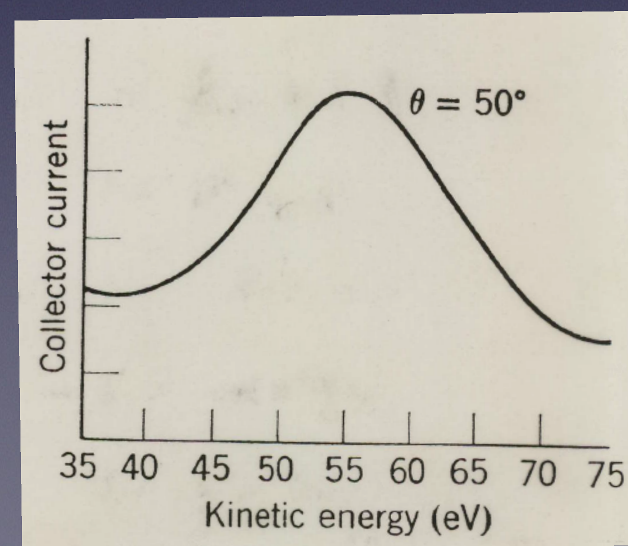

Incident
beam
Scattered
beam
θ (50°)
φ (65°)
φ
Crystal
d = 0.91 Å
Atomic
planes


Incident
wavefront
Scattered
wavefront
l
d
φ
l
90° − φ

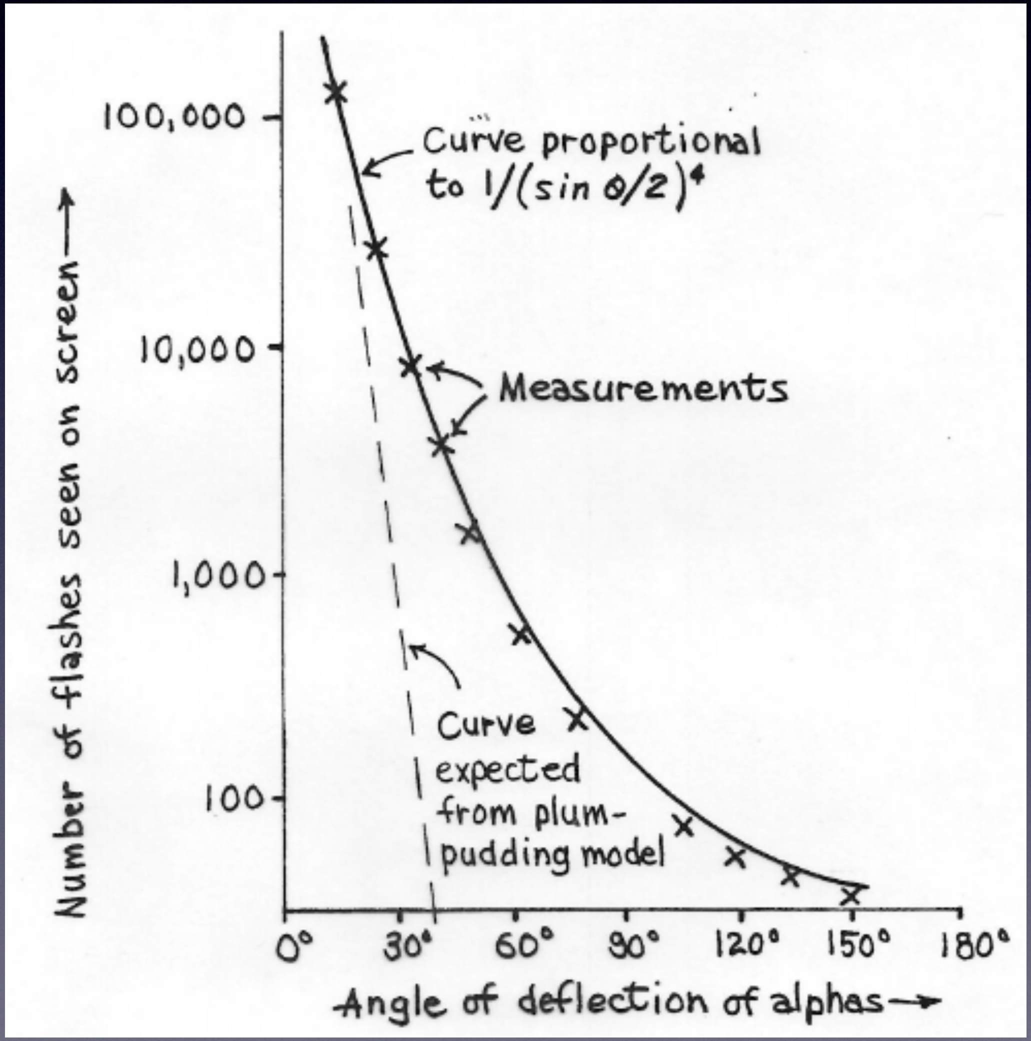
Matter waves





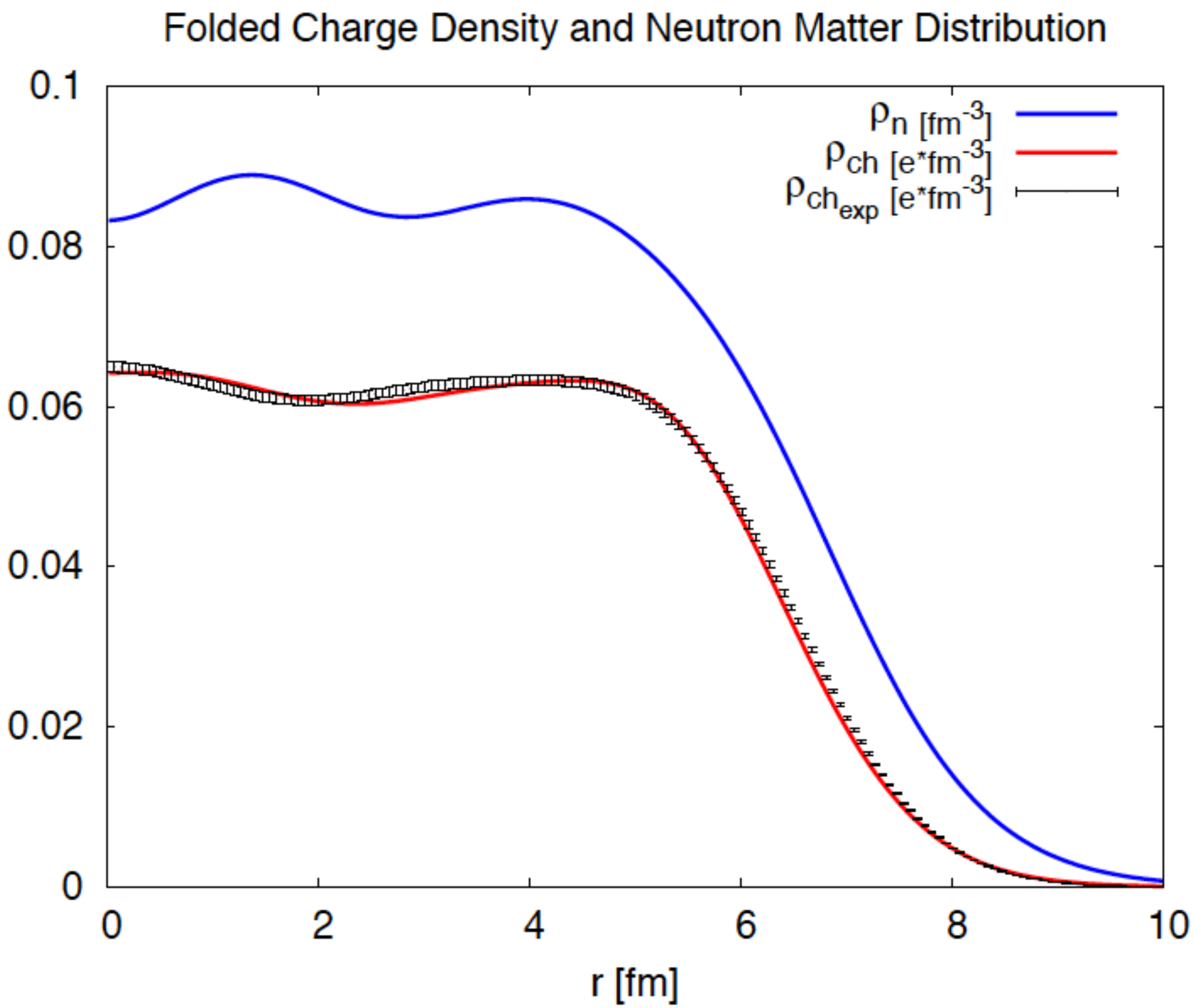


Rutherford discovery

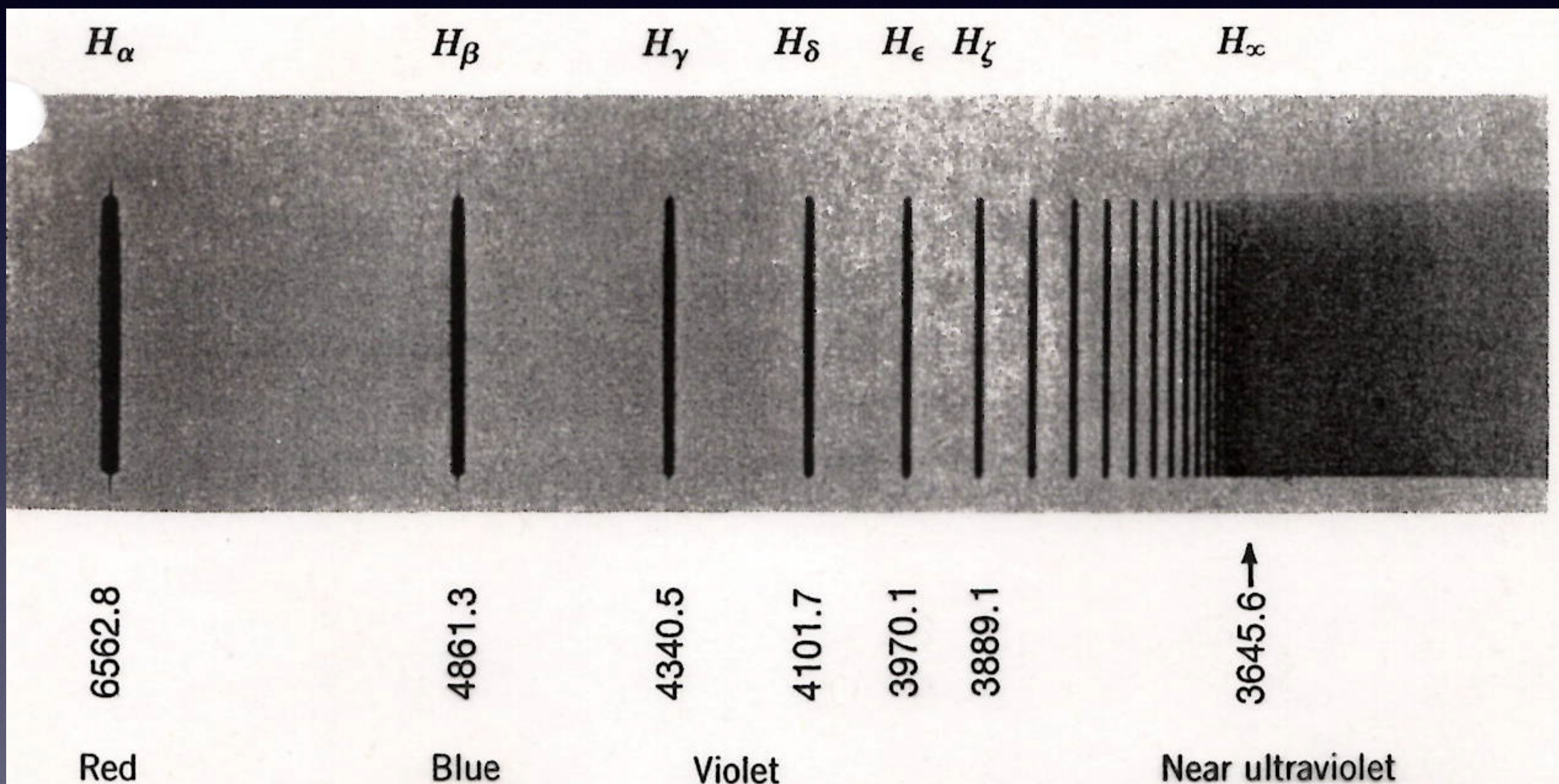


^{208}Pb Charge density

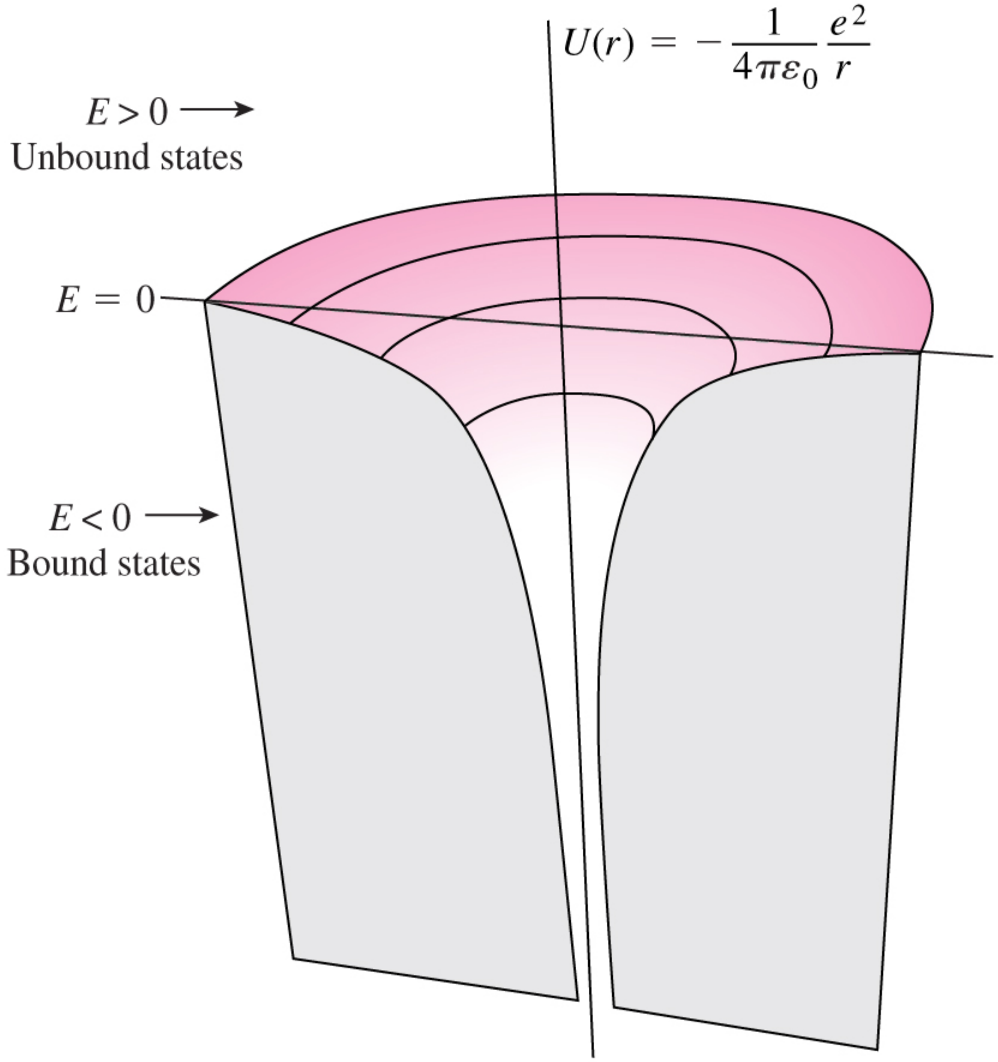
- Possible to get a good charge density (preliminary)



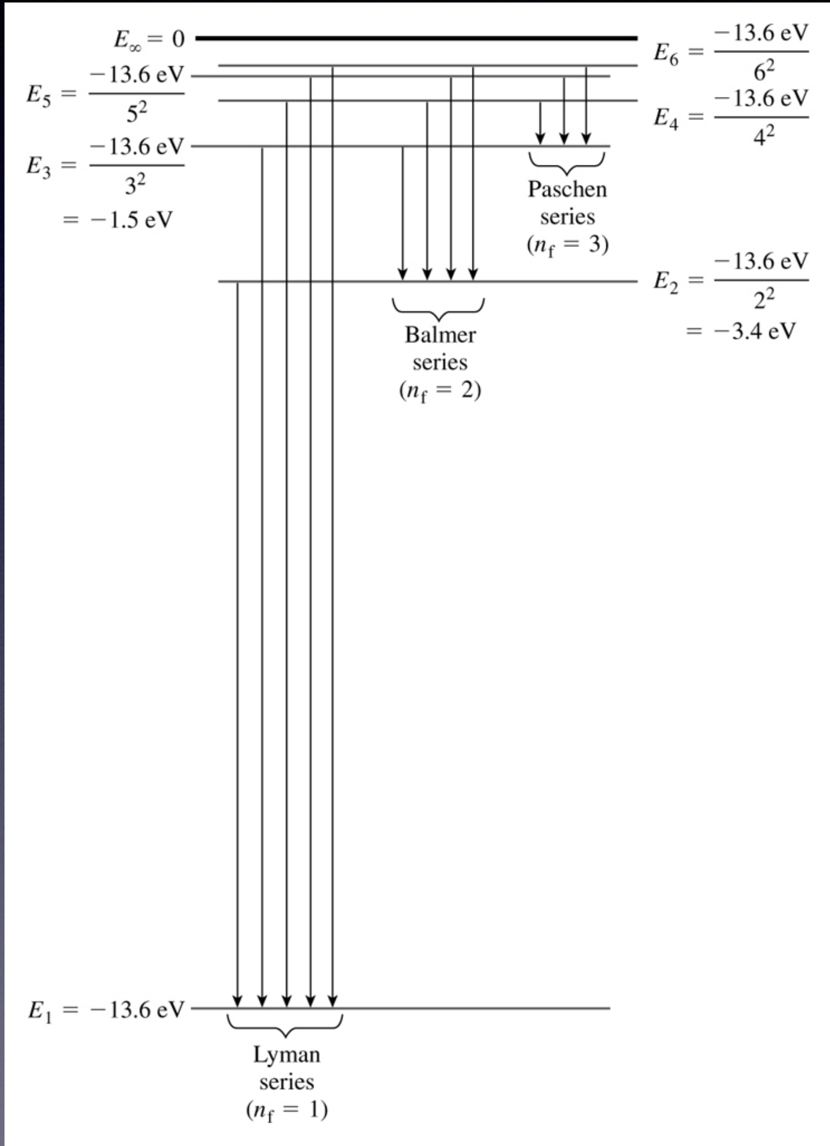
What you “see” for Hydrogen



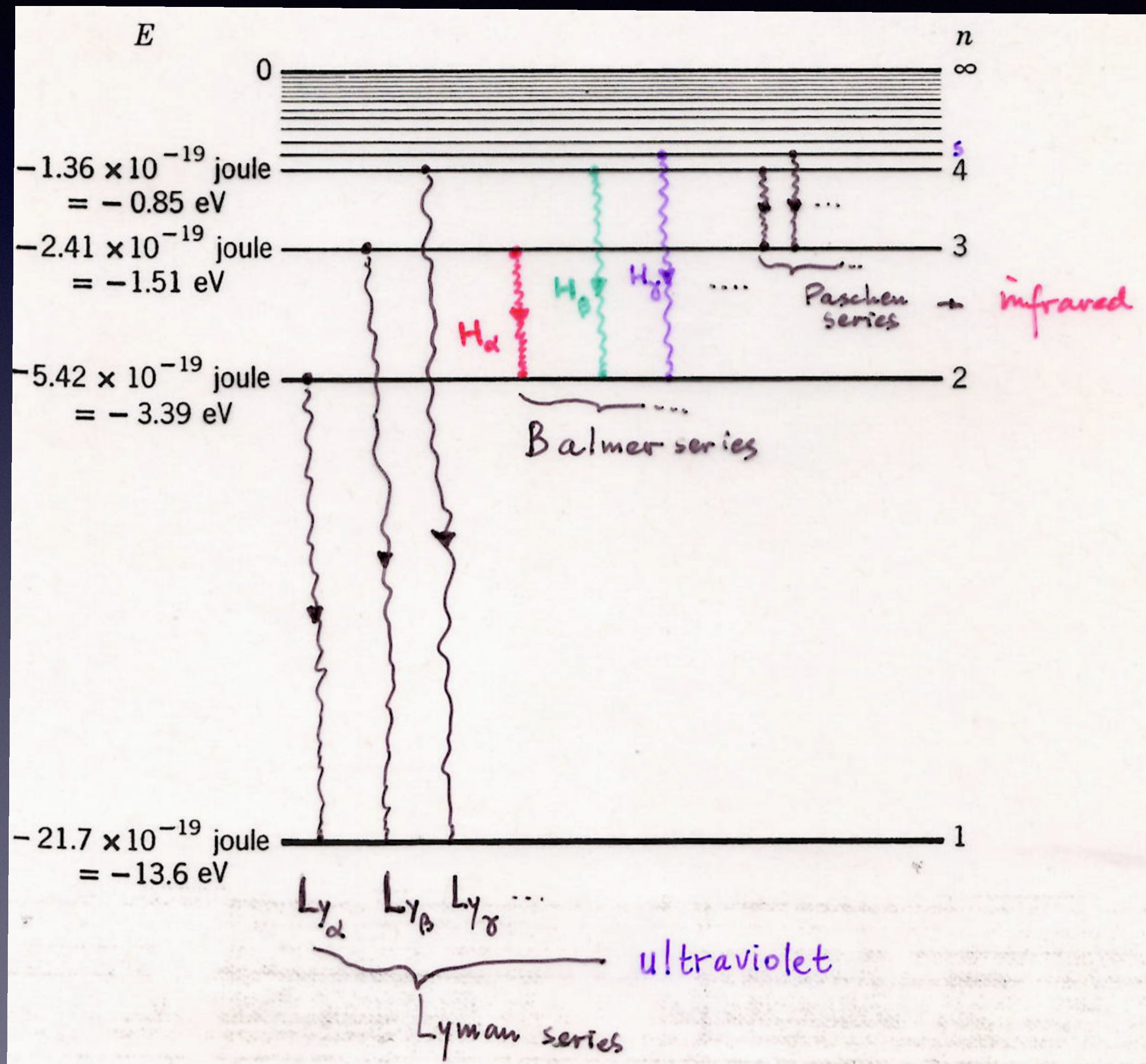
Electron potential in Hydrogen



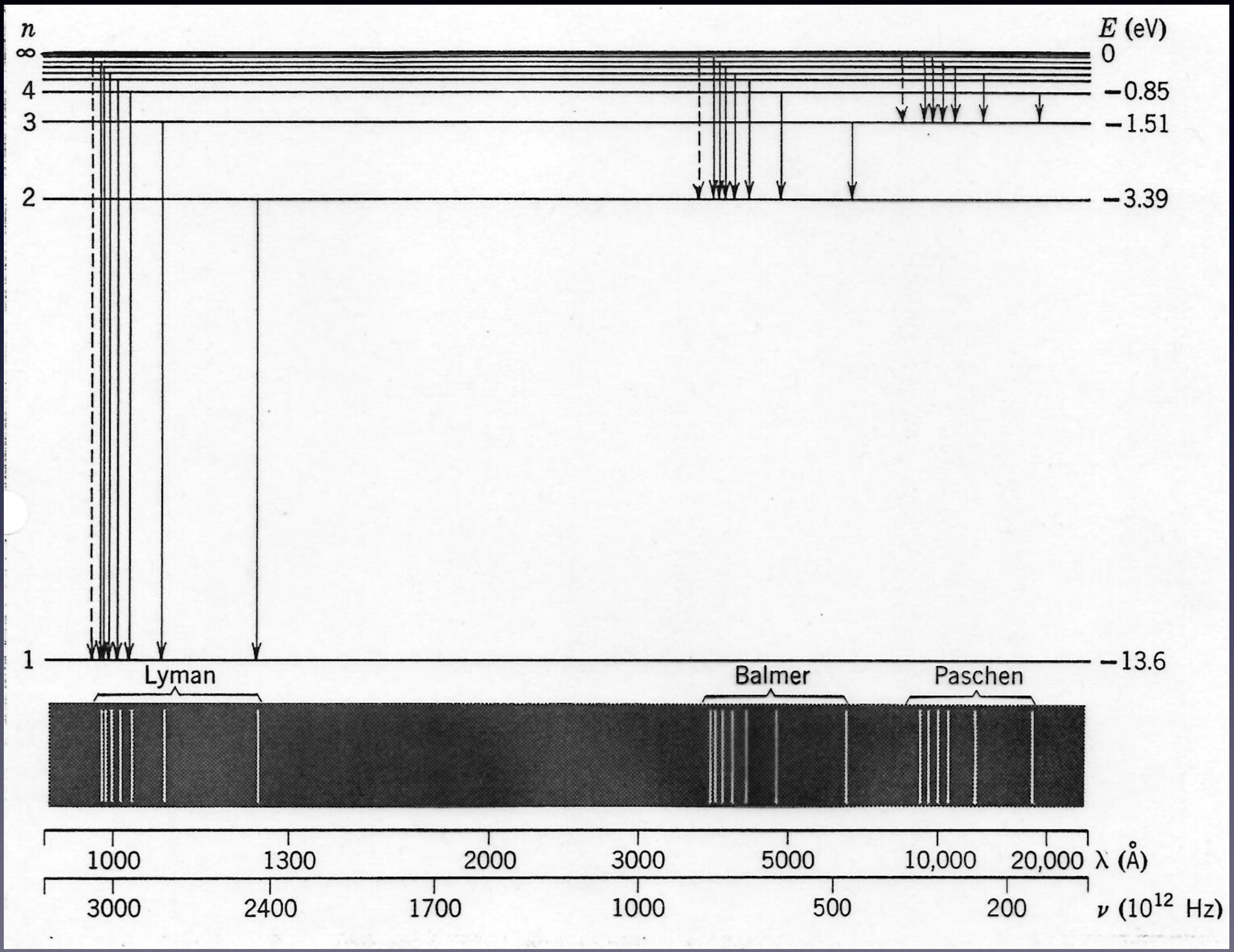
Book picture



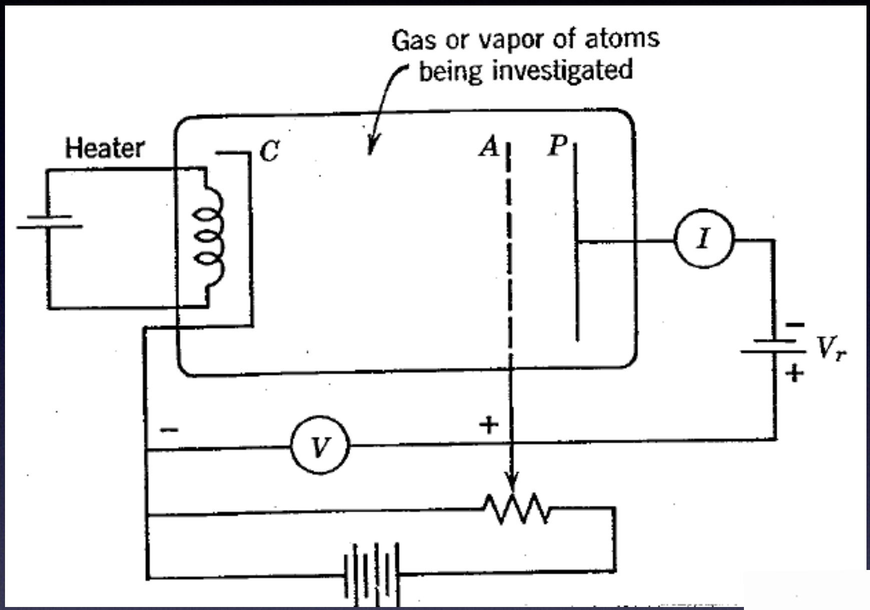
Perspective



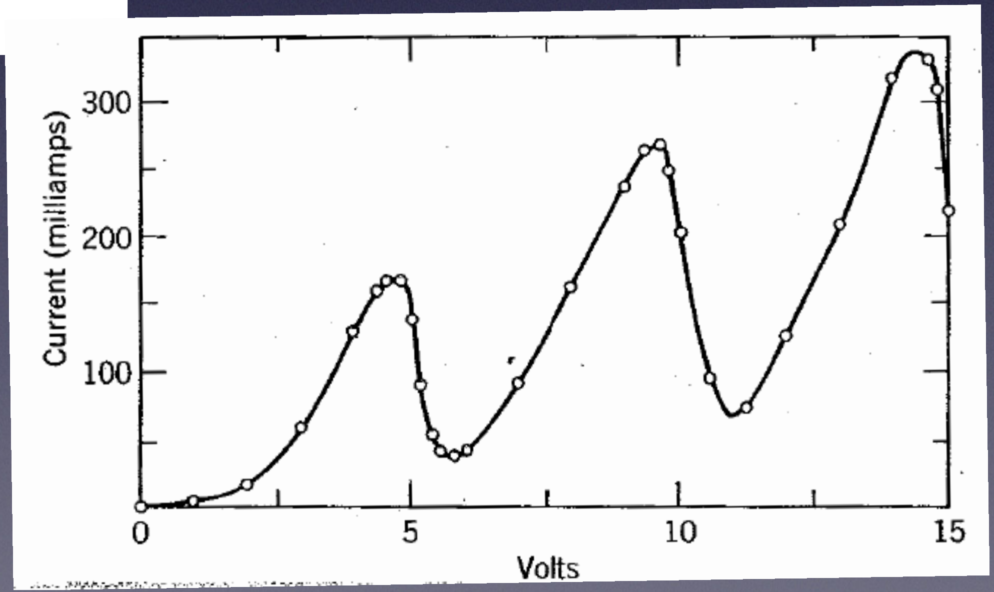
More of the same



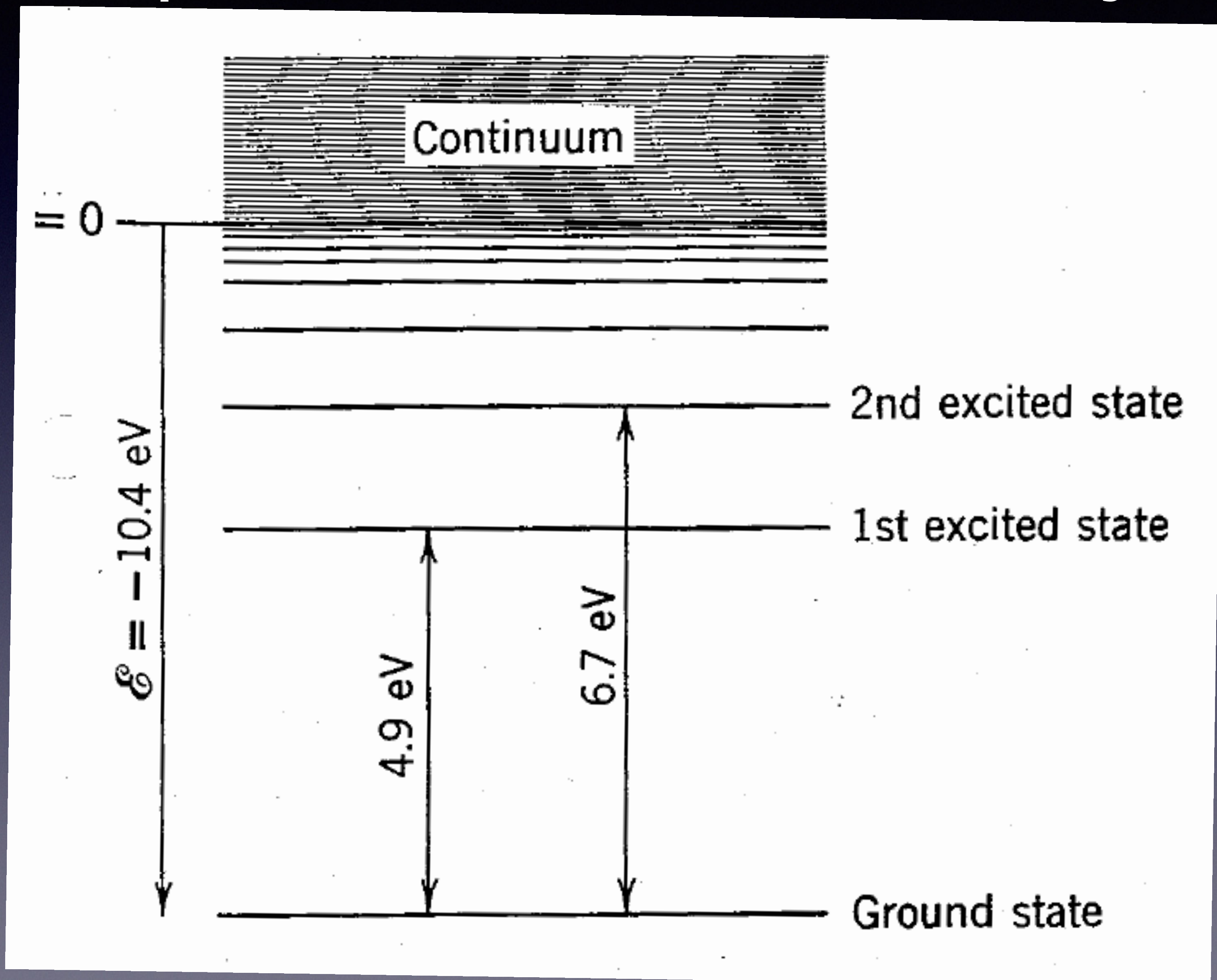
Frank & Hertz 1914



Mercury vapor

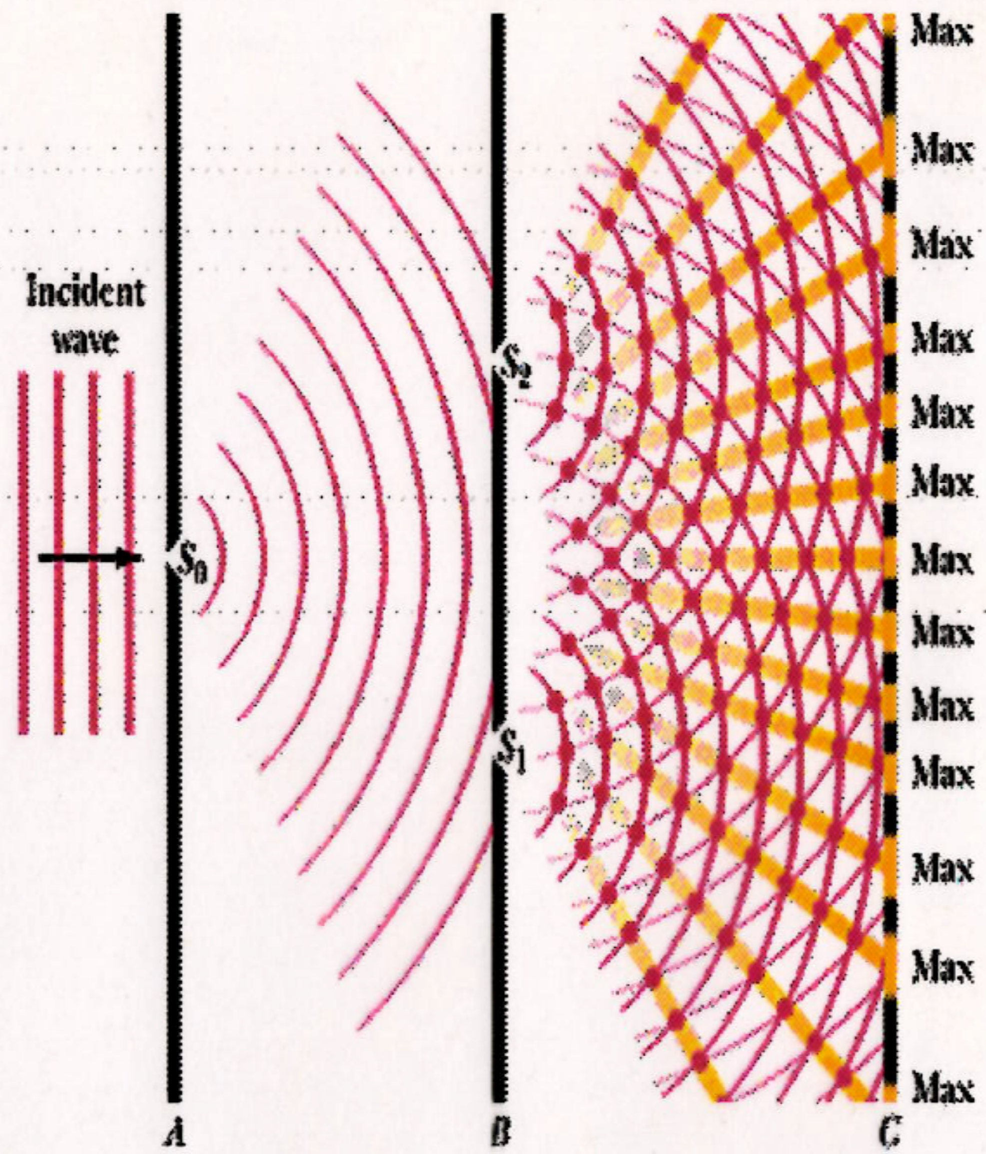


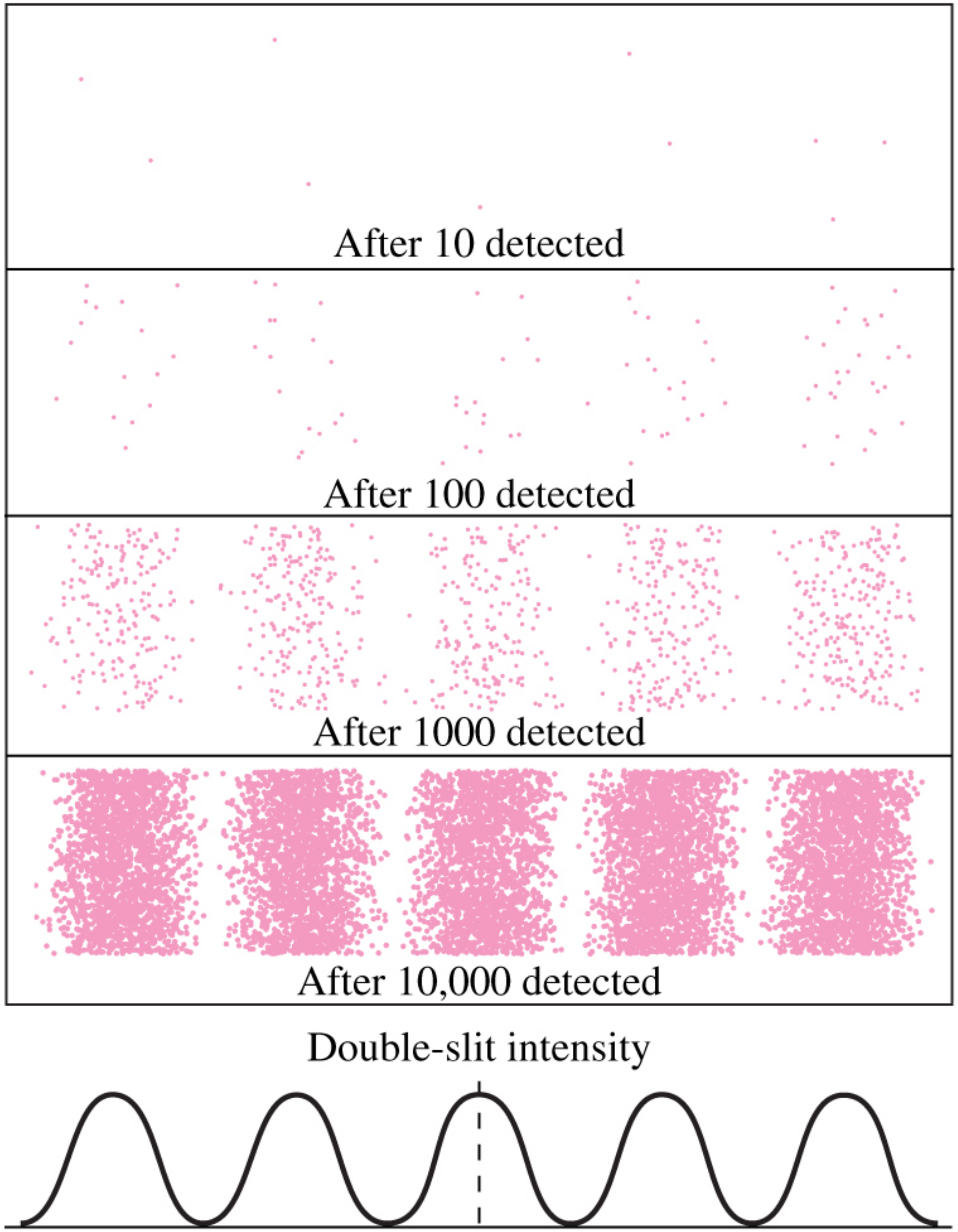
Spectrum Mercury

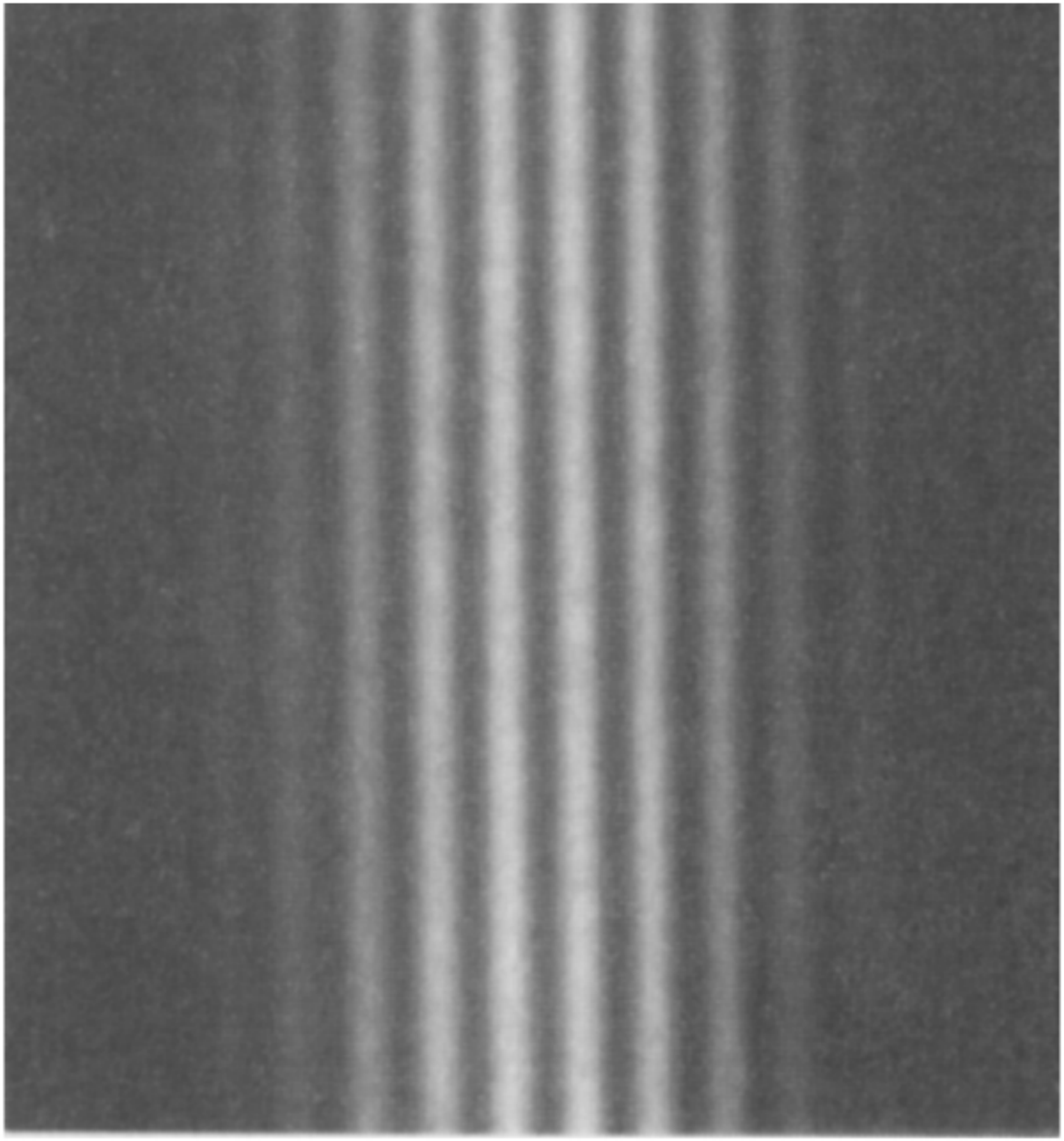


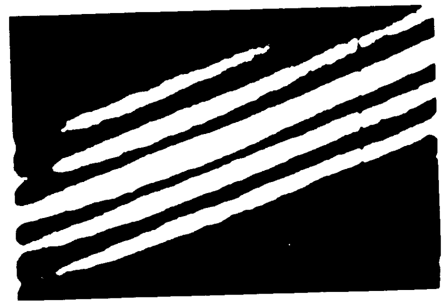
Double-slit experiment

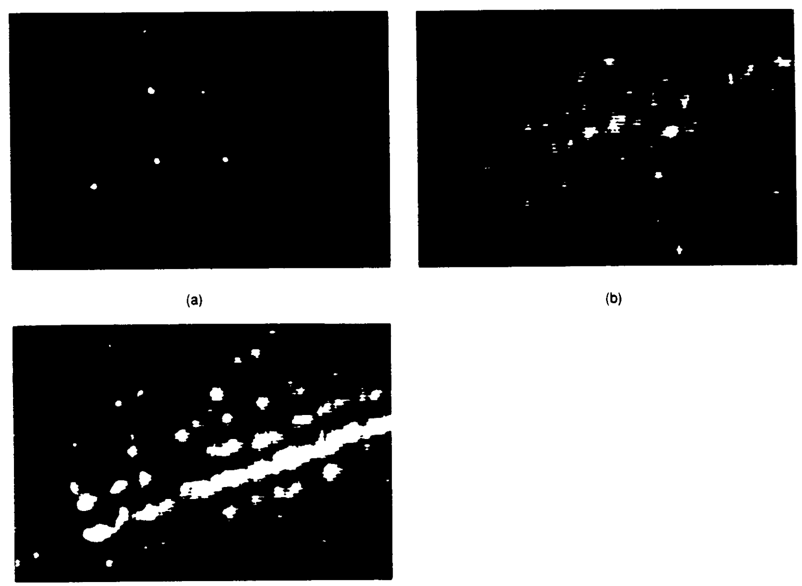
FIGURE 36-6 In Young's interference experiment, incident monochromatic light is diffracted by slit S_0, which then acts as a point source of light that emits semicircular wavefronts. As that light reaches screen B, it is diffracted by slits S_1 and S_2, which then act as two point sources of light. The light waves traveling from slits S_1 and S_2 overlap and undergo interference, forming an interference pattern of maxima and minima on viewing screen C. This figure is a cross section; the screens, slits, and interference pattern extend into and out of the page.




After 10 detected
After 100 detected
After 1000 detected
After 10,000 detected
Double-slit intensity



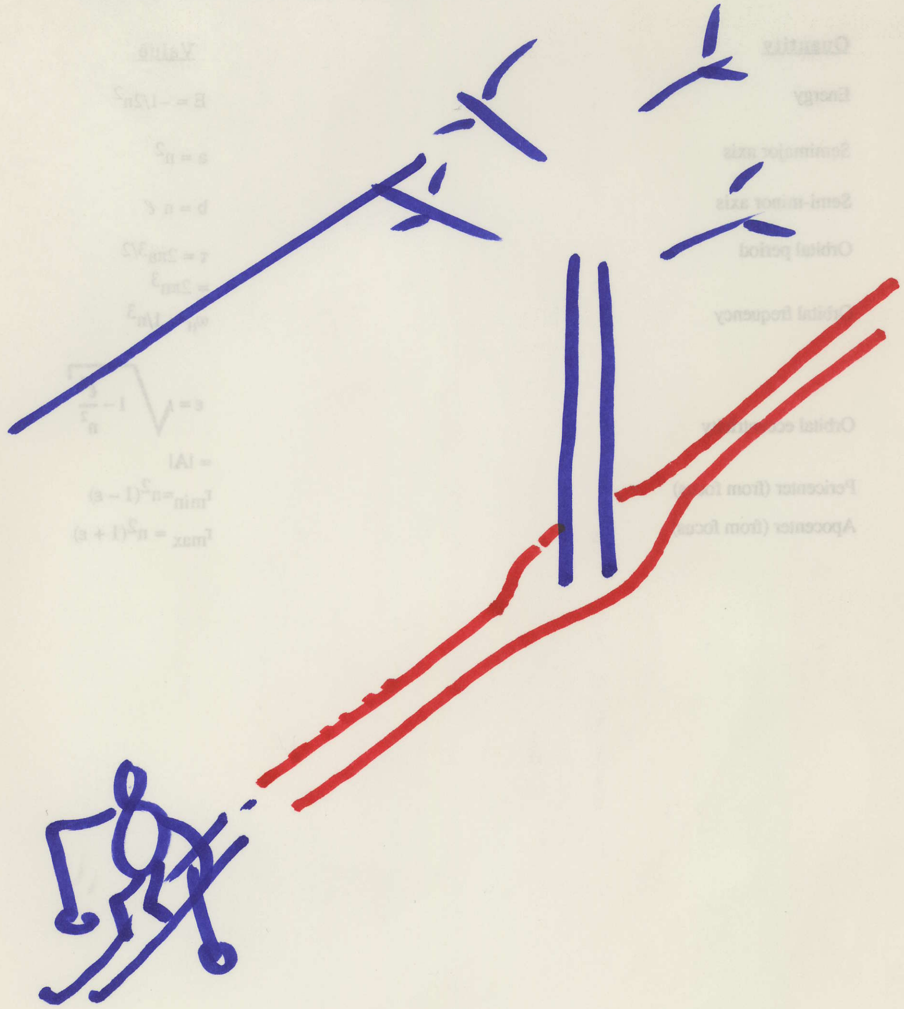


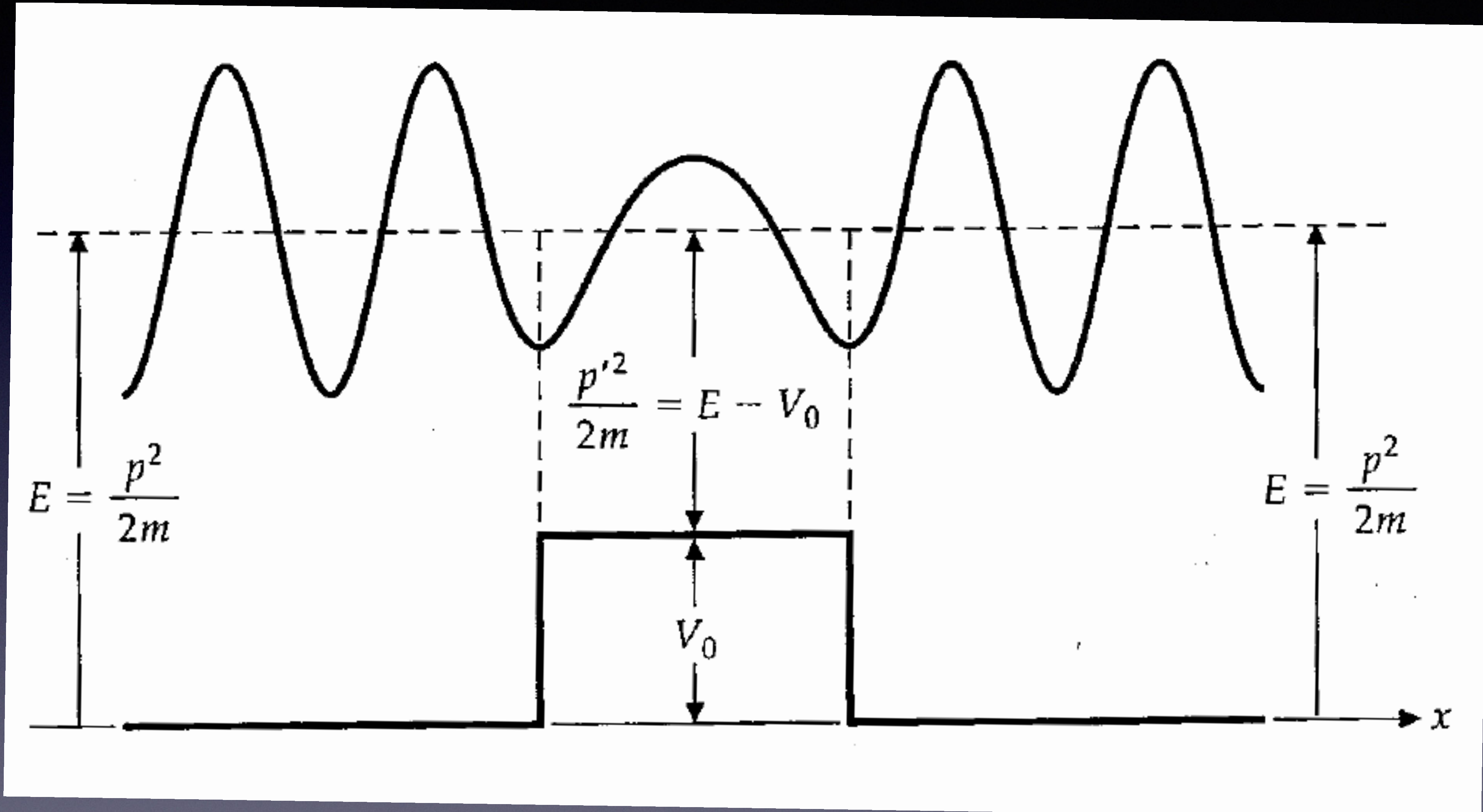


(a)

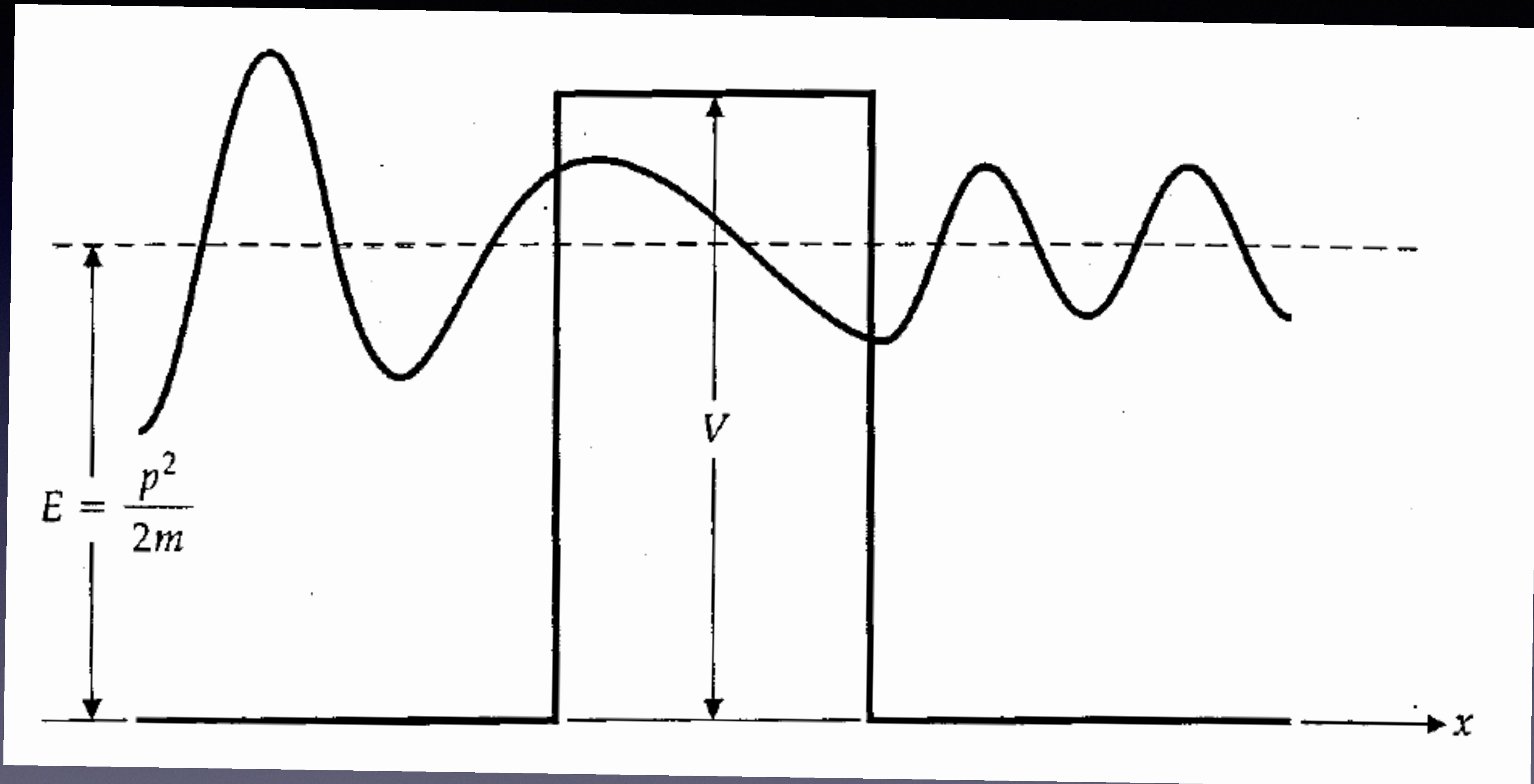
(b)

(c)

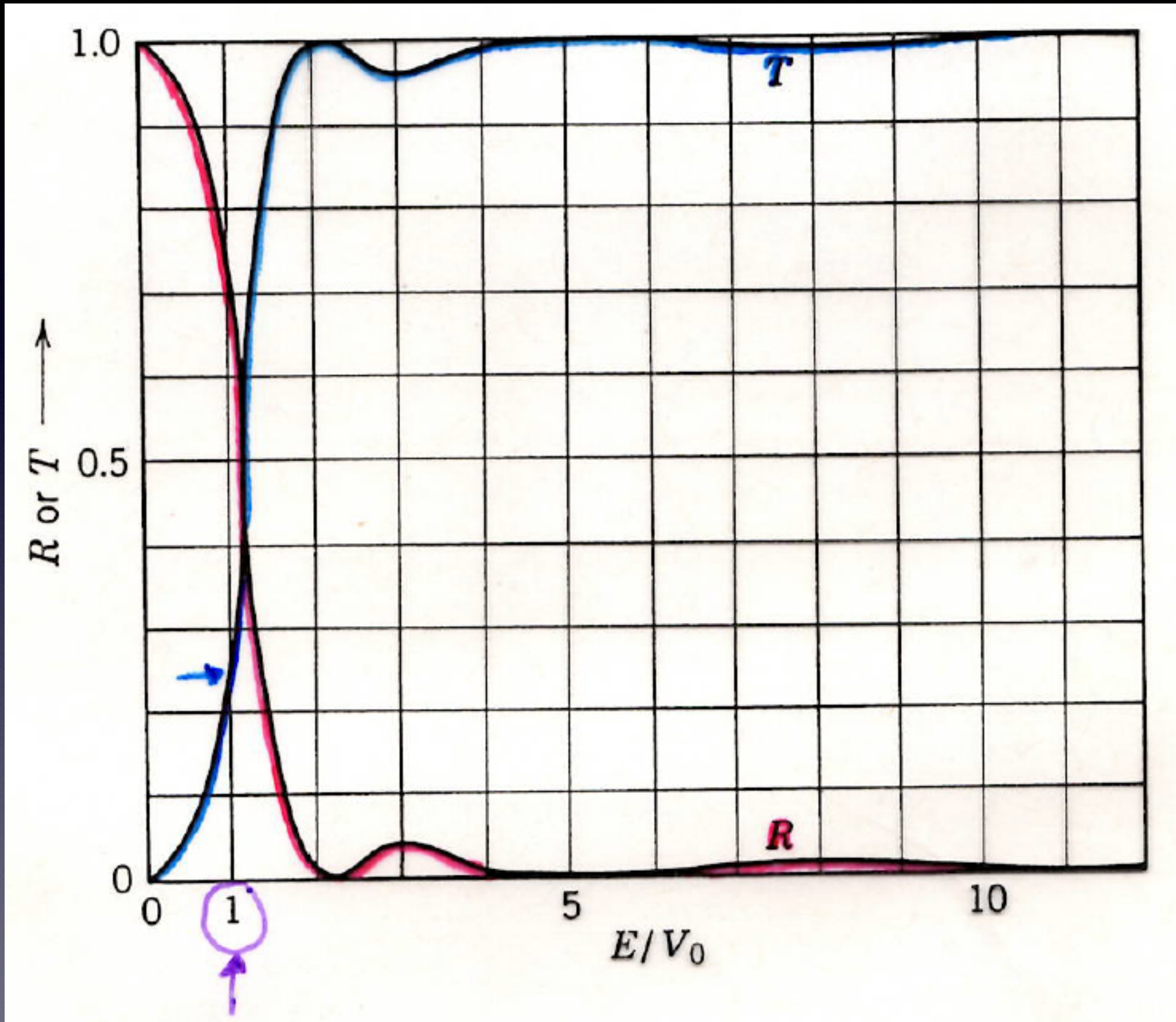




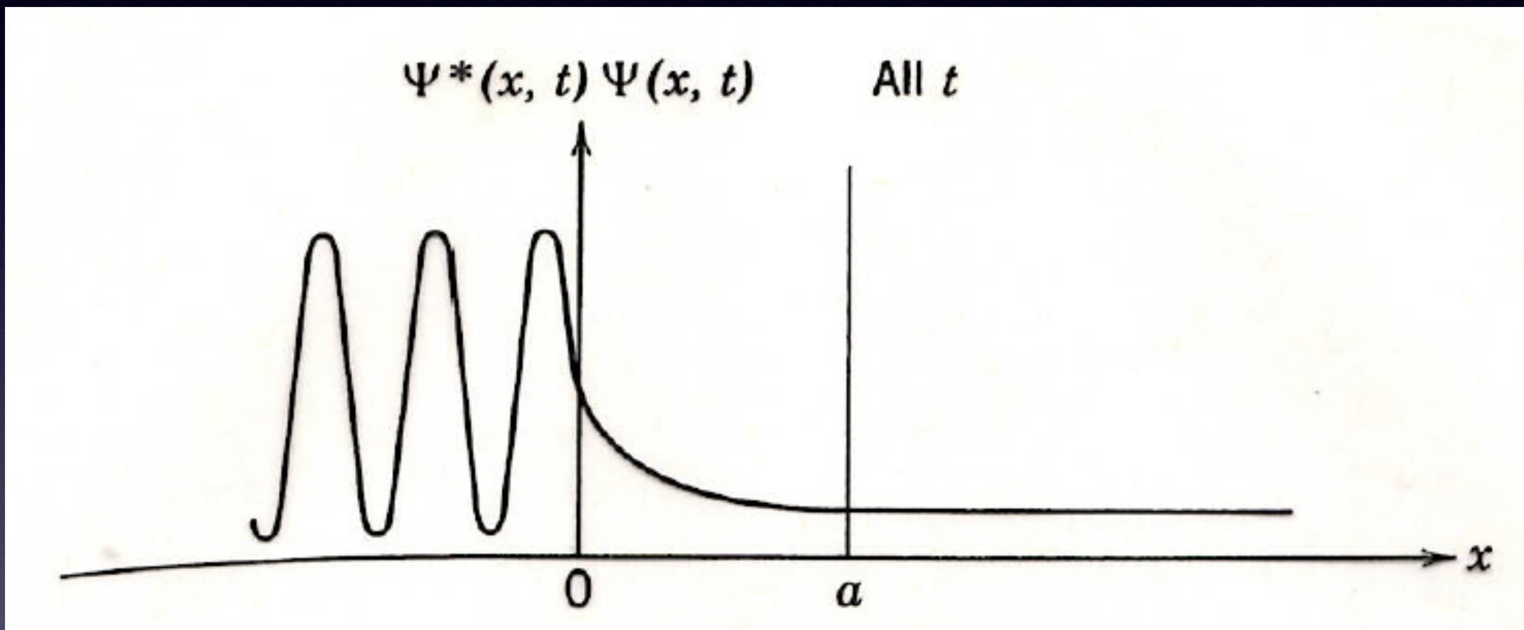
$\frac{p'^2}{2m} = E - V_0$
$E = \frac{p^2}{2m}$
$E = \frac{p^2}{2m}$
V_0
x

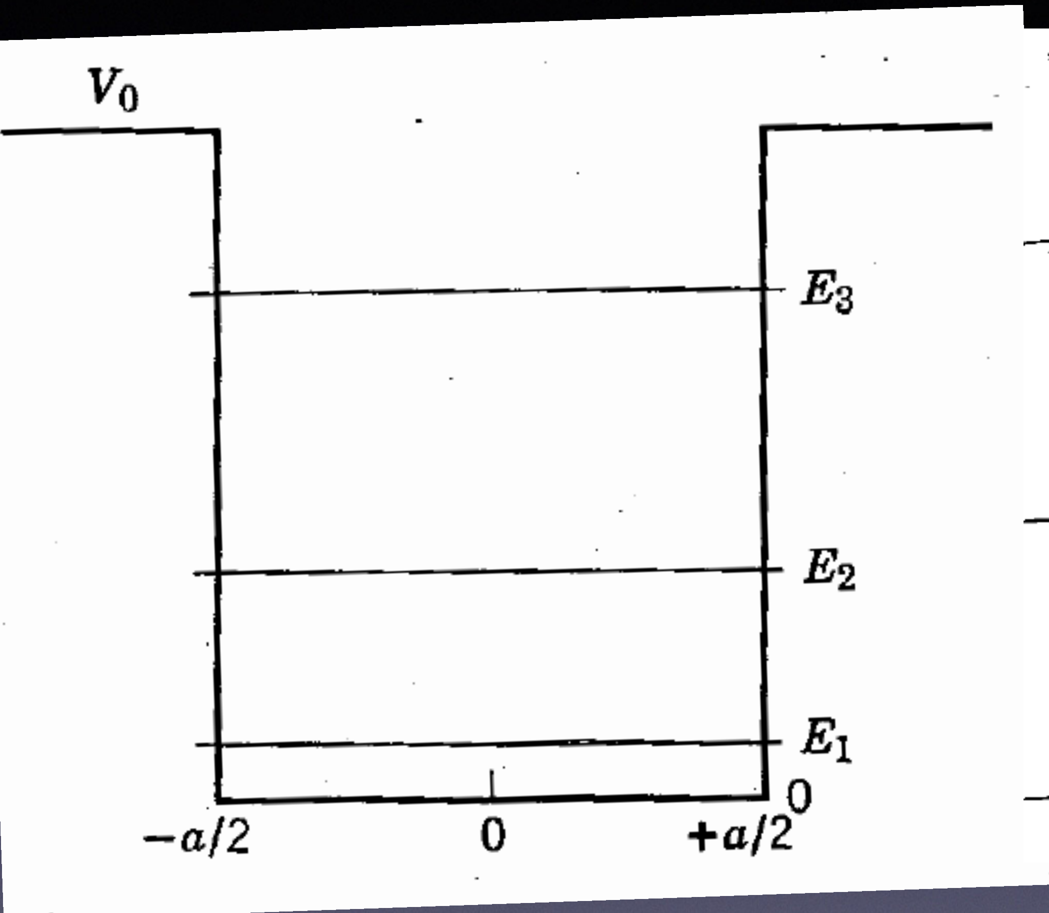


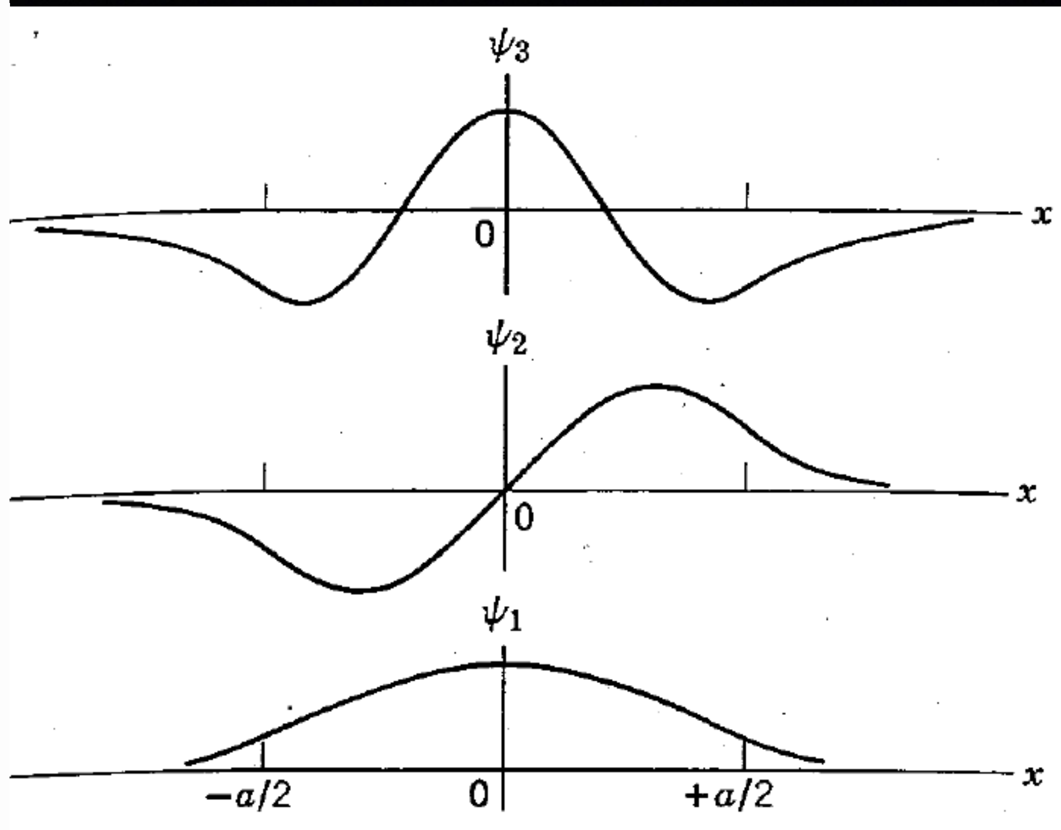
V
$E = \frac{p^2}{2m}$
x

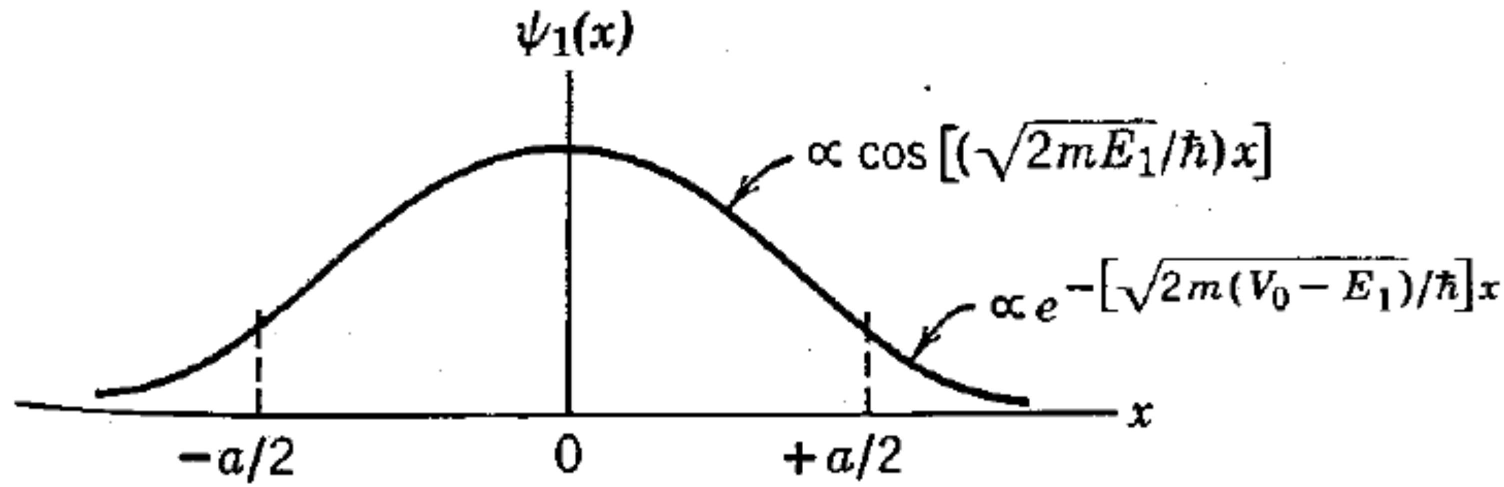


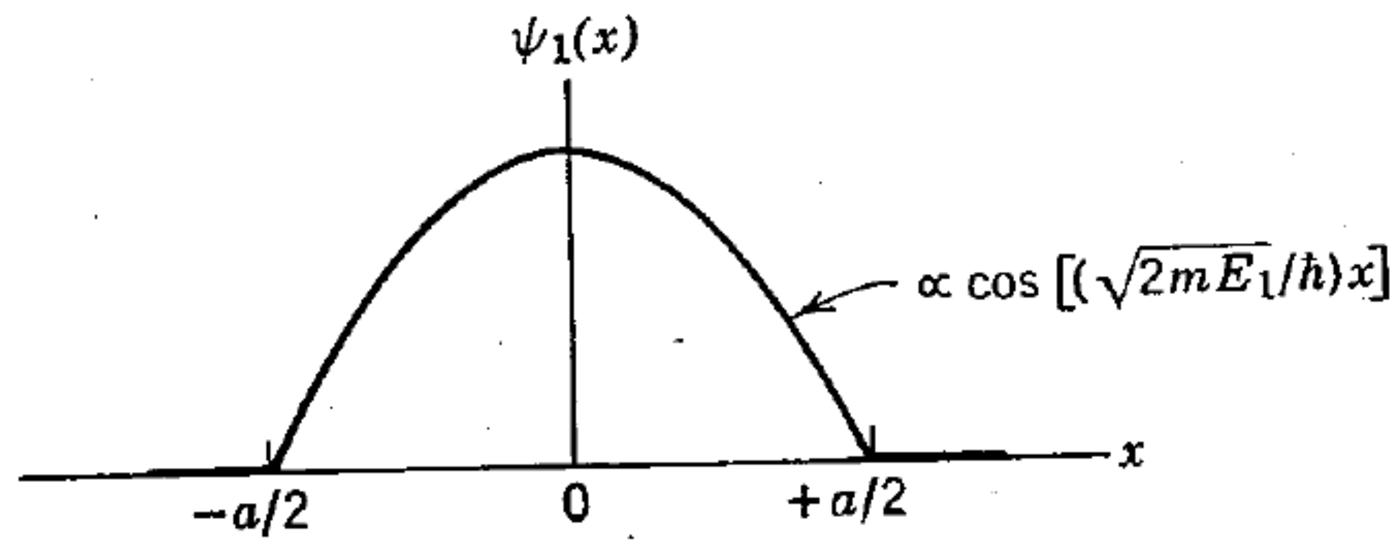
1.0
0.5
0
R or T ⟶
T
R
0
1
5
10
E/V0

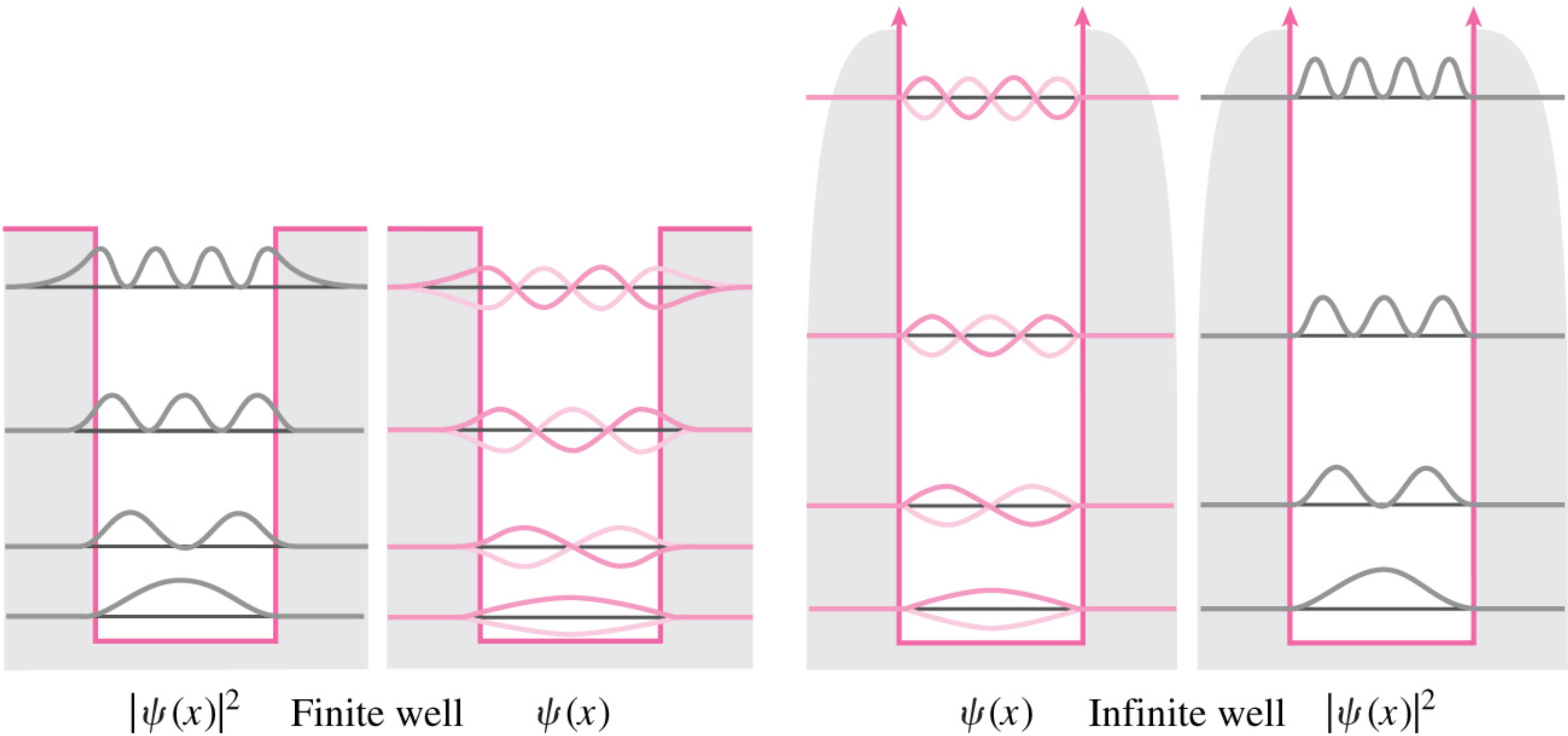

Ψ*(x, t) Ψ(x, t)
All t
0
a
x

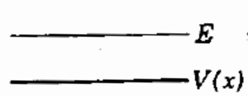
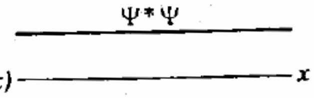
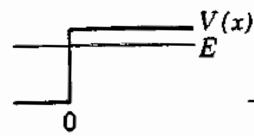
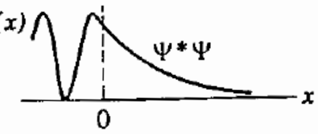
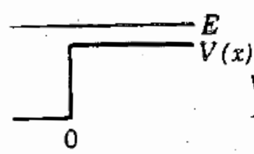
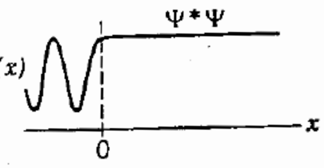
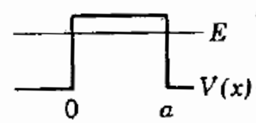
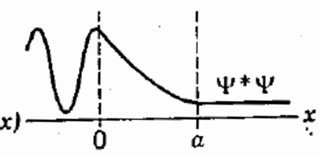
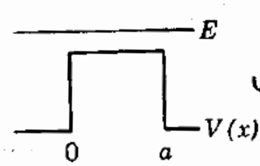
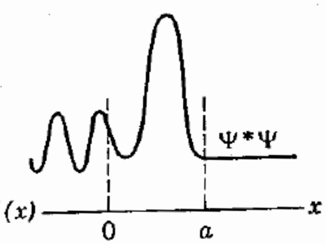
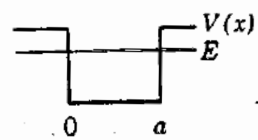
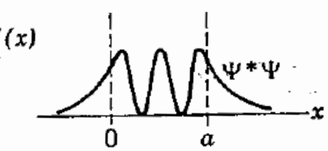
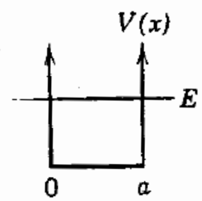
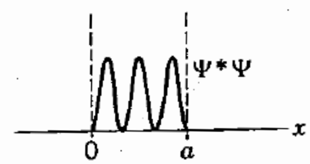
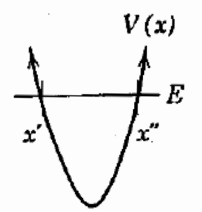
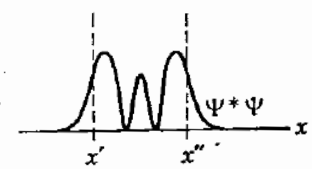

V_0
E_3
E_2
E_1
0
$-a/2$
0
$+a/2$


ψ_3
x
0
ψ_2
x
0
ψ_1
x
$-a/2$
0
$+a/2$


$\psi_1(x)$
$\propto \cos[(\sqrt{2mE_1}/\hbar)x]$
$\propto e^{-[\sqrt{2m(V_0-E_1)}/\hbar]x}$
x
$-a/2$
0
$+a/2$


$\psi_1(x)$
$\propto \cos[(\sqrt{2mE_1}/\hbar)x]$
x
$-a/2$
0
$+a/2$


$|\psi(x)|^2$
Finite well
$\psi(x)$
$\psi(x)$
Infinite well
$|\psi(x)|^2$

Name of System	Physical Example	Potential and Total Energies	Probability Density	Significant Feature
Zero potential	Proton in beam from cyclotron			Results used for other systems
Step potential (energy below top)	Conduction electron near surface of metal			Penetration of excluded region
Step potential (energy above top)	Neutron trying to escape nucleus			Partial reflection at potential discontinuity
Barrier potential (energy below top)	α particle trying to escape Coloumb barrier			Tunneling
Barrier potential (energy above top)	Electron scattering from negatively ionized atom			No reflection at certain energies
Finite square well potential	Neutron bound in nucleus			Energy quantization
Infinite square well potential	Molecule strictly confined to box			Approximation to finite square well
Simple harmonic oscillator potential	Atom of vibrating diatomic molecule			Zero-point energy