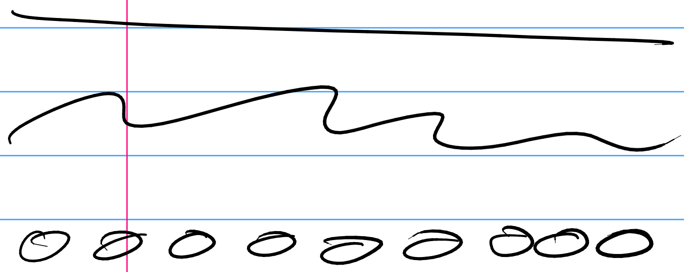
Quantum Physics



$E = h\lambda$

$\text{Photon} = \frac{hc}{\lambda}$

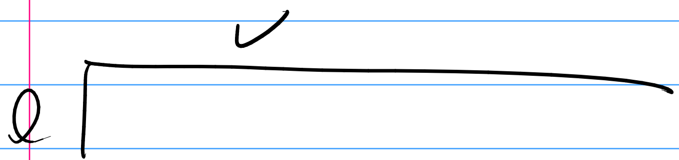
$h \Rightarrow$ planck's constant

$f \Rightarrow$ frequency

$E = hf$

electron Volt

$1eV = 1.6 \times 10^{-19} J$



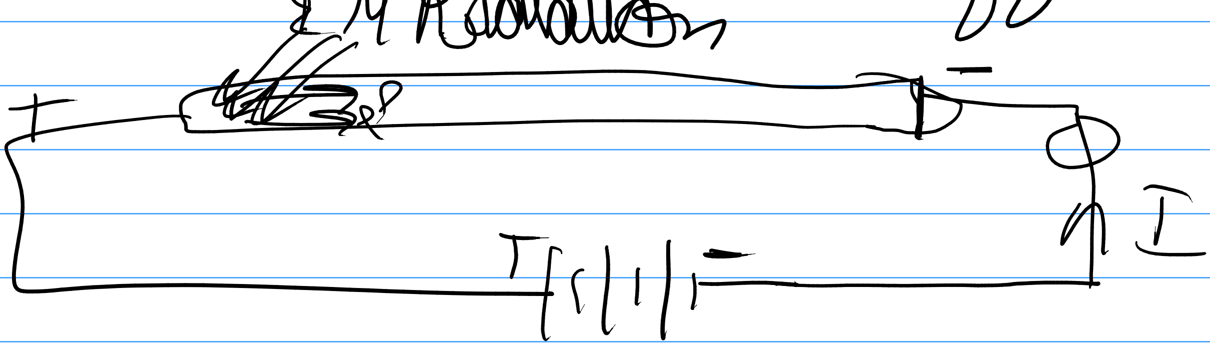
$W = Q \cdot V = 1.6 \times 10^{-19} J$

$P = \frac{E}{c} = \frac{hf}{c}$

$m - v$

$p = mv$

Photo Electric Effect



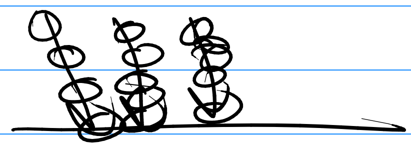
Photoelectric effect
- emitted e^- are known as photo e^-

It was found that when electromagnetic radiation was incident on certain metals, e were emitted from these metals.

Further observation for a given metal
- No electrons were emitted below a certain frequency known as the threshold frequency f_0

- If the intensity of the radiation was increased, the emitted e had more energy.

$$c = f_0 \lambda_0$$



work function of that element ϕ(eV)

if $hf < \phi \rightarrow$ nothing happens

if $hf = \phi \rightarrow e^-$ emitted with $0 \; E_k$

if $hf > \phi \Rightarrow e$ emitted with rest of energy as E_k

① If intensity of radiation is increased more photons are incident on metal plate $\therefore$ more e^- are given out (for 1 photon we get 1 e) (frequency constant)

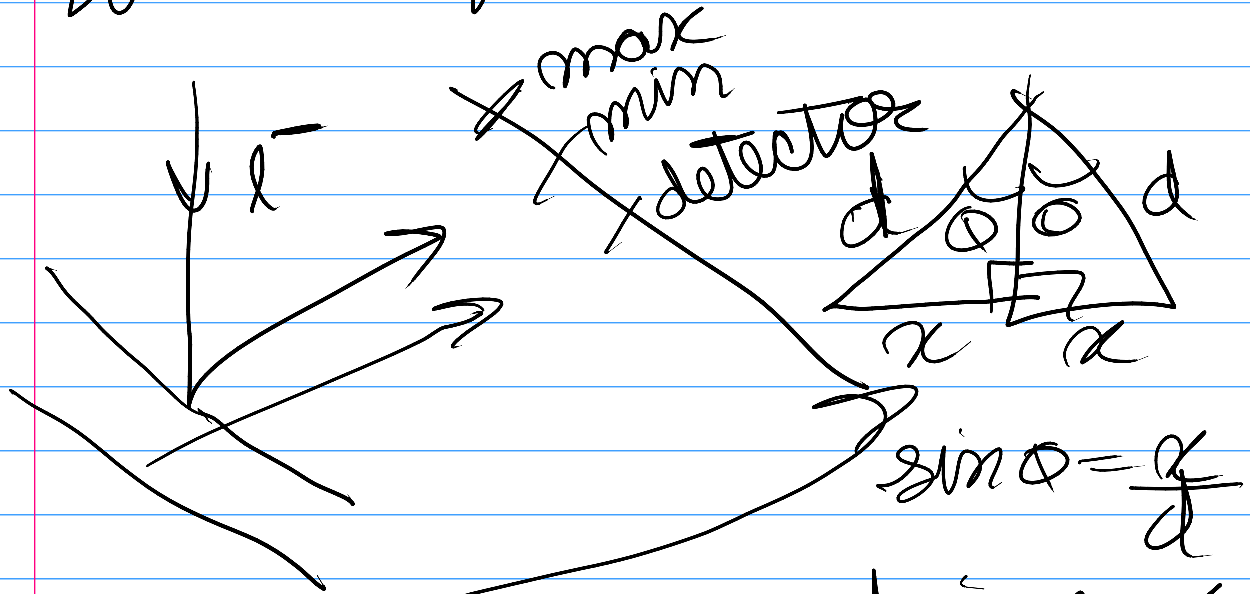
② If frequency is increased, then the emitted e^- have more energy (intensity constant)

The E_k of photo e^- only depends on the frequency of incident photons.

22.3

Photo electric effect → provides evidence for particulate nature

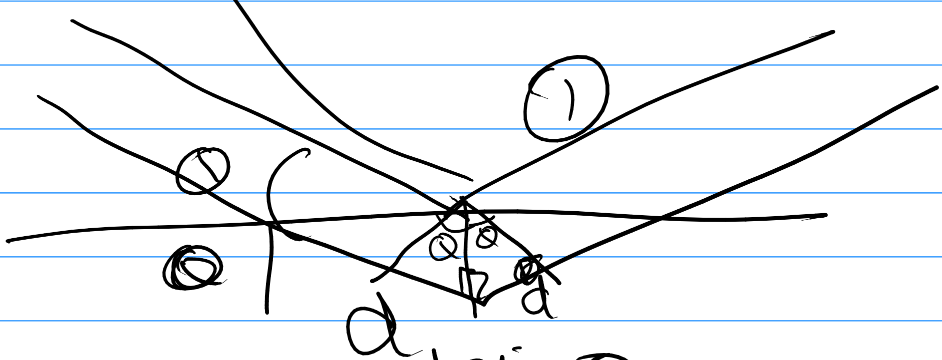
& diffraction for wave nature.



$\sin\theta = \frac{x}{d}$

$d\sin\theta = x$

PD = $d\sin\theta$



$2d\sin\theta$

$d\sin\theta + d\sin\theta = 2d\sin\theta$

if $2d\sin\theta = n\lambda$, (constructive)

if $2d\sin\theta = (n+\frac{1}{2})\lambda$ (destructive)

De Brogli's Hypothesis →

Any particle moving with a velocity v behaves like a wave & ∴ must have a wavelength. This wavelength is given by

wavelength $\lambda = \frac{h}{p}$ h → planck's constant
p → momentum

22.4 Energy levels in line spectra

Every atom possesses definite but discrete levels of energy which are unique only to that atom. Under normal circumstances when the atom is at rest (ground energy) then it is said to be in a ground state as it has lowest energy level. If the atom is given any energy it will only accept it if the energy which atom raises it to one of the discrete energy levels. When it has risen to this level, it is said to be in an excited state & it immediately drops down to the ground state directly or in stages. During each of these stages, it will emit a photon having energy equal to the level that it was raised to. If hydrogen is placed in a vacuum tube & a high voltage is applied to the electrodes then electrons will move from the cathode towards the anode at a high speed. In doing so they collide against the hydrogen atoms, which will then rise to an excited state. They then come down to the ground state, emitting an e^- which has energy (hc/λ) that is characteristic of that element. In this way a certain no. of lines will be given out which are characteristic only for this element & are called the emission spectrum of the element.

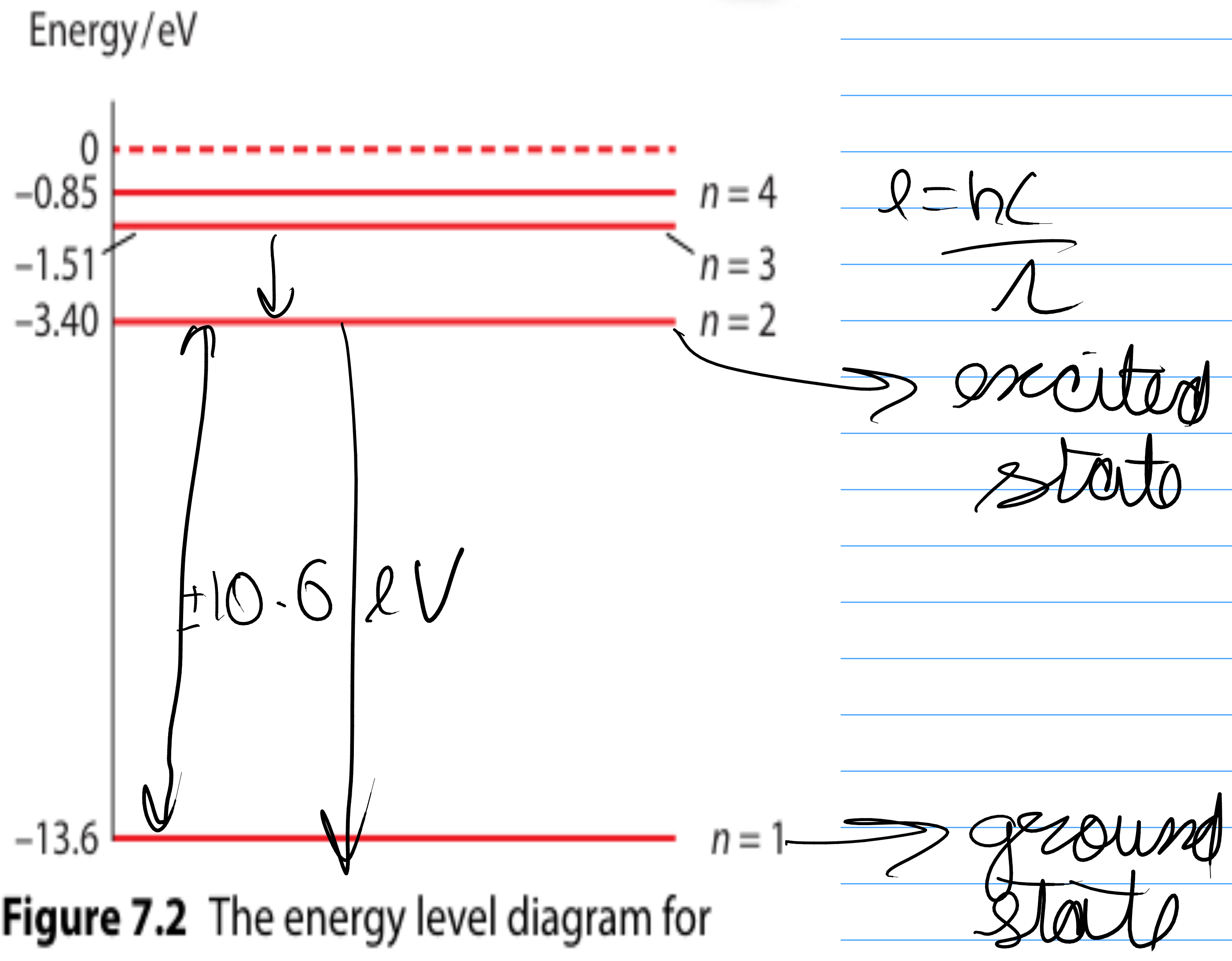
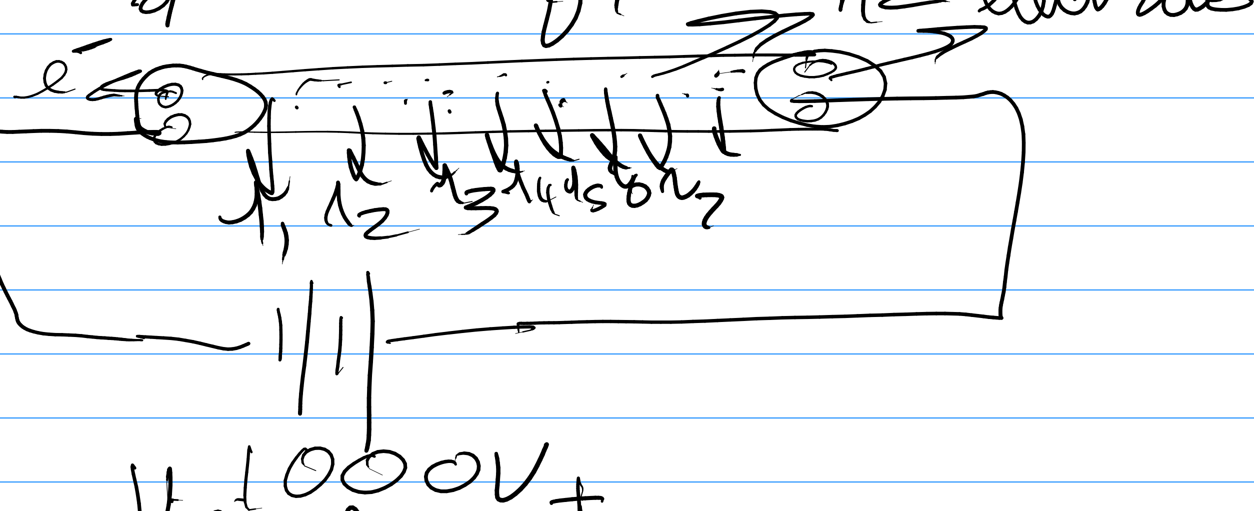


Figure 7.2 The energy level diagram for hydrogen according to Bohr's calculations.

$$E_1 - E_2 = \frac{hc}{\lambda}$$

emission spectrum of H



Visible spectrum

$-13.6\,eV$ emission spectrum

$$10.2\,eV \times 931.5\,MeV \times 1.6\times10^{-19} = \frac{hc}{\lambda}$$