

RELATIVITY

A SHORT DIVERSION

20TH CENTURY PHYSICS HAS TWO BIG THEMES:

- ① QUANTUM MECHANICS
- ② RELATIVITY

1905 = EINSTEIN

SPECIAL RELATIVITY

* NON-UNIVERSALITY OF TIME

DIFFERENT OBSERVERS MOVING WITH RESPECT
TO EACH OTHER DISAGREE ABOUT
HOW TIME ELAPSES.

* SPEED OF LIGHT, $c = 3 \times 10^8 \text{ m/s}$

AS AN UPPER SPEED LIMIT.

1915 = EINSTEIN

GENERAL RELATIVITY

A NEW THEORY OF GRAVITY

* A NEW FORM OF ENERGY
REST ENERGY

$$E^2 = m^2 c^4 + p^2 c^2$$

↑
ENERGY
(KINETIC
+
REST)
↑
REST
MASS
OF
A
PARTICLE
↑
MOMENTUM
OF
A
PARTICLE

- IF $p=0$ (PARTICLE AT REST)
THEN $E = mc^2$.

- IF $m=0$ (FOR EXAMPLE, A PHOTON HAS NO REST MASS)

$$E = pc$$

$$p = E/c$$

LIGHT (PHOTONS) ~~DOES~~ DOES CARRY ENERGY AND MOMENTUM.

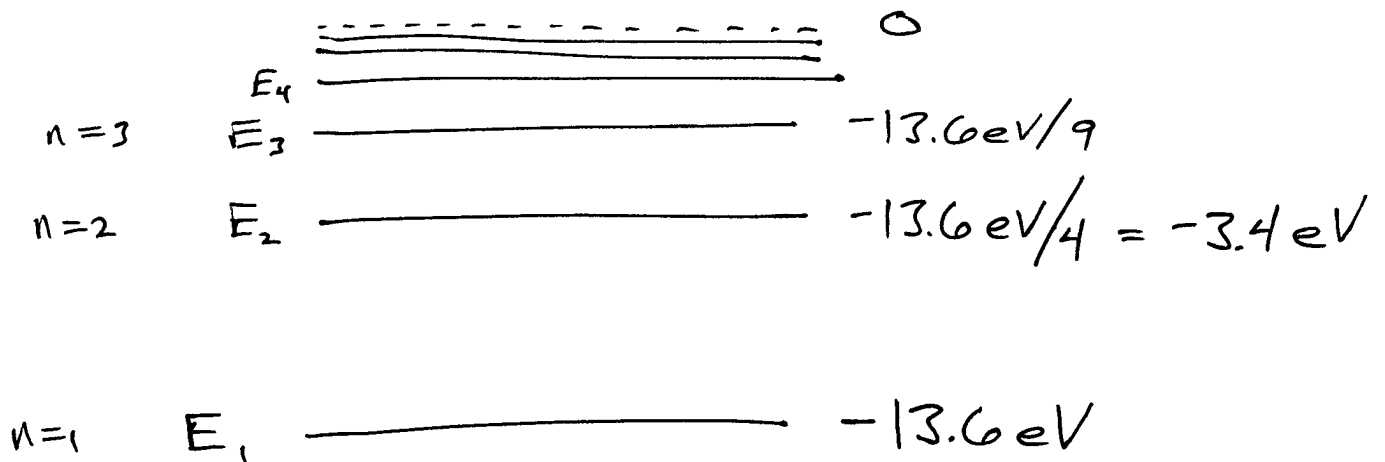
BOHR ATOM

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$$E_n = (-13.6 \text{ eV}) \frac{Z^2}{n^2}$$

$Z = \# \text{ PROTONS}$

HYDROGEN $Z=1$

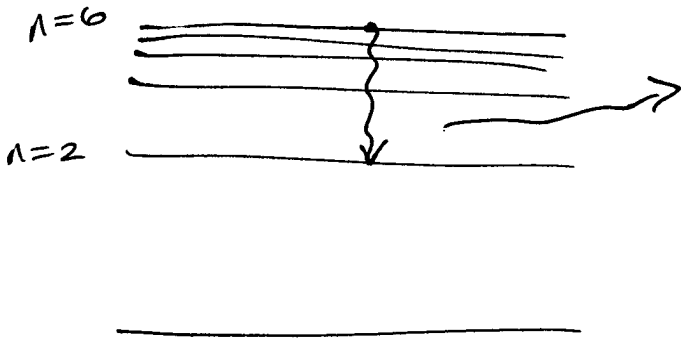


NEGATIVE ENERGIES \Rightarrow BOUND ELECTRON

POSITIVE ENERGY \Rightarrow FREE ELECTRON

Ex 27-13

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$$hf = E_6 - E_2$$

$$\frac{hc}{\lambda} = (-13.6 \text{ eV}) \frac{1}{6^2} - (-13.6 \text{ eV}) \frac{1}{2^2}$$

$$= -0.38 \text{ eV} - (-3.4 \text{ eV})$$

$$= 3.02 \text{ eV}$$

$$\lambda = \frac{hc}{3.02 \text{ eV}} = \frac{(6.63 \times 10^{-34} \text{ J}\cdot\text{s})(3 \times 10^8 \text{ m/s})}{(3.02 \text{ eV}) \left(\frac{1.602 \times 10^{-19} \text{ J}}{1 \text{ eV}} \right)}$$

$$= 4.11 \times 10^{-7} \text{ m}$$

$$= 411 \text{ nm}$$