= 62.190 M.

~~Spring-2015~~

Atom

Fall-20

1a

The emission of spectra takes place when electron passes from higher energy level to another of lower energy level giving definite spectral lines. Bohr was able to account satisfactory theory for the bright-lines in a number of different atomic spectral series in hydrogen.

The electron in the H atom exists normally in the ground state or lowest energy level. If the atom is excited, the electron will move to some higher energy level and again drop back to the lowest energy level in the stable position if not ionized. This happens either directly or through intermediate steps. When electron returns to lower level from higher, ~~it~~ excess energy will be liberated as radiation of some definite frequencies. This will give rise to emission spectra. ~~The~~

It can be only observed in hydrogen. Incase of other elements multiple lines in the atomic spectra has been observed.

Spring-2018

④ Heisenburg Uncertainty Principle:

It states that ~~we~~ it is impossible to determine accurately both the exact position and the exact energy of an electron simultaneously. The more accurately we measure the energy of a moving electron, the less accurately we determine it's position and vice versa.

## (*) Derivation of de-Broglie wave-particle relationship :

We know, from Planck's equation.

$$E = h\nu \quad \text{——— (I)}$$

where E is energy and, $\nu$ is frequency and h is the planck's constant.

From Einstein's equation, we get,

$$E = mc^2 \quad \text{——— (II)}$$

where E is nergy, m is mass of photon and c is the velocity of light.

Putting the (I) and (II) equation together we get,

$$h\nu = mc^2$$

$$\Rightarrow mc = \frac{h\nu}{c}$$

$$\Rightarrow mc = \frac{h}{\lambda} \quad \left[\because \text{wavelength}, \lambda = \frac{c}{\nu}\right]$$

$$\Rightarrow \lambda = \frac{h}{mc}$$

If electron moves with velocity v, then,

$$\lambda = \frac{h}{mv}$$

(Derived).

1/c we know.

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_1^2}\right)$$

$$\Rightarrow \frac{1}{\lambda} = (109676\ cm^{-1})\left(\frac{1}{1^2} - \frac{1}{5^2}\right)$$

$$\Rightarrow \frac{1}{\lambda} = (109676)\times\left(\frac{24}{25}\right)$$

$$\Rightarrow \lambda = 9.4976 \times 10^{-6} \times 10^{8} = 949.76\ Å.$$

1/d

<u>Quantum number</u>: The value that is used when describing the energy levels available to atoms and molecules. There are four quantum numbers:

1. Principal Quantum number $(n)$
2. Subsidary / Azimuthal " " $(l)$
3. Magnetic Quantum " $(m)$
4. Spin " " $(s)$.

<u>Following sets</u>:

i) $n=3$, $l=2$, $m=+1$, $s=-\frac{1}{2}$

is valid as $n=3$, $l=2$; $[n-1]$ $m=(2l+1)\rightarrow(+1)$ within the limit. $s=-$

(ii) $n=4$, $l=4$, $m=+1$, $s=+\frac{1}{2}$

not valid, $l=4$ no way. $l=n-1$, it should be 3.

iii) $n=3$, $l=2$, $m=+3$, $s=-\frac{1}{2}$ (NO)

$m=+3$ no way. it should be $+2, +1, 0, -1, -2$.

Spring- 2017

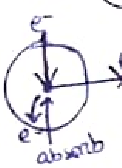
\[1/a\] Bohr's Model :

① ~~Postulate of Energy level~~:
In an atom, electrons revolves around the positively charged nucleus in a definit circular path called orbits or shells.

② ~~Postulate of~~ The angular momentum of an electron revolving around the neucleus in an orbit is integer multiple of $h/2\pi$.

It's $mvr = nh/2\pi$.

③ The electrons can move from lower to higher energy level by ~~emitting~~ absorbing energy and also move from higher to lower energy level ~~absorbing~~ emitting energy.




Bohrs model explains spectra of hydrogen atom -
(High to low $\longrightarrow$ radiation $\rightarrow$ emission of spectra).

\[1/b\] Radius of an orbit and Energy of electron derivation:

We know,

charge of neucleus $= Ze$, where $Z$ is atomic number.

The attraction force between electron and

neucleus $= \cancel{Zee}\ Z.e.\dfrac{e}{r^2} = \dfrac{Ze^2}{r^2}$

The attraction force is counter balanced by centifugal force $= \dfrac{mv^2}{r}$

So, $\frac{mv^2}{r} = \frac{Ze^2}{r^2}$

$\Rightarrow v^2 = \frac{Ze^2}{rm}$ ——— (I)

From Bohr's postulate,

$mvr = nh/2\pi$

$\Rightarrow v = \frac{nh}{2mr\pi}$

$\Rightarrow v^2 = \frac{n^2h^2}{4m^2r^2\pi^2}$ ——— (II)

From (I) and (II) we get,

$\frac{Ze^2}{mr} = \frac{n^2h^2}{4m^2r^2\pi^2}$

$\Rightarrow r = \frac{n^2h^2}{4m\pi^2Ze^2}$.

Again, we know total energy of an electron in any orbit, $E = KE + PE$

$= \frac{1}{2}mv^2 + \left(-\frac{Ze^2}{r}\right)$ ——— (IV)

We know, $mv^2/r = Ze^2/r^2$

$\Rightarrow mv^2 = \frac{Ze^2}{r}$ ——— (V)

Putting the value from (V) in (IV),

$E = \frac{Ze^2}{2r} - \frac{Ze^2}{r}$

$= \frac{-Ze^2}{2r}$ ——— (VI)

Putting the value of r in (vi),

$$E = \frac{Ze^2}{2} \cdot \frac{4\pi^2 m Ze^2}{n^2 h^2}$$

$$\boxed{E = -\frac{2\pi^2 m Z^2 e^4}{n^2 h^2}}$$ (Derived)

**1/c** Balmer series, $n_1 = 2$.

Given, $n_2 = 5$.

$R = 109676 \text{ cm}^{-1}$

Now, $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$\Rightarrow \frac{1}{\lambda} = (109676)\left(\frac{25-4}{100}\right)$

$\Rightarrow \lambda = \frac{100}{109676 \times 21} = 4.342 \times 10^{-5} \times 10^{8}$ Å

$= 4341.8$ Å

**1/d**

(i) $n=1$, $l=0$, $m_l=0$, $s=+1$ (No valid)

spin can not be whole number, either $-\frac{1}{2}$ or $+\frac{1}{2}$

(ii) $n=1$, $l=3$, $m=+3$ $s=+\frac{1}{2}$

l should be less than n

and m is $(2l+1)$

(iii) $n=3$, $l=2$, $m=+3$, $s=-\frac{1}{2}$

(iv) n is smaller than l.

Spring - 2019

(*) Dual character of a matter:

The ~~particles~~ atom of a matter have two ~~char~~ natures, that is behaving as wave and also as particles. That is known as dual character of a matter.

(*) Hund's rule: Every orbital in a subshell is singly occupied with one electron before any one orbital is doubly occupied and all electrons in singly occupied orbitals have the same spin.

Pauli's rule: No two electrons in an atom have the same four quantum numbers.