Sem 1 2002/2003 : Q1a : Quantum Theory

Sem I (2002/03) : Quantum Theory

1(a) The energy of an electron in an atom is quantized – it exists only in certain fixed quantities, rather than being continuous. So an atom can emit only certain quantities of energy. Each change in the atom's energy results from the gain or loss of one ore more "packets" definite amounts of energy. In this case the energy of the emitted (or absorbed) radiation is equal to the difference in the atom's energy states:

$$\Delta E_{atom} = E_{\substack{emitted/absorbed \\ radiation}} = \Delta n h\nu$$

Sem 1 2002/2003 : Q3a : Quantum Theory

Sem I (2002/03) QUATUM THEORY

Q3 :

(a) Given : $\frac{1}{\lambda} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ R_H = constant

$$E_n = -\frac{Z^2 e^4 m}{8\epsilon_0^2 n^2 h^2}$$

$$\Delta E = E_{n_2} - E_{n_1} = -\frac{Z^2 e^4 m}{8\epsilon_0^2 n_2^2 h^2} - \left(-\frac{Z^2 e^4 m}{8\epsilon_0^2 n_1^2 h^2}\right)$$

$n_2 > n_1$

$$= \frac{Z^2 e^4 m}{8\epsilon_0^2 h^2 n_1^2} - \frac{Z^2 e^4 m}{8\epsilon_0^2 h^2 n_2^2}$$

$$\frac{hc}{\lambda} = \Delta E = \frac{Z^2 e^4 m}{8\epsilon_0^2 h^2}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\therefore \frac{1}{\lambda} = \frac{Z^2 e^4 m}{8\epsilon_0^2 h^3 c}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

where $R_H = \frac{Z^2 e^4 m}{8\epsilon_0^2 h^3 c}$ (Proved)

(b) Balmer Siries : $\lambda = 379\,nm = 379\times10^{-9}\,m$

$\lambda = 430\,nm = 430\times10^{-9}\,m$

$$\frac{1}{\lambda} = R_H\left[\frac{1}{2^2} - \frac{1}{n_1^2}\right]$$

$$\left(\frac{1}{379\times10^{-9}\,m}\right) = (1.09678\times10^7\,m^{-1})\left(\frac{1}{4} - \frac{1}{n_1^2}\right)$$

$$0.2406 = 0.25 - \frac{1}{n_1^2}$$

$$n_1 = 10$$

$$\left(\frac{1}{430\times10^{-9}\,m}\right) = (1.09678\times10^7\,m^{-1})\left(\frac{1}{4} - \frac{1}{n_2^2}\right)$$

$$0.2121 = 0.25 - \frac{1}{n_2^2}$$

$$n_2 = 5$$

$\lambda = 379\,nm$ corresponds to $n = 10$ to $n = 2$

$\lambda = 430\,nm$ corresponds to $n = 5$ to $n = 2$

Both happens in the visible region

Sem 1 (2002/03) Quantum Theory

$Q_3(c)$

C

$1s^2 2s^2 2p^2$

$n=1 \quad l=0 \quad m_l=0 \quad s=+\frac{1}{2}$
$n=1 \quad l=0 \quad m_l=0 \quad s=-\frac{1}{2}$ } $1s^2$ ↑↓ 1s

$n=2 \quad l=0 \quad m_l=0 \quad s=+\frac{1}{2}$
$n=2 \quad l=0 \quad m_l=0 \quad s=-\frac{1}{2}$ } $2s^2$ ↑↓ 2s

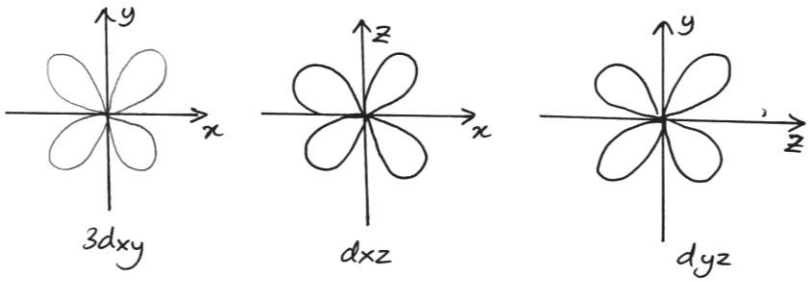
$n=2 \quad l=1 \quad m_l=0 \quad s=+\frac{1}{2}$
$n=2 \quad l=1 \quad m_l=+1 \quad s=+\frac{1}{2}$ } $2p^2$

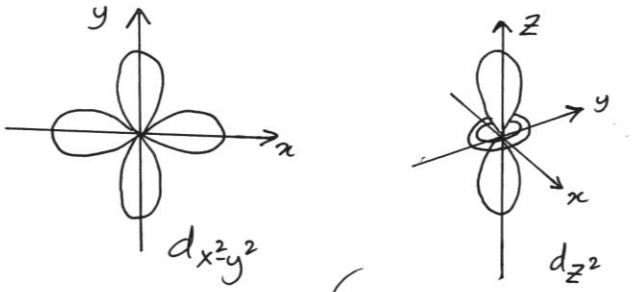
0	+1	-1
↑	↑	

2p

$Q_3(d)$ 3d

$3d_{xy}$ $3d_{xz}$ $3d_{yz}$ $3d_{x^2-y^2}$ $3d_{z^2}$





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