Welland Gouldsmith School Patuli

Chemistry Worksheet

Atomic Structure

Class – XI

Session - 2020-21

1.Fill in the blanks: -

a) quanta b) threshold frequency

c)quantized d)$1.09679 \times 10^{7} m^{-1}$

2.State true or false: -

a)False b)True c)False d)False

3.For a transition in hydrogen atom-

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

$n_1 = 1$, $n_2 = 4$

$R_H = 109677 cm^{-1}$

$\bar{v} = 102822.2 cm^{-1}$

frequency of spectral line = $c\bar{v}$

$= 3 \times 10^{10} \times 102822.2$

$= 3.08466 \times 10^{15} s^{-1}$

Wavelength of spectral line = $1/\bar{v}$

$= 9.72552 \times 10^{-6} cm$

4.The mass of an electron is 9.1×10^{-31} kg.

If its K.E is 4.25×10^{-25} J. Calculate its wavelength.

Ans- kinetic energy(K.E) = $\frac{1}{2} mv^2$,

Mass of electron = $9.1 \times 10^{-31} kg$

Thus, velocity of electron=$(2K.E/m)^{1/2}$

$= \underline{966.47 m/s}$

The wavelength (λ)=h/mv

$=(6.626X10^{-34})/(9.1X10^{-31}X966.47)$

$= 7.534X10^{-7}$ or $\underline{7534A^{0}}$

5)According to Heisenberg principle

$$\Delta x \, \Delta v \geq \frac{h}{4\pi m}$$

Uncertainty in velocity= $3X10^{4}$ X (0.001/100)

$= 0.30 cm\ s^{-1}$

Uncertainty in position = $(6.626X10^{27})/(4X3.14X9.1X10^{-28}X0.03)$

$= \underline{1.9 cm}$

Hence the uncertainty in position of an electron is 1.9cm.

6)Ionisation Energy of an hydrogen like atom =13.6eV x Z^2 (Z→atomic number)

Ionization Energy of He^{+}= 13.6ev x $(2)^2$

$= \underline{54.4\ eV}$

7)Quantities that have certain specific values are called quantized. Bohr suggested that the energy of the electron in hydrogen was quantized because it was in a specific orbit. Because the energies of the electron can have only certain values, the changes in energies can have only certain values. Bohr suggested that the energy of light emitted from electrified hydrogen gas was equal to the energy difference of the electron's energy states:

$E_{light} = hv = \Delta E_{electron}$

This means that only certain frequencies (and thus, certain wavelengths) of light are emitted.Thus,Quantized energy means that the electrons can possess only certain discrete energy values; values between those quantized values are not permitted.

Depending upon the quantized energy received by an hydrogen atom, its electron can get excited to any higher energy level.An excited electron is free to drop to any of the lower energy levels available to it.Thus, a large number of transitions each corresponding to a spectral line may take place.

8)The expression for the angular momentum
$mvr=2\pi nh$, or $2\pi r=mvnh$ ......(i)
The wavelength is given by the De Broglie's equation.
$\lambda=mvm$ .....(ii)
From (i) and (ii), we have
$2\pi r=n\lambda$
Hence, the circumference of the Bohr orbit for the hydrogen atom is an integral multiple of the de Broglie's wavelength associated with the electron revolving around the orbit.

9)According to Balmer formula

$$\bar{\upsilon} = \frac{1}{\lambda} = R_H[\frac{1}{n_1^2} - \frac{1}{n_2^2}]$$

For the Balmer series, $n_1 = 2$.
Thus, the expression of wavenumber($\tilde{\nu}$) is given by,

$$\bar{\nu} = \left[\frac{1}{(2)^2} - \frac{1}{n_f^2}\right](1.097\times10^7\ \mathrm{m}^{-1})$$

Wave number (ṽ) is inversely proportional to the wavelength of transition. Hence, for the longest wavelength transition, ṽ has to be the smallest.

For ṽ to be minimum, n_f should be minimum. For the Balmer series, a transition from n_i = 2 to n_f = 3 is allowed. Hence, taking n_f = 3,we get:

$$\bar{\nu} = (1.097 \times 10^7)\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

$$\bar{\nu} = (1.097 \times 10^7)\left[\frac{1}{4} - \frac{1}{9}\right]$$

$$= (1.097 \times 10^7)\left(\frac{9-4}{36}\right)$$

$$= (1.097 \times 10^7)\left(\frac{5}{36}\right)$$

ṽ= 1.5236×10^6 m^{-1}

10)Frequency of radio waves = $1X10^5$MHz

=$1X10^5X10^6$ Hz

=10^{11}Hz

Wavelength of radio waves (λ)= C/v

=$(3X10^8)/(10^{11})$

=$3X10^{-3}$ m