21. (a) $\bar{v} = \dfrac{1}{\lambda} = R_H Z = \left(\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right)$

In Balmer series $n_1 = 2$ & $n_2 = 3, 4, 5....$ Last line of the spectrum is called series limit.

Limiting line is the line of shortest wavelength and high energy when $n_2 = \infty$

$\therefore \ \bar{v} = \dfrac{1}{\lambda} = \dfrac{R_H}{n_1^2} = \dfrac{3.29 \times 10^{15}}{2^2} = \dfrac{3.29 \times 10^{15}}{4}$

$= 8.22 \times 10^{14}\,\text{s}^{-1}$

22. (d) Energy required to break one mole of Cl – Cl bonds in Cl_2

$= \dfrac{242 \times 10^3}{6.023 \times 10^{23}} = \dfrac{hc}{\lambda}$

$= \dfrac{6.626 \times 10^{-34} \times 3 \times 10^8}{\lambda}$

$\therefore \lambda = \dfrac{6.626 \times 10^{-34} \times 3 \times 10^8 \times 6.023 \times 10^{23}}{242 \times 10^8}$

$= 0.4947 \times 10^{-6}\,\text{m} = 494.7\,\text{nm}$

23. (b) $\lambda = \dfrac{h}{mv}$

$h = 6.6 \times 10^{-34}\,\text{J/s}$

$m = 1000\,\text{kg}$

$v = 36\,\text{km/hr} = \dfrac{36 \times 10^3}{60 \times 60}\,\text{m/sec} = 10\,\text{m/sec}$

$\therefore \ \lambda = \dfrac{6.6 \times 10^{-34}}{10^3 \times 10} = 6.6 \times 10^{-38}\,\text{m}$
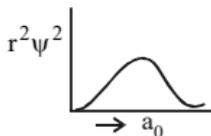
24. (c) $r_n = a_0 n^2$

$r = a_0 \times (3)^2 = 9a_0$

$mvr = \dfrac{nh}{2\pi}; \ \ mv = \dfrac{nh}{2\pi r} = \dfrac{3h}{2\pi \times 9a_0} = \dfrac{h}{6\pi\,a_0}$

$\lambda = \dfrac{h}{mv} = \dfrac{n}{h} \times 6\pi a_0 = 6\pi a_0$

25. (c) $l = 2$ represent d orbital for which

26. (b) de – Broglie wavelength is given by :

$\lambda = \dfrac{h}{mv}$ ... (i)

$\text{K.E.} = \dfrac{1}{2}mv^2$

$v^2 = \dfrac{2KE}{m}$

$v = \sqrt{\dfrac{2KE}{m}}$

Substituting this in equation (i)

$\lambda = \dfrac{h}{m}\sqrt{\dfrac{m}{2KE}}$

$\lambda = h\sqrt{\dfrac{1}{2m(K.E.)}}$ ...(i)

i.e. $\lambda \propto \dfrac{1}{\sqrt{KE}}$

$\therefore$ when KE become 4 times wavelength become 1/2.

27. (a) The electronic configuration of Rubidium (Rb = 37) is

$1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6\,5s^1$

Since last electron enters in $5s$ orbital

Hence $n = 5$, $l = 0$, $m = 0$, $s = \pm\dfrac{1}{2}$

28. (c) The kinetic energy of the ejected electron is given by the equation

$h v = h v_o + \dfrac{1}{2}mv^2 \quad \because \ v = \dfrac{c}{\lambda}$

or $\quad \dfrac{hc}{\lambda} = \dfrac{hc}{\lambda_o} + \dfrac{1}{2}mv^2$

$\dfrac{1}{2}mv^2 = \dfrac{hc}{\lambda} - \dfrac{hc}{\lambda_o}$

$= hc\left(\dfrac{\lambda_o - \lambda}{\lambda \lambda_o}\right)$

$\therefore \qquad v^2 = \dfrac{2hc}{m}\left(\dfrac{\lambda_o - \lambda}{\lambda \lambda_o}\right)$

or $\qquad v = \sqrt{\dfrac{2hc}{m}\left(\dfrac{\lambda_o - \lambda}{\lambda \lambda_o}\right)}$

29. (d) Total energy of a revolving electron is the sum of its kinetic and potential energy.

Total energy = K.E. + P.E.

$= \dfrac{e^2}{2r} + \left(-\dfrac{e^2}{r}\right)$

$= -\dfrac{e^2}{2r}$

30. (b) Energy of 1 mole of photons,

$E = N_0 \times h\,v$

$= \dfrac{N_0 \times h \times c}{\lambda}$

$= \dfrac{6.023 \times 10^{23} \times 6.63 \times 10^{-34} \times 3 \times 10^8}{253.7 \times 10^{-9}}$

$= 472.2\,\text{kJ}$

Energy converted into KE $= (472.2 - 430.53)\,\text{kJ}$

% of energy converted into KE $= \dfrac{(472.2 - 430.53)}{472.2}$

$= 8.76\,\%$