Atomic models and Planck's quantum theory

63. Answer: (c)

Explanation:

In Bohr's model for a circular orbit, for an electron:

- Kinetic energy K = + (1/2) m v^2
- Potential energy U = - k e^2 / r (negative)

From the balance of centripetal and Coulomb forces and using Virial-like relations for Coulomb force, one finds:

U = -2K and E_total = K + U = K - 2K = -K.

Therefore E_total = -K ⇒ K : E_total = K : (-K) = 1 : -1.

So the correct ratio is 1 : -1 (option c).

64. Answer: (c)

Explanation:

Energy of an electron in hydrogen (per atom) in Bohr model is: E_n = -13.6057 eV / n^2.

To convert to kJ mol^-1: 1 eV per atom = 96.485 kJ mol^-1. So:

E_n (kJ mol^-1) = -13.6057 × 96.485 / n^2 ≈ -1312.0 / n^2 kJ mol^-1.

Option (c) (-1313.3/n^2) is the closest given numeric choice and is the correct option.

65. (b) Bohr radius $= \frac{r_2}{r_1} = \frac{(2)^2}{(1)^2} = 4.$

66. (b) $v = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = 109678\left[\frac{1}{1} - \frac{1}{4}\right] = 82258.5$

$\lambda = 1.21567 \times 10^{-5} cm$ or $\lambda = 12.1567 \times 10^{-6} cm$

$= 12.1567 \times 10^{-8} m$

$v = \frac{c}{\lambda} = \frac{3\times10^8}{12.567\times10^{-8}} = 24.66 \times 10^{14} Hz.$

67. (c) We know that $\lambda = \frac{h}{mv}$; $\therefore\ m = \frac{h}{m\lambda}$

The velocity of photon (v) = $3 \times 10^8 m\,sec^{-1}$

$\lambda = 1.54 \times 10^{-8} cm = 1.54 \times 10^{-10} meter$

$\therefore m = \frac{6.626\times10^{-34} Js}{1.54\times10^{-10} m\times3\times10^{8} m\,sec^{-1}}$

$= 1.4285 \times 10^{-32} kg.$

68. (a) The spliting of spectral line by the magnetic field is called Zeeman effect.

69. (b) $r \propto n^2$ (excited state $n = 2$)

$r = 4a_0$

70. (d) $r_n \propto n^2 : A_n \propto n^4$

$\frac{A_2}{A_1} = \frac{n_2^4}{n_1^4} = \frac{2^4}{1^4} = \frac{16}{1} = 16:1$

71. (a) It will take $\frac{4\pi^2 mr^2}{nh}$

72. (d) $r_H = 0.529 \frac{n^2}{z} \text{Å}$

For hydrogen ; $n = 1$ and $z = 1$therefore

$r_H = 0.529\text{Å}$

For $Be^{3+}: Z = 4$ and $n = 2$ Therefore

$r_{Be^{3+}} = \frac{0.529\times2^2}{4} = 0.529\text{Å}.$

73. (a) $E_{\text{ionisation}} = E_\infty - E_n = \frac{13.6Z_{eff}^2}{n^2} eV$

$= \left[\frac{13.6Z^2}{n_2^2} - \frac{13.6Z^2}{n_1^2}\right]$

$E = h\nu = \frac{13.6\times1^2}{(1)^2} - \frac{13.6\times1^2}{(4)^2}; h\nu = 13.6 - 0.85$

$\because\ h = 6.625 \times 10^{-34}$

$\nu = \frac{13.6-0.85}{6.625\times10^{-34}} \times 1.6 \times 10^{-19} = 3.08 \times 10^{15} s^{-1}$.

74. (c) $\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\frac{1}{\lambda} = 1.097 \times 10^7 m^{-1}\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$

$\therefore\ \lambda = 91 \times 10^{-9} m$

We know $10^{-9} = 1nm$ So $\lambda = 91nm$

75. (d) $r \propto n^2$

For I[st] orbit $\gamma = 1$

For III[rd] orbit = $\gamma \propto 3^2 = 9$

So it will 9γ.

76. (b) Bohr suggest a formulae to calculate the radius and energy of each orbit and gave the following formulae

$r_n = \frac{n^2h^2}{4\pi^2kme^4Z}$

Where except n^2, all other unit are constant so $r_n \propto n^2$.

77. (a) Energy of an electron $E = \frac{-E_0}{n^2}$

For energy level $(n = 2)$

$E = -\frac{13.6}{(2)^2} = \frac{-13.6}{4} = -3.4eV$.

78. (a) Energy of ground stage (E_0) = $-13.6eV$ and energy level = 5

$E_5 = \frac{-13.6}{n^2} eV = \frac{-13.6}{5^2} = \frac{-13.6}{25} = -0.54eV$.

79. (c) Positive charge of an atom is present in nucleus.

80. Correct Answer: (a)
The emitted electrons have energy less than a maximum value of energy depending upon frequency of incident radiations.

81. (a) For $n_4 \rightarrow n_1$, greater transition, greater the energy difference, lesser will be the wavelength.