Atomic models and Planck's quantum theory

43. (d) $\left(\frac{q}{m}\right)_\alpha = \frac{1}{2}\left(\frac{q}{m}\right)_p = \frac{1}{2} \times 9.6 \times 10^7 = 4.8 \times 10^7 Ckg^{-1}$

44. (a) According to Hydrogen spectrum series.

45. (d) The electron can move only in these circular orbits where the angular momentum is a whole number multiple of $\frac{h}{2\pi}$ or it is quantised.

46. (b) Generally electron moving in orbits according to Bohr‘s principle.

47. (a) According to the planck’s law that energy of a photon is directly proportional to its frequency *i.e.* $E = hv$

48. (c) Balmer

Explanation:

The Lyman series lies in the ultraviolet (UV) region.

The Balmer series lies in the visible region (transitions ending at n=2n = 2n=2).

The Paschen, Brackett, and Pfund series lie in the infrared (IR) region.

Therefore, only the Balmer series corresponds to the visible range of the hydrogen spectrum.

49. (d) Bohr’s radius of the hydrogen atom

$r = \frac{n^2 \times 0.529\text{Å}}{z}$; where *z* = Atomic number,

n = Number of orbitals

50. (a) Fifth Bohr orbit to second one

Explanation:

The Balmer series corresponds to transitions where the final orbit is n=2n = 2n=2.

The first line (Hα) is n=3→n=2

The second line (Hβ) is n=4→n=2

The third line (Hγ) is n=5→n=2

Hence, the third line of the Balmer series is caused by the transition from the fifth orbit to the second orbit

51. (a) $E = -\frac{2.172\times10^{-18}}{n^2} = \frac{-2.172\times10^{-18}}{2^2}$

$= -5.42 \times 10^{-19} J.$

52. (c) $\Delta E = \frac{hc}{\lambda}$ or $\lambda = \frac{hc}{\Delta E}$

$= \frac{6.64\times10^{-34}\times3\times10^{8}}{3\times10^{-8}} = 6.64 \times 10^{-8}$Å

53. (d) $r_n = r_1 \times n^2$

$r_3 = 0.53 \times 3^2 = 0.53 \times 9 = 4.77$Å

54. (c) According to Rutherford an atom consists of nucleus which is small in size but carries the entire mass (P+ N).

55. (b) Wavelength of spectral line emitted is inversely proportional to energy $\lambda \propto \frac{1}{E}$.

56. (b) $E \propto \frac{1}{\lambda}$; $E_1 = \frac{1}{8000}$; $E_2 = \frac{1}{16000}$

$$\frac{E_1}{E_2} = \frac{16000}{8000} = 2 \quad \Rightarrow \quad E_1 = 2E_2$$

57. (a) Heisenberg’s uncertainty principle

Explanation:

In solids, the atoms are very closely packed, and the outermost electron wavefunctions overlap.

Due to this overlap and according to Heisenberg’s Uncertainty Principle (Δx·Δp≥h/4π\Delta x \cdot \Delta p \geq h/4\piΔx·Δp≥h/4π), the energy levels of electrons cannot remain sharply defined and instead spread out into energy bands.

This band formation explains the electrical and optical properties of solids (conductors, semiconductors, insulators).

Hence, the formation of energy bands in solids is a direct consequence of the Heisenberg Uncertainty Principle.

58. (a) $$\nu = \frac{c}{\lambda} = \frac{3\times10^{8} ms^{-1}}{600\times10^{-9} m} = 5.0 \times 10^{14} Hz.$$

59. (b) $$E = \frac{-13.6}{n^2} eV = \frac{-13.6}{2^2} = \frac{-13.6}{4} = -3.40 eV$$

60. Answer: (c)

Explanation:

Bohr's model assumes electrons move in precise circular orbits with definite values of position and momentum. The Heisenberg uncertainty principle states that position and momentum cannot both be known exactly at the same time ($\Delta x \cdot \Delta p \geq \hbar/2$). This directly contradicts Bohr's assumption of well-defined trajectories. Planck's quantum theory (quantization of energy) is a foundation for Bohr's quantized orbits, so it does not contradict Bohr. Pauli's exclusion principle is about identical fermions (electrons) not occupying the same quantum state — it does not contradict the basic Bohr model (it refines multi-electron structure).

61. Answer: (a)
Explanation:
Rutherford's nuclear model (1911) proposed a tiny, dense, positively charged nucleus containing most of the mass. At the time of Rutherford's model, neutrons were not yet discovered (neutron discovered by James Chadwick in 1932). Rutherford's model included the positive charge (later known to be due to protons) but did not include neutrons explicitly. Therefore statement (a) is not true for Rutherford's original model.

Notes on other options:
- (b) is true: nucleus is very small compared to the whole atom.
- (c) is not generally true for all atoms (number of protons and neutrons need not be equal), but the statement asks which is not true in Rutherford's model specifically; Rutherford's model did not assert equality of p and n. However among the choices, (a) is the historically incorrect assertion for Rutherford's model because neutrons were not part of his model.
- (d) is generally true for a neutral atom: electrons and protons numbers are equal (charge neutrality), so (d) is not the best choice for 'not true'.

62. Answer: (b)
Explanation:
Series in hydrogen emission are characterized by the lower energy level n1 to which electron falls:
- Lyman series: n1 = 1 (ultraviolet)
- Balmer series: n1 = 2 (visible)
- Paschen series: n1 = 3 (infrared)

So Paschen corresponds to transitions with final level n1 = 3 and initial level n2 = 4,5,6,... (option b).