Worksheet Questions

Q1. The energy eigenvalues E_n of a quantum system in the potential $V = cx^8$ (where $c > 0$ is a constant), for large values of the quantum number n, varies as

(a) $n^{4/3}$ (b) $n^{8/5}$ (c) $n^{5/4}$ (d) $n^{6/5}$

Q2. Ionisation potential for a hydrogen atom is $13.6\,eV$. The ground state energy for a positronium atom where an electron revolves round a positron, is:

(a) $-13.6\,eV$ (b) $13.6\,eV$ (c) $-6.8\,eV$ (d) $6.8\,eV$

Q3. The energy required to remove both electrons from the helium atom in its ground state is $79eV$. How much energy is required to ionize helium (i.e., to remove one electron)?

(a) $27eV$ (b) $39eV$ (c) $51.8eV$ (d) $54.8eV$

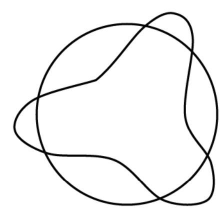
Q4. The de Broglie wavelength of an electron of energy $200MeV$ is

(a) $0.62\times10^{-8}\,m$ (b) $0.62\times10^{-10}\,m$ (c) $0.62\times10^{-12}\,m$ (d) $0.62\times10^{-14}\,m$

Q5. Consider a hypothetical system of two quark in a bound state is interactive via potential energy $V(r) = kr$, where k is constant and r is distance between the two quarks. As per Bohr model $L = n\hbar$, where L is angular momentum and n is an integer, the radius of the circular orbit representing by the system is proportional to

(a) n (b) n^2 (c) $n^{1/3}$ (d) $n^{2/3}$

Q6. How is de-Broglie wavelength (λ) of an electron in the nth Bohr orbit related to the radius R of the orbit?



(a) $n\lambda = \pi R$ (b) $n\lambda = \frac{3\pi R}{2}$

(c) $n\lambda = 2\pi R$ (d) $n\lambda = 4\pi R$

Q7. What is the speed v_n of the electron in the nth Bohr orbit of hydrogen atom, if v_1 is the speed of the electron in the first Bohr orbit?

(a) $v_1 n$ (b) $v_1 n^3$ (c) $\frac{v_1}{n}$ (d) $\frac{v_1}{n^3}$

Q8. If elements with principal quantum number $n > 4$ were not allowed in nature, the number of possible elements would be

(a) 60 (b) 32 (c) 4 (d) 64

Q9. Consider the spectral line resulting from the transition $n=2 \rightarrow n=1$ in the atoms and ions given below. The shortest wavelength is produced by

(a) Hydrogen atom (b) Deuterium atom

(c) Singly ionized helium (d) Doubly ionised lithium

Q10. A hydrogen atom and a Li^{++} ion are both in the second excited state. If l_H and l_{Li} are their respective electronic angular momenta, and E_H and E_{Li} their respective energies, then

(a) $l_H > l_{Li}$ and $|E_H| > |E_{Li}|$ (b) $l_H = l_{Li}$ and $|E_H| < |E_{Li}|$

(c) $l_H = l_{Li}$ and $|E_H| > |E_{Li}|$ (d) $l_H < l_{Li}$ and $|E_H| < |E_{Li}|$

Q11. Energy of $24.6eV$ is required to remove one of the electrons from a neutral helium atom. The energy in (eV) required to remove both the electrons from a neutral helium atom is

(a) 38.2 (b) 49.2 (c) 51.8 (d) 79.0

Q12. In Bohr's model of the hydrogen atom which of the following statements is Incorrect?

(a) The radius of the n^{th} orbit is proportional to n^2

(b) The total energy of the electron in n^{th} orbit is inversely proportional to n

(c) The angular momentum of electron in an n^{th} orbit is an integral multiple of $\frac{h}{2\pi}$

(d) The magnitude of potential energy of the electron in any orbit is greater than its kinetic energy

Q13. The electric potential between a proton and an electron is given by $V = V_0 \ln\left(\frac{r}{r_0}\right)$, where r_0 is a constant. Assuming Bohr's model to be applicable, the variation of r_n with n, n being the principal quantum number is:

(a) $r_n \propto n$ (b) $r_n \propto \frac{1}{n}$ (c) $r_n \propto n^2$ (d) $r_n \propto \frac{1}{n^2}$

Q14. Given that the ground state energy of the hydrogen atom is $-13.6eV$, the ground state energy of muonium (which is a bound state of an electron (e^-) and muon (μ^+) is

(a) $-6.8eV$ (b) $+6.8eV$ (c) $-13.6.eV$ (d) $13.6.eV$

Q15. A muon (μ^-) from cosmic rays is trapped by a proton to form a hydrogen-like atom. Given that a muon is approximately 207 times heavier than an electron, the shortest wavelength of the spectral line (in the analogue of the Lyman series) of such an atom will be

(a) $0.67 A^0$ (b) $6.67 A^0$ (c) $0.489 A^0$ (d) $4.89 A^0$

Q16. The wavelength of the first paschen line of hydrogen atom is $1870nm$. The wavelength of the corresponding line for a hydrogenic atom with $z = 6$ is

(a) $18.2nm$ (b) $51.94nm$ (c) $109.3nm$ (d) $156.5nm$

Q17. A muon $\left(\mu^{-}\right)$ is trapped by a proton to form a hydrogen like atom. Given that muon is approximately 207 times heavier than an electron, the longest wavelength of the spectral line (Balmer series) of such an atom will be

(a) $6.67nm$ (b) $3.52nm$ (c) $66.7nm$ (d) $35.2nm$

Q18. Given that the ground state energy of the hydrogen atom is $-13.6eV$, the ground state energy of muonic (which is a bound state of one proton and muon) is

(a) $-2.53\times10^{3}eV$ (b) $-25.3\times10^{3}eV$ (c) $-0.253\times10^{3}eV$ (d) $-253eV$

Q19. Muonium is an atom made of an electron and muon. Given the Bohr radius for the ground state of the Hydrogen atom to be $0.53A^{0}$, the Bohr radius for the ground state of muonium is____________ A^{0} (up to two decimal places).

Q20. In hydrogen atom spectrum, the ratio of the longest wavelength in the Balmer series (final state $n = 2$) to that in the paschen series (final state $n = 3$) is___________

Q21. Which of the following relation correctly represents the relation between kinetic energy T and potential energy U.

(a) $T = 2U$ (b) $T = -2U$ (c) $U = 2T$ (d) $U = -2T$

Q22. Which of the following relation correctly represents the relation between kinetic energy T and total energy E.

(a) $E = -T$ (b) $E = \frac{T}{2}$ (c) $E = -\frac{T}{2}$ (d) $T = -\frac{E}{2}$

Q23. Which of the following relation correctly represents the relation between potential energy U and total energy E.

(a) $E = \frac{U}{2}$ (b) $U = \frac{E}{2}$ (c) $E = -\frac{U}{2}$ (d) $U = -\frac{E}{2}$